

COVID-19 in Nigeria: Rural-urban Socio-economic Implications

This project is part of a Capstone Project conducted to fulfil the requirements for completing the Coursera-IBM Data Science Professional Certificate Program.

Introduction

The COVID-19 pandemic has had varying impacts on countries, and on regions within each Country. Nigeria is no exception. The pandemic - infections, testing, deaths - has exposed some of the pre-existing disparities in both social and economic factors, some of which have accentuated the differences in the severity of the impact from region to region. While some governments are aware of some of these disparities and their effects on the severity of the pandemic, many governments are met with the current challenge of dealing with response to the virus in real-time, with little effort or resources to spare for a more wholistic view of the challenge for a more coordinated response.

An analysis of the existing data on COVID-19, as well as socio-economic indicators, should throw more light on areas of the country that require more attention by the Nigerian government in terms of the immediate response to the pandemic, as well as support the adoption of a national strategy to combat the virus successfully. It should also provide a basis for which the Federal government, working with each state, can allocate resources to tackle the socio-economic conditions and better prepare for whatever future pandemics or epidemics may occur.

Data Type and Data Source

The Nigerian government houses most of its data with the Nigerian Bureau of Statistics, which maintains a website that is accessible. The Bureau of Statistics, in conjunction with the Ministry of Health, maintains the COVID-19 database that includes the number of people tested, number of deaths, number of people recovered, as well as active cases of infections. This data is accessible via JSON files. It is unclear what reporting structure that each state uses to transmit its data, and the frequency of reporting. However, it is believed that this dataset is the best dataset on the pandemic from Nigeria.

Data on socio-economic indicators are either unavailable or inaccessible. A search of the Bureau of Statistics databases only results in data on unemployment, and Consumer Price index (CPI). Other such indicators like the GDP per state could not be found on the database. The most-recent population census carried out in Nigeria was conducted in 2006. Since then, only projections have been made using estimates of population growth rate per year. The population growth projections go only as far out as 2016. This is the best information on the Nigerian population and same was used for this study.

Data on access to healthcare facility index was also retrieved from the Bureau of Statistics. It should be noted that it is unclear to the author how this index was determined. Therefore, to augment this dataset, Foursquare location data was utilized to assess availability of healthcare services in each state using the "Medical Facility" category ID.

In summary, the following datasets were utilized for this study:

- a. Population in Nigeria by States (Bureau of Statistics)
- b. Consumer Price Index by States (Bureau of Statistics)

- c. Unemployment Data by States (Bureau of Statistics)
- d. COVID-19 latest Data by States (Bureau of Statistics)
- e. Access to Healthcare facility Indices by States (Bureau of Statistics)
- f. Foursquare location data using “Medical Center” category ID as filter

Methodology

The hypothesis explored by this study is that Nigerian states that are hit hardest with the COVID-19 pandemic are the states that present with poorer socio-economic indicators. Socio-economic indicators utilized include the unemployment rate, and the Consumer Price Index (CPI). According to the US Bureau of Labor Statistics, the CPI is a measure of the change in the price of goods and services over time that a consumer pays who lives in an urban area. To test this hypothesis, the COVID-19 dataset was explored by comparing the number of tests, cases, deaths, and recoveries on a state-by-state basis. Choropleth maps were created to provide visual understanding of how widespread this pandemic is in the Country. Stacked-horizontal bar charts were also utilized to explore the dataset. Socio-economic indicator datasets were also explored using Choropleth maps.

Foursquare location API dataset was explored for each state, utilizing the state’s longitude and latitude. A radius of 100,000 meters from the Lat/Lon location was used to determine the number of medical facilities around the state as recorded in the Foursquare API data using the “Medical Center” category ID as a filter.

The data from the Foursquare search was converted to a health access indicator by applying the population data to determine the number of medical centers per one million people (i.e. hospitals per 1000k). While the Foursquare dataset is limited by the veracity and quality of description of data input to the database by users, the author believes that the amount of location data on such platforms as Foursquare is a good proxy for the level of knowledge of the population regarding amenities that are available to them, particularly in this age of mobile phones, internet and internet search engines.

The population density for each state was also determined by dividing the state’s population by the land size in square-kilometers.

Tests for correlation were conducted between COVID-19 data and the socio-economic indicators, as well as the access to healthcare indicators, and the population density. The Pearson correlation was utilized for this study. It measures the linear dependence between two variables. The results of the correlation test can range from -1 to 0 to +1. A value of +1 means total positive linear correlation, a value of -1 means total negative linear correlation, while a value of 0 means no linear correlation.

Results

The population density for each state is shown in Figure 1. The State of Lagos is the business capital of the Country and has the highest population density. The Southern states of Anambra, Imo, Akwa Ibom, Abia, and Rivers, and the North-western state of Katsina follow suite in population density.

The COVID-19 cases in Nigeria continue the upward trend. While the number of infections cannot be compared with those of many developed nations, it is still relatively high for the capacity of the medical system. Figure-2 below shows a Choropleth map of Nigeria with the most recent COVID-19 cases, while Figure-2b is a stacked bar chart that shows the number of deaths, active cases, and recovered cases per state. Many of the cases exist in the twin business and political capital cities of Lagos and

the Federal Capital Territory (FCT) respectively. The temperate climate State of Plateau has also seen an increase in cases, while the State of Kaduna is next in line with the most COVID-19 cases.

