Defining Septicemia Incidence and Mortality in South Carolina Through Access to Health Care, Behavioral Health, and Low Socio-Economic Status

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DEFINING SEPTICEMIA INCIDENCE AND MORTALITY IN SOUTH CAROLINA
THROUGH ACCESS TO HEALTH CARE, BEHAVIORAL HEALTH, AND LOW
SOCIO-ECONOMIC STATUS

By

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Thesis Summary

This study aims to provide an in-depth view of septicemia mortality and incidence in the state of South Carolina through the lenses of socio-economic factors, access to healthcare, and behavioral health factors. This study was conducted using data from the South Carolina Revenue and Fiscal Affairs Office, utilizing their Hospitalization, Inpatient, Emergency Department, and Outpatient data both separately and combined depending on the data point, along with additional data sources for support (see works cited). We hypothesize that the higher rates of septicemia mortality and incidence in the southeastern United States, as well as in South Carolina in particular, could be associated with rurality, low socio-economic status, and risky behavioral health choices. Bivariate analyses were conducted with SAS 9.4. We found higher rates of septicemia mortality among residents in rural areas, minority residents, and areas with high economic inequality.

Introduction

Septicemia, more commonly referred to as sepsis, is one of the many various infections often found within a hospital, primary care office, or other health care facility. It is characterized by an individual’s body attempting to combat any variety of infection that may be occurring, particularly after an invasive procedure, and taking advantage of individuals in an immunocompromised state (Botero, J., & Pérez, M., 2012). Occasionally, the infection grows too great, and the bloodstream becomes overwhelmed with immune chemicals, resulting in copious inflammation throughout the body, and in the worst cases, clots in the blood as well as organ damage and/or failure. If sepsis is left undetected or untreated it may easily lead to a quick death. Historical accounts of sepsis have been found dating back to the ancient Greeks and have continued to appear throughout history.
Sepsis was officially discovered, and later coined, “septicemia” in 1886 during the rise of germ theory and sanitation practices. Sepsis has been a prevalent problem since before humanity knew how to classify it, yet it remains a difficult threat to us today (Botero, J., & Pérez, M., 2012). Thankfully, sanitation efforts specifically surrounding health care facilities and surgical procedures have gained great strides since the original discovery of sepsis, and we now view the infection as only one of many of the various and as sundry ailments that can plague anyone during a surgical, immunocompromised, or otherwise unsuspecting period, as opposed to being center stage.

Despite the more recent advancement in sanitation and awareness of sepsis, sepsis mortality rates have not budged in recent years. While the incidence and risk of developing sepsis are lower than ever, when compared to risk and incidence rates of many other infectious diseases, sepsis remains as one of the most predominant infections we know of. By most medical and technological advancement standards, sepsis is a major problem in the United States. Deaths due to sepsis, as well as the aftereffects due to sepsis can be debilitating to individuals and their loved ones. Over time a trend has emerged which shows that certain areas of the United States have much higher rates of prevalence and mortality than other areas. These areas tend to be located in the South-Eastern region of the US, beginning in Maryland and trickling down the curve to Texas. This is known as the “Sepsis Mortality Belt” (Ogundipe, F., et al., 2019).

Here in South Carolina, Septicemia has held a spot among the top 10 causes of death in the state for many years. To define why an outbreak is occurring continually, researchers often look at many factors related to geography, the population at risk, and the care available to them. This is a problem that needs to be further examined because it threatens the life of each and every individual who becomes hospitalized or visits any kind of health care facility. This means
that sepsis is a widespread problem which has the possibility of affecting every single American, especially those in the sepsis mortality belt. This thesis strives to define sepsis incidence and mortality in South Carolina by focusing on access to health care, behavioral health, and low socio-economic status.

**Methodology**

Race, socioeconomic status, geography, and many other factors affect each person’s health every day. The aforementioned factors are those which have the potential to affect risk of developing sepsis the greatest (Goldstein, E., et al., 2019). These are the factors which will be the key to this thesis. This study utilizes basic exploratory and deductive research with the goal of expanding knowledge on septicemia incidence and mortality in South Carolina, specifically in regard to the theories presented. The methodology by which this thesis will be completed include a research-based approach, where data will be collected from a government database, and a review of professional secondary and primary literature will be performed to obtain any necessary qualitative data. These methods were chosen due to the need for greater exploration and contextual understanding of the previously documented disparity of the infection in question, as well as due to the nature of this thesis, drawing conclusions based upon a theory and proving it based on both qualitative and quantitative analysis. In order to collect data regarding diseases of this nature, in-depth data must be extracted from a government-based database. Though the cooperation of the South Carolina Department of Health and Environmental Control (DHEC) the researcher will obtain, analyze, and discern the significance of the primary and secondary hospitalization and emergency department visit data provided.

This data has been collected and cleaned by the South Carolina Revenue and Fiscal Affairs Office (SCRFA). This data is collected on a very wide scale and is collected across every
county and city within South Carolina. The office utilizes data from any and all healthcare providers who share their data. This data is representative of the full scale of individuals who reside within the state with no restrictions based on age, gender, race, ethnicity, geographic location, or any other demographic considerations. The data used in this study had been checked multiple times and cross referenced with multiple state agencies and boards before being accessed. Our final sample size was 66,251 persons in 2017, which was the denominator used in determining prevalence and proportions.

