DISPARITIES IN STROKE MORTALITIES: LONGITUDINAL STUDY OF UNDERSERVED POPULATIONS IN US

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Abstract - This study analyzed the mortality rates of cerebrovascular diseases across the United States from 1999 – 2017. Study variables included geographic location (rural / urban), gender and race. Disparities in the mortality rates due to stroke were analyzed using t-tests. Regression models were also utilized to assess the trends in disparities over the study time frame. Results indicated that African American males and those living in non-urban areas were at the highest risk for death due to acute cardiovascular events. Study findings reinforce the need to implement innovative approaches in treating acute cardiovascular events to reduce the mortality rates.

Keywords - Cardiovascular Diseases, Health Disparities, Minority Health, Stroke.

I. INTRODUCTION

Cardiovascular diseases include arrythmias, acute myocardial infarction (heart attack), cerebrovascular disease (stroke) and peripheral arterial diseases. Over the last few decades cardiovascular diseases have been the number one cause of death in the United States [1]. These diseases account for more deaths than AIDS, road traffic accidents, suicides, homicides and diabetes combined [2].

Risk factors for cardiovascular diseases include increase in age, unhealthy diet, physical inactivity, tobacco, alcohol abuse, stress and genetics [3]. Most cardiovascular risk factors are preventable by healthy lifestyles [4]. Social and economic conditions have also been attributable to higher incidence of cardiovascular diseases [5]. They include lower educational attainment, poverty, lack of stable housing, lack of access to health car and non-availability of adequate health care services [5,6]. Adult females have a protective factor for cardiovascular diseases due to estrogen and their mortality rates are much lower than men between 20 – 55 years [7]. After menopause the risk factors for cardiovascular diseases increases significantly among women.

II. METHODOLOGY

The aim of this study was to assess the disparities in cardiovascular mortalities in the United States. Data from the Office of Vital Statistics from years 1999 – 2017 were used for the study. Specific ICD codes related to acute myocardial infarction and cerebrovascular diseases were separately analyzed. Population for each year was based on the census data. Crude rates (per 100,000 population) and age-adjusted rates (per 100,000 population) were calculated. Variables for the study included gender (male, female), race (American Indian, Asian, African American and Caucasian), geographic location (large central metro, large fringe metro, medium metro, small metro, micropolitan and noncore). Statistical analysis included t-tests to detect significant differences between study variables. Linear regression models were performed to analyze significant differences in trends. Differences in slopes between study variables over the study time frame indicated increasing or decreasing disparities based on demographic variables.

III. RESULTS

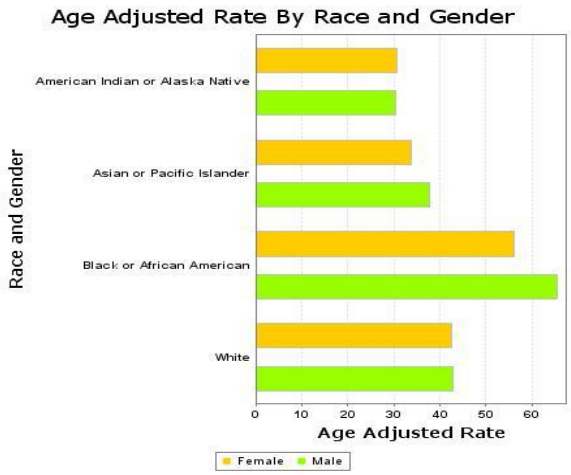


Fig 1: Age adjusted rates for stroke mortality by gender and race

A total of 146,383 deaths were attributable to cerebrovascular disease between 1999 – 2017 with a crude rate of 44.0 and age-adjusted rate of 37.6. The age-adjusted rate for stroke among African American

males was 62.6 compared with 38.7 for Caucasian males. Likewise, the age-adjusted rate for stroke among African American females was 50.0 compared with 39.0 for Caucasian males. These differences were statistically significant each year as well as for the 18-year duration ($p<0.05$). Linear regression models over the study duration indicated diverging slopes – meaning the disparities have been slightly increasing over a period of time.

With regard to the urbanization, a consistent pattern was observed with Large central metro areas having the lowest mortality rates followed by large fringe metro, medium metro, small metro, micropolitan and non-core. Within each urbanization code African Americans had significantly higher mortality rates compared to Caucasians. African Americans in the rural areas had age-adjusted rates consistently over 55 per 100,000 population over the study duration.

