

# Optimal Locations to Build Additional Hospitals in New Jersey

IBM Data Science Capstone Project Report

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## 1. Introduction

### 1.1 Background

Hospitals are an integral part to society. Hospitals, also referred to as medical centers, are health care institutions that provide patient treatments with specialized medical, nursing staff and medical equipment. They serve to provide treatment and help cure illnesses all around the world. Over the years, technology and science have discovered over 10,000 diseases that could affect humans and most of those diseases do not have a cure. In order to survive global pandemics, there must be enough medical supplies and hospitals to take care of those affected. I have decided to do my project on this topic as it is an important real-life scenario and has an impact considering all that is going on across the world with the current COVID-19 pandemic.

### 1.2 Problem

COVID-19 has proved to be one of the worst pandemics the world has faced. The United States especially got hit the hardest with this virus compared to other countries. Back in March, when the virus first hit the US, New Jersey was one of the many states that were affected the most. It got to the point where there were not enough hospital beds for those infected across the tristate. Hospitals were jam packed and nurses and doctors were overwhelmed and running out of resources. Taking into account the number of municipalities, population, income, and number of hospitals, this project aims to show where an addition of new hospitals would be most beneficial in the state of New Jersey. This not only will help in future pandemics, but also help on a regular basis in terms of distributing patients across different hospitals closest to them to reduce hospital wait time etc.

## 1.3 Interest

Adding new hospitals in New Jersey would be of interest to the Department of Health and Human Services, considering they are the ones in charge of enhancing the health and well-being of all Americans through providing effective health and human services. It would also be of interest to any fresh doctors and nurses looking for a job.

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## 2. Data

### 2.1 Data sources

I used the following data sources:

- Basic data about New Jersey, including counties and municipalities was scrapped from [Wikipedia](#).
- Population data per county as of early 2020 and median income data per county as of 2018 was also scrapped from [new jersey demographics](#), and [Indexmundi](#), respectively.
- **Python's Geopy library** was used to locate the geographical coordinates of each county. Geopy was not able to find two of the coordinates so I used **Google Maps** to manually get those.
- **Foursquare API** was used to gather all the hospitals located near each county.

### 2.2 Data usage/cleaning

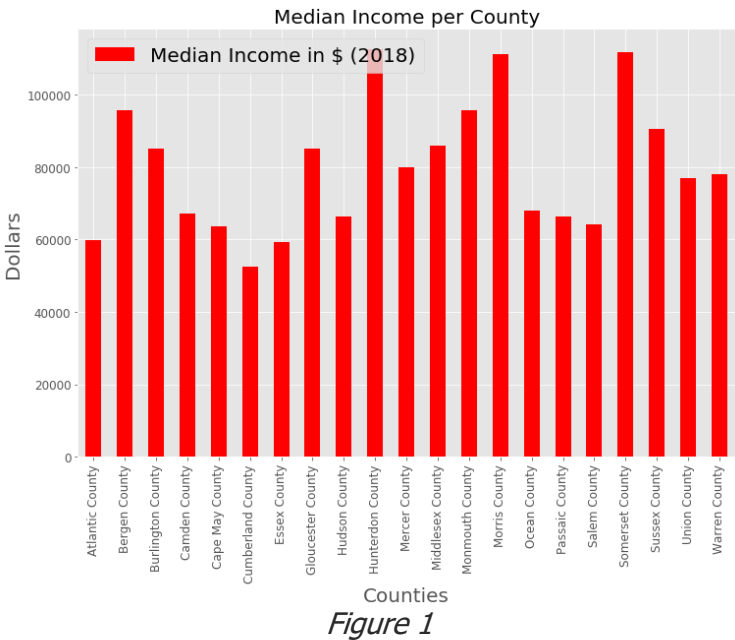
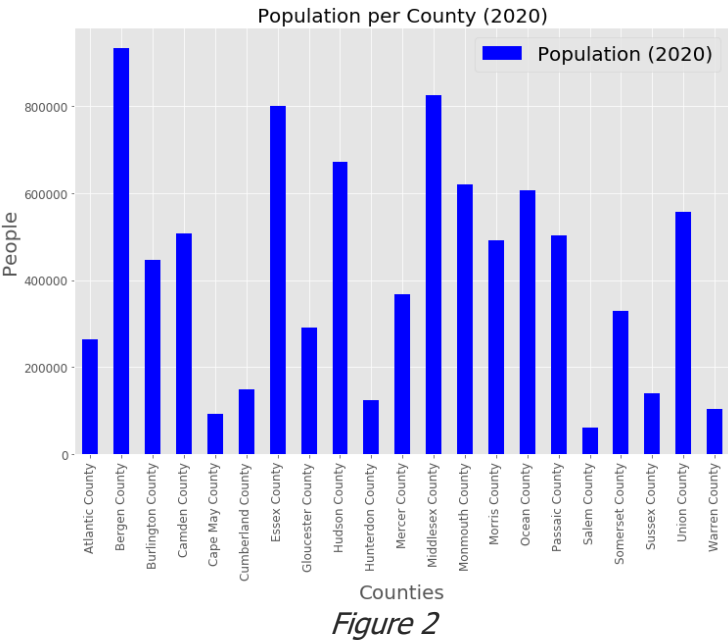
Data that was extracted from all three websites was scrapped and combined into one table for readability. This includes counties, municipalities, population, and income. The [Wikipedia](#) website had lots of excess information on its table such as municipal type, form of government, community established, and year incorporated. I dropped all these columns since they provided no value to solve the problem. The website also contained population data from 2010 and 2017, which I dropped and replaced with the 2020 data scrapped from the [new jersey demographics](#) website. The geographical coordinates for each New Jersey county was gathered from the Geopy library and appended to the final table. Two locations were not found so I manually had to append the latitude and longitude through searching on Google Maps. Next, hospital data was gathered from Foursquare. This included hospital latitude and longitude as well as the hospital name. Foursquare ended up gathering hospitals

from New York, Pennsylvania, and Delaware since they are relatively close to New Jersey. Since I am only focused on New Jersey, I dropped the hospitals that were from a different state. Once all the New Jersey hospitals were gathered, I was able to get the number of hospitals per county to see which counties have more hospitals and which have less. Out of all this, only the number of counties, population, income, and the number of hospitals per county were used to solve the problem. Municipality names and hospital names are categorical variables and do not impact this analysis, so they were omitted. Data was then normalized and grouped into clusters using machine learning algorithms to determine a correlation between each other. The goal of this is to locate counties that did not have many hospitals and correlate that to the population and income in that area, and the overall density of how many towns reside in the county. Finally, this data will be used to inference a solution to the problem stated and figure out the ideal locations for building additional hospitals.

### 3. Methodology

#### 3.1 Basic data analysis

Before delving into all the advanced machine learning techniques used, I made four basic bar charts to depict each variable per county. Figure 1 shows the population as of early 2020 for each county. Figure 2 shows the median income per county based on the 2018 Census. Figure 3 shows the number of hospitals per county based on Foursquare data. And finally, Figure 4 shows the number of municipalities (towns) per county.



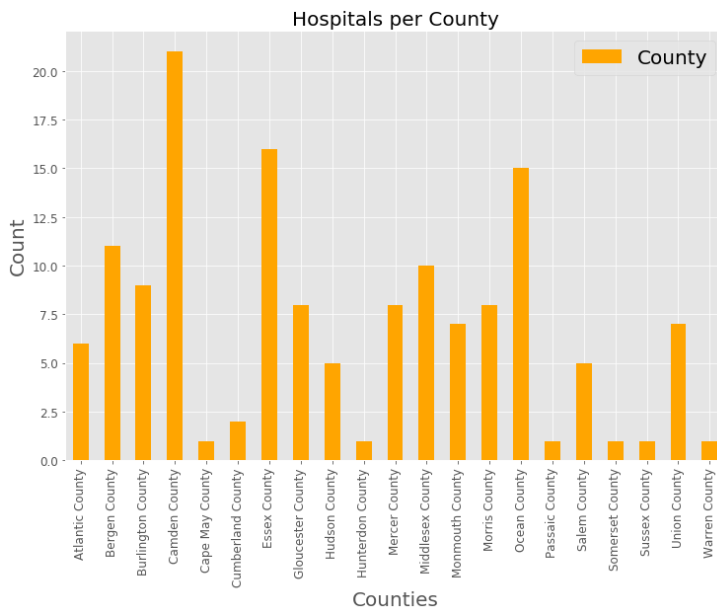


Figure 3

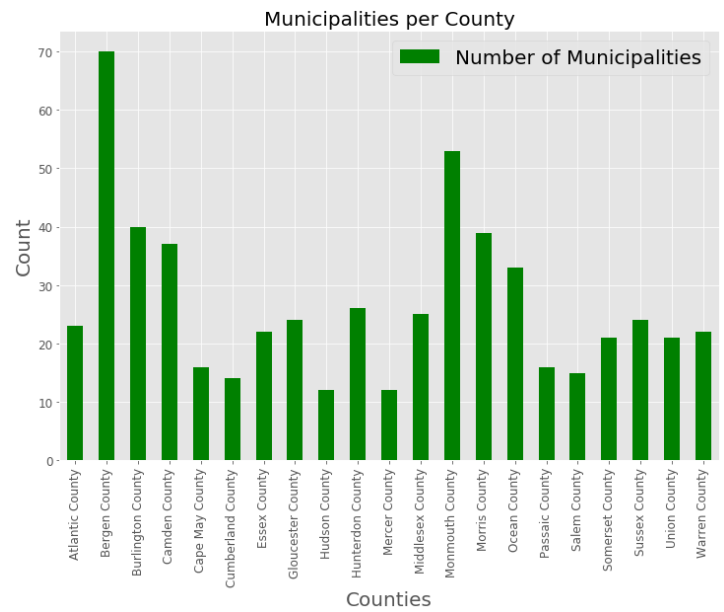


Figure 4

Foursquare API returned many hospitals some of which were also not in New Jersey. It also returned many duplicates since the towns in NJ are relatively nearby. Duplicates and out of state hospitals were dropped from my table. To figure out in fact which hospital belongs to which county, I used a distance metric to calculate the distance between each hospital and every county in NJ. A simple one-line SQL command was used to cross join (Cartesian product) the Dataframe with the 21 counties and their geographical coordinates and the Dataframe with the 144 hospitals and their geographical coordinates returned by Foursquare. Then I was able to calculate the distance and then sort the Dataframe to pick only the shortest distance to each hospital to a county to determine which hospital belongs to which county.

Now that I have gathered the four pieces of critical data (Population, Income, Number of Municipalities, Number of Hospitals), I can proceed with advanced data analysis. I decided to segment the data into pairs to see the correlation between each variable. Based on that I can inference a solution to the problem.

## 3.2 Machine learning techniques

For analyzing the data, I had to use machine learning tools. All the variables in the data (population, income, number of municipalities, number of hospitals) are all quantitative variables, in other words they are numerical. Since these features are relatively inconsistent with each other, I had to normalize the data. Normalizing makes model training less sensitive to the scale of features and in turn leads to a more accurate model. I used Python's sklearn preprocessing and StandardScaler libraries to do this. The data is standardized through

scaling, fitting, and transforming the data segments. The result is a normalized dataset which could then be used for classification and clustering. To cluster the data into groups, K-means algorithm was used. This is an unsupervised machine learning model that is a method of vector quantization which partitions  $n$  observations into  $k$  clusters. To determine the optimal number of  $k$  clusters, the silhouette score method was used. Determining the optimal  $k$  is important because it will lead to more accurate results. The silhouette score measures how similar a point is to its cluster versus the next closest cluster. The higher the score, the better.

### 3.3 Correlation between Population and # of Municipalities

I hypothesized that the lower the population the less towns there are in the county and vice versa. Figure 5 shows the graphical representation of the silhouette score so we can see the appropriate value for  $k$ . As we can see, the highest score is at  $k=4$ , which means 4 clusters is optimal for this dataset. Finally, we use K-means to cluster the dataset into 4 groups and display the clusters in the form of a scatter plot as shown in Figure 6. Based on the plot we can see that my hypothesis is correct since there is a strong positive relationship between the two variables. The cluster in yellow seems to be an outlier group.

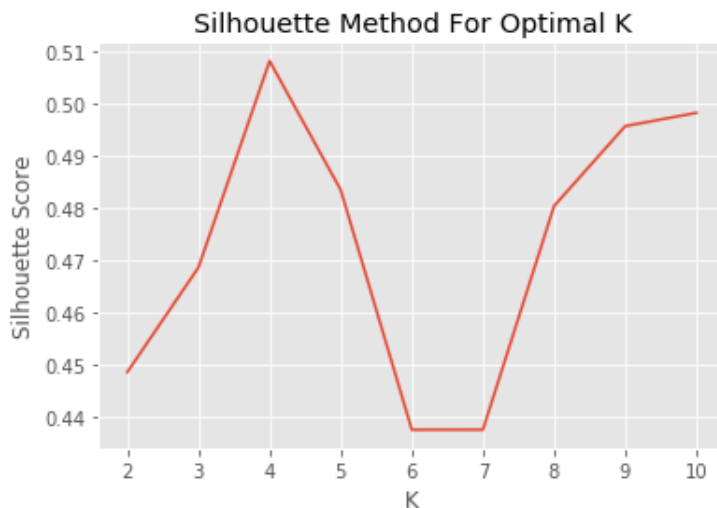


Figure 5

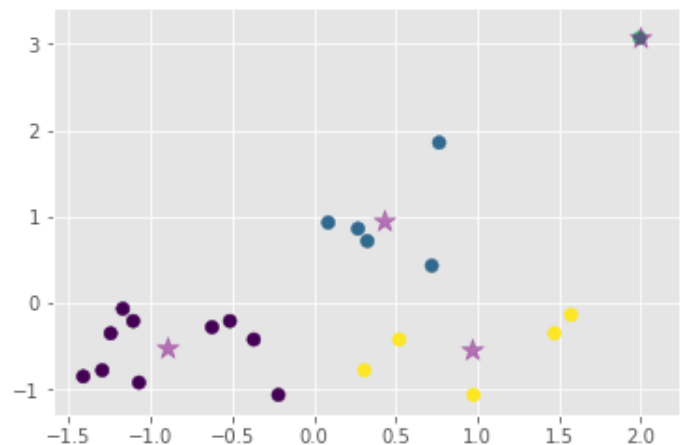


Figure 6

### 3.4 Correlation between Median Income and # of Municipalities

I hypothesized that there would not be much of a correlation between the income and number of towns. Figure 7 shows the graphical representation of the silhouette score so we can see the appropriate value for  $k$ . As we can see, the highest score is at  $k=5$ , which means 5 clusters is optimal for this dataset. Finally, we use K-means to cluster the dataset into 5 groups and display the clusters in the form of a scatter plot as shown in Figure 8. It turns out

there is a slight linear trend to my surprise, with the cluster in light blue as the outlier group. It appears that in counties with less municipalities, resides people with low income.

