Disparities in Physical Access to Major Imaging Equipment in the Southeast United States: Findings from the 2020 Release of the American Hospital Association Database

Submitted in partial completion for the Bachelor of Science Degree in Management with a Concentration in Health Analytics at The University of Alabama

Introduction

Major imaging equipment is an important resource that enables providers to provide quality care in medical facilities such as stand-alone clinics, hospitals, and stand-alone emergency rooms (1-3). It can be used to detect a plethora health problems through the use of MRIs, CT scans, mammograms, and X-rays. Although these are all common forms of imaging equipment, there is one that appears to be used more often than others: the mammogram unit (4).

Breast cancer is one of the most frequently diagnosed forms of cancer among women and is also one of the leading causes of cancer related deaths (5). The two most common forms of breast cancer are ductal carcinoma in situ (DCIS) and invasive breast cancer (ILC). DCIS is a form of breast cancer that is either non-invasive or pre-invasive meaning that it has not grown into the rest of the tissue (6). ILC is an invasive form of breast cancer that has spread into the tissue around the center of growth (7). However, both forms of cancer can be contained if caught very early in the cancer progression through the use of a mammogram (8).

The challenge facing some population is that not everyone has convenient access to mammograms, especially those who live in rural areas within the southeast of the United States. These rural areas tend to have a socioeconomic status, which can be associated with the status of a person's health (9), much lower than urban areas which usually have a middle to high rating on the SES scale (10).

Overview

Our team was given the opportunity to research disparities between urban and rural areas regarding physical access to major imaging equipment. Given historical disparities (10), we decided to narrow our focus to the southeast region, specifically Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Missouri, and Arkansas. With such a broad topic, we chose to investigate major imaging equipment related to breast cancer screening and prevention, which also narrowed our scope to look for women aged 40 years and older.

As an exploratory study, our team decided to conduct several minor analyses before digging into the data. Therefore, we narrowed the scope of our research question, once we were able to examine broad trends in the data. Thereafter, we devised concrete tasks for our project, which we divided among members of the team. Next, we refined our data, which allowed us to examine the correlation of our findings with published breast cancer statistics. Lastly, we created visual representations of our findings to further convey results. Once we had our

data and visuals, we were able to compare it with the research to create an analysis of the two and determine our limitations with the data we were given.

Methodology

The primary data sources used in our analyses included the American Hospital Association (AHA) Database (11), the American Community Survey (12), and vehicle routing information from ESRI's StreetMap Premium (13). Rurality was operationalized using the US Health Resources and Service Administration's rural health area criteria (14). Full details of the database, and schema of data sources used in this project can be found here: https://bit.ly/3nLuYMF. T-SQL programming in SQL Server Management Studio © and Azure Data Studio © were used to execute most queries presented in this report. Tableau © was used among group members to discuss and internalize findings. A faculty mentor assisted in the development of some maps in ArcGIS Pro ©, and advanced queries not covered during lecture.

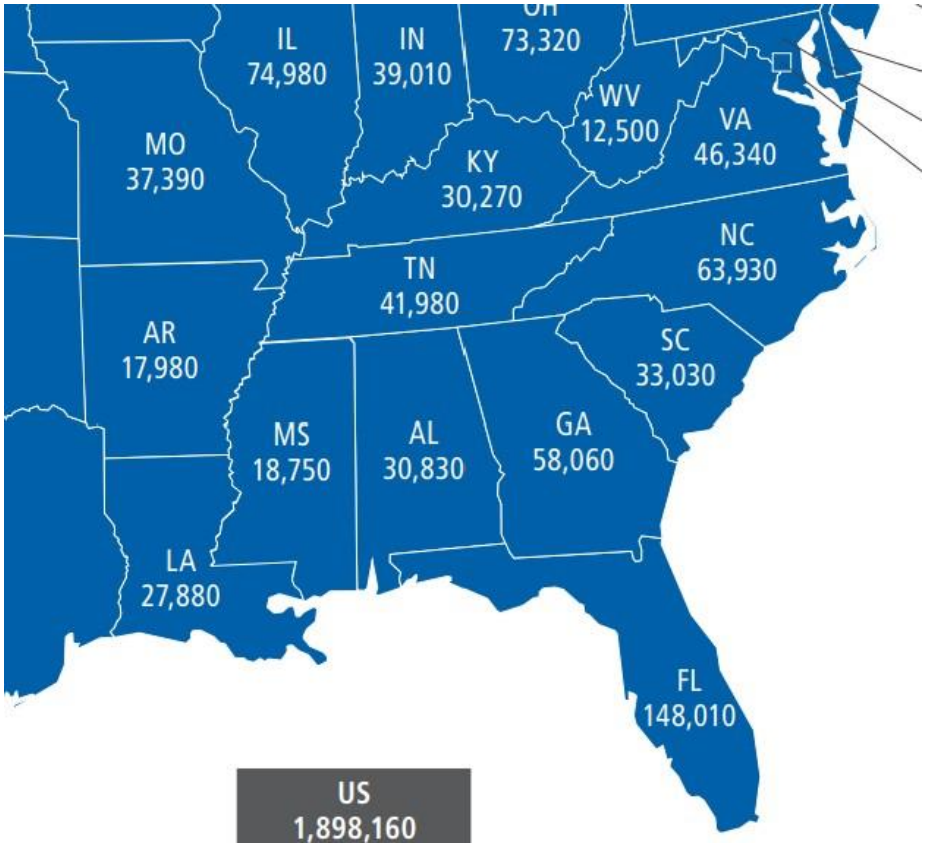
Initially, we searched for all the items in the AHA Database that had some combination of keywords related to "major imaging" listed in the field description of the column. Tis returned the following columns: SMRI was majoring imaging with outpatient services, SMRIOC was major imaging of on-campus sites, and SMRIOF was major imaging of off-campus sites. Following the results, we were able to then sort through hospitals within the data that reported having any of the three and how many they had, this returned 1,642 hospitals, all varying in the amount they had for any of the three field names, which created our first temporary table.