Access to this data will allow the researcher to gain the greatest understanding of sepsis and its related issues within the target geographic and demographic region. The researcher will also use secondary sources and literature to assist in the exploration of the key variables being observed, as well as in writing and preparing the thesis, and determining the significance of the results. This will enable accurate comparison of the research to formerly published studies and will allow a greater understanding of the topic and prevent bias. For the more technical methods, necessary paperwork will be obtained, as well as permissions to access and work with hospitalization data, to get the access to all the data necessary. The data will be analyzed using bivariate analysis with SAS 9.4 and further evaluated with secondary data sources to draw conclusions on the problem.

In South Carolina, there are 46 counties, each of which is classified as either rural or urban. The Economic Research Service component of the Department of Agriculture releases data each year on the rurality of each state and its counties into categories of rurality based on Census data. Rurality is often used as a measurement for healthcare policy, as well as evaluating health data and programs. This study will use the definition based on the U.S. Office of Management and Budget Metropolitan Statistical Area Designation in determining which
counties are rural or urban. This definition states rurality as all counties outside metropolitan areas in 2003 based on the 2000 census data. According to this definition, 25 counties in South Carolina are considered rural, and 21 are considered urban (see map 1).

Additional knowledge will also be presented from prior educational and work purposes to build the case for the significance of sepsis in South Carolina. The methods being used are standard secondary research practices, and the usage of literature to aid in the further explanation and exploration of the quantitative is necessary to understand the gravity of the problem being examined.

Occasionally, problems within research projects can be encountered. Some issues that may have occurred during this study are problems with the analyzation of the data, in the form of improper coding or codes used, in the form of bias or error in the original data gathering on behalf of the SCRFA, in the form of bias when interpreting the numerical results of the data analyzation, and in the form of bias when comparing the data found in this study to data found in other studies or explanations found in literature. Though every potential bias-eliminating step and procedure was used throughout the process of curating this study, it is always possible that errors were encountered in many steps in the process.

**Expected Results and Significance**

Sepsis has largely been known in South Carolina as a widespread and viscous illness, and while many doctor’s offices and hospitals having begun to hang warning signs and symptoms charts as well as show short videos about the dangers of the illness, this does not stop sepsis from attacking any and all who show weakness in their immune system. It is anticipated that the results of this study will be very conclusive towards the stated hypothesis. It is anticipated that the cause of discrepancies on sepsis mortality and incidence rates will be closely tied to race and
ethnicity. Race is the most prevalent and easily studied person-variable, and it is intrinsically tied to the other factors of the hypothesis, socioeconomic status and behavioral health. This study hypothesizes that there will be substantial differences between Whites residing in, for example, Greenville county, and African Americans residing in McCormick county. It is anticipated that this study will be instrumental in tying together aspects of racial and wealth disparity, as well as the dramatic yet often overlooked differences between the rural and urban geographies. It is also anticipated that factors involved with behavioral health will have implications as well. Additionally, socio-economic factors and access to healthcare are also hypothesized to create large discrepancies within this health problem.

**Study Results**

**Access to Care**

In 1983, the President's Commission for the Study of Ethical Problems in Medicine and Biomedicine and Behavioral Science Research determined the definition of “access” to healthcare as being, “…the timely use of personal health services to achieve the best possible health outcomes” (Institute of Medicine, 1993). In order to measure access, there are indicators such as healthcare utilization and improving health outcomes that must be examined, as well as barriers to those benchmarks. Barriers to access include structure barriers such as geographic location, financial barriers such as lack of health insurance, and personal and cultural barriers such as age or belonging to a religion which restricts certain medical procedures. All of these barriers must be taken into account when dealing with a health problem such as septicemia.

In 2017, the US Census determined South Carolina’s population to be 5,024,369. This study utilized data from SCRFA which gave us a sample size of 66,251 sepsis cases. These values were used in determining prevalence and proportions throughout this study. The results of
this study found the rate of septicemia hospitalizations to be 67.2 per 100,000 population in rural areas compared to 57.7 in urban areas from data from the SCRFA. Emergency department visits for septicemia occurred at a rate of 50.4 per 100,000 in rural areas versus 16.1 in urban areas (see map 2). These rates indicate that geography could play a part in septicemia incidence, and possibly mortality, due to the rates of septicemia hospitalizations and emergency department visits being greater in rural areas. Specifically, it could be possible that individuals living further away from others, as well as from healthcare facilities, may not seek medical care until the infection has become a large issue, whereas individuals living closer to healthcare may seek medical care before the infection spreads.

In South Carolina, only 83.9% of residents age 21-64 were insured in 2017 according to the US Census Bureau Small Area Health Insurance Estimates (SAHIE). This percentage is low compared to the national average of 89.3%. Individuals living in rural counties were insured at an average of 82.9%. Individuals living in urban counties were insured at an average of 84.1%. This serves to add to the conclusion that rurality must be taken into account when examining access to healthcare (see map 3). Additionally, racial implications for access to care may be observed when examining health insurance status in the state. In South Carolina in 2017, 87.0% of non-Hispanic Whites were insured, compared to only 81.9% of non-Hispanic Blacks. This difference in percentage could be due to the larger population of non-Hispanic Whites in the state, however, a drastic difference is seen when comparing the rates for each racial group, where non-Hispanic Whites were insured at a rate of 3263.1 per 100,000 population compared to only 1300.7 for non-Hispanic Blacks. The differences in rural and urban counties’ health insurance status, as well as the present racial disparities, could be a possible reasons for higher rates of septicemia in rural communities.
Another factor to consider concerning access to care and how it is able to impact the incidence and mortality of septicemia, is the percentage of households that have no access to a healthcare provider. Many individuals in rural areas are located quite a distance away from their nearest healthcare provider, and possibly even further from the closest hospital. Many in these areas struggle due to a lack of a vehicle to take them to a healthcare appointment. This affects individuals living in both rural and urban areas. Public transportation is also an issue, as there are few options for cheap and safe public transportation available, and advantageous bus or tram routes are typically are only located within the larger metropolitan areas throughout the state such as in Greenville, Spartanburg, and Charleston counties.