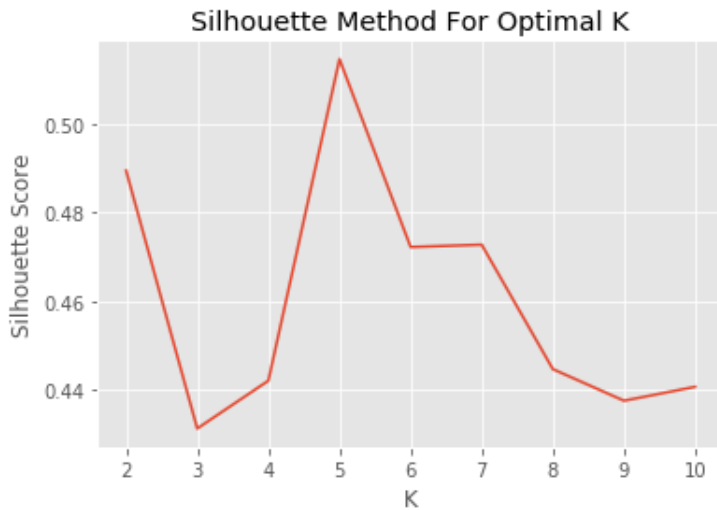


Figure 7

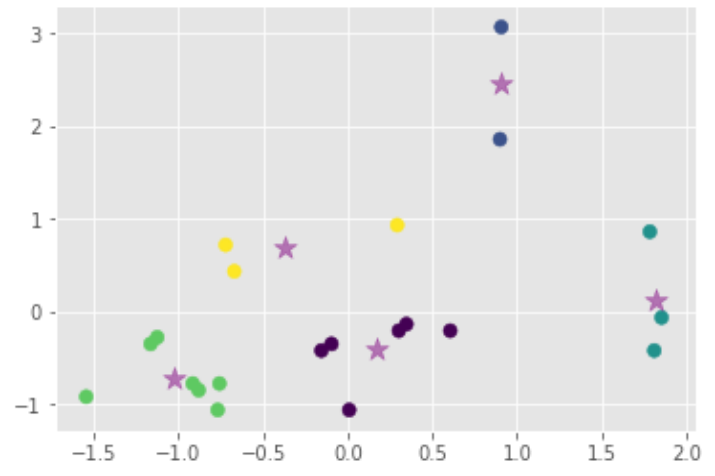


Figure 8

### 3.5 Correlation between # of Hospitals and # of Municipalities

I hypothesize that there is a strong correlation between number of hospitals and number of towns in a county. The counties with many towns would likely have much more hospitals than those without. Figure 9 shows the graphical representation of the silhouette score so we can see the appropriate value for k. As we can see, the highest score is at  $k=3$ , which means 3 clusters is optimal for this dataset. Finally, we use K-means to cluster the dataset into 3 groups and display the clusters in the form of a scatter plot as shown in Figure 10. Based on the plot we see my hypothesis is correct as there is a linear relationship. The cluster in purple seems to be an outlier group.

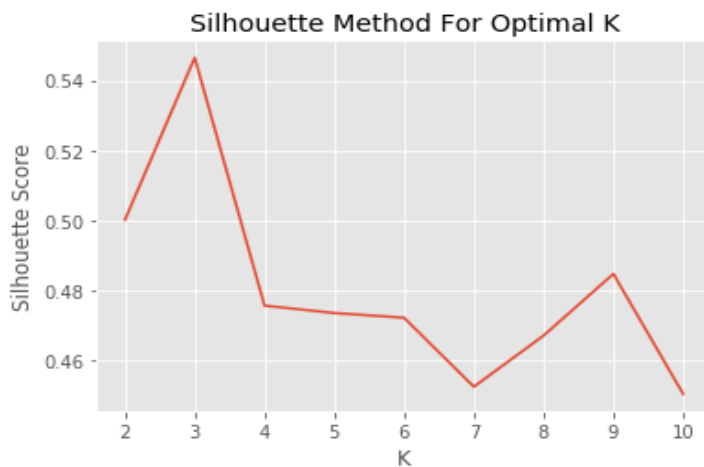


Figure 9

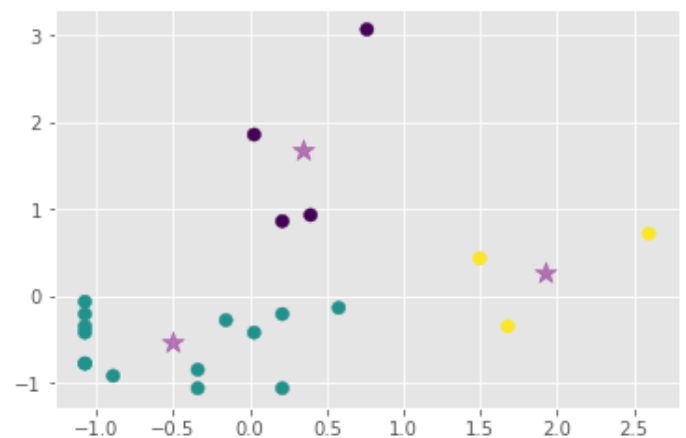


Figure 10

### 3.6 Correlation between Population and # of Hospitals

I hypothesize that the higher the population the greater number of hospitals and vice versa. It makes sense since a county with lot of people would need access to more medical supplies in case of a pandemic for example. Figure 11 shows the graphical representation of the silhouette score so we can see the appropriate value for k. As we can see, the highest score is at k=6, which means 6 clusters is optimal for this dataset. Finally, we use K-means to cluster the dataset into 6 groups and display the clusters in the form of a scatter plot as shown in Figure 12. Based on the plot there seems to be a slight positive linear relationship, but it is hard to notice at first.

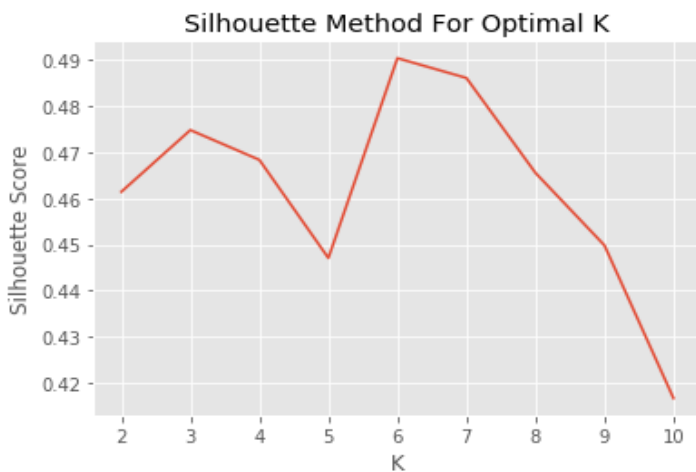


Figure 11

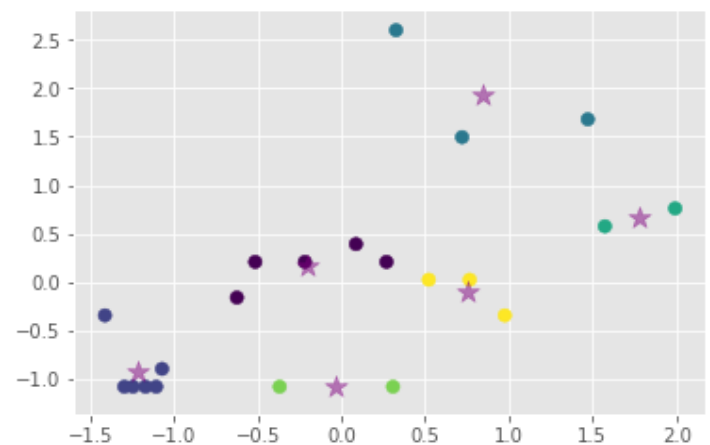


Figure 12

### 3.7 Correlation between Median Income and # of Hospitals

I hypothesize that there is no correlation between income and number of hospitals. Figure 13 shows the graphical representation of the silhouette score so we can see the appropriate value for k. As we can see, the highest score is at k=5, which means 5 clusters is optimal for this dataset. Finally, we use K-means to cluster the dataset into 5 groups and display the clusters in the form of a scatter plot as shown in Figure 14. Based on the plot, we can see that there is not really any relationship. If anything, there seems to be a neutral horizontal relationship with the light blue cluster being the outlier group.

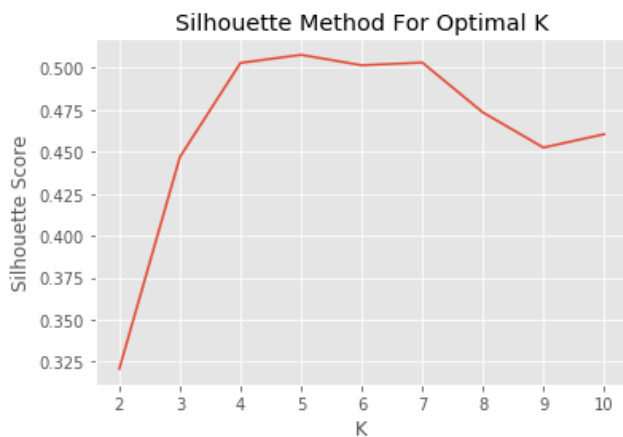


Figure 13

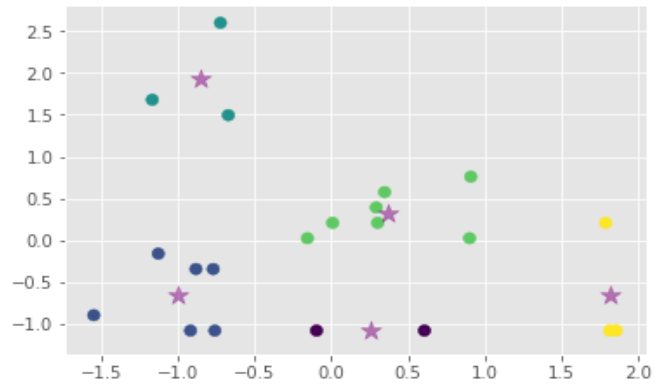


Figure 14

### 3.8 Correlation between Population and Median Income

I hypothesize that there is no correlation between population and income. Figure 15 shows the graphical representation of the silhouette score so we can see the appropriate value for  $k$ . As we can see, the highest score is at  $k=5$ , which means 5 clusters is optimal for this dataset. Finally, we use K-means to cluster the dataset into 5 groups and display the clusters in the form of a scatter plot as shown in Figure 16. Based on the plot my hypothesis is correct. The plot is hard to read but it looks like the yellow and purple clusters are outlier groups. Or the data could very well be unrelated which is why the points look scattered.

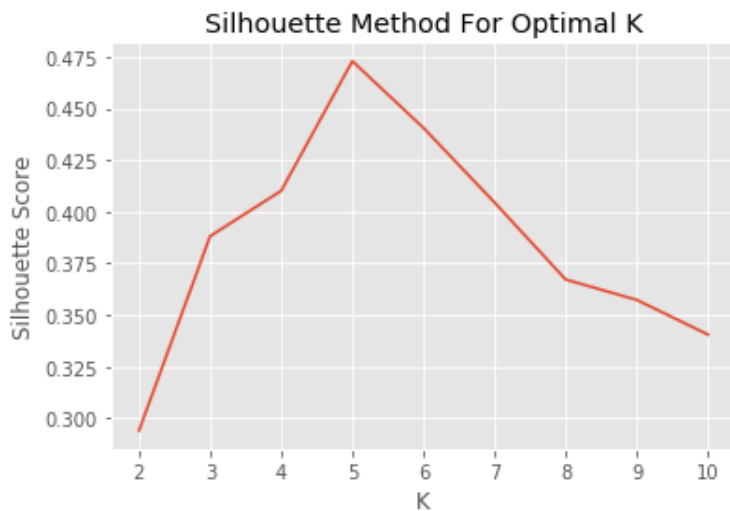


Figure 15

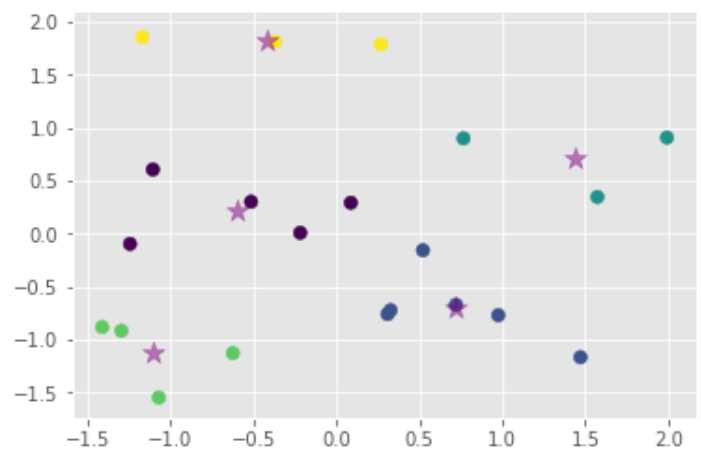


Figure 16



## 4. Results

### 4.1 Analysis of Population and # of Municipalities

As we saw this combination had 4 clusters:

	County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)		Hospital Name	Number of Hospitals
0	Atlantic County	Egg Harbor Township, Atlantic City, Galloway Township, Hamilton Township, Pleasantville, Hammonton, Somers Point, Ventnor City, Brigantine, Northfield, Absecon, Buena Vista, Linwood, Margate City, Mullica Township, Buena, Egg Harbor City, Weymouth Township, Folsom, Estell Manor, Port Republic, Longport, Corbin City	23	39.5143	-74.6633	263670	59989		AtlantiCare Regional Medical Center, Atlantic City Campus; AtlantiCare Regional Medical Center - Imaging Services; ARMC City Hospital 3rd Fl Dialysis; Acuity Specialty Hospital, Shore Medical Center, ARMC PCCU	6
4	Cape May County	Lower Township, Middle Township, Upper Township, Ocean City, Dennis Township, Wildwood, North Wildwood, Cape May, Wildwood Crest, Woodbine, Sea Isle City, Avalon, West Cape May, Stone Harbor, West Wildwood, Cape May Point	16	39.1765	-74.8012	92039	63690		Cape Regional Medical Center	1
5	Cumberland County	Vineland, Millville, Bridgeton, Maurice River, Upper Deerfield Township, Fairfield Township, Commercial Township, Hopewell Township, Lawrence Township, Deerfield Township, Downe Township, Stow Creek Township, Greenwich Township, Shiloh	14	39.3183	-75.1623	149527	52593		Inspira Medical Center Vineland, Cumberland Manor	2
7	Gloucester County	Washington Township, Monroe Township, Deptford, West Deptford, Glassboro, Franklin Township, Mantua, Harrison Township, Woolwich Township, Woodbury, East Greenwich Township, Pitman, Clayton, Paulsboro, Logan Township, Greenwich Township, Westville, Elk Township, South Harrison Township, Woodbury Heights, National Park, Swedesboro, Wenonah, Newfield	24	39.7267	-75.1535	291636	85160		Kennedy University Hospital; Virtua Medicine; Kennedy ER Washington Twp, Jefferson Washington Township Hospital; Kennedy Surgical Center, Virtua Center for Surgery - Washington Township; Inspira Medical Center Woodbury, Joan Wiley, DO	8
9	Hunterdon County	Raritan Township; Readington; Clinton Township; Lebanon Township; Tewksbury; Union Township, Holland Township; Alexandria Township; Flemington; Delaware Township; East Amwell; Bethlehem Township; Lambertville; Kingwood Township; West Amwell; High Bridge; Franklin Township; Clinton; Glen Gardner; Hampton, Frenchtown; Lebanon; Milford, Califon; Bloomsbury; Stockton	26	40.5771	-74.9262	124371	112535		Hunterdon Medical Center	1
10	Mercer County	Hamilton; Trenton; Ewing; Lawrence; Princeton; East Windsor; West Windsor; Hopewell Township; Robbinsville; Hightstown; Pennington; Hopewell	12	40.2807	-74.7034	367430	79990		University Medical Center of Princeton at Plainsboro, Medical Arts Pavilion, University Medical Center of Princeton at Plainsboro, RWJ University Hospital Hamilton, NorthStar Vets, Robertwood Johnson University Hospital Hamilton; Tele North; Mercer Family Health Center, Capital Health Regional Medical Center, Capital Health Medical Center - Hopewell	8
16	Salem County	Pennsville; Pittsgrove Township; Carneys Point, Penns Grove; Salem; Pilesgrove Township; Upper Pittsgrove; Woodstown; Alloway Township; Mannington Township; Oldmans Township; Lower Alloways Creek; Elmer; Elsinboro Township	15	39.5981	-75.3488	62385	64309		Elmer Hospital; Inspira Medical Center Elmer; Elmer Hospital-surgical waiting room; Memorial Hospital Salem County; Salem Medical Center	5
17	Somerset County	Franklin Township; Bridgewater; Hillsborough; Bernards Township; Montgomery; North Plainfield; Warren; Branchburg; Somerville; Bound Brook; Manville; Bedminster; Bernardsville; Green Brook; Raritan; Watchung; South Bound Brook; Peapack and Gladstone, Far Hills; Rocky Hill; Millstone	21	40.5675	-74.619	328934	111772		Carrier Clinic	1
18	Sussex County	Vernon; Sparta; Hopatcong; Wantage Township; Byram Township; Hardyston Township; Newton; Andover Township; Frankford Township; Hampton Township; Franklin; Stillwater Township; Montague; Stanhope; Green Township; Fredon Township; Hamburg; Lafayette; Ogdensburg; Sussex; Sandyston Township; Branchville; Andover; Walpack Township	24	41.1334	-74.693	140488	90520		Newton Medical Center	1
20	Warren County	Phillipsburg; Hackettstown; Lopatcong Township; Mansfield Township; Washington Township; Washington; Blairstown; Greenwich Township; Independence Township; White Township; Alamuchy; Pohatcong Township; Franklin Township; Knowlton Township; Liberty Township; Belvidere; Harmony Township; Oxford Township; Alpha; Frelinghuysen Township; Hope Township; Hardwick Township	22	40.8602	-74.972	105267	78145		Hackettstown Regional Medical Center	1

Cluster 1 above contains 10 counties. The counties with the least number of municipalities and the least population were grouped together.