Our next step was to find the short name of the target population, we were able to find the short names for women over the age of forty within the ACS_DATADICTIONARY. This allowed us to create our second temporary table for our final table and map, which would return 74,001 GEOID_Data results. GEOID_Data is a nominal identifier in the American Community Survey, which is unique for every census tract. For our third temporary table, we needed to refine our location to the southeast region, which we decided would be Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Missouri, and Arkansas. Creating the matrix for our final tables and map was the next step, which included joining all three tables together through the GEOID_Data, refining travel time to 60 minutes to find the distinct number of hospitals within the area and finding the total travel time for each hospital in each census tract, returning 14,617 results.

The final map and tables included all the data we found, including the socioeconomic status and the number of urban and rural hospitals in each state and the median time frame it takes someone to get to the hospitals within their census tract. We chose to keep our travel time

to 60 minutes to have a large spread of data to compare to our research.

Research Process



(ACS)

To start the research process, we began by looking at the major breast cancer trends such as cases, incidence rates, death rates, and overall deaths. After looking through the data we discovered that the rates of new cancer cases have fluctuated between 120 to 126 cases per 100,000 women (CDC), but the actual count of cases has been on the rise. Although the amount of cases has been increasing, the death rate has been decreasing. Since the CDC started tracking the death rate for female breast cancer in 1999, the rate for it has been on a steady decline. While the rates for new cases and deaths have been either fluctuating and decreasing respectively, the count of cases or deaths have been either increasing or stagnant. The reason for the rates reflecting different numbers is because the population in the United States is growing every year which will obviously allow for more cases and deaths to be recorded.

With death cases climbing due to the growing population, but death rates declining, we also looked at the percentages of women over the age of forty who were consistently getting

mammograms to see if there were any correlations between the two. According to the CDC's database, when mammogram percentages began being tracked in 1987 only 29 percent of women over the age of forty had gotten a mammogram within the past two years. After looking through this data we found that when the death rates of female breast cancer started declining in 1999, it was also the same year that had the highest percentage of women receiving mammograms at 70.3 percent. After 1999, however, mammogram rates did decline and stay stagnant, but they were still much higher than the years prior to 1999 (CDC). These higher rates of women getting mammograms can be linked to the decline in death rates due to the cancer being caught in its