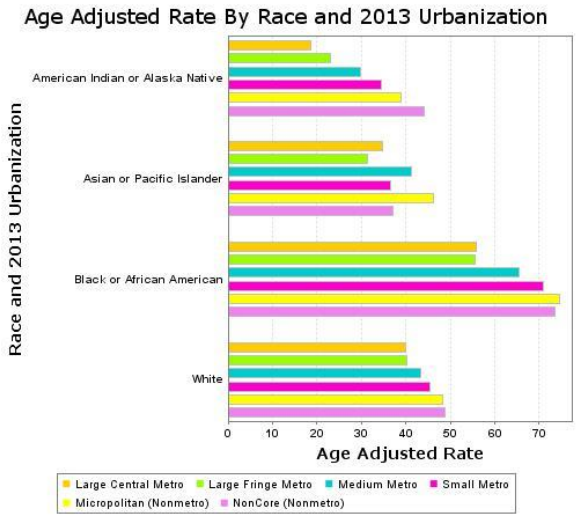


Fig 2: Age adjusted rate for stroke mortality by race and geographic distribution based on 2013 urbanization codes

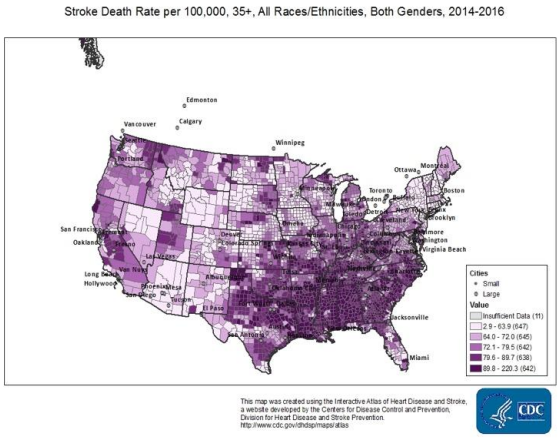


Fig 3: Geographic distribution of stroke mortality in US

Regression analysis for the overall model for stroke mortality over the study duration indicated significant differences among both urbanization codes and race. The model had an R-square of 0.5 with $p < 0.01$. Generalized linear models and analysis of variance reinforced the consistent disparities in stroke mortality over the study duration ($t = 17.48$, $F = 305$, $p < 0.01$). All models to test significant findings utilized age-adjusted rates for analysis.

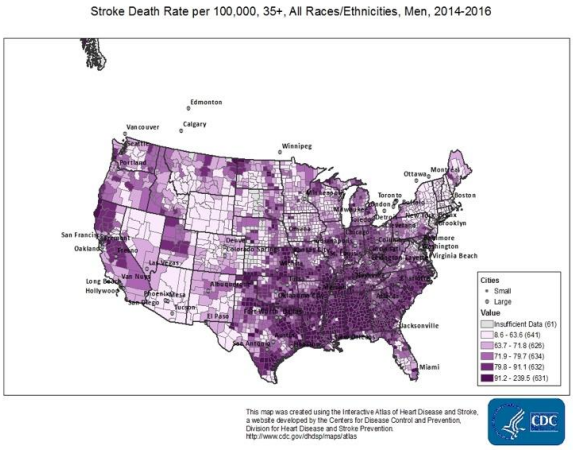


Fig 4: Stroke mortality for men across US 2014-16

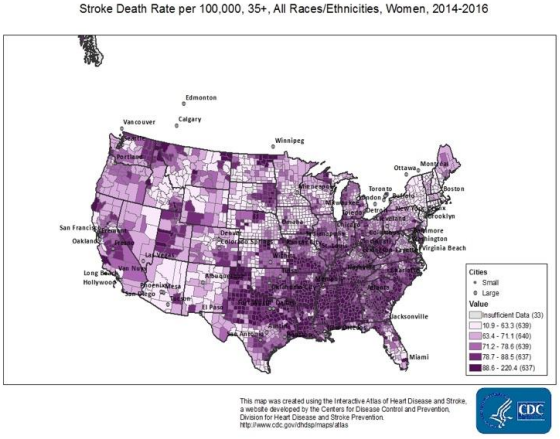


Fig 5: Stroke mortality for women across US 2014-16

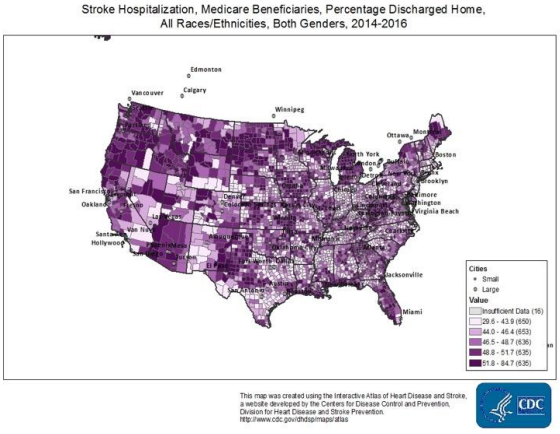


Fig 6: Percentage of stroke hospitalizations discharged home across US Medicare beneficiaries 2014-16

County level mortality data for stroke were also analyzed for the years 2014-16 to assess the recent trends in mortality and ongoing health disparities. Data from Medicare recipients were used to summarize hospital discharge results. Data from vital statistics were used to summarize results for the mortality reports [8]. These results are summarized in Figures 3 to 6. These findings re-emphasize the health disparities in stroke mortality in recent years.