	County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
2	Burlington County	Evesham Township, Mount Laurel, Willingboro, Pemberton Township, Medford, Burlington Township, Moorestown, Maple Shade, Delran, Cinnaminson, Lumberton, Florence, Bordentown Township, Southampton, Burlington, Mount Holly, Edgewater Park, Westampton, Mansfield Township, Riverside, Chesterfield, North Hanover, Palmyra, New Hanover, Tabernacle, Shamong, Hainesport, Eastampton, Delanco, Medford Lakes, Bordentown, Springfield Township, Riverton, Beverly, Woodland Township, Bass River, Pemberton, Wrightstown, Washington Township, Fieldsboro	40	39.9325	-74.7227	445349	84992	Virtua Memorial Hospital, Deborah Heart and Lung Center, Virtua Memorial 5 Stokes, Acuity Specialty Hospital, Lourdes Medical Center Of Burlington County, Lourdes Medical Center of Burlington County, Virtua Memorial Emergency Dept, CareOne Harmony Village, Samaritan Hospice @ Virtua Memorial Hospital	9
3	Camden County	Camden, Cherry Hill, Gloucester Township, Winslow Township, Pennsauken, Voorhees, Lindenwold, Haddon Township, Collingswood, Haddonfield, Bellmawr, Gloucester City, Waterford Township, Pine Hill, Audubon, Runnemede, Berlin, Haddon Heights, Stratford, Barrington, Berlin Township, Somerdale, Clementon, Mount Ephraim, Magnolia, Oaklyn, Merchantville, Woodlynne, Lawnside, Gibbsboro, Brooklawn, Laurel Springs, Chesilhurst, Audubon Park, Hi-Nella, Pine Valley, Tavistock	37	39.8015	-74.9686	506471	67118	Virtua Voorhees Hospital, Virtua Berlin Hospital, Cooper University Hospital, Virtua Hospital(labor + Delivery - OR # 1; Virtua Voorhees CHOP Specialty Care Center, Jefferson Stratford Hospital, Cooper Surgical Associates, Virtua Marlton Hospital, Garden State OB/GYN - Voorhees, Camden County Health Services Center, elmwood hills healthcare center, Millennium Surgical Center, Virtua Health & Wellness Center - Voorhees, MedExpress Urgent Care, Jefferson Cherry Hill Hospital, Jefferson University Hospitals - Voorhees, Our Lady of Lourdes Hospital, Lourdes At Cherry Hill, Marlton Rehabilitation Hospital, cooper medical center 8th floor solarium, 1 Cooper Plaza, Camden, NJ	21
12	Monmouth County	Middletown, Howell, Marlboro, Manalapan, Freehold Township, Long Branch, Neptune, Ocean Township, Wall Township, Hazlet, Aberdeen, Tinton Falls, Holmdel, Asbury Park, Eatontown, Red Bank, Freehold, Millstone Township, Colts Neck, Keansburg, Matawan, West Long Branch, Keyport, Rumson, Upper Freehold, Union Beach, Fair Haven, Little Silver, Manasquan, Oceanport, Belmar, Highlands, Neptune City, Brielle, Spring Lake Heights, Atlantic Highlands, Bradley Beach, Shrewsbury, Monmouth Beach, Spring Lake, Avon-by-the-Sea, Englishtown, Allentown, Sea Girt, Lake Como, Sea Bright, Farmingdale, Shrewsbury Township, Roosevelt, Interlaken, Deal, Allenhurst, Loch Arbour	53	40.2589	-74.1240	618795	95699	Ocean Medical Center, Jersey Shore University Medical Center, Monmouth Medical Center, Riverview Medical Center, CentraState Medical Center, Northwest Pavilion, Jersey Shore University Medical Center - Nuclear Medicine	7
13	Morris County	Parsippany, Mount Olive, Randolph, Rockaway Township, Roxbury, Morris Township, Montville, Jefferson Township, Washington Township, Morristown, Dover, Denville, Madison, Pequannock, Hanover, Florham Park, East Hanover, Lincoln Park, Chatham Township, Kinnelon, Chatham, Long Hill Township, Boonton, Chester Township, Butler, Wharton, Rockaway, Mendham Township, Morris Plains, Mount Arlington, Mendham, Boonton Township, Mountain Lakes, Harding Township, Mine Hill, Riverdale, Netcong, Chester Borough, Victory Gardens	39	40.868	-74.5601	491845	111316	Gagnon Cardiovascular Institute, Morristown Medical Center, Morristown Memorial Hospital, St. Clare's Hospital, Kessler Rehab Center, St. Clare's Hospital - Dover Campus, Saint Clare's Denville Hospital, Kindred Hospital New Jersey - Morris County	8
14	Ocean County	Lakewood, Toms River, Brick, Jackson, Manchester, Berkeley Township, Lacey Township, Stafford Township, Barnegat, Little Egg Harbor, Point Pleasant, Beachwood, Plumsted Township, Ocean Township, Point Pleasant Beach, South Toms River, Tuckerton, Long Beach, Seaside Heights, Lakehurst, Pine Beach, Ocean Gate, Lavallette, Island Heights, Eagleswood, Seaside Park, Surf City, Beach Haven, Ship Bottom, Bay Head, Barnegat Light, Harvey Cedars, Mantoloking	33	39.9778	-74.3319	607186	68021	Kimball Medical Center, Hackensack Meridian Health Southern Ocean Medical Center, Southern Ocean Medical Center, Community Medical Center, Urgent Care Now- Lanoka Harbor, Children's Specialized Hospital, dream world, community medical center radiology, Community Medical Center Cafeteria, CMC - Outpatient Infusion, Cmc hospital, Community Medical Center Doctors Lounge, Urgent Care Now- Toms River, Specialty Hospital of Central Jersey, Monmouth Medical Center, Southern Campus	15

Cluster 2 above contains 5 counties. The counties with an average amount of municipalities and population were grouped together. Not the most but also not the least.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
Bergen County	Hackensack; Teaneck; Fort Lee; Fair Lawn; Garfield; Englewood; Bergenfield; Paramus; Mahwah; Ridgewood; Lodi; Cliffs Park; Lyndhurst; Palisades Park; Elmwood Park; Rutherford; Dumont; Wyckoff; New Milford; North Arlington; Tenafly; Ramsey; Fairview; Saddle Brook; Oakland; Ridgefield Park; Hasbrouck Heights; Glen Rock; Edgewater; River Edge; Wallington; Ridgefield; Westwood; Little Ferry; Franklin Lakes; Hillsdale; River Vale; Waldwick; Maywood; Washington Township; Leonia; East Rutherford; Park Ridge; Cresskill; Closter; Upper Saddle River; Bogota; Oradell; Montvale; Wood-Ridge; Emerson; Midland Park; Aliendale; Carlstadt; Old Tappan; Woodcliff Lake; Norwood; Rochelle Park; Englewood Cliffs; Demarest; Harrington Park; Northvale; Ho-Ho-Kus; Haverth; Saddle River; Moonachie; South Hackensack; Alpine; Rockleigh; Teterboro	70	40.9678	-74.0563	932202	95837	Hackensack University Medical Center; Holy Name Medical Center; EPMC - Englewood Hospital and Medical Center; The Valley Hospital; Hackensack Meridian Health Pascack Valley Medical Center; St. Joseph's Regional Medical Center; Bergen Regional Medical Center; Joseph M. Sanzari Children's Hospital; John Thuermer Cancer Center; Holy Name Terrace Cafe; CityMD Teterboro	11

Cluster 3 above contains 1 county. This county has the most municipalities in New Jersey and the highest population.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
6 Essex County	Newark; East Orange; Irvington; Bloomfield; West Orange; Montclair; Belleville; City of Orange; Livingston; Nutley; Maplewood; Millburn; South Orange Village; Verona; Cedar Grove; West Caldwell; Caldwell; Glen Ridge; Fairfield; North Caldwell; Roseland; Essex Falls	22	40.7914	-74.2479	798975	59302	Saint Barnabas Medical Center; Mountainside Hospital; Kessler Institute for Rehabilitation; Clara Maass Medical Center; Barnabas Health Ambulatory Care Center; Arlington Dog And Cat Hospital; VA Medical Center - East Orange; Veterans Hospital; East Orange General Hospital; SBMC - Radiation Oncology; The Cooperman Family Pavilion West Oncology; Clara Maass Icu Unit; University Hospital; St. Michael's Medical Center; St. Mary's General Hospital; Immedicenter	16
8 Hudson County	Jersey City; Union City; Bayonne; North Bergen; Hoboken; West New York; Kearny; Secaucus; Harrison; Weehawken; Guttenberg; East Newark	12	40.7382	-74.0551	672391	66289	Meadowlands Hospital Medical Center; CarePoint Health; Hoboken University Medical Center; Hackensack Meridian Health Palisades Medical Center; CarePoint Health; Bayonne Medical Center; Jersey City Medical Center	5
11 Middlesex County	Edison; Woodbridge; Old Bridge; Piscataway; New Brunswick; Perth Amboy; East Brunswick; South Brunswick; Sayreville; North Brunswick; Monroe Township; South Plainfield; Plainsboro; Carteret; South River; Highland Park; Middlesex; Metuchen; South Amboy; Spotswood; Dunellen; Milltown; Jamesburg; Cranbury; Helmetta	25	40.4111	-74.3587	825062	85954	Robert Wood Johnson University Hospital; Saint Peter's University Hospital; 6 North; Robert Wood Johnson University Hospital; Hackensack Meridian Health Raritan Bay Medical Center - Perth Amboy; Raritan Bay - Old Bridge; Bayshore Community Hospital; Northern Monmouth Regional Surgery Center, LLC; Medplus Home Health; Raritan Bay Medical Center Cafeteria	10
15 Passaic County	Paterson; Clifton; Passaic; Wayne; West Milford; Hawthorne; Little Falls; Ringwood; Woodland Park; Wanaque; Pompton Lakes; Totowa; North Haledon; Haledon; Bloomingdale; Prospect Park	16	41.0462	-74.3178	501826	66476	Chilton Memorial Hospital	1
19 Union County	Elizabeth; Union; Plainfield; Linden; Westfield; Rahway; Scotch Plains; Cranford; Summit; Hillsdale; Roselle; Springfield; Clark; Roselle Park; Berkeley Heights; New Providence; Kenilworth; Fanwood; Mountainside; Garwood; Winfield	21	40.6652	-74.3045	556341	77095	Overlook Medical Center; Newark Beth Israel Medical Center; Trinitas Regional Medical Center; RWJ University Hospital Rahway; Runnells Specialized Hospital; Mercy 6; JFK Johnson Rehabilitation Institute	7

Cluster 4 above contains 5 counties. This appears to be an outlier cluster. The counties here have a lot of population but not a lot of municipalities.

## 4.2 Analysis of Median Income and # of Municipalities

As we saw this combination had 5 clusters:

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
7 Gloucester County	Washington Township; Monroe Township; Deptford; West Deptford; Glassboro; Franklin Township; Mantua; Harrison Township; Woolwich Township; Woodbury; East Greenwich Township; Pitman; Clayton; Paulsboro; Logan Township; Greenwich Township; Westville; Elk Township; South Harrison Township; Woodbury Heights; National Park; Swedesboro; Wenonah; Newfield	24	39.7267	-75.1535	291636	85160	Kennedy University Hospital; Virtua Medicine; Kennedy ER Washington Twp; Jefferson Washington Township Hospital; Kennedy Surgical Center; Virtua Center for Surgery - Washington Township; Inspira Medical Center Woodbury; Joan Wiley, DO	8
10 Mercer County	Hamilton; Trenton; Ewing; Lawrence; Princeton; East Windsor; West Windsor; Hopewell Township; Robbinsville; Hightstown; Pennington; Hopewell	12	40.2807	-74.7034	367430	79990	University Medical Center of Princeton at Plainsboro; Medical Arts Pavilion; University Medical Center of Princeton at Plainsboro; RWJ University Hospital Hamilton; NorthStar Vets; Robertwood Johnson University Hospital Hamilton; Tele North; Mercer Family Health Center; Capital Health Regional Medical Center; Capital Health Medical Center - Hopewell	8
11 Middlesex County	Edison; Woodbridge; Old Bridge; Piscataway; New Brunswick; Perth Amboy; East Brunswick; South Brunswick; Sayreville; North Brunswick; Monroe Township; South Plainfield; Plainsboro; Carteret; South River; Highland Park; Middlesex; Metuchen; South Amboy; Spotswood; Dunellen; Milltown; Jamesburg; Cranbury; Helmetta	25	40.4111	-74.3587	825062	85954	Robert Wood Johnson University Hospital; Saint Peter's University Hospital; 6 North; Robert Wood Johnson University Hospital; Hackensack Meridian Health Raritan Bay Medical Center - Perth Amboy; Raritan Bay - Old Bridge; Bayshore Community Hospital; Northern Monmouth Regional Surgery Center, LLC; Medplus Home Health; Raritan Bay Medical Center Cafeteria	10
18 Sussex County	Vernon; Sparta; Hopatcong; Wantage Township; Byram Township; Hardyston Township; Newton; Andover Township; Frankford Township; Hampton Township; Franklin; Stillwater Township; Montague; Stanhope; Green Township; Fredon Township; Hamburg; Lafayette; Ogdenburg; Sussex; Sandyston Township; Branchville; Andover; Walpack Township	24	41.1334	-74.693	140488	90520	Newton Medical Center	1
19 Union County	Elizabeth; Union; Plainfield; Linden; Westfield; Rahway; Scotch Plains; Cranford; Summit; Hillsdale; Roselle; Springfield; Clark; Roselle Park; Berkeley Heights; New Providence; Kenilworth; Fanwood; Mountainside; Garwood; Winfield	21	40.6652	-74.3045	556341	77095	Overlook Medical Center; Newark Beth Israel Medical Center; Trinitas Regional Medical Center; RWJ University Hospital Rahway; Runnells Specialized Hospital; Mercy 6; JFK Johnson Rehabilitation Institute	7
20 Warren County	Phillipsburg; Hackettstown; Lopatcong Township; Mansfield Township; Washington Township; Washington; Blairstown; Greenwich Township; Independence Township; White Township; Allamuchy; Pohatcong Township; Franklin Township; Knowlton Township; Liberty Township; Belvidere; Harmony Township; Oxford Township; Alpha; Frelinghuysen Township; Hope Township; Hardwick Township	22	40.8602	-74.972	105267	78145	Hackettstown Regional Medical Center	1