Characteristic	1987	1993	1999	2000	2005	2008	2010	2015	2018
Age and percent of poverty level[5]	Percent of women having a mammogram within past 2 years[1]								
40 years and over, crude:									
Below 100%	14.6	41.1	57.4	54.8	48.5	51.4	51.4	52.2	51.7
100%–199%	20.9	47.5	59.5	58.1	55.3	55.8	53.8	54.9	56.8
200%–399%	29.7	63.2	69.1	68.8	67.2	64.4	66.2	63.4	65.3
400% or more	42.9	74.1	79.8	81.5	76.6	79.0	78.1	74.7	75.4
40–49 years:									
Below 100%	18.6	36.1	51.3	47.4	42.5	46.6	48.1	45.8	42.7
100%–199%	18.4	47.8	52.8	43.6	49.8	46.5	46.2	47.5	53.2
200%–399%	31.2	63.0	63.0	60.2	61.8	56.8	59.2	55.6	61.3
400% or more	44.1	69.6	77.4	75.8	73.6	72.5	73.6	68.2	69.8
50–64 years:									
Below 100%	14.6	47.3	63.3	61.7	50.4	57.5	54.7	56.9	55.7
100%–199%	24.2	47.0	64.9	68.3	58.8	58.9	57.3	60.5	61.1
200%–399%	29.7	66.1	74.8	75.1	70.7	69.8	70.7	69.0	70.3
400% or more	44.7	78.7	83.4	86.9	80.6	84.3	82.8	79.2	78.7
65 years and over:									
Below 100%	13.1	40.4	57.6	54.8	52.3	49.1	50.6	52.7	55.3
100%–199%	19.9	47.6	60.2	60.3	56.1	59.4	55.5	54.4	55.8
200%–399%	27.7	60.3	70.0	71.1	68.6	65.0	67.2	63.3	63.1
400% or more	34.7	71.3	76.7	81.9	72.6	78.3	74.5	73.1	75.1

earlier stages.

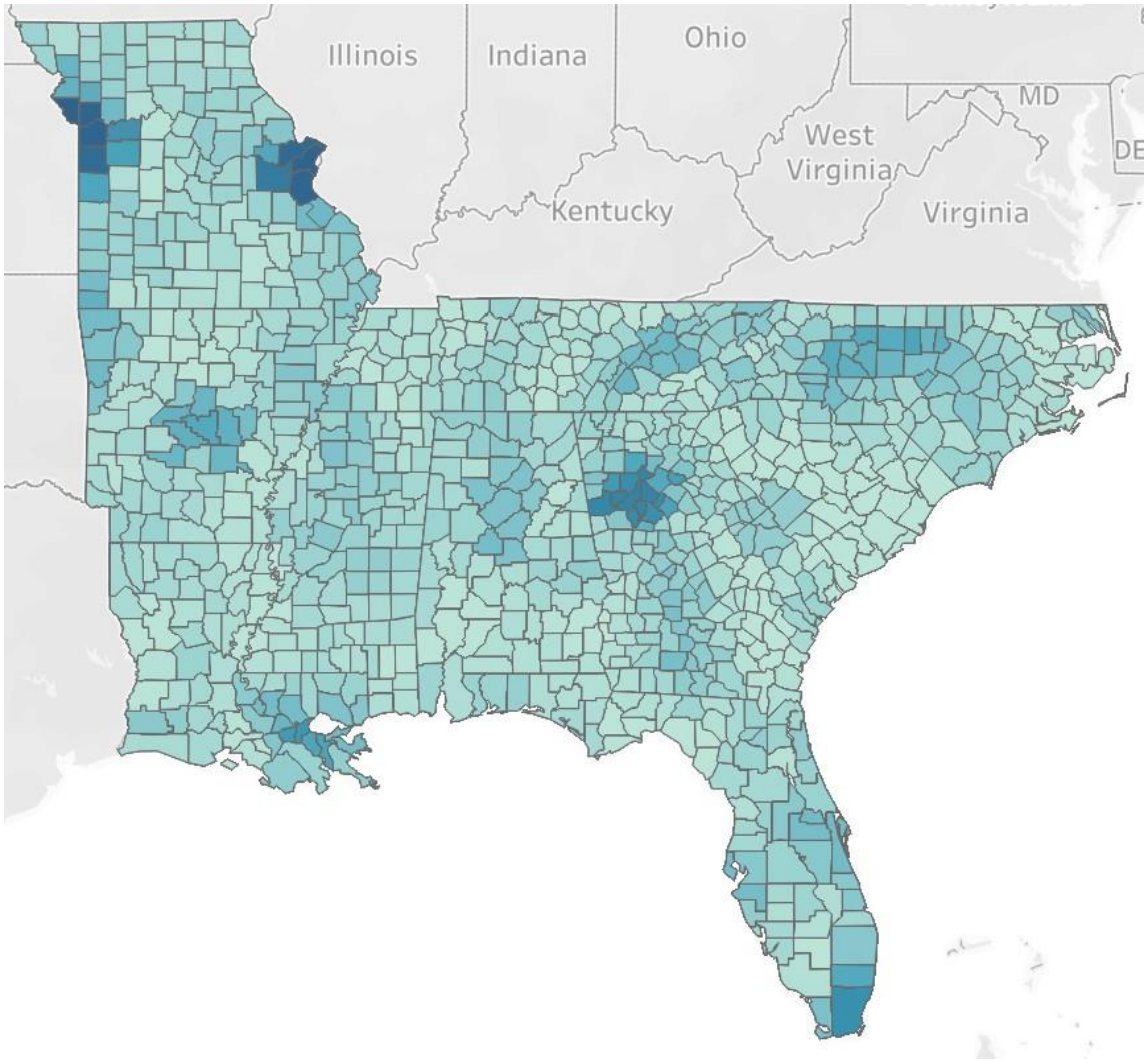
(CDC)