Most significant finding form the county level data was the outcome of stroke based on race and geographic distribution. African Americans had the highest rate of mortality upon stroke diagnosis. Those living in the Mississippi delta area in the Southeast part of United States had the lowest survival rates for stroke. Those living in the Pacific northwest and western part of the United States had significantly higher survival rates and were more likely to be discharged home after an incident of stroke. Figures 3 and 6 appear more like mirror-images as they represent two major outcomes of stroke: mortality and being discharged home.

DISCUSSION

To summarize, the study findings represents continued disparities in stroke mortality over the last two decades. Stroke mortality disproportionately affects African Americans and also those living in rural areas. Other studies have found consistent results using cross-sectional data. However, this study used longitudinal data over 18 years timeframe to reinforce the findings. Asian / Pacific Islanders had the lowest rates of mortality due to stroke followed by American Indians, Caucasians and African Americans.

It should be noted that the hospitalizations for stroke result in greater number of deaths among African Americans. Future studies should focus on treatment modalities for acute cardiovascular events particularly among African American population. The study findings also call for greater need for acute stroke management in rural primary health care centers using innovative technologies. Most deaths due to acute cerebrovascular diseases can be prevented if proper treatment including thombolytics are given within the first 45 minutes of the incident. Educating rural communities and minority populations about recognizing signs and symptoms of stroke, educating the emergency technicians about identification and acute management of stroke is very critical in preventing mortalities.

Cardiovascular diseases have long been the leading cause of mortality in the United States. Majority of the deaths due to acute myocardial infarction and stroke can be prevented by early recognition and treatment. Telemedicine, particularly telestroke has been highly successful in reducing the stroke mortality particularly in rural areas. In recent years, a variety of handheld devices are capable of providing high-quality radio-imaging at home (point-of-care assessments). Further, these devices can be connected or integrated with smartphone operating systems to aid in rapid communication. By utilizing artificial intelligence, these point-of care ultrasound (POCUS) devices along with m-health technologies can immensely augment the telestroke / traditional telemedicine approaches to significantly lower the mortality rates in cardiovascular diseases. Artificial intelligence serves to connect the dots with patient, physician and the diagnostic aids. Effective implementation of proven effective technologies will significantly benefit rural and underserved populations.

Cultural characteristics among race, ethnicity and geographic regions play a significant role in the stroke outcomes. As noted in the study findings, African Americans living in the Mississippi delta area had the highest rates of stroke. They also had the lowest survival rates than any other races across all the geographic areas. The cardiovascular outcomes of African Americans living in the Atlantic northeast was much lower than those living in the Southeast part of US. Cultural characteristics such as social norms related to body image, food preparation, educational status, access for physical activity and access to health care play a very important role in cardiovascular outcomes.

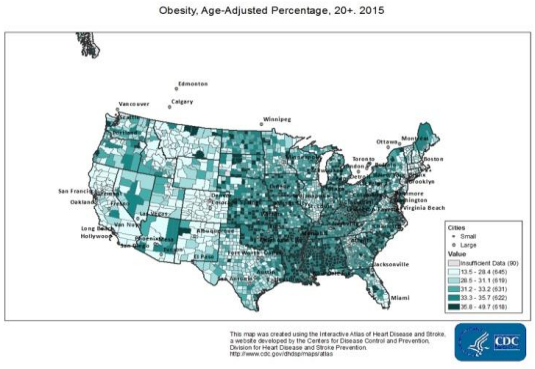


Fig 7: Distribution of obesity across the United States

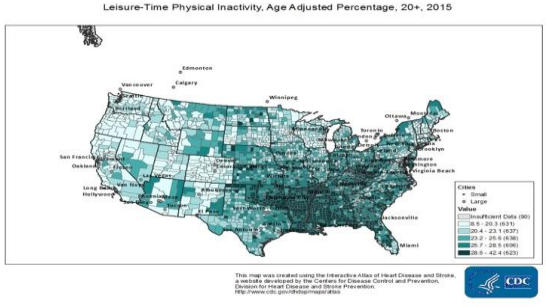


Fig 8: Physical inactivity among adults in the United States

Figures 7 and 8 indicates greatest risk factors for cardiovascular diseases: obesity and physical inactivity. The county-level distribution of obesity and physical inactivity almost resembles the mortality data for stroke across the United States. This study also looked into other variables including poverty rates, stable housing, educational attainment and Hispanic origins. However, there were no significant correlations with stroke mortality with those social and demographic variables. Obesity and physical inactivity had the highest correlations among all the risk factors for stroke mortality.

This study also looked into the availability of primary, secondary and tertiary stroke care centers across the United States. In the last decade or so, emphasis was laid on creating more health care centers which were stroke-ready. The anticipated outcome of these programs were to reduce the stroke mortality among areas that traditionally have had very high rates of stroke. However, mapping of stroke mortality and proximity to stroke centers did not indicate any significant correlation in this study. Large areas in the western part of the country and Pacific northwest have very low density of certified stroke care centers and yet, their survival rates for stroke is very high.

Future studies should evaluate the efficacy of primary health care centers in rural and underserved areas in managing acute stroke by utilizing innovative approaches as outlined above.

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