In South Carolina, 12,2220 households do not own a car according to the Census Bureau American Community Survey. Although public transportation may be available in the form of rideshare or medical service vehicles, these options can be costly; additionally, it can be risky to wait for a ride, as minutes could be the difference between life and death in some extreme circumstances. Some healthcare facilities offer a transportation service; however, it can be inconvenient to schedule a ride or too advanced for others with little education or language barriers for example, and many individuals opt to take an ambulance. This is another issue entirely, due to the high cost of EMS services, along with the low wages of those living in rural (or even urban) areas.

Rurality is often associated with a lack of facilities available to the public which extends to healthcare as well. The South Carolina Office for Healthcare Workforce compiles a *South Carolina Health Professions Data Book* every few years which contains data on the scarcity of healthcare resources in each county. In the 2019 issue centered on data from the year 2017, South Carolina had a rate of 25.4 physicians, 10.1 primary care physicians, 5.1 nurse
practitioners, and 2.5 physician assistants per 10,000 population (see map 4). The National Conference of State Legislatures states that in South Carolina under the Scope of Practice Policy, these three occupations (physician, physician assistant, and nurse practitioner), are lawfully able to own and run their own practice, independent of any medical system. The report breaks down each county by shortages in each health sector, as well as shows rates and numbers of different healthcare providers in each county relative to population.

According to the rural and urban definitions used by this study, rural counties averaged rates of 11.2 physicians, 6.0 primary care physicians, 3.24 nurse practitioners, and 1.6 physician assistants per 10,000 population. Many rural counties were also lacking in the primary care health profession shortage area designations. Urban counties averaged rates of 18.6 physicians, 8.0 primary care physicians, 4.15 nurse practitioners, and 2.0 physician assistants per 10,000 population. According to the rural and urban definitions defined by The South Carolina Office for Healthcare Workforce, rural areas (not counties) averaged 10.1 physicians, 5.4 primary care physicians, 3.1 nurse practitioners, and 1.3 physician assistants per 10,000 population in 2017. Urban areas (not counties) averaged 29.5 physicians, 11.4 primary care physicians, 5.5 nurse practitioners, and 2.8 physician assistants per 10,000 population in 2017. This is just one of a number of large disparities rurality impacts for access to care.

In 2017, the South Carolina state health initiative, Live Healthy SC, found that 4,095 per 100,000 emergency department visits in the state were avoidable, and similarly, 1,194 per 100,000 hospitalizations were avoidable as well (see map 5). Avoidable emergency department visits and hospitalizations not only tax the healthcare system in its entirety, but can be a symptom of a larger access to healthcare problem, and an unnecessary risk of sepsis. In South Carolina, hospitals are required to treat anyone who checks in, regardless of insurance or income
status, according to the Emergency Medical Treatment and Labor Act of 1986. This means that low-income individuals are able to seek treatment at the hospital, regardless of the status of their condition. Because they do not have insurance to cover a regular doctor’s visit or the money to cover it on their own, individuals may not seek medical attention until the infection is severe, which leaves the burden of financial responsibility to fall on the hospital. This may be why the mortality rate of septicemia is much higher in lower-income and rural areas. We can also see this when looking at secondary diagnoses for sepsis upon admission to the hospital. The most common secondary diagnoses include pneumonia, severe sepsis with septic shock, acute respiratory failure, acute kidney failure, pneumonitis, metabolic encephalopathy, end of stage renal disease, severe malnutrition, heart attack, acidosis, urinary tract infection, and heart failure, among others. These secondary diagnoses put septicemias’ severity into context, as well as shows how severe the infection often is before individuals are seeking medical care.

Another factor to consider when examining access to care is age. According to a 2016 Vital Signs report by the CDC, age is a commonly reported risk factor for sepsis, and one of the most severe (CDC, 2016). The report found that those at the highest risk of obtaining sepsis were those over the age of 65, as well as infants younger than the age of 1 (along with those with chronic diseases). In South Carolina, this trend unfortunately holds true. Despite making up only 17.2% of the total population of South Carolina in 2017, 57.3% of all sepsis cases in the state in 2017 were in individuals over the age of 65. 19.2% were individuals aged 55-64, 11.2% were individuals aged 45-54, 5.99% were individuals aged 35-44, and individuals aged 0-25 made up 6.23% of cases. Age is a demographic factor, but it is primarily an access to care problem. Individuals aged 65 and over are the most likely to have a disability, to be immobile or close to it, to have a difficult time driving to and from doctors’ visits or may not be able to drive at all,
and are more sedentary, less resilient, and overall have more health complications than younger age groups. Something to consider for this factor could be that certain counties may have a higher median age, or larger percentages of individuals over 65 living there, and that this could affect the rates of septicemia as well. Another way to look at this is by census tract. A census tract is a different way of breaking down geographical location in order to gain a better understanding of the demographic breakdown of a region, therefore providing insight into the area. The census tracts are determined by the Bureau of Census (see map 6). Map 6 shows the average life expectancy by census tract area. When comparing map 6 to map 1 we can see major overlap of rural areas and the lower life expectancy areas within the state. This points yet again to the importance of rurality in defining septicemia in South Carolina.