Cluster 1 above contains 6 counties. The counties with a high income and average number of municipalities were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
1 Bergen County	Hackensack; Teaneck; Fort Lee; Fair Lawn; Garfield; Englewood; Bergenfield; Paramus; Mahwah; Ridgewood; Lodi; Cliffside Park; Lyndhurst; Palisades Park; Elmwood Park; Rutherford; Dumont; Wyckoff; New Milford; North Arlington; Tenafly; Ramsey; Fairview; Saddle Brook; Oakland; Ridgefield Park; Hasbrouck Heights; Glen Rock; Edgewater; River Edge; Wallington; Ridgefield; Westwood; Little Ferry; Franklin Lakes; Hillsdale; River Vale; Waldwick; Maywood; Washington Township; Leonia; East Rutherford; Park Ridge; Cresskill; Closter; Upper Saddle River; Bogota; Oradell; Montvale; Wood-Ridge; Emerson; Midland Park; Allendale; Carlstadt; Old Tappan; Woodcliff Lake; Norwood; Rochelle Park; Englewood Cliffs; Demarest; Harrington Park; Northvale; Ho-Ho-Kus; Haworth; Saddle River; Moonachie; South Hackensack; Alpine; Rockleigh; Teterboro	70	40.9678	-74.0563	932202	95837	Hackensack University Medical Center; Holy Name Medical Center; EHMCO - Englewood Hospital and Medical Center; The Valley Hospital; Hackensack Meridian Health Pascack Valley Medical Center; St. Joseph's Regional Medical Center; Bergen Regional Medical Center; Joseph M. Sanzani Children's Hospital; John Thuermer Cancer Center; Holy Name Terrace Cafe; CityMD Teletorbo	11
12 Monmouth County	Middletown; Howell; Marlboro; Manalapan; Freehold Township; Long Branch; Neptune; Ocean Township; Wall Township; Hazlet; Aberdeen; Tinton Falls; Holmdel; Asbury Park; Eatontown; Red Bank; Freehold; Millstone Township; Colts Neck; Kearsburg; Matawan; West Long Branch; Keyport; Rumson; Upper Freehold; Union Beach; Fair Haven; Little Silver; Mansquan; Oceanport; Belmar; Highlands; Neptune City; Brielle; Spring Lake Heights; Atlantic Highlands; Bradley Beach; Shrewsbury; Monmouth Beach; Spring Lake; Avon-by-the-Sea; Englishtown; Allentown; Sea Girt; Lake Como; Sea Bright; Farmingdale; Shrewsbury Township; Roosevelt; Interlaken; Deal; Allenhurst; Loch Arbour	53	40.2589	-74.1240	618795	95699	Ocean Medical Center; Jersey Shore University Medical Center; Monmouth Medical Center; Riverview Medical Center; CentraState Medical Center; Northwest Pavilion; Jersey Shore University Medical Center - Nuclear Medicine	7

Cluster 2 above contains 2 counties. The counties with the highest number of municipalities and a high income were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
9 Hunterdon County	Raritan Township; Readington; Clinton Township; Lebanon Township; Tewksbury; Union Township; Holland Township; Alexandria Township; Flemington; Delaware Township; East Amwell; Bethlehem Township; Lambertville; Kingwood Township; West Amwell; High Bridge; Franklin Township; Clinton; Glen Gardner; Hampton; Frenchtown; Lebanon; Milford; Califon; Bloomsbury; Stockton	26	40.5771	-74.9262	124371	112535	Hunterdon Medical Center	1
13 Morris County	Parsippany; Mount Olive; Randolph; Rockaway Township; Roxbury; Morris Township; Montville; Jefferson Township; Washington Township; Morristown; Dover; Denville; Madison; Pequannock; Hanover; Florham Park; East Hanover; Lincoln Park; Chatham Township; Kinnelon; Chatham; Long Hill Township; Boonton; Chester Township; Butler; Wharton; Rockaway; Mendham Township; Morris Plains; Mount Arlington; Mendham; Boonton Township; Mountain Lakes; Harding Township; Mine Hill; Riverdale; Netcong; Chester Borough; Victory Gardens	39	40.868	-74.5601	491845	111316	Gagnon Cardiovascular Institute; Morristown Medical Center; Morristown Memorial Hospital; St. Clare's Hospital; Kessler Rehab Center; St. Clare's Hospital - Dover Campus; Saint Clare's Denville Hospital; Kindred Hospital New Jersey - Morris County	8
17 Somerset County	Franklin Township; Bridgewater; Hillsborough; Bernards Township; Montgomery; North Plainfield; Warren; Branchburg; Somerville; Bound Brook; Manville; Bedminster; Bernardsville; Green Brook; Raritan; Watchung; South Bound Brook; Peapack and Gladstone; Far Hills; Rocky Hill; Millstone	21	40.5675	-74.619	328934	111772	Carrier Clinic	1

Cluster 3 above contains 3 counties. The counties with the highest income and an average number of municipalities were grouped together. This is the outlier group.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
0 Atlantic County	Egg Harbor Township; Atlantic City; Galloway Township; Hamilton Township; Pleasantville; Hammonton; Somers Point; Ventnor City; Brigantine; Northfield; Absecon; Buena Vista; Linwood; Margate City; Mullica Township; Buena; Egg Harbor City; Weymouth Township; Folsom; Estell Manor; Port Republic; Longport; Corbin City	23	39.5143	-74.6633	263670	59989	AtlantiCare Regional Medical Center; Atlantic City Campus; AtlantiCare Regional Medical Center - Imaging Services; ARMCCity Hospital 3rd Fl Dialysis; Acuity Specialty Hospital; Shore Medical Center; ARMC PCCU	6
4 Cape May County	Lower Township; Middle Township; Upper Township; Ocean City; Dennis Township; Wildwood; North Wildwood; Cape May; Wildwood Crest; Woodbine; Sea Isle City; Avalon; West Cape May; Stone Harbor; West Wildwood; Cape May Point	16	39.1765	-74.8012	92039	63690	Cape Regional Medical Center	1
5 Cumberland County	Vineland; Millville; Bridgeton; Maurice River; Upper Deerfield Township; Fairfield Township; Commercial Township; Hopewell Township; Lawrence Township; Deerfield Township; Downe Township; Stow Creek Township; Greenwich Township; Shiloh	14	39.3183	-75.1623	149527	52593	Inspira Medical Center Vineland; Cumberland Manor	2
6 Essex County	Newark; East Orange; Irvington; Bloomfield; West Orange; Montclair; Belleville; City of Orange; Livingston; Nutley; Maplewood; Millburn; South Orange Village; Verona; Cedar Grove; West Caldwell; Caldwell; Glen Ridge; Fairfield; North Caldwell; Roseland; Essex Fells	22	40.7914	-74.2479	798975	59302	Saint Barnabas Medical Center; Mountainside Hospital; Kessler Institute for Rehabilitation; Clara Maass Medical Center; Barnabas Health Ambulatory Care Center; Arlington Dog And Cat Hospital; VA Medical Center - East Orange; Veterans Hospital; East Orange General Hospital; SBMC - Radiation Oncology; The Cooperman Family Pavilion West Oncology; Clara Maass Icu Unit; University Hospital; St. Michael's Medical Center; St. Mary's General Hospital; Immedicenter	16
8 Hudson County	Jersey City; Union City; Bayonne; North Bergen; Hoboken; West New York; Kearny; Secaucus; Harrison; Weehawken; Guttenberg; East Newark	12	40.7382	-74.0551	672391	66289	Meadowlands Hospital Medical Center; CarePoint Health; Hoboken University Medical Center; Hackensack Meridian Health Palisades Medical Center; CarePoint Health; Bayonne Medical Center; Jersey City Medical Center	5
15 Passaic County	Paterson; Clifton; Passaic; Wayne; West Milford; Hawthorne; Little Falls; Ringwood; Woodland Park; Wanaque; Pompton Lakes; Totowa; North Haledon; Haledon; Bloomingdale; Prospect Park	16	41.0462	-74.3178	501826	66476	Chilton Memorial Hospital	1
16 Salem County	Pennsville; Pittsgrove Township; Carneys Point; Penns Grove; Salem; Pilesgrove Township; Upper Pittsgrove; Woodstown; Alloway Township; Quinton Township; Mannington Township; Oldmans Township; Lower Alloways Creek; Elmer; Elsinboro Township	15	39.5981	-75.3488	62385	64309	Elmer Hospital; Inspira Medical Center Elmer; Elmer Hospital-surgical waiting room; Memorial Hospital Salem County; Salem Medical Center	5

Cluster 4 above contains 7 counties. The counties with the lowest income and lowest number of municipalities were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
2 Burlington County	Evesham Township; Mount Laurel; Willingboro; Pemberton Township; Medford; Burlington Township; Moorestown; Maple Shade; Delran; Cinnaminson; Lumberton; Florence; Bordentown Township; Southampton; Burlington; Mount Holly; Edgewater Park; Westampton; Mansfield Township; Riverside; Chesterfield; North Hanover; Palmyra; New Hanover; Tabernacle; Shamong; Hainesport; Eastampton; Delanco; Medford Lakes; Bordentown; Springfield Township; Riverton; Beverly; Woodland Township; Bass River; Pemberton; Wrightstown; Washington Township; Fieldsboro	40	39.9325	-74.7227	445349	84992	Virtua Memorial Hospital; Deborah Heart and Lung Center; Virtua Memorial 5 Stokes; Acuity Specialty Hospital; Lourdes Medical Center Of Burlington County; Lourdes Medical Center of Burlington County; Virtua Memorial Emergency Dept; CareOne Harmony Village; Samaritan Hospice @ Virtua Memorial Hospital	9
3 Camden County	Camden; Cherry Hill; Gloucester Township; Winslow Township; Pennsauken; Voorhees; Lindenwold; Haddon Township; Collingswood; Haddonfield; Bellmawr; Gloucester City; Waterford Township; Pine Hill; Audubon; Runnemede; Berlin; Haddon Heights; Stratford; Barrington; Berlin Township; Somerdale; Clementon; Mount Ephraim; Magnolia; Oaklyn; Merchantville; Woodlynne; Lawnside; Gibbsboro; Brooklawn; Laurel Springs; Chesilhurst; Audubon Park; Hi-Nella; Pine Valley; Tavistock	37	39.8015	-74.9686	506471	67118	Virtua Voorhees Hospital; Virtua Berlin Hospital; Cooper University Hospital; Virtua Hospital(labor + Delivery - OR # 1; Virtua Voorhees CHOP Specialty Care Center; Jefferson Stratford Hospital; Cooper Surgical Associates; Virtua Marlton Hospital; Garden State OB/GYN - Voorhees; Camden County Health Services Center; elmwood hills healthcare center; Millennium Surgical Center; Virtua Health & Wellness Center - Voorhees; MedExpress Urgent Care; Jefferson Cherry Hill Hospital; Jefferson University Hospitals - Voorhees; Our Lady of Lourdes Hospital; Lourdes At Cherry Hill; Marlton Rehabilitation Hospital; cooper medical center 8th floor solarium; 1 Cooper Plaza, Camden, NJ	21
14 Ocean County	Lakewood; Toms River; Brick; Jackson; Manchester; Berkeley Township; Lacey Township; Stafford Township; Barnegat; Little Egg Harbor; Point Pleasant; Beachwood; Plumsted Township; Ocean Township; Point Pleasant Beach; South Toms River; Tuckerton; Long Beach; Seaside Heights; Lakehurst; Pine Beach; Ocean Gate; Lavallette; Island Heights; Eagleswood; Seaside Park; Surf City; Beach Haven; Ship Bottom; Bay Head; Barnegat Light; Harvey Cedars; Mantoloking	33	39.9778	-74.3319	607186	68021	Kimball Medical Center; Hackensack Meridian Health Southern Ocean Medical Center; Southern Ocean Medical Center; Community Medical Center; Urgent Care Now- Lanoka Harbor; Children's Specialized Hospital; dream world; community medical center radiology; Community Medical Center Cafeteria; CMC - Outpatient Infusion; Cmc hospital; Community Medical Center Doctors Lounge; Urgent Care Now- Toms River; Specialty Hospital of Central Jersey; Monmouth Medical Center; Southern Campus	15

Cluster 5 above contains 3 counties. The counties have an average amount of municipalities and an average amount of income. Not the most but also not the least.

## 4.3 Analysis of # of Hospitals and # of Municipalities

As we saw this combination had 3 clusters:

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
1 Bergen County	Hackensack; Teaneck; Fort Lee; Fair Lawn; Garfield; Englewood; Bergenfield; Paramus; Mahwah; Ridgewood; Lodi; Cliffside Park; Lyndhurst; Palisades Park; Elmwood Park; Rutherford; Dumont; Wyckoff; New Milford; North Arlington; Tenafly; Ramsey; Fairview; Saddle Brook; Oakland; Ridgefield Park; Hasbrouck Heights; Glen Rock; Edgewater; River Edge; Wallington; Ridgefield; Westwood; Little Ferry; Franklin Lakes; Hillsdale; River Vale; Waldwick; Maywood; Washington Township; Leonia; East Rutherford; Park Ridge; Cresskill; Closter; Upper Saddle River; Bogota; Oradell; Montvale; Wood-Ridge; Emerson; Midland Park; Allendale; Carlstadt; Old Tappan; Woodcliff Lake; Norwood; Rochelle Park; Englewood Cliffs; Demarest; Harrington Park; Northvale; Ho-Ho-Kus; Haworth; Saddle River; Moonachie; South Hackensack; Alpine; Rockleigh; Teterboro	70	40.9678	-74.0563	932202	95837	Hackensack University Medical Center; Holy Name Medical Center; EHMC - Englewood Hospital and Medical Center; The Valley Hospital; Hackensack Meridian Health Pasack Valley Medical Center; St. Joseph's Regional Medical Center; Bergen Regional Medical Center; Joseph M. Sanzani Children's Hospital; John Theurer Cancer Center; Holy Name Terrace Cafe; CityMD Teterboro	11
2 Burlington County	Evesham Township; Mount Laurel; Willingboro; Pemberton Township; Medford; Burlington Township; Moorestown; Maple Shade; Delran; Cinnaminson; Lumberton; Florence; Bordentown Township; Southampton; Burlington; Mount Holly; Edgewater Park; Hainesport; Eastampton; Delanco; Medford Lakes; Bordentown; Springfield Township; Riverton; Beverly; Woodland Township; Bass River; Pemberton; Wrightstown; Washington Township; Fieldsboro	40	39.9325	-74.7227	445349	84992	Virtua Memorial Hospital; Deborah Heart and Lung Center; Virtua Memorial 5 Stokes; Acuity Specialty Hospital; Lourdes Medical Center Of Burlington County; Lourdes Medical Center of Burlington County; Virtua Memorial Emergency Dept; CareOne Harmony Village; Samaritan Hospice @ Virtua Memorial Hospital	9
12 Monmouth County	Middletown; Howell; Marlboro; Manalapan; Freehold Township; Long Branch; Neptune; Ocean Township; Wall Township; Hazlet; Aberdeen; Tinton Falls; Holmdel; Asbury Park; Eatontown; Red Bank; Freehold; Millstone Township; Colts Neck; Keansburg; Matawan; West Long Branch; Keyport; Rumson; Upper Freehold; Union Beach; Fair Haven; Little Silver; Manasquan; Oceanport; Belmar; Highlands; Neptune City; Brielle; Spring Lake Heights; Atlantic Highlands; Bradley Beach; Shrewsbury; Monmouth Beach; Spring Lake; Avon-by-the-Sea; Englishtown; Allentown; Sea Girt; Lake Como; Sea Bright; Farmingdale; Shrewsbury Township; Roosevelt; Interlaken; Deal; Allenhurst; Loch Arbour	53	40.2589	-74.1240	618795	95699	Ocean Medical Center; Jersey Shore University Medical Center; Monmouth Medical Center; Riverview Medical Center; Central State Medical Center; Northwest Pavilion; Jersey Shore University Medical Center - Nuclear Medicine	7
13 Morris County	Parsippany; Mount Olive; Randolph; Rockaway Township; Roxbury; Morris Township; Montville; Jefferson Township; Washington Township; Morristown; Dover; Denville; Madison; Pequannock; Hanover; Florham Park; East Hanover; Lincoln Park; Chatham Township; Kinnelon; Chatham; Long Hill Township; Boonton; Chester Township; Butler; Wharton; Rockaway; Mendham Township; Morris Plains; Mount Arlington; Mendham; Boonton Township; Mountain Lakes; Harding Township; Mine Hill; Riverdale; Netcong; Chester Borough; Victory Gardens	39	40.868	-74.5601	491845	111316	Gagnon Cardiovascular Institute; Morristown Medical Center; Morristown Memorial Hospital; St. Clare's Hospital; Kessler Rehab Center; St. Clare's Hospital - Dover Campus; Saint Clare's Denville Hospital; Kindred Hospital New Jersey - Morris County	8