After seeing the overall percentages of women receiving mammograms, we then looked into the percentages of people receiving mammograms within certain poverty levels. We found that people who were below the 100% poverty level were much less likely to have had a mammogram within the past two years, sitting at 51.7 percent. Unsurprisingly, the group that had the highest percentage were women that were in the poverty level of 400% or more, with 75.4 percent of women receiving a mammogram. Many people who are in the bottom percentage of the poverty level tend to live in rural areas because they are typically affordable areas to live and are usually farther away from certain medical services, such as mammograms. Those in the higher percentages of the poverty level live in urban areas because it has much easier access to medical services that are essential. This allowed us to come to the conclusion that the reason people who live in rural areas are not getting mammograms as much as those in urban areas are because they either cannot afford it, or they are not willing to travel to a place that has the mammogram readily available.

Analysis

The tables and final map that we were able to create from our data mining, allowed us to compare it to the research we had done to analyze our findings. One of the tables included the social economic status for each census tract and another shows the median travel time to hospitals within each census tract. The visual map shows the data from our tables to compare visually to other states within our region. Our final tables and map are below:

Final Map:



Our final map highlights areas in each state with greater access for women over forty years of age to major imaging equipment. The highlighted areas correlate with larger cities in each state with higher rates of population, which would not have any correlation to the disparities between rural and urban areas. The map does suggest that higher populated areas would require greater access to facilities with major imaging equipment. The states with a greater number of hospitals in each census tract do correlate with the states who have higher potential breast cancer statistics for 2021.

Median number of hospitals within each census tract in each state with socioeconomic status:

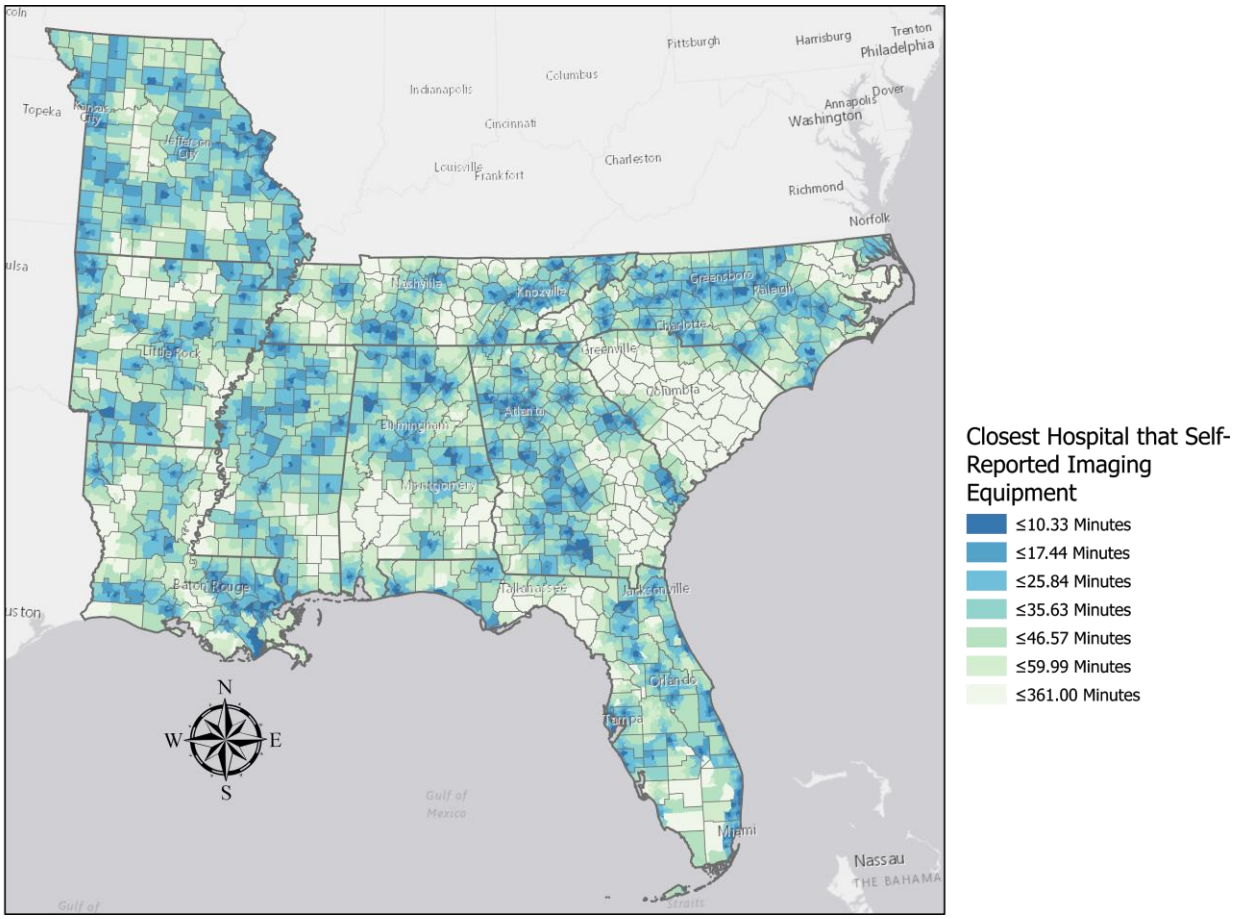
State Name	Statewide	Urban	Rural	High SES	Middle SES	Low SES
Alabama	3	3	2	5	3	2
Arkansas	4	8	2	8	7	3
Florida	5	5	1	6	5	5
Georgia	5	12	2	14	5	3
Louisiana	5	7	1	10	6	2
Mississippi	2	3	2	3	2	2
Missouri	17	20	2	20	15	4
North Carolina	5	6	2	6	5	4
South Carolina	0	0	0	0	0	0
Tennessee	3	3	1	3	3	3