**Socio-Economic Status**

Financial problems are often a significant contributor to healthcare problems as well as the continuation or worsening of health conditions. This is due to lack of funds for testing and scans, treatment, medications, general visits, surgeries, and more. Many studies have found that individuals with a low socioeconomic status obtain worse health outcomes. One study states, “…higher incomes are usually associated with better nutritional status, housing conditions, medical services, etc. In addition, people with higher levels of education tend to have better health awareness and health-related knowledge” (Wang & Geng, 2019). Poverty status can be used to gain insight on economic impacts of disease and health conditions in a geographic location. In the 25 rural counties in South Carolina, the percentage of people experiencing poverty was an average of 21.8%, compared to 16.9% in the 21 urban counties (see map 7). This higher percentage of poverty within rural communities could be a contributing factor to lack of care, either emergent or continued, for septicemia.
Another marker of financial burden in health is economic or income inequality. According to the Economic Policy Institute, South Carolina is ranked number 25 in the country for income inequality, where the top 1% of earners make an average of 19.7 times the amount of the bottom 99% combined. In many cases, areas with higher rates of economic inequality have worse health outcomes and worse healthcare options as well. In South Carolina, rural counties economic inequality averaged a rate of 15.0 compared to 16.7 in urban counties, where rural counties had a higher rate of economic inequality than urban counties, showing the differences in the richer area of cities and highly developed areas compared to their lower socioeconomic counterparts oftentimes right down the street (see map 8). When observing map 8 we can see similarities to both map 1 and map 2 where septicemia incidence is higher, as well as where income inequality is higher, compared to the census tracts of the state.

Another factor considered as to the severity of septicemia in South Carolina is the average household income both for the state and each county. The state’s average household income was $47,781 in 2017 according to the American Community Survey through the census bureau, compared to an average of $61,372 in the United States. Because the average household in South Carolina earns about 15% less than the average household in the country, a relationship between monetary resources available and a lack of pursuit of medical care or continuing medical care could be implied. The average charges for hospitalizations for a primary diagnosis of septicemia were $74,360 and the average charges for emergency department visits for a primary diagnosis of septicemia were $11,461 according to the SCRFA. The office also found that the average length of a hospital stay for septicemia was 7.6 days. A week in the hospital is no small length, and no small cost. Considering that the total charges for hospitalizations for a primary diagnosis of septicemia were $2,121,124,949 in 2017 according to the SCRFA, it can be
understood that the average hospital stay for septicemia is incredibly expensive. Additionally, the mean span in days between visits for primary in-patient hospitalizations was 52.63 days, meaning that on average, individuals who were diagnosed with septicemia, entered a hospital for it and were discharged, were re-admitted to the hospital less than two months later for septicemia again. This recurrence is a large problem with septicemia seen across the nation. Many individuals may not have the money for medication to completely eradicate the illness, or some may not have the funds to reside in the hospital until it is completely cleared. These individuals may opt to leave the hospital before they are completely healed, possibly leading to worsening health and reoccurrence of the disease.

In the United States, and in South Carolina, the number of adults who are delaying their medical care due to cost is extremely concerning. In 2016, the South Carolina Behavioral Risk Factor Reporting System found that 31% of adults who reported making less than $15,000 per year delayed medical care due to cost. 29.3% of adults who reported making $15,000-$25,000 delayed medical care, followed by 16.4% of those who reported making $25,000-$35,000, followed by 13.6% of those who reported making $35,000-$50,000, and 5.7% of those who reported making $50,000 and up. As we can see, as financial burden decreases, the percentage of adults who delayed their medical care decreased, leading to the conclusion that those who are in a better financial position seek medical care more often, and would be more likely to visit the doctor for septicemia. This is especially concerning given the CDC’s 2016 Vital Signs report that found that 80% of patients diagnosed with sepsis developed it outside of the hospital, and seven in ten patients with sepsis recently used healthcare services or had chronic diseases requiring frequent medical care. The report also states that many adult patients who develop sepsis are unaware that something is wrong. This is due to a lack of common knowledge and information
on sepsis, as well as the nature of the infection. The signs and symptoms can be somewhat benign until the infection has taken over. Often, individuals are in a position where they know something is wrong, but the symptoms are not severe enough to warrant the expenses of a doctor’s visit until it is too late. The CDC states that “…saving patients from sepsis is a race against time.” Time is money, and when patients in South Carolina do not have the money or time to see a doctor, the infection takes over.

Another economic burden to consider is the role of race and ethnicity within economic status. Using data from the SCRFA, in 2017 non-Hispanic Whites made up 65.78% of emergency department visits due to septicemia, non-Hispanic Blacks made up 30.53%, and Hispanics made up 1.42%. Logically this is expected due to the general demographic makeup of the state. According to the South Carolina Department of Health and Environmental Control’s South Carolina Community Assessment Network, in 2017 non-Hispanic Whites made up 68.5% of the population and non-Hispanic Blacks made up 29.1%. This makes the distribution of emergency department visits by race intuitive information, but what is not as intuitive is the discrepancy in mortality rate by race. The SCRFA data found that Non-Hispanic Whites mortality rate due to septicemia was 13.2 per 100,000 in 2017, compared to 20.4 per 100,00 for non-Hispanic Blacks. This means that non-Hispanic Blacks died of septicemia at 1.5 times the rate of non-Hispanic Whites in South Carolina, despite their presence in the total population being considerably less. As stated previously, 87% of South Carolinian non-Hispanic Whites aged 21-64 in 2017 were insured, compared to only 81.9% of non-Hispanic Blacks of the same age. Since non-Hispanic Blacks were less insured, they may not have been as able to seek medical care and could have had more expenses in regard to a diagnosis like septicemia.