Cluster 1 above contains 4 counties. The counties with the greatest number of municipalities and a lot of hospitals were grouped together. This could be an outlier group because the municipality to hospital ratio does not add up.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
0 Atlantic County	Egg Harbor Township; Atlantic City; Galloway Township; Hamilton Township; Pleasantville; Hammonton; Somers Point; Ventnor City; Brigantine; Northfield; Absecon; Buena Vista; Linwood; Margate City; Mullica Township; Buena; Egg Harbor City; Weymouth Township; Folsom; Estell Manor; Port Republic; Longport; Corbin City	23	39.5143	-74.6833	283870	59089	AtlantiCare Regional Medical Center; Atlantic City Campus; AtlantiCare Regional Medical Center - Imaging Services; ARMCCity Hospital 3rd Fl Dialysis; Acuity Specialty Hospital; Shore Medical Center; ARMC PCOU	6
4 Cape May County	Lower Township; Middle Township; Upper Township; Ocean City; Dennis Township; Wildwood; North Wildwood; Cape May; Wildwood Crest; Woodbine; Sea Isle City; Avalon; West Cape May; Stone Harbor; West Wildwood; Cape May Point	16	39.1765	-74.8012	92039	63690	Cape Regional Medical Center	1
5 Cumberland County	Vineland; Millville; Bridgeton; Maurice River; Upper Deerfield Township; Fairfield Township; Commercial Township; Hopewell Township; Lawrence Township; Deerfield Township; Downe Township; Stow Creek Township; Greenwich Township; Shiloh	14	39.3183	-75.1023	149527	52593	Inspira Medical Center Vineland; Cumberland Manor	2
7 Gloucester County	Washington Township; Monroe Township; Deptford; West Deptford; Glassboro; Franklin Township; Mantua; Harrison Township; Woolwich Township; Woodbury; East Greenwich Township; Pitman; Clayton; Paulsboro; Logan Township; Greenwich Township; Westville; Elk Township; South Harrison Township; Woodbury Heights; National Park; Swedesboro; Wenonah; Newfield	24	39.7287	-75.1535	291636	85160	Kennedy University Hospital; Virtua Medicine; Kennedy ER Washington Twp; Jefferson Washington Township Hospital; Kennedy Surgical Center; Virtua Center for Surgery - Washington Township; Inspira Medical Center Woodbury; Joan Wiley DO	6
8 Hudson County	Jersey City; Union City; Bayonne; North Bergen; Hoboken; West New York; Kearny; Secaucus; Harrison; Weehawken; Guttenberg; East Newark	12	40.7382	-74.0551	672391	68289	Meadowlands Hospital Medical Center; CarePoint Health; Hoboken University Medical Center; Hackensack Meridian Health Palisades Medical Center; CarePoint Health; Bayonne Medical Center; Jersey City Medical Center	6
9 Hunterdon County	Raritan Township; Readington; Clinton Township; Lebanon Township; Tewksbury; Union Township; Holland Township; Alexandria Township; Flemington; Delaware Township; East Amwell; Bethlehem Township; Lambertville; Kingwood Township; West Amwell; High Bridge; Franklin Township; Clinton; Glen Gardner; Hampton; Frenchtown; Lebanon; Milford; Califon; Bloomsbury; Stockton	26	40.5771	-74.9282	124371	112535	Hunterdon Medical Center	1
10 Mercer County	Hamilton; Trenton; Ewing; Lawrence; Princeton; East Windsor; West Windsor; Hopewell Township; Robbinsville; Hightstown; Pennington; Hopewell	12	40.2807	-74.7034	367430	76990	University Medical Center of Princeton at Plainsboro; Medical Arts Pavilion; University Medical Center of Princeton at Plainsboro; RWJ University Hospital Hamilton; NorthStar Vets; Robertwood Johnson University Hospital Hamilton; Tele North; Mercer Family Health Center; Capital Health Regional Medical Center; Capital Health Medical Center - Hopewell	8
11 Middlesex County	Edison; Woodbridge; Old Bridge; Piscataway; New Brunswick; Perth Amboy; East Brunswick; South Brunswick; Sayreville; North Brunswick; Monroe Township; South Plainfield; Plainsboro; Carteret; South River; Highland Park; Middlesex; Metuchen; South Amboy; Spotswood; Dunellen; Milltown; Jamesburg; Cranbury; Helmetta	25	40.4111	-74.3587	825062	85054	Robert Wood Johnson University Hospital; Saint Peter's University Hospital; 6 North; Robert Wood Johnson University Hospital; Hackensack Meridian Health Raritan Bay Medical Center - Perth Amboy; Raritan Bay -Old Bridge; Bayshore Community Hospital; Northern Monmouth Regional Surgery Center, LLC; Medplus Home Health; Raritan Bay Medical Center Cafeteria	10
15 Passaic County	Paterson; Clifton; Passaic; Wayne; West Milford; Hawthorne; Little Falls; Ringwood; Woodland Park; Wanaque; Pompton Lakes; Totowa; North Haledon; Haledon; Bloomington; Prospect Park	16	41.0462	-74.3178	501826	68476	Chilton Memorial Hospital	1
16 Salem County	Pennsville; Pittsgrove Township; Carneys Point; Penns Grove; Salem; Pilesgrove Township; Upper Pittsgrove; Woodstown; Alloway Township; Quinton Township; Mannington Township; Oldmans Township; Lower Alloways Creek; Elmer; Elsinboro Township	15	39.5961	-75.3488	62385	64309	Elmer Hospital; Inspira Medical Center Elmer; Elmer Hospital-surgical waiting room; Memorial Hospital Salem County; Salem Medical Center	5
17 Somerset County	Franklin Township; Bridgewater; Hillsborough; Bernards Township; Montgomery; North Plainfield; Warren; Branchburg; Somerville; Bound Brook; Manville; Sedminster; Bernardsville; Green Brook; Raritan; Watchung; South Bound Brook; Peapack and Gladstone; Far Hills; Rocky Hill; Millstone	21	40.5875	-74.619	328934	111772	Carrier Clinic	1
18 Sussex County	Vernon; Sparta; Hopatcong; Wantage Township; Byram Township; Hardyston Township; Newton; Andover Township; Frankford Township; Hampton Township; Franklin; Stillwater Township; Montague; Stanhope; Green Township; Fredon Township; Hamburg; Lafayette; Ogdensburg; Sussex; Sandyston Township; Branchville; Andover; Walpack Township	24	41.1334	-74.893	140488	90520	Newton Medical Center	1
19 Union County	Elizabeth; Union; Plainfield; Linden; Westfield; Rahway; Scotch Plains; Cranford; Summit; Hillside; Roselle; Springfield; Clark; Roselle Park; Berkeley Heights; New Providence; Kenilworth; Fanwood; Mountainside; Garwood; Winfield	21	40.6652	-74.3045	558341	77095	Overlook Medical Center; Newark Beth Israel Medical Center; Trinitas Regional Medical Center; RWJ University Hospital Rahway; Runnels Specialized Hospital; Mercy 8; JFK Johnson Rehabilitation Institute	7
20 Warren County	Phillipsburg; Hackettstown; Lopatcong Township; Mansfield Township; Washington Township; Washington; Blairstown; Greenwich Township; Independence Township; White Township; Allamuchy; Pohatcong Township; Franklin Township; Knowlton Township; Liberty Township; Belvidere; Harmony Township; Oxford Township; Alpha; Frelinghuysen Township; Hope Township; Hardwick Township	22	40.8802	-74.972	105287	78145	Hackettstown Regional Medical Center	1

Cluster 2 above contains 14 counties. The counties with the least number of municipalities and the least number of hospitals were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
3 Camden County	Camden; Cherry Hill; Gloucester Township; Winslow Township; Pennsauken; Voorhees; Lindenwald; Haddon Township; Collingswood; Haddonfield; Bellmawr; Gloucester City; Waterford Township; Pine Hill; Audubon; Runnemede; Berlin; Haddon Heights; Stratford; Barrington; Berlin Township; Somerdale; Clementon; Mount Ephraim; Magnolia; Oaklyn; Merchantville; Woodlynne; Lawnside; Gibbsboro; Brooklawn; Laurel Springs; Chesilhurst; Audubon Park; Hi-Nella; Pine Valley; Tavistock	37	39.8015	-74.9586	506471	67118	Virtua Voorhees Hospital; Virtua Berlin Hospital; Cooper University Hospital; Virtua Hospital(labor + Delivery - OR # 1; Virtua Voorhees CHOP Specialty Care Center; Jefferson Stratford Hospital; Cooper Surgical Associates; Virtua Marlton Hospital; Garden State OB/GYN - Voorhees; Camden County Health Services Center; elmwood hills healthcare center; Millennium Surgical Center; Virtua Health & Wellness Center - Voorhees; MedExpress Urgent Care; Jefferson Cherry Hill Hospital; Jefferson University Hospitals - Voorhees; Our Lady of Lourdes Hospital; Lourdes At Cherry Hill; Marlton Rehabilitation Hospital; cooper medical center 8th floor solarium; 1 Cooper Plaza, Camden, NJ	21
6 Essex County	Newark; East Orange; Irvington; Bloomfield; West Orange; Montclair; Belleville; City of Orange; Livingston; Nutley; Maplewood; Millburn; South Orange Village; Verona; Cedar Grove; West Caldwell; Caldwell; Glen Ridge; Fairfield; North Caldwell; Roseland; Essex Fells	22	40.7914	-74.2479	798975	59302	Saint Barnabas Medical Center; Mountainside Hospital; Kessler Institute for Rehabilitation; Clara Maass Medical Center; Barnabas Health Ambulatory Care Center; Arlington Dog And Cat Hospital; VA Medical Center - East Orange; Veterans Hospital; East Orange General Hospital; SEMC - Radiation Oncology; The Cooperman Family Pavilion West Oncology; Clara Maass Icu Unit; University Hospital; St. Michael's Medical Center; St. Mary's General Hospital; Immedicenter	16
14 Ocean County	Lakewood; Toms River; Brick; Jackson; Manchester; Berkeley Township; Lacey Township; Stafford Township; Barnegat; Little Egg Harbor; Point Pleasant; Beachwood; Plumsted Township; Ocean Township; Point Pleasant Beach; South Toms River; Tuckerton; Long Beach; Seaside Heights; Lakehurst; Pine Beach; Ocean Gate; Lavallette; Island Heights; Eagleswood; Seaside Park; Surf City; Beach Haven; Ship Bottom; Bay Head; Barnegat Light; Harvey Cedars; Mantoloking	33	39.9778	-74.3319	607186	68021	Kimball Medical Center; Hackensack Meridian Health Southern Ocean Medical Center; Southern Ocean Medical Center; Community Medical Center; Urgent Care Now- Lanoka Harbor; Children's Specialized Hospital; dream world; community medical center radiology; Community Medical Center Cafeteria; CMC - Outpatient Infusion; Cmc hospital; Community Medical Center Doctors Lounge; Urgent Care Now- Toms River; Specialty Hospital of Central Jersey; Monmouth Medical Center; Southern Campus	15

Cluster 3 above contains 3 counties. The counties with an average number of municipalities and the greatest number of hospitals were grouped together.

## 4.4 Analysis of Population and # of Hospitals

As we saw this combination had 6 clusters:

	County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
0	Atlantic County	Egg Harbor Township; Atlantic City; Galloway Township; Hamilton Township; Pleasantville; Hammonton; Somers Point; Ventnor City; Brigantine; Northfield; Absecon; Buena Vista; Linwood; Margate City; Mullica Township; Buena; Egg Harbor City; Weymouth Township; Folsom; Estell Manor; Fort Republic; Longport; Corbin City	23	39.5143	-74.6633	263670	59989	AtlantiCare Regional Medical Center, Atlantic City Campus; AtlantiCare Regional Medical Center - Imaging Services; ARMCity Hospital 3rd Fl Dialysis; Acuity Specialty Hospital; Shore Medical Center; ARMC PCCU	6
2	Burlington County	Evesham Township; Mount Laurel; Willingsboro; Pemberton Township; Medford; Burlington Township; Moorestown; Maple Shade; Delran; Cinnaminson; Lumberton; Florence; Bordertown Township; Southampton; Burlington; Mount Holly; Edgewater Park; Westampton; Mansfield Township; Riverside; Chesterfield; North Hanover; Palmyra; New Hanover; Tabernacle; Shamong; Hainesport; Eastampton; Delanco; Medford Lakes; Bordertown; Springfield Township; Riverton; Beverly; Woodland Township; Bass River; Pemberton; Wrightstown; Washington Township; Fieldsboro	40	39.9325	-74.7227	445349	84992	Virtua Memorial Hospital; Deborah Heart and Lung Center; Virtua Memorial 5 Stokes; Acuity Specialty Hospital; Lourdes Medical Center Of Burlington County; Lourdes Medical Center of Burlington County; Virtua Memorial Emergency Dept; CareOne Harmony Village; Samaritan Hospice @ Virtua Memorial Hospital	9
7	Gloucester County	Washington Township; Monroe Township; Deptford; West Deptford; Glassboro; Franklin Township; Mantua; Harrison Township; Woolwich Township; Woodbury; East Greenwich Township; Pitman; Clayton; Paulsboro; Logan Township; Greenwich Township; Westville; Elk Township; South Harrison Township; Woodbury Heights; National Park; Swedesboro; Wenonah; Newfield	24	39.7267	-75.1535	291636	85160	Kennedy University Hospital; Virtua Medicine; Kennedy ER Washington Twp; Jefferson Washington Township Hospital; Kennedy Surgical Center; Virtua Center for Surgery - Washington Township; Inspira Medical Center Woodbury; Joan Wiley, DO	8
10	Mercer County	Hamilton; Trenton; Ewing; Lawrence; Princeton; East Windsor; West Windsor; Hopewell Township; Robbinsville; Hightstown; Pennington; Hopewell	12	40.2007	-74.7034	367430	79990	University Medical Center of Princeton at Plainsboro; Medical Arts Pavilion; University Medical Center of Princeton at Plainsboro; RWJ University Hospital Hamilton; NorthStar Vets; Robertwood Johnson University Hospital Hamilton; Tele North; Mercer Family Health Center; Capital Health Regional Medical Center; Capital Health Medical Center - Hopewell	8
13	Morris County	Parsippany; Mount Olive; Randolph; Rockaway Township; Roxbury; Morris Township; Montville; Jefferson Township; Washington Township; Morristown; Dover; Denville; Madison; Pequannock; Hanover; Florham Park; East Hanover; Lincoln Park; Chatham Township; Kinnelon; Chatham; Long Hill Township; Bontion; Chester Township; Butler; Wharton; Rockaway; Mendham Township; Morris Plains; Mount Arlington; Mendham; Bontion Township; Mountain Lakes; Harding Township; Mine Hill; Riverdale; Netcong; Chester Borough; Victory Gardens	39	40.868	-74.5601	491845	111316	Gagnon Cardiovascular Institute; Morristown Medical Center; Morristown Memorial Hospital; St. Clare's Hospital; Kessler Rehab Center; St. Clare's Hospital - Dover Campus; Saint Clare's Denville Hospital; Kindred Hospital New Jersey - Morris County	8

Cluster 1 above contains 5 counties. The counties with an average population and an average number of hospitals were grouped together. Not the most but also not the least.