Median travel time within each census tract in each state:

State Name	Statewide	Urban	Rural	High SES	Middle SES	Low SES
Alabama	24.2942	19.7872	41.9567	17.1710	24.2942	28.4218
Arkansas	20.2343	12.7541	37.0957	11.3296	19.2147	26.2262
Florida	18.5310	18.0185	42.9055	16.8826	18.6869	18.7696
Georgia	20.4314	17.0213	38.5881	15.5007	21.2318	23.5669
Louisiana	14.9529	12.1499	44.0505	11.0354	15.4308	18.6154
Mississippi	28.9843	24.9675	31.1534	20.3989	26.8834	30.9333
Missouri	14.3524	11.8280	32.5733	11.6721	15.2663	12.0500
North Carolina	19.8639	16.7606	34.8845	17.1364	20.3925	22.4450
South Carolina	0	0	0	0	0	0
Tennessee	23.4557	18.7462	41.2 052	21.8259	25.0451	18.0055

Our analysis was that for women over the age of forty in the southeast region of the U.S., access to major imaging equipment differed only slightly between those in rural or urban areas. We hypothesized that those who lived in rural areas would have a longer commute time to the closest hospitals compared to those who live in urban areas, which was roughly twice as long as urban travel time.

This was relatively similar to the number of hospitals in rural and urban areas in each state, except for a few outliers, such as Arkansas, Georgia, Louisiana, Missouri, and South Carolina. For Arkansas, Georgia, Louisiana, and Missouri, the number of hospitals in urban areas was extensively greater than the number of hospitals in rural areas and their median travel times were slightly greater than double the travel time. This might suggest that rural areas in these states may need a closer inspection of the disparities between rural and urban areas and their access to major imaging equipment.



South Carolina returned no statistical data for either table, which might suggest that South Carolina is a limitation of the data search. Upon further inquiry, the data did show that South Carolina did report for the data collection but suggest that they may not have responded to major imaging questions. Research showed that South Carolina has hospitals with major imaging equipment and their breast cancer statistics did not stand out against other states.

Conclusion

In conclusion, our findings support the hypothesis that in areas with higher rates of breast cancer in women over the age of forty years old, the access to facilities with major imaging equipment are higher in urban areas over rural areas. The disparities in access to major imaging equipment shows a correlation to the distance and travel time within each census tract. Our research also showed the disparities may have a correlation to the socioeconomic status of those who may not have access to major imaging facilities. Another correlation is the relationship between lower socioeconomic status and those who live in rural areas, suggesting that the disparities between lack of access in facilities with major imaging equipment may be due to poverty rates rather than distance. Limitations with the data search were refined to data from South Carolina and a potential lack of reporting.

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