**Behavioral Health**
Behavioral health, or health behaviors, are actions that individuals take that impact health outcomes, and “…Health behaviors are associated with a multitude of health and well-being outcomes at the individual and population levels” (Short & Mollborn, 2016). In regard to the contraction of a disease, illness, or even the continuation of either, the health behaviors typically examined in detail are eating well, physical activity, smoking, alcohol consumption, and others. Each of these and other health behaviors has the capacity to increase an individual’s likelihood of developing or retaining an infection such as septicemia.

According to the South Carolina DHEC Vital Statistics records, the median age of death varies greatly between men and women depending on race and ethnicity. For males, non-Hispanic Whites median age of death is 73, for non-Hispanic Blacks it is 67, and for Hispanics it is 58. For women, non-Hispanic Whites median age of death is 80, for non-Hispanic Blacks it is 73, and for Hispanics it is 74. Not only is there a vast difference in the median age of death for women and men, but also within each racial or ethnic breakdown. The most startling difference here is the difference between non-Hispanic White women, at 80 years, and Hispanic men at 58. According to the CDC, “premature death” is death that occurs before a person reaches the age of 75. With this definition in mind, the only group in South Carolina who does not average premature deaths are non-Hispanic White women. This has implications for septicemia in South Carolina due to the causes of premature death being a bad diet, high blood pressure, obesity, and tobacco use, all of which are unhealthy behaviors which have a relationship with septicemia (Committee on Population, 2015). When these factors are considered in those with septicemia, a relationship between premature death and the infection can be established and examined.

One way we can examine behavioral health and its impact on diseases or infections in a population is to look at said population, its demographics, and its health concerns. A behavioral
health factor to consider for septicemia incidence and mortality is the percentage of individuals who eat healthily. According to the South Carolina Behavioral Risk Factor Surveillance System (BRFSS), a 5-year estimate from 2013-2017 in South Carolina found that 23.3% of adults reported eating vegetables less than once per day. Racial and ethnic breakdowns were as follows: 19.5% of non-Hispanic Whites reported eating vegetables less than once per day, 38.6% of non-Hispanic Blacks, 24.7% of Hispanics, and 25.1% of non-Hispanic Others (including multi-racial groups). Breaking this down by income group revealed that 38.2% individuals earning less than $15,000 per year reported eating vegetables less than once per day, 30.9% of those earning between $15,000 and $25,000, 26.6% of those earning between $25,000 and $35,000, 22.6% of those earning between $35,000 and $50,000, and 15.1% of those earning more than $50,000. This demonstrates a clear correlation between income and healthy behaviors. When breaking this down by education, 40.2% of those who completed less than high school reported eating vegetables less than once per day, 29.9% of those who completed only high school or an equivalent, 20.4% of those who completed some college, and 13.9% of those who graduated from college. Again, a clear relationship between healthy eating behaviors and education can be seen.

Similar to vegetables, the South Carolina BRFSS found that 44.3% of South Carolinians reported eating fruits less than once per day. The racial and ethnic breakdowns were as follows: 44.8% of non-Hispanic Whites reported eating fruit less than once per day, 45.6% of non-Hispanic Blacks, 37.3% of Hispanics, and 40.9% of non-Hispanic Others (including multi-racial groups). Breaking this down by income revealed that 50.9% of individuals earning less than $15,000 per year reported eating fruits less than once per day, 46.4% of those earning between $15,000 and $25,000, 46.2% of those earning between $25,000 and $35,000, 47.1% of those
earning between $35,000 and $50,000, and 40.3% of those earning more than $50,000. Again, a relationship between income and health behaviors can be established. Additionally, when breaking this down by education, 51.7% of those who completed less than high school reported eating vegetables less than once per day, 49.1% of those who completed only high school or an equivalent, 43.3% of those who completed some college, and 35.6% of those who graduated from college. Another relationship can be inferred from this data.

Other behavioral health factors that could give insight to the high number of individuals infected with septicemia each year in South Carolina are physical activity, how it relates to obesity, and obesity itself. Data collected from the SC BRFSS in 2018 shows that 26.7% of South Carolinian adults reported not participating in any physical activity in the past month. In 2017, 51.4% of adults reported falling short of the recommended 150 minutes of aerobic physical activity per week, and 81.2% reported falling short of participating in enough aerobic and muscle strengthening exercises to meet the guidelines recommended to them. Lack of physical activity could be a large factor contributing to the increase in infection rate and mortality rate of this illness, due to lowered health and resiliency. In South Carolina in 2018, 35.4% of adults reported being overweight, 34.3% reported being obese, 28.4% reported being a normal weight, and 1.9% reported being underweight. With 63.8% of the adult population reporting themselves as being either overweight or obese, it would stand to reason that there would be little physical activity, and that health issues in regular life, regardless of the presence of a serious infection, would present health problems and complications (see map 9). Obesity in the United States is an epidemic of its own right, and South Carolina is known for having one of the highest rates of adult obesity in the United States according to BRFSS data. This could be a contributing factor to the rates of septicemia in the state. According to SC BRFSS data, 23% of adults reported that
in 2019 they had one to thirteen days of each month where their physical health was not good, and 13.5% reported that they had fourteen or more days where their physical health was not good. Combined, 36.5% of South Carolinian adults had poor health on at least some of the days in every month. When adults are aware of their own lack of physical health, it would stand to reason that infections and diseases would occur more commonly.