	County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
4	Cape May County	Lower Township; Middle Township; Upper Township; Ocean City; Dennis Township; Wildwood; North Wildwood; Cape May; Wildwood Crest; Woodbine; Sea Isle City; Avalon; West Cape May; Stone Harbor; West Wildwood; Cape May Point	16	39.1765	-74.8012	92039	63690	Cape Regional Medical Center	1
5	Cumberland County	Vineland; Millville; Bridgeton; Maurice River; Upper Deerfield Township; Fairfield Township; Commercial Township; Hopewell Township; Lawrence Township; Deerfield Township; Downe Township; Stow Creek Township; Greenwich Township; Shiloh	14	39.3183	-75.1623	149527	52593	Inspira Medical Center Vineland; Cumberland Manor	2
9	Hunterdon County	Raritan Township; Readington; Clinton Township; Lebanon Township; Tewksbury; Union Township; Holland Township; Alexandria Township; Flemington; Delaware Township; East Amwell; Bethlehem Township; Lambertville; Kingwood Township; West Amwell; High Bridge; Franklin Township; Clinton; Glen Gardner; Hampton; Frenchtown; Lebanon; Millford; Califon; Bloomsbury; Stockton	26	40.5771	-74.9262	124371	112535	Hunterdon Medical Center	1
16	Salem County	Pennsville; Pittsgrove Township; Carneys Point; Penns Grove; Salem; Pilesgrove Township; Upper Pittsgrove; Woodstown; Alloway Township; Quinton Township; Mannington Township; Oldmans Township; Lower Alloways Creek; Elmer; Elsinboro Township	15	39.5981	-75.3488	62385	64309	Elmer Hospital; Inspira Medical Center Elmer; Elmer Hospital-surgical waiting room; Memorial Hospital Salem County; Salem Medical Center	5
18	Sussex County	Vernon; Sparta; Hopatcong; Wantage Township; Byram Township; Hardyston Township; Newton; Andover Township; Frankford Township; Hampton Township; Franklin; Stillwater Township; Montague; Stanhope; Green Township; Fredon Township; Hamburg; Lafayette; Odgensburg; Sussex; Sandyston Township; Branchville; Andover; Walpack Township	24	41.1334	-74.693	140488	90520	Newton Medical Center	1
20	Warren County	Phillipsburg; Hackettstown; Lopatcong Township; Mansfield Township; Washington Township; Blainstown; Greenwiche Township; Independence Township; White Township; Allamuchy; Pohatcong Township; Franklin Township; Knowlton Township; Liberty Township; Belvidere; Harmony Township; Oxford Township; Alpha; Frelinghuysen Township; Hope Township; Hardwick Township	22	40.8602	-74.972	105267	78145	Hackettstown Regional Medical Center	1

Cluster 2 above contains 6 counties. The counties with the lowest population and the least number of hospitals were grouped together.

	County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
3	Camden County	Camden; Cherry Hill; Gloucester Township; Winslow Township; Pennsauken; Voorhees; Lindenwald; Haddon Township; Collingswood; Haddonfield; Bellmawr; Gloucester City; Waterford Township; Pine Hill; Audubon; Runnemede; Berlin; Haddon Heights; Stratford; Barrington; Berlin Township; Somerdale; Clementon; Mount Ephraim; Magnolia; Oaklyn; Merchantville; Woodlynne; Lawnside; Gibbsboro; Brooklawn; Laurel Springs; Cheslhurst; Audubon Park; Hi-Nella; Pine Valley; Tavistock	37	39.8015	-74.9686	506471	67118	Virtua Voorhees Hospital; Virtua Berlin Hospital; Cooper University Hospital; Virtua Hospital(labor + Delivery - OR # 1; Virtua Voorhees CHOP Specialty Care Center; Jefferson Stratford Hospital; Cooper Surgical Associates; Virtua Marlton Hospital; Garden State OB/GYN - Voorhees; Camden County Health Services Center; elmwood hills healthcare center; Millennium Surgical Center; Virtua Hill Wellness Center - Voorhees; MedExpress Urgent Care; Jefferson Cherry Hill Hospital; Jefferson University Hospitals - Voorhees; Our Lady of Lourdes Hospital; Lourdes At Cherry Hill; Marlton Rehabilitation Hospital; cooper medical center 8th floor solarium; 1 Cooper Plaza, Camden, NJ	21
6	Essex County	Newark; East Orange; Irvington; Bloomfield; West Orange; Montclair; Belleville; City of Orange; Livingston; Nutley; Maplewood; Millburn; South Orange Village; Verona; Cedar Grove; West Caldwell; Caldwell; Glen Ridge; Fairfield; North Caldwell; Roseland; Essex Fells	22	40.7914	-74.2479	798975	59302	Saint Barnabas Medical Center; Mountainside Hospital; Kessler Institute for Rehabilitation; Clara Maass Medical Center; Barnabas Health Ambulatory Care Center; Arlington Dog And Cat Hospital; VA Medical Center - East Orange; Veterans Hospital; East Orange General Hospital; SBMC - Radiation Oncology; The Cooperman Family Pavilion West Oncology; Clara Maass Icu Unit; University Hospital; St. Michael's Medical Center; St. Mary's General Hospital; Immedicenter	16
14	Ocean County	Lakewood; Toms River; Brick; Jackson; Manchester; Berkeley Township; Lacey Township; Stafford Township; Barnegat; Little Egg Harbor; Point Pleasant; Beachwood; Plumsted Township; Ocean Township; Point Pleasant Beach; South Toms River; Tuckerton; Long Beach; Seaside Heights; Lakelhurst; Pine Beach; Ocean Gate; Lavallette; Island Heights; Eagleswood; Seaside Park; Surf City; Beach Haven; Ship Bottom; Bay Head; Barnegat Light; Harvey Cedars; Mantoloking	33	39.9778	-74.3319	607186	68021	Kimball Medical Center; Hackensack Meridian Health Southern Ocean Medical Center; Southern Ocean Medical Center; Community Medical Center; Urgent Care Now- Lanoka Harbor; Children's Specialized Hospital; dream world; community medical center radiology; Community Medical Center Cafeteria; CMC - Outpatient Infusion; Cmc hospital; Community Medical Center Doctors Lounge; Urgent Care Now- Toms River; Specialty Hospital of Central Jersey; Monmouth Medical Center; Southern Campus	15

Cluster 3 above contains 3 counties. The counties with a lot of population and the greatest number of hospitals were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
1 Bergen County	Hackensack; Teaneck; Fort Lee; Fair Lawn; Garfield; Englewood; Bergenfield; Paramus; Mahwah; Ridgewood; Lodi; Cliffside Park; Lyndhurst; Palisades Park; Elmwood Park; Rutherford; Dumont; Wyckoff; New Milford; North Arlington; Tenafly; Ramsey; Fairview; Saddle Brook; Oakland; Ridgefield Park; Hasbrouck Heights; Glen Rock; Edgewater; River Edge; Wallington; Ridgefield; Westwood; Little Ferry; Franklin Lakes; Hillsdale; River Vale; Waldwick; Maywood; Washington Township; Leonia; East Rutherford; Park Ridge; Cresskill; Closter; Upper Saddle River; Bogota; Oradell; Montvale; Wood-Ridge; Emerson; Midland Park; Allendale; Carlstadt; Old Tappan; Woodcliff Lake; Norwood; Rochelle Park; Englewood Cliffs; Demarest; Harrington Park; Northvale; Ho-Ho-Kus; Haworth; Saddle River; Moonachie; South Hackensack; Alpine; Rockleigh; Teterboro	70	40.9678	-74.0563	932202	95837	Hackensack University Medical Center; Holy Name Medical Center; EHMCC - Englewood Hospital and Medical Center; The Valley Hospital; Hackensack Meridian Health Pascack Valley Medical Center; St. Joseph's Regional Medical Center; Bergen Regional Medical Center; Joseph M. Sanzari Children's Hospital; John Thuermer Cancer Center; Holy Name Terrace Cafe; CityMD Teterboro	11
11 Middlesex County	Edison; Woodbridge; Old Bridge; Piscataway; New Brunswick; Perth Amboy; East Brunswick; South Brunswick; Sayreville; North Brunswick; Monroe Township; South Plainfield; Plainsboro; Carteret; South River; Highland Park; Middlesex; Metuchen; South Amboy; Spotswood; Dunellen; Milltown; Jamesburg; Cranbury; Helmetta	25	40.4111	-74.3587	825062	85954	Robert Wood Johnson University Hospital; Saint Peter's University Hospital; 6 North; Robert Wood Johnson University Hospital; Hackensack Meridian Health Raritan Bay Medical Center - Perth Amboy; Raritan Bay - Old Bridge; Bayshore Community Hospital; Northern Monmouth Regional Surgery Center, LLC; Mediplus Home Health; Raritan Bay Medical Center Cafeteria	10

Cluster 4 above contains 2 counties. The counties with the most population and a lot of hospitals were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
15 Passaic County	Paterson; Clifton; Passaic; Wayne; West Milford; Hawthorne; Little Falls; Ringwood; Woodland Park; Wanaque; Pompton Lakes; Totowa; North Haledon; Haledon; Bloomingdale; Prospect Park	16	41.0462	-74.3178	501826	66476	Chilton Memorial Hospital	1
17 Somerset County	Franklin Township; Bridgewater; Hillsborough; Bernards Township; Montgomery; North Plainfield; Warren; Branchburg; Somerville; Bound Brook; Manville; Bedminster; Bernardsville; Green Brook; Raritan; Watchung; South Bound Brook; Peapack and Gladstone; Far Hills; Rocky Hill; Millstone	21	40.5675	-74.619	328934	111772	Carrier Clinic	1

Cluster 5 above contains 2 counties. The counties with an average population and the lowest number of hospitals were grouped together. This could be a possible area where additional hospitals could be built.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
8 Hudson County	Jersey City; Union City; Bayonne; North Bergen; Hoboken; West New York; Kearny; Secaucus; Harrison; Weehawken; Guttenberg; East Newark	12	40.7382	-74.0551	672391	66289	Meadowlands Hospital Medical Center; CarePoint Health; Hoboken University Medical Center; Hackensack Meridian Health Palisades Medical Center; CarePoint Health; Bayonne Medical Center; Jersey City Medical Center	5
12 Monmouth County	Middletown; Howell; Marlboro; Manalapan; Freehold Township; Long Branch; Neptune; Ocean Township; Wall Township; Hazlet; Aberdeen; Tinton Falls; Holmdel; Asbury Park; Eatontown; Red Bank; Freehold; Millstone Township; Colts Neck; Keansburg; Matawan; West Long Branch; Keyport; Rumson; Upper Freehold; Union Beach; Fair Haven; Little Silver; Manasquan; Oceanport; Belmar; Highlands; Neptune City; Grille; Spring Lake Heights; Atlantic Highlands; Bradley Beach; Shrewsbury; Monmouth Beach; Spring Lake; Avon-by-the-Sea; Englishtown; Allentown; Sea Girt; Lake Como; Sea Bright; Farmingdale; Shrewsbury Township; Roosevelt; Interlaken; Deal; Allenhurst; Loch Arbour	53	40.2589	-74.1240	618795	95699	Ocean Medical Center; Jersey Shore University Medical Center; Monmouth Medical Center; Riverview Medical Center; CentraState Medical Center; Northwest Pavilion; Jersey Shore University Medical Center - Nuclear Medicine	7
19 Union County	Elizabeth; Union; Plainfield; Linden; Westfield; Rahway; Scotch Plains; Cranford; Summit; Hillside; Roselle; Springfield; Clark; Roselle Park; Berkeley Heights; New Providence; Kenilworth; Fanwood; Mountainside; Garwood; Winfield	21	40.6652	-74.3045	556341	77095	Overlook Medical Center; Newark Beth Israel Medical Center; Trinitas Regional Medical Center; RWJ University Hospital Rahway; Rumrills Specialized Hospital; Meroy 6; JFK Johnson Rehabilitation Institute	7

Cluster 6 above contains 3 counties. The counties with a lot of population and an average number of hospitals were grouped together.

## 4.5 Analysis of Median Income and # of Hospitals

As we saw this combination had 5 clusters:

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
18 Sussex County	Vernon; Sparta; Hopatcong; Wantage Township; Byram Township; Hardyston Township; Newton; Andover Township; Frankford Township; Hampton Township; Franklin; Stillwater Township; Montague; Stanhope; Green Township; Fredon Township; Hamburg; Lafayette; Ogdensburg; Sussex; Sandyston Township; Branchville; Andover; Walpack Township	24	41.1334	-74.693	140488	90520	Newton Medical Center	1
20 Warren County	Phillipsburg; Hackettstown; Lopatcong Township; Mansfield Township; Washington Township; Washington; Blairstown; Greenwich Township; Independence Township; White Township; Allamuchy; Pohatcong Township; Franklin Township; Knowlton Township; Liberty Township; Belvidere; Harmony Township; Oxford Township; Alpha; Frelinghuysen Township; Hope Township; Hardwick Township	22	40.8602	-74.972	105267	78145	Hackettstown Regional Medical Center	1

Cluster 1 above contains 2 counties. The counties with an average amount of income and the least number of hospitals were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
0 Atlantic County	Egg Harbor Township; Atlantic City; Galloway Township; Hamilton Township; Pleasantville; Hammonton; Somers Point; Ventnor City; Brigantine; Northfield; Absecon; Buena Vista; Linwood; Margate City; Mullica Township; Buena; Egg Harbor City; Weymouth Township; Folsom; Estell Manor; Port Republic; Longport; Corbin City	23	39.5143	-74.6633	263670	59989	AtlantiCare Regional Medical Center; Atlantic City Campus; AtlantiCare Regional Medical Center - Imaging Services; ARMCCity Hospital 3rd Fl Dialysis; Acuity Specialty Hospital; Shore Medical Center; ARMC PCCU	6
4 Cape May County	Lower Township; Middle Township; Upper Township; Ocean City; Dennis Township; Wildwood; North Wildwood; Cape May; Wildwood Crest; Woodbine; Sea Isle City; Avalon; West Cape May; Stone Harbor; West Wildwood; Cape May Point	16	39.1765	-74.8012	92039	63690	Cape Regional Medical Center	1
5 Cumberland County	Vineland; Millville; Bridgeton; Maurice River; Upper Deerfield Township; Fairfield Township; Commercial Township; Hopewell Township; Lawrence Township; Deerfield Township; Downe Township; Stow Creek Township; Greenwich Township; Shiloh	14	39.3183	-75.1623	149527	52593	Inspira Medical Center Vineland; Cumberland Manor	2
8 Hudson County	Jersey City; Union City; Bayonne; North Bergen; Hoboken; West New York; Kearny; Secaucus; Harrison; Weehawken; Guttenberg; East Newark	12	40.7382	-74.0551	672391	66289	Meadowlands Hospital Medical Center; CarePoint Health; Hoboken University Medical Center; Hackensack Meridian Health Palisades Medical Center; CarePoint Health; Bayonne Medical Center; Jersey City Medical Center	5
15 Passaic County	Paterson; Clifton; Passaic; Wayne; West Milford; Hawthorne; Little Falls; Ringwood; Woodland Park; Wanaque; Pompton Lakes; Totowa; North Haledon; Haledon; Bloomingdale; Prospect Park	16	41.0462	-74.3178	501826	66476	Chilton Memorial Hospital	1
16 Salem County	Pennsville; Pittsgrove Township; Carneys Point; Penns Grove; Salem; Pilesgrove Township; Upper Pittsgrove; Woodstown; Alloway Township; Quinton Township; Mannington Township; Oldmans Township; Lower Alloways Creek; Elmer; Elsinboro Township	15	39.5981	-75.3488	62385	64309	Elmer Hospital; Inspira Medical Center Elmer; Elmer Hospital-surgical waiting room; Memorial Hospital Salem County; Salem Medical Center	5