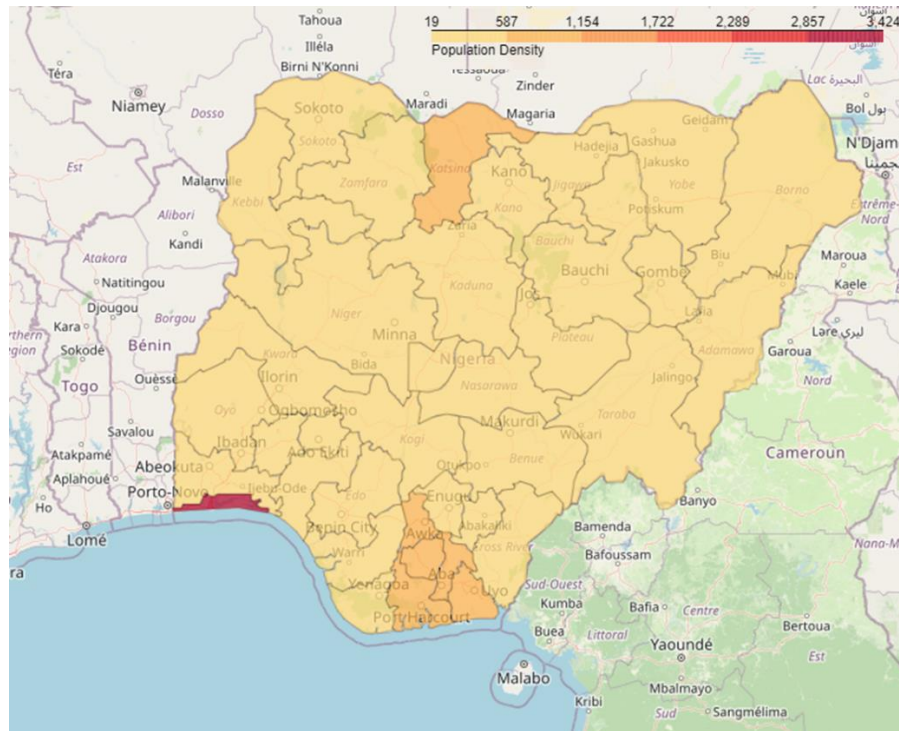


Figure 1a. Population Density (Population per sq-km) in Nigeria

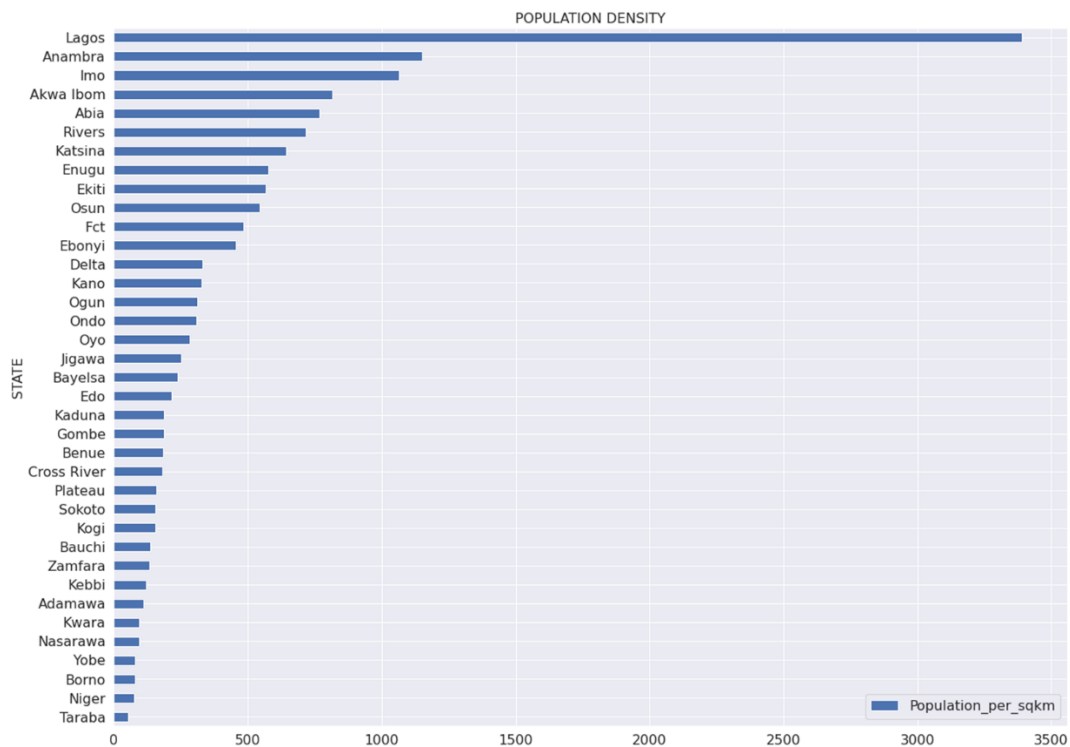


Figure 1b. Population Density in Nigeria per State