Education is a commonly used marker for health and health status. This is because individuals who are more educated are able to make more informed decisions for their health, leading to better health outcomes. Also, increased education can lead to better job opportunities and more economic stability, which enables individuals to seek medical care regularly as well as for sickness, decreasing the risk of major health issues, and eliminating the possibility of an infection or disease getting out of hand before it is too late. In South Carolina in 2018, SC BRFSS data found that 13.7% of adults reported never completing high school, 29.9% reported completing high school or an equivalent, 31.9% reported completing some college, and 24.6% reported completing a college degree. In the United States on average, 11% of adults reported never completing high school, 28.8% reported completing high school or an equivalent, 31.6% reported completing some college, and 26.7% reported completing a college degree. Overall, adults in South Carolina pursue higher education at a lesser rate than the national average. One study states that, “Basic educational expertise and skills, including fundamental knowledge, reasoning ability, emotional self-regulation, and interactional abilities, are critical components of health. Moreover, education is a fundamental social determinant of health – an upstream cause of health” (Hahn, Truman, 2015). We know that education directly affects health outcomes, so it would stand to reason that higher educational attainment is indicative of healthier adults and better health outcomes, specifically with infections such as septicemia.
Alcohol can be a complication in many health issues, diseases, and infections due to its multitude of health effects. For septicemia, its effects on the immune system are particularly troublesome (Trevejo-Nunez & Giraldina, 2015). Because of its toxic attributes, alcohol can be considered as a risk factor for septicemia incidence and mortality. In South Carolina in 2018, the BRFSS report found that 48.5% of adults reported having had at least one alcoholic drink in the past 30 days. When breaking this down by race, 51.2% of non-Hispanic Whites, 42.1% of non-Hispanic Blacks, 47.3% of Hispanics, and 60.2% of non-Hispanic Others reported having at least one alcoholic drink in the past 30 days. According to BRFSS, in 2018 15.1% of adults reported binge drinking (binge drinking is defined here as males having five or more drinks on one occasion and females having four or more drinks on one occasion). When breaking this down by race, 15.8% of non-Hispanic Whites, 12.5% of non-Hispanic Blacks, and 19.5% of Hispanics reported binge drinking. Large amounts of alcohol consumed can certainly interfere with the body’s ability to fight off infection and could contribute to the high volume of septicemia cases within the state, as well as play a role in the continuation of the infection, ultimately leading to an increase in the mortality rate.

Smoking is another factor that can inhibit the body’s ability to fight off infections. Smoking, even more so than drinking, is a risk factor for infections, not only in acquiring them in the first place, but also in the ability to fight them off once acquired. According to a meta-analysis examined by Lidia Arcavi and Neal Benowitz published in the JAMA Internal Medicine Journal, “Mechanisms by which smoking increases the risk of infections include structural changes in the respiratory tract and a decrease in immune response. Cigarette smoking is a substantial risk factor for important bacterial and viral infections.” In South Carolina, 18% of adults reported being current, consistent smokers in 2018. Of these, 12.3% of adults reported
smoking every day, and 5.7% reported smoking some days. 25.5% of adults reported being a former smoker. Even those who were smokers previously have incurred damage to their body that can impact their ability to fight off infections such as septicemia.

Mental Health is a tricky concern and risk factor for many diseases, both mentally and physically. One study found that, “Findings suggest the presence of depression may confer an increased risk of infection and that this increased susceptibility is not confined to a specific time period following the onset of depression” (Andersson, et al., 2016). Not only have clinical trial demonstrated that depression lowers the body’s immune response and ability to fight infection, but it also reduces the patients desire and will to live. When individuals are struggling mentally, a diagnosis of septicemia may be too overwhelming to fight, and depression or other mental health issues may impact their will to live. In 2018, 19.9% of adults reported that they had been told by a healthcare provider that they had depression, higher than the national average of 19.6%. This, in combination with other behavioral health factors, could be a contributing factor to the high rates of septicemia mortality in South Carolina.

Discussion

The results of this study paint a picture that comes full circle. We have examined the connection between the key points of the study, access to care, socioeconomic status, and behavioral health, to the incidence and mortality of septicemia. These factors affect the prevalence of septicemia in South Carolina and contribute to the rising number of cases of septicemia and the consistent ranking as one of the major causes of death in the state.

In access to care we found many factors that contribute to a lack of access to proper healthcare, and the many various health complications this can cause for individuals of all races, ages, and living situations. Specifically, for septicemia, we found that rurality is a major
consideration to take into account for septicemia mortality, as well as insurance status, lack of transportation available to both individuals and public transport options, the availability of primary care and other medical services in rural areas, a large number of avoidable emergency department visits and hospitalizations, concerning secondary diagnoses, and age and mobility. We also discussed the importance of viewing topics by census tract in order to gain more in-depth data and understanding of the issue.

For socioeconomic status we found that rural counties had higher percentages of poverty and discussed the level of economic inequality in South Carolina as well as in rural versus urban counties. We also explored average household income and how low income can impact individual’s ability to receive medical care, as well as found high charges and high economic burden caused by septicemia emergency department visits and hospitalizations. We also found implications for septicemia in delayed medical care due to cost, as well as dove into the role that race and ethnicity has on the incidence and mortality of septicemia, and how they are intrinsically tied to socioeconomic status.