Cluster 2 above contains 6 counties. The counties with an average income and a low number of hospitals were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
3 Camden County	Camden; Cherry Hill; Gloucester Township; Winslow Township; Pennsauken; Voorhees; Lindenwold; Haddon Township; Collingswood; Haddonfield; Bellmawr; Gloucester City; Waterford Township; Pine Hill; Audubon; Runnemede; Berlin; Haddon Heights; Stratford; Barrington; Berlin Township; Somerdale; Clementon; Mount Ephraim; Magnolia; Oaklyn; Merchantville; Woodlynne; Lawnside; Gibbsboro; Brooklawn; Laurel Springs; Chesilhurst; Audubon Park; Hi-Nella; Pine Valley; Tavistock	37	39.8015	-74.9686	506471	67118	Virtua Voorhees Hospital; Virtua Berlin Hospital; Cooper University Hospital; Virtua Hospital(labor + Delivery - OR # 1; Virtua Voorhees CHOP Specialty Care Center; Jefferson Stratford Hospital; Cooper Surgical Associates; Virtua Marlton Hospital; Garden State OB/GYN - Voorhees; Camden County Health Services Center; elmwood hills healthcare center; Millennium Surgical Center; Virtua Health & Wellness Center - Voorhees; MedExpress Urgent Care; Jefferson Cherry Hill Hospital; Jefferson University Hospitals - Voorhees; Our Lady of Lourdes Hospital; Lourdes At Cherry Hill; Marlton Rehabilitation Hospital; cooper medical center 8th floor solarium; 1 Cooper Plaza, Camden, NJ	21
6 Essex County	Newark; East Orange; Irvington; Bloomfield; West Orange; Montclair; Belleville; City of Orange; Livingston; Nutley; Maplewood; Millburn; South Orange Village; Verona; Cedar Grove; West Caldwell; Caldwell; Glen Ridge; Fairfield; North Caldwell; Roseland; Essex Fells	22	40.7914	-74.2479	798975	59302	Saint Barnabas Medical Center; Mountainside Hospital; Kessler Institute for Rehabilitation; Clara Maass Medical Center; Barnabas Health Ambulatory Care Center; Arlington Dog And Cat Hospital; VA Medical Center - East Orange; Veterans Hospital; East Orange General Hospital; SBMC - Radiation Oncology; The Cooperman Family Pavilion West Oncology; Clara Maass Icu Unit; University Hospital; St. Michael's Medical Center; St. Mary's General Hospital; Immedicenter	16
14 Ocean County	Lakewood; Toms River; Brick; Jackson; Manchester; Berkeley Township; Lacey Township; Stafford Township; Barnegat; Little Egg Harbor; Point Pleasant; Beachwood; Plumsted Township; Ocean Township; Point Pleasant Beach; South Toms River; Tuckerton; Long Beach; Seaside Heights; Lakehurst; Pine Beach; Ocean Gate; Lavallette; Island Heights; Eagleswood; Seaside Park; Surf City; Beach Haven; Ship Bottom; Bay Head; Barnegat Light; Harvey Cedars; Mantoloking	33	39.9778	-74.3319	607186	68021	Kimball Medical Center; Hackensack Meridian Health Southern Ocean Medical Center; Southern Ocean Medical Center; Community Medical Center; Urgent Care Now- Lanoka Harbor; Children's Specialized Hospital; dream world; comunity medical center radiology; Community Medical Center Cafeteria; CMC - Outpatient Infusion; Cmc hospital; Community Medical Center Doctors Lounge; Urgent Care Now- Toms River; Specialty Hospital of Central Jersey; Monmouth Medical Center; Southern Campus	15

Cluster 3 above contains 3 counties. The counties with a low income and the greatest number of hospitals were grouped together. This is an outlier group.



County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
1 Bergen County	Hackensack; Teaneck; Fort Lee; Fair Lawn; Garfield; Englewood; Bergenfield; Paramus; Mahwah; Ridgewood; Lodi; Cliffside Park; Lyndhurst; Palisades Park; Elmwood Park; Rutherford; Dumont; Wyckoff; New Milford; North Arlington; Tenafly; Ramsey; Fairview; Saddle Brook; Oakland; Ridgefield Park; Hasbrouck Heights; Glen Rock; Edgewater; River Edge; Wallington; Ridgefield; Westwood; Little Ferry; Franklin Lakes; Hillsdale; River Vale; Waldwick; Maywood; Washington Township; Leonia; East Rutherford; Park Ridge; Cresskill; Closter; Upper Saddle River; Bogota; Oradell; Montvale; Wood-Ridge; Emerson; Midland Park; Allendale; Carlstadt; Old Tappan; Woodcliff Lake; Norwood; Rochelle Park; Englewood Cliffs; Demarest; Harrington Park; Northvale; Ho-Ho-Kus; Haworth; Saddle River; Moonachie; South Hackensack; Alpine; Rockleigh; Teterboro	70	40.0678	-74.0563	932202	95837	Hackensack University Medical Center; Holy Name Medical Center; EHMC - Englewood Hospital and Medical Center; The Valley Hospital; Hackensack Meridian Health Pascack Valley Medical Center; St. Joseph's Regional Medical Center; Bergen Regional Medical Center; Joseph M. Sanzari Children's Hospital; John Theurer Cancer Center; Holy Name Terrace Cafe; CityMD Teterboro	11
2 Burlington County	EvESHAM Township; Mount Laurel; Willingboro; Pemberton Township; Medford; Burlington Township; Moorestown; Maple Shade; Delran; Cinnaminson; Lumberton; Florence; Bordentown Township; Southampton; Burlington; Mount Holly; Edgewater Park; Westampton; Mansfield Township; Riverside; Chesterfield; North Hanover; Palmyra; New Hanover; Tabernacle; Shamong; Hainesport; Eastampton; Delanco; Medford Lakes; Bordentown; Springfield Township; Riverton; Beverly; Woodland Township; Bass River; Pemberton; Wrightstown; Washington Township; Fieldsboro	40	39.9325	-74.7227	445349	84962	Virtua Memorial Hospital; Deborah Heart and Lung Center; Virtua Memorial S Stokes; Acuity Specialty Hospital; Lourdes Medical Center Of Burlington County; Lourdes Medical Center of Burlington County; Virtua Memorial Emergency Dept. CareOne Harmony Village; Samaritan Hospice @ Virtua Memorial Hospital	9
7 Gloucester County	Washington Township; Monroe Township; Deptford; West Deptford; Glassboro; Franklin Township; Mantua; Harrison Township; Woolwich Township; Woodbury; East Greenwich Township; Pitman; Clayton; Paulsboro; Logan Township; Greenwich Township; Westville; Elk Township; South Harrison Township; Woodbury Heights; National Park; Swedesboro; Wenonah; Newfield	24	39.7267	-75.1535	201636	85160	Kennedy University Hospital; Virtua Medicine; Kennedy ER Washington Twp; Jefferson Washington Township Hospital; Kennedy Surgical Center; Virtua Center for Surgery - Washington Township; Inspira Medical Center Woodbury; Joan Wiley, DO	8
10 Mercer County	Hamilton; Trenton; Ewing; Lawrence; Princeton; East Windsor; West Windsor; Hopewell Township; Robbinsville; Hightstown; Pennington; Hopewell	12	40.2807	-74.7034	367430	79960	University Medical Center of Princeton at Plainsboro; Medical Arts Pavilion; University Medical Center of Princeton at Plainsboro; RWJ University Hospital; Hamilton; NorthStar Vets; Robertwood Johnson University Hospital; Hamilton; Tele North; Mercer Family Health Center; Capital Health Regional Medical Center; Capital Health Medical Center - Hopewell	8
11 Middlesex County	Edison; Woodbridge; Old Bridge; Piscataway; New Brunswick; Perth Amboy; East Brunswick; South Brunswick; Sayreville; North Brunswick; Monroe Township; South Plainfield; Plainsboro; Carteret; South River; Highland Park; Middlesex; Metuchen; South Amboy; Spotswood; Dunellen; Milltown; Jamesburg; Cranbury; Helmetta	25	40.4111	-74.3587	825082	85954	Robert Wood Johnson University Hospital; Saint Peter's University Hospital; St. North; Robert Wood Johnson University Hospital; Hackensack Meridian Health Raritan Bay Medical Center - Perth Amboy; Raritan Bay -Old Bridge; Bayshore Community Hospital; Northern Monmouth Regional Surgery Center; LLC; Medplus Home Health; Raritan Bay Medical Center Cafeteria	10
12 Monmouth County	Middletown; Howell; Marlboro; Manalapan; Freehold Township; Long Branch; Neptune; Ocean Township; Wall Township; Hazlet; Aberdeen; Tinton Falls; Holmdel; Asbury Park; Eatontown; Red Bank; Freehold; Millstone Township; Colts Neck; Keanburg; Matawan; West Long Branch; Keyport; Rumson; Upper Freehold; Union Beach; Fair Haven; Little Silver; Manasquan; Oceanport; Belmar; Highlands; Neptune City; Brielle; Spring Lake Heights; Atlantic Highlands; Bradley Beach; Shrewsbury; Monmouth Beach; Spring Lake; Avon-by-the-Sea; Englishtown; Allentown; Sea Girt; Lake Como; Sea Bright; Farmingdale; Shrewsbury Township; Roosevelt; Interlaken; Deal; Allenhurst; Loch Arbour	53	40.2589	-74.1240	618795	95599	Ocean Medical Center; Jersey Shore University Medical Center; Monmouth Medical Center; Riverview Medical Center; CentraState Medical Center; Northwest Pavilion; Jersey Shore University Medical Center - Nuclear Medicine	7
19 Union County	Elizabeth; Union; Plainfield; Linden; Westfield; Rahway; Scotch Plains; Cranford; Summit; Hillside; Roselle; Springfield; Clark; Roselle Park; Berkeley Heights; New Providence; Kenilworth; Fairwood; Mountainside; Garwood; Winfield	21	40.6552	-74.3045	556341	77095	Overlook Medical Center; Newark Beth Israel Medical Center; Trinitas Regional Medical Center; RWJ University Hospital Rahway; Runnels Specialized Hospital; Mercy 6; JFK Johnson Rehabilitation Institute	7

Cluster 4 above contains 7 counties. The counties with a lot of income and a lot of hospitals were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
9 Hunterdon County	Raritan Township; Readington; Clinton Township; Lebanon Township; Tewksbury; Union Township; Holland Township; Alexandria Township; Flemington; Delaware Township; East Amwell; Bethlehem Township; Lambertville; Kingwood Township; West Amwell; High Bridge; Franklin Township; Clinton; Glen Gardner; Hampton; Frenchtown; Lebanon; Milford; Calton; Bloomsbury; Stockton	26	40.5771	-74.9262	124371	112535	Hunterdon Medical Center	1
13 Morris County	Parsippany; Mount Olive; Randolph; Rockaway Township; Roxbury; Morris Township; Montville; Jefferson Township; Washington Township; Morristown; Dover; Denville; Madison; Pequannock; Hanover; Florham Park; East Hanover; Lincoln Park; Chatham Township; Kinnelon; Chatham; Long Hill Township; Boonton; Chester Township; Butler; Wharton; Rockaway; Mendham Township; Morris Plains; Mount Arlington; Mendham; Boonton Township; Mountain Lakes; Harding Township; Mine Hill; Riverdale; Netcong; Chester Borough; Victory Gardens	39	40.868	-74.5601	491845	111316	Gagnon Cardiovascular Institute; Morristown Medical Center; Morristown Memorial Hospital; St. Clare's Hospital; Kessler Rehab Center; St. Clare's Hospital - Dover Campus; Saint Clare's Denville Hospital; Kindred Hospital New Jersey - Morris County	8
17 Somerset County	Franklin Township; Bridgewater; Hillsborough; Bernards Township; Montgomery; North Plainfield; Warren; Branchburg; Somerville; Bound Brook; Manville; Bedminster; Bernardsville; Green Brook; Raritan; Watchung; South Bound Brook; Peapack and Gladstone; Far Hills; Rocky Hill; Millstone	21	40.5675	-74.619	328934	111772	Carrier Clinic	1

Cluster 5 above contains 3 counties. The counties that have the most income and least number of hospitals were grouped together. This could also be an outlier group.

## 4.6 Analysis of Population and Median Income

As we saw this combination had 5 clusters:

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
2 Burlington County	Evesham Township; Mount Laurel; Willingboro; Pemberton Township; Medford; Burlington Township; Moorestown; Maple Shade; Delran; Cinnaminson; Lumberton; Florence; Bordentown Township; Southampton; Burlington; Mount Holly; Edgewater Park; Westampton; Mansfield Township; Riverside; Chesterfield; North Hanover; Palmyra; New Hanover; Tabernacle; Shamong; Hainesport; Eastampton; Delanco; Medford Lakes; Bordentown; Springfield Township; Riverton; Beverly; Woodland Township; Bass River; Pemberton; Wrightstown; Washington Township; Fieldsboro	40	39.9325	-74.7227	445349	84992	Virtua Memorial Hospital; Deborah Heart and Lung Center; Virtua Memorial 5 Stokes; Acuity Specialty Hospital; Lourdes Medical Center Of Burlington County; Lourdes Medical Center of Burlington County; Virtua Memorial Emergency Dept; CareOne Harmony Village; Samaritan Hospice @ Virtua Memorial Hospital	9
7 Gloucester County	Washington Township; Monroe Township; Deptford; West Deptford; Glassboro; Franklin Township; Mantua; Harrison Township; Woolwich Township; Woodbury; East Greenwich Township; Pitman; Clayton; Paulsboro; Logan Township; Greenwich Township; Westville; Elk Township; South Harrison Township; Woodbury Heights; National Park; Swedesboro; Wenonah; Newfield	24	39.7267	-75.1535	291636	85160	Kennedy University Hospital; Virtua Medicine; Kennedy ER Washington Twp; Jefferson Washington Township Hospital; Kennedy Surgical Center; Virtua Center for Surgery - Washington Township; Inspira Medical Center Woodbury; Joan Wiley, DO	8
10 Mercer County	Hamilton; Trenton; Ewing; Lawrence; Princeton; East Windsor; West Windsor; Hopewell Township; Robbinsville; Hightstown; Pennington; Hopewell	12	40.2807	-74.7034	367430	79990	University Medical Center of Princeton at Plainsboro; Medical Arts Pavilion; University Medical Center of Princeton at Plainsboro; RWJ University Hospital Hamilton; NorthStar Vets; Robertwood Johnson University Hospital Hamilton; Tele North; Mercer Family Health Center; Capital Health Regional Medical Center; Capital Health Medical Center - Hopewell	8
18 Sussex County	Vernon; Sparta; Hopatcong; Wantage Township; Byram Township; Hardyston Township; Newton; Andover Township; Frankford Township; Hampton Township; Franklin; Stillwater Township; Montague; Stanhope; Green Township; Fredon Township; Hamburg; Lafayette; Odensburg; Sussex; Sandyston Township; Branchville; Andover; Walpack Township	24	41.1334	-74.693	140488	90520	Newton Medical Center	1
20 Warren County	Phillipsburg; Hackettstown; Lopatcong Township; Mansfield Township; Washington Township; Washington; Blairstown; Greenwich Township; Independence Township; White Township; Allamuchy; Pohatcong Township; Franklin Township; Knowlton Township; Liberty Township; Belvidere; Harmony Township; Oxford Township; Alpha; Frelinghuysen Township; Hope Township; Hardwick Township	22	40.8602	-74.972	105267	78145	Hackettstown Regional Medical Center	1

