

Engineering a Resilient Regional Healthcare System: Improving Stroke Care in
Shelby County, TN
(Technical Paper)

Childhood Obesity: Teaching Children Healthy Habits
(STS Paper)

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On my honor as a University student, I have neither given nor received unauthorized aid on this
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Introduction

Cardiovascular disease is an overarching category of disease that includes stroke, hypertension, heart failure, and other conditions. These diseases can be influenced by genetic factors but are usually caused by environmental triggers such as diet, lifestyle, and exercise (AHA, 2017). Cardiovascular disease is the leading cause of death in the United States, resulting in one in every four deaths. As this is a unanimous statistic across all racial and ethnic groups, cardiovascular disease is a problem all Americans face (CDC, 2021).

Engineering a Resilient Regional Healthcare System

How can the regional healthcare system of Shelby County, Tennessee, be improved to better respond to stroke patients?

This question will be answered as part of a biomedical engineering capstone project with Nathan Edwards, an advisor from The MITRE Corporation, and teammates: John Quezada and Megan Everett. Current healthcare delivery models are focused on fixed facilities, which limits flexibility in high strain scenarios. Therefore, when under a strain, like a pandemic, these healthcare delivery models experience bottlenecks and are unable to deliver proper healthcare to all portions of a population.

Strokes are the leading cause of death in the United States, causing on average 140,000 deaths per year. Stroke survival and recovery is highly affected by inadequate healthcare delivery. It has been shown that patients have less disability three months after a stroke if they arrive at an emergency room within three hours of symptom onset (CDC, 2021). Difficulties surrounding patient access to rapid care, post-emergency care, and early detection resources, as well as a lack of information surrounding preventative measures, continue to persist due to the suboptimal design of current healthcare systems. If healthcare resources could be reconfigured

into a model that was optimized for stroke care, patient outcomes could be greatly improved, even when a healthcare system is under strain.

The goal of this capstone project is to establish a model with defined multivariate objective functions that can examine healthcare delivery resource mechanisms in Shelby County and their associated degree of resiliency in high strain conditions. In its current state, Shelby County experiences one of the highest stroke death rates (50.5 per 100,000 people) in the state of Tennessee. This is significantly higher than the national average of 37.3 per 100,000 people (CDC, 2017-2019). To combat high stroke death rates Shelby County officials have employed several measures, like creating a mobile stroke unit or introducing telemedicine options (Bolton, 2019). However, Shelby County's main priority remains Covid-19, as their ICU bed occupancy for many of their hospitals is above 70 percent (HHS, 2021). A lack of resiliency to respond to stressful situations, such as the Covid-19 pandemic, means the quality of other areas of care, like strokes, suffers too. By analyzing the current situation in Shelby County, a reallocation of resources and potential solutions may be proposed to ensure care is not directed away from strokes.

The model created will be based on the current healthcare system of Shelby County, Tennessee. This region was chosen for its size, availability of resources, and high stroke prevalence. We will address this goal by researching the barriers associated with stroke prevention and treatment, while focusing on Shelby County data and healthcare resources. We will then use operational research methods to analyze our findings and incorporate the analysis into a more optimal delivery and resilience model using a data science approach. The final deliverable for this project will be a peer-reviewed joint publication on our methods and recommendations.

Childhood Obesity: Teaching Children Healthy Habits

How are schools in the rural United States working to prevent childhood obesity?

In the United States, childhood obesity disproportionately affects youth in disadvantaged communities, including low-income rural areas. Rural children are 26 percent more likely to be obese than urban children (Robinson et al., 2019). Childhood obesity increases the risk of type 2 diabetes and can increase risk of cardiovascular disease and some types of cancers later in life (AHA, 2017).

Researchers have investigated many aspects of the current approach to wellness in schools. For example, Caspi et al. (2015) found that even within the same state, rural schools' environments were less healthful for students than those of city schools. Rural children were more likely to see advertisements for junk food at school, and less likely to be subject to enforced policies promoting healthy diets. However, further research is needed to evaluate the effects of such factors on obesity rates. Brazendale et al. (2021) found that rural schoolchildren's behavior was healthier on days when they attended school than on weekends, indicating that school can promote children's health. They found that when children did not attend school, their obesogenic behavior increased, even if they attended an activity like a day camp or sports practice. Brazendale et al. therefore recommend structured time away from school to promote healthy diet and activity. Hoffman et al. (2018) found that many rural school systems lack the food and labor resources they need for effective nutrition promotion. Administrators of rural school districts reported difficulties hiring staff with nutritional qualifications and finding funding to cover increased costs of nutritional programs. Hoffman recommends following

strategies employed by urban schools, such as using flexible meal schedules and improving dining areas to increase student participation.

Thus, efforts to reinforce current techniques may be the most effective policy. When Brazendale et al. (2021) examined obesogenic behaviors of children in and out of school, they solely recommended greater physical activity. The researchers studied only rural children and did not compare diets on school and non-school days. Many rural schools cannot simply implement city schools' methods.

Participants include low-income parents in rural areas who rely on free or reduced lunch programs during the school year and government funded programs for summer meals. The U.S. Department of Agriculture generally fund these nutrition programs (RWJF, 2021). Residents of rural areas have formed coalitions, such as Healthier Together Georgia, to improve local nutrition (UGA, 2019). To manage limited resources, rural school administrators must often forego nutrition standards (Reiley, 2021). To offer children direct guidance in nutrition, teachers need training, but many rural schools have insufficient resources for such training (Barrington, 2021).

Conclusion

Together, from a technical and social standpoint, these projects attempt to address different aspects of cardiovascular disease in the United States. By creating a model focused on a specific regional health care system, Shelby County specific solutions can be made to combat the extreme stroke prevalence here. This model also presents a novel approach to modelling a healthcare system by utilizing Geographic Information Software to create a spatial representation of Shelby County by zip code. The social report attempts to address cardiovascular disease more

broadly by focusing on combatting childhood obesity in rural schools. Obesity is a leading factor to cardiovascular issues later in life. By reviewing current issues relating to nutrition in rural schools, this paper attempts to suggest methods to better support rural schools in creating strong nutritional programs as a way to combat childhood obesity.

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