For behavioral health we looked in depth at racial and ethnic implications of septicemia, as well as median age of death in relation to premature death. We found correlations between eating of healthy foods, particularly fruits and vegetables, with socioeconomic factors such as education and income, with health status as far as weight and physical activity, as well as the individual’s state of good or poor health. We also considered the role of education on septicemia, and the roles of risky health behaviors such as alcohol consumption and smoking. We also looked at the connection between mental health and its negative impacts on septicemia. All of these factors come together to create a strong case for explaining septicemia mortality and incidence in South Carolina.
The proposed hypothesis centered strongly around rurality as well as race and ethnicity. We believe these factors to be among the most important when defining septicemia in South Carolina. Through the research presented in this study, we have found substantial evidence to support our claim. In the opening content of the research presented, differences in hospitalization and emergency department visit rates are highlighted. We can see from the get-go that septicemia mortality and incidence occur at a much higher rate in rural counties in South Carolina than in urban counties. This trend continues to build on itself as we dig deeper into the research and present new information that further compound this claim. Each section we delve into had implications relating to the rurality of communities and their relative ability to fight this infection. We also see that race and ethnicity are tied to rurality and become aware of their sizeable involvement in the discussion on septicemia. Throughout the entirety of the study, we consistently see disparities within septicemia in regard to race and ethnicity, where the non-Hispanic White population consistently have better health outcomes than the non-Hispanic Black and Hispanic population in particular. This trend is supported by large amounts of other data both in South Carolina and in the United States. We have shown disparities in access to care in the section on insurance as well. Other sections such as implications of age, households with a vehicle available, and others may also have racial implications, but they were beyond the scope of our study.

Another major aspect of this study were the implications and importance of economic inequality and its role on septicemia incidence and mortality. Economic implications are often a driving force as well as a risk factor for many different diseases and infections. In septicemia’s case, we found that much of this is due to the quality of care that can be afforded, as well as the presence of resources to access quality care. Socioeconomic factors are unique in that they
impact almost all other aspects of this study, from behavioral health to access to care, money and its ties drive the entire world of healthcare. We found solid data that points to socioeconomic factors being arguably the most key factors in preventing both septicemia incidence and mortality. If individuals living in rural areas had access to a vehicle, or money to purchase gas for their travel (which can be quite a far distance), to the doctor, or money to afford the doctor’s visit, the tests to determine septicemia’s presence, the medication required to treat it, as well as any and all follow-up appointments to deal with the infection, the money to purchase healthy foods, obtain mental health care to improve mental resiliency when dealing with an infection, money to attend higher education in order to understand the risks associated with poor health choices, as well as to understand when to take health seriously, the rates of incidence and mortality would decline.

Ultimately, each section of this study is intrinsically tied to each other, each influencing the others and vice versa. Without enough money, it does not matter if a patient has access to a healthcare facility or hospital, if an individual is not educated enough to understand when a health condition requires treatment it does not matter if they possess the financial means to pay for health services, and so on. Other studies have found similar results, specifically, a study done by researchers at the University of Alabama School of Medicine, Birmingham, sorted certain county clusters based on mortality which revealed that the majority of these mortality clusters were in the Southeast US, and that these clustered counties had lower education rates, larger populations in poverty, larger populations without medical insurance, and had a higher unemployment rate (Moore, et al., 2017). These results help to validate our findings and show how prevalent these factors are in regard to septicemia. The results also give credibility to the importance of the three areas hypothesized by this study. Interestingly, the study also states,
“Strongly clustered and moderately clustered counties had lower median household income, median value of housing units, and were less urban when compared to counties within the non-clustered group” (Moore, et al., 2017). The study found that strongly clustered counties for septicemia were more rural than counties with low clustering for the infection. Again, this confirms our hypothesis that rurality is a key factor to consider when dealing with septicemia incidence and mortality. The study also discusses the role of race within this issue, and states that minority populations were more at-risk of dying from sepsis than their White counterparts, similar to the findings of this study and adding another layer to our proposed hypothesis.

An older study posted in the International Journal of Health Geographics done on sepsis mortality geography, referenced by the study done by the University of Alabama School of Medicine, Birmingham, found that rates of septicemia were the highest in 11 states across the Southeast and Mid-Atlantic United States, of which South Carolina was included. Though the study did not make many claims as to why this was the case, it did discuss racial implications, stating racial demographic differences by region as a potential factor for the higher rates. This study also discussed the similarities between the findings they encountered and the previously coined, “Stroke Belt,” comprising of 7 states in the Southeast US, and even more specifically, the “Stroke Buckle,” comprised of only North Carolina, South Carolina, and Georgia, which had the highest death rates due to stroke (Wang, et al., 2010). This important comparison can be used to show similarities in risk factors and demographic factors for both stroke and sepsis in South Carolina. From this study, we were able to glean much information that was applicable to our study and use it as a backbone for furthering the study’s findings.