Cluster 1 above contains 5 counties. The counties have an average to low population and high income. This could be an outlier group.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
3 Camden County	Camden; Cherry Hill; Gloucester Township; Winslow Township; Pennsauken; Voorhees; Lindenwald; Haddon Township; Collingswood; Haddonfield; Bellmawr; Gloucester City; Waterford Township; Pine Hill; Audubon; Runnemede; Berlin; Haddon Heights; Stratford; Barrington; Berlin Township; Somerdale; Clementon; Mount Ephraim; Magnolia; Oaklyn; Merchantville; Woodlynne; Lawnside; Gibbsboro; Brooklawn; Laurel Springs; Chesilhurst; Audubon Park; Hi-Nella; Pine Valley; Tavistock	37	39.8015	-74.9686	506471	67118	Virtua Voorhees Hospital; Virtua Berlin Hospital; Cooper University Hospital; Virtua Hospital(labor + Delivery - OR # 1; Virtua Voorhees CHOP Specialty Care Center; Jefferson Stratford Hospital; Cooper Surgical Associates; Virtua Marlton Hospital; Garden State OB/GYN - Voorhees; Camden County Health Services Center; elmwood hills healthcare center; Millennium Surgical Center; Virtua Health & Wellness Center - Voorhees; MedExpress Urgent Care; Jefferson Cherry Hill Hospital; Jefferson University Hospitals - Voorhees; Our Lady of Lourdes Hospital; Lourdes At Cherry Hill; Marlton Rehabilitation Hospital; cooper medical center 8th floor solarium; 1 Cooper Plaza, Camden, NJ	21
6 Essex County	Newark; East Orange; Irvington; Bloomfield; West Orange; Montclair; Belleville; City of Orange; Livingston; Nutley; Maplewood; Millburn; South Orange Village; Verona; Cedar Grove; West Caldwell; Caldwell; Glen Ridge; Fairfield; North Caldwell; Roseland; Essex Fells	22	40.7914	-74.2479	798975	59302	Saint Barnabas Medical Center; Mountainside Hospital; Kessler Institute for Rehabilitation; Clara Maass Medical Center; Barnabas Health Ambulatory Care Center; Arlington Dog And Cat Hospital; VA Medical Center - East Orange; Veterans Hospital; East Orange General Hospital; SBMC - Radiation Oncology; The Cooperman Family Pavilion West Oncology; Clara Maass Icu Unit; University Hospital; St. Michael's Medical Center; St. Mary's General Hospital; Immedcenter	16
8 Hudson County	Jersey City; Union City; Bayonne; North Bergen; Hoboken; West New York; Kearny; Secaucus; Harrison; Weehawken; Guttenberg; East Newark	12	40.7382	-74.0551	672391	68289	Meadowlands Hospital Medical Center; CarePoint Health; Hoboken University Medical Center; Hackensack Meridian Health Palisades Medical Center; CarePoint Health; Bayonne Medical Center; Jersey City Medical Center	5
14 Ocean County	Lakewood; Toms River; Brick; Jackson; Manchester; Berkeley Township; Lacey Township; Stafford Township; Barnegat; Little Egg Harbor; Point Pleasant; Beachwood; Plumsted Township; Ocean Township; Point Pleasant Beach; South Toms River; Tuckerton; Long Beach; Seaside Heights; Laharhurst; Pine Beach; Ocean Gate; Lavallette; Island Heights; Eagleswood; Seaside Park; Surf City; Beach Haven; Ship Bottom; Bay Head; Barnegat Light; Harvey Cedars; Mantoloking	33	39.9778	-74.3319	607186	68021	Kimball Medical Center; Hackensack Meridian Health Southern Ocean Medical Center; Southern Ocean Medical Center; Community Medical Center; Urgent Care Now- Lanoka Harbor; Children's Specialized Hospital; dream world; community medical center radiology; Community Medical Center Cafeteria; CMC - Outpatient Infusion; Cmc hospital; Community Medical Center Doctors Lounge; Urgent Care Now- Toms River; Specialty Hospital of Central Jersey; Monmouth Medical Center; Southern Campus	15
15 Passaic County	Paterson; Clifton; Passaic; Wayne; West Milford; Hawthorne; Little Falls; Ringwood; Woodland Park; Wanaque; Pompton Lakes; Totowa; North Haledon; Haledon; Bloomingdale; Prospect Park	16	41.0462	-74.3178	501826	66476	Chilton Memorial Hospital	1
19 Union County	Elizabeth; Union; Plainfield; Linden; Westfield; Rahway; Scotch Plains; Cranford; Summit; Hillside; Roselle; Springfield; Clark; Roselle Park; Berkeley Heights; New Providence; Kenilworth; Fanwood; Mountainside; Garwood; Winfield	21	40.6652	-74.3045	556341	77095	Overlook Medical Center; Newark Beth Israel Medical Center; Trinitas Regional Medical Center; RWJ University Hospital Rahway; Runnells Specialized Hospital; Mercy 6; JFK Johnson Rehabilitation Institute	7

Cluster 2 above contains 6 counties. The counties with an average population and an average income were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
1 Bergen County	Hackensack; Teaneck; Fort Lee; Fair Lawn; Garfield; Englewood; Bergenfield; Paramus; Mahwah; Ridgewood; Lodi; Cliffside Park; Lyndhurst; Palisades Park; Elmwood Park; Rutherford; Dumont; Wyckoff; New Milford; North Arlington; Tenafly; Ramsey; Fairview; Saddle Brook; Oakland; Ridgeland Park; Hasbrouck Heights; Glen Rock; Edgewater; River Edge; Wallington; Ridgeland; Westwood; Little Ferry; Franklin Lakes; Hillsdale; River Vale; Waldwick; Maywood; Washington Township; Leonia; East Rutherford; Park Ridge; Cresskill; Closter; Upper Saddle River; Bogota; Oradell; Montvale; Wood-Ridge; Emerson; Midland Park; Allendale; Carlstadt; Old Tappan; Woodcliff Lake; Norwood; Rochelle Park; Englewood Cliffs; Demarest; Harrington Park; Northvale; Ho-Ho-Kus; Haworth; Saddle River; Moonachie; South Hackensack; Alpine; Rockledge; Teletboro	70	40.9678	-74.0563	932202	95837	Hackensack University Medical Center; Holy Name Medical Center; EPMC - Englewood Hospital and Medical Center; The Valley Hospital; Hackensack Meridian Health Passaic Valley Medical Center; St. Joseph's Regional Medical Center; Bergen Regional Medical Center; Joseph M. Sanzari Children's Hospital; John Theurer Cancer Center; Holy Name Terrace Cafe; CityMD Teletboro	11
11 Middlesex County	Edison; Woodbridge; Old Bridge; Piscataway; New Brunswick; Perth Amboy; East Brunswick; South Brunswick; Sayreville; North Brunswick; Monroe Township; South Plainfield; Plainsboro; Carteret; South River; Highland Park; Middlesex; Metuchen; South Amboy; Spotswood; Dunellen; Milltown; Jamesburg; Cranbury; Helmetta	25	40.4111	-74.3587	825062	85954	Robert Wood Johnson University Hospital; Saint Peter's University Hospital; 6 North; Robert Wood Johnson University Hospital; Hackensack Meridian Health Raritan Bay Medical Center - Perth Amboy; Raritan Bay - Old Bridge; Bayside Community Hospital; Northern Monmouth Regional Surgery Center, LLC; Medplus Home Health; Raritan Bay Medical Center Cafeteria	10
12 Monmouth County	Middletown; Howell; Marlboro; Manalapan; Freehold Township; Long Branch; Neptune; Ocean Township; Wall Township; Hazlet; Aberdeen; Tinton Falls; Holmdel; Asbury Park; Eatontown; Red Bank; Freehold; Millstone Township; Colts Neck; Keansburg; Matawan; West Long Branch; Keyport; Rumson; Upper Freehold; Union Beach; Fair Haven; Little Silver; Manasquan; Oceanport; Belmar; Highlands; Neptune City; Brielle; Spring Lake Heights; Atlantic Highlands; Bradley Beach; Shrewsbury; Monmouth Beach; Spring Lake; Avon-by-the-Sea; Englishtown; Allentown; Sea Girt; Lake Como; Sea Bright; Farmingdale; Shrewsbury Township; Roosevelt; Interlaken; Deal; Allenhurst; Loch Arbour	53	40.2589	-74.1240	618795	95699	Ocean Medical Center; Jersey Shore University Medical Center; Monmouth Medical Center; Riverview Medical Center; CentraState Medical Center; Northwest Pavilion; Jersey Shore University Medical Center - Nuclear Medicine	7

Cluster 3 above contains 3 counties. The counties with a high population and a high income were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
0 Atlantic County	Egg Harbor Township; Atlantic City; Galloway Township; Hamilton Township; Pleasantville; Hammonton; Somers Point; Ventnor City; Brigantine; Northfield; Absecon; Buena Vista; Linwood; Margate City; Mullica Township; Buena; Egg Harbor City; Weymouth Township; Folsom; Estell Manor; Port Republic; Longport; Corbin City	23	39.5143	-74.6633	263670	59989	AtlantiCare Regional Medical Center, Atlantic City Campus; AtlantiCare Regional Medical Center - Imaging Services; ARMCCity Hospital 3rd Fl Dialysis; Acuity Specialty Hospital; Shore Medical Center; ARMC PCCU	6
4 Cape May County	Lower Township; Middle Township; Upper Township; Ocean City; Dennis Township; Wildwood; North Wildwood; Cape May; Wildwood Crest; Woodbine; Sea Isle City; Avalon; West Cape May; Stone Harbor; West Wildwood; Cape May Point	16	39.1765	-74.8012	92039	63690	Cape Regional Medical Center	1
5 Cumberland County	Vineland; Millville; Bridgeton; Maurice River; Upper Deerfield Township; Fairfield Township; Commercial Township; Hopewell Township; Lawrence Township; Deerfield Township; Downe Township; Stow Creek Township; Greenwich Township; Shiloh	14	39.3183	-75.1623	149527	52593	Inspira Medical Center Vineland; Cumberland Manor	2
16 Salem County	Pennsville; Pittsgrove Township; Carneys Point; Penns Grove; Salem; Pilesgrove Township; Upper Pittsgrove; Woodstown; Alloway Township; Quinton Township; Mannington Township; Oldmans Township; Lower Alloways Creek; Elmer; Elsinboro Township	15	39.5981	-75.3488	62385	64309	Elmer Hospital; Inspira Medical Center Elmer; Elmer Hospital-surgical waiting room; Memorial Hospital Salem County; Salem Medical Center	5

Cluster 4 above contains 4 counties. The counties with the lowest population and the lowest income were grouped together.

County	Municipality	Number of Municipalities	Latitude	Longitude	Population (2020)	Median Income in \$ (2018)	Hospital Name	Number of Hospitals
9 Hunterdon County	Raritan Township; Readington; Clinton Township; Lebanon Township; Tewksbury; Union Township; Holland Township; Alexandria Township; Flemington; Delaware Township; East Amwell; Bethlehem Township; Lambertville; Kingwood Township; West Amwell; High Bridge; Franklin Township; Clinton; Glen Gardner; Hampton; Frenchtown; Lebanon; Milford; Califon; Bloomsbury; Stockton	26	40.5771	-74.9262	124371	112535	Hunterdon Medical Center	1
13 Morris County	Parsippany; Mount Olive; Randolph; Rockaway Township; Roxbury; Morris Township; Montville; Jefferson Township; Washington Township; Morristown; Dover; Denville; Madison; Pequannock; Hanover; Florham Park; East Hanover; Lincoln Park; Chatham Township; Kinnelon; Chatham; Long Hill Township; Boonton; Chester Township; Butler; Wharton; Rockaway; Mendham Township; Morris Plains; Mount Arlington; Mendham; Boonton Township; Mountain Lakes; Harding Township; Mine Hill; Riverdale; Netcong; Chester Borough; Victory Gardens	39	40.868	-74.5601	491845	111316	Gagnon Cardiovascular Institute; Morristown Medical Center; Morristown Memorial Hospital; St. Clare's Hospital; Kessler Rehab Center; St. Clare's Hospital - Dover Campus; Saint Clare's Denville Hospital; Kindred Hospital New Jersey - Morris County	8
17 Somerset County	Franklin Township; Bridgewater; Hillsborough; Bernards Township; Montgomery; North Plainfield; Warren; Branchburg; Somerville; Bound Brook; Manville; Bedminster; Bernardsville; Green Brook; Raritan; Watchung; South Bound Brook; Peapack and Gladstone; Far Hills; Rocky Hill; Millstone	21	40.5675	-74.619	328934	111772	Carrier Clinic	1

Cluster 5 above contains 3 counties. The counties with a low population and the most income were grouped together. This could be an outlier group.

## 5. Discussion

Looking back at the observations, we can see that the higher the population the higher the number of municipalities and vice versa. We also saw that lower income families tend to live in counties with not as many towns and middle-class families live in counties with many towns. Also, there are more hospitals in counties with more towns. This makes perfect sense since there would be a higher population in those towns too. I also noticed that the lower income counties had the most hospitals which I found interesting because hospital and medical bills are very expensive. But at the same time, I also found that higher income counties also have a lot of hospitals, granted not as much as the other counties. This made me realize the one big limitation in this project, that is the Foursquare API. Foursquare most likely did not locate all the hospitals in New Jersey simply because sufficient data was not entered into its systems. We can also conclude that population and income have no correlation in this situation as proven by the scatter plot and the data cluster tables. That brings us now to the main question in this project, that is which locations would benefit from additional hospitals. After

analyzing the data and all the outliers the charts and tables produced, I have come up with solution. I compared the outliers for each different combination to come up with the top 5 counties. The recommended counties that I would suggest would greatly benefit from an addition of a new hospital is Hunterdon County, Morris County, Somerset County, Passaic County, and Middlesex County. Middlesex County only has 10 hospitals, yet it is the 2<sup>nd</sup> most populated county in New Jersey. It also consists of 25 municipalities which is more than average. Passaic County only has 1 hospital and 15 municipalities. It also has over 500,000 people living in the area which is more than average. The median income for people living in this county is on the lower side so I would recommend building a charity hospital here to help aid those who cannot afford the cost. Somerset County only has 1 hospital and over 300,000 people living in the area. It also has 21 municipalities. That is a lot of people and towns for only having one hospital. Morris County has 39 municipalities, around 500,000 people living in the area yet only has 8 hospitals. Finally, Hunterdon County has only 1 hospital and has 26 municipalities. Although its population is roughly 130,000, one hospital is not enough to share amongst 26 different towns.

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## **6. Conclusion**

All in all, in this study I was able to analyze data from various sources and compare the individual relationship with each other to determine any correlations to come up with ideal locations to build additional hospitals. Machine learning techniques such as clustering and normalization were used to help achieve the results. This model can greatly help New Jersey prepare for future pandemics and even daily! This model can be improved by implementing some socioeconomic data as well as data from the COVID-19 pandemic, but they were more difficult to extract. Also analyzing the towns rather than the counties would have provided a better model however there are 565 towns in New Jersey which would have been difficult to implement especially with the limitations of Foursquare and Geopy. With this additional data and more accurate hospital readings/coordinates, we would be able to visualize a regression line on the scatter plots much easier since the points would be much closer together.