Throughout our study, there were a small number of data points found which we were not anticipating. One of the first of these was the difference in the rate of diagnosis of septicemia by
race. Non-Hispanic Whites were diagnosed with sepsis at a rate of 56.79 per 10,000 population, and non-Hispanic Blacks were diagnosed with sepsis at a rate of 56.47 per 10,000 population. This was interesting because of the vast difference in the mortality rate of septicemia by race. As stated previously, the mortality rate for non-Hispanic Whites was 13.2 per 100,000 population, compared to 20.4 per 100,000 for non-Hispanic Blacks. Interestingly though, this creates an even larger disparity between the races for mortality rate, considering that both races obtain septicemia at almost the same rate, but die from it at quite a different rate, more than 1.5 times the rate. Another result we were not anticipating was the difference between males and females with hospitalizations and emergency department visits. Males comprised 47.8% of hospitalizations for septicemia, and females made up 51.2%. Males comprised 52.2% of emergency department visits for septicemia, and females made up 48.8%. These percentages are almost identically flipped for hospitalizations and emergency department visits, indicating a very small difference between males and females in this regard. Because of the small difference, we did not pursue sex as a defining characteristic of septicemia incidence to be studied in this report. This is similar to other studies and bodies of research, where males and females develop septicemia at nearly the same rate, however we were anticipating a larger difference than we found. There were a few other variations in the data that we were not anticipating, however their significance amounted to less than the points covered. Other differences were small, so they were not included in this discussion.

There were a few limitations to this study, especially regarding data and the data available for our use. This study utilized many different data sources, all of which were helpful and informative and added to our hypothesis. We used ICD-10 codes to search for data, which could not be a true reflection of the actual numbers of septicemia incidence and mortality, which
is always a risk. Since this is an exploratory data analysis, there was no individual data included in the report because it was not able to be collected. We used many different sources as well as many different aspects of the data sources however, there was a small amount of data unutilized, and a larger amount of data unavailable that we could have used to either provide more context to our data questions, or offer explanations to other findings we stated, or even to help solidify certain points or information we found interesting within the study. Most of this data was related to demographic breakdowns, especially age, race, ethnicity, and even some data based on the individual county level that we might have used for the rural versus urban juxtaposition highlighted throughout the study. Though the lack of certain data available does not directly conclude that the data presented here is invalidated, it would have been beneficial to be able to present more specific data in certain circumstances. Additional data may have also been revealed if other studies of this nature had already been conducted, however, due to the lack of data and research into this particular, specific area, there was not much for our study to back itself up upon. Having a larger body of research concerning our particular hypothesis and research questions may have allowed this study to have a more profound impact on the field implicated.

**Conclusion**

This study presented many different elements of data and worked to provide insights into the high number of septicemia cases as well as a high mortality rate within South Carolina. The results of this study point towards a few different aspects of health and healthcare within the state that if focused on, could be life saving for many individuals. The findings discussed can be used in the future by other researchers to further the body of research available for septicemia in South Carolina, and in other states as well. The findings could also be utilized by health organizations, both local and statewide, in order to spread awareness of key indicators of septicemia and
perhaps start new policies or implement new programs in order to combat this epidemic of
disease and death.

The ultimate use for this data and study would be the furthering of the pool of knowledge in existence for this particular issue, as well as the creation of policy from these health implications outlined. The implications of race and ethnicity, how they relate to socioeconomic status as well as health equity, evaluating access to care both for patients and the accessibility and locations of healthcare services and practitioners, as well as how health choices and risky health behaviors can have a role in all health outcomes, even healthcare acquired infections. Further research could provide more insight into direct relationships between race and septicemia incidence and mortality, as we believe that to be one of the biggest contributing risk factors for this infection. Though we did not look at it directly but more as a part of a larger problem, more research into that aspect of the infection could prove useful in the creation of new policies and educational programs. Health interventions and policies aimed at septicemia concerning the data or data concepts presented in this study should ideally be aimed at both patients and healthcare professionals. Healthcare professionals need to be aware of the risks involved with septicemia as far as instructing patients on their own inherent risk, as well as their other obtained risk from increased exposure to healthcare facilities, and patients need to be aware of how their choices and their own demographic risk factors impact their health and health risks. Ideally, implementing educational materials in care facilities, as well as pushing for the expansion of Medicaid would be the most useful objective of this study. With this in mind, septicemia incidence and mortality in South Carolina may begin to decline.
Works Cited


Maps

Map 1: Rural Versus Urban Counties in South Carolina

Urban: Dark

Rural: Light

Source: The Economic Research Service South Carolina Rural Definitions State-Level Maps
Map 2: Septicemia Incidence in South Carolina by County by Quartile, Rate per 10,000

Source: South Carolina Revenue and Fiscal Affairs Office, 2018
Map 3: Insurance Status in South Carolina by County by Quartile, Percentage

Source: South Carolina Revenue and Fiscal Affairs Office, 2018
Map 4: Primary Care Physicians in South Carolina by County by Quartile, Rate per 10,000

Source: South Carolina Office of Healthcare Workforce South Carolina Health Professions Data Book, 2018
Map 5: Avoidable Hospitalizations and Emergency Department Visits in South Carolina by County by Quartile, Rate per 100,000

Source: South Carolina Revenue and Fiscal Affairs Office, 2018
Map 6: Life Expectance at Birth by Census Tract by Quintile, Years

Source: US Small-area Life Expectancy Estimates Project (USALEEP) between the National Center for Health Statistics (NCHS), the National Association for Public Health Statistics and Information Systems (NAPHSIS), and the Robert Wood Johnson Foundation (RWJF), 2010-2015
Map 7: Poverty Status in South Carolina by County by Quartile, Rate per 10,000

Source: South Carolina Revenue and Fiscal Affairs Office, 2018
Map 8: Gini Index of Income Inequality in South Carolina by County by Quartile

Source: U.S. Census Bureau, 2013-2017
Map 9: Obesity in South Carolina by County by Quartile, Rate per 10,000

Prevalence of Obesity among Adults
2014-2016

Source: SC DHEC BRFSS, 2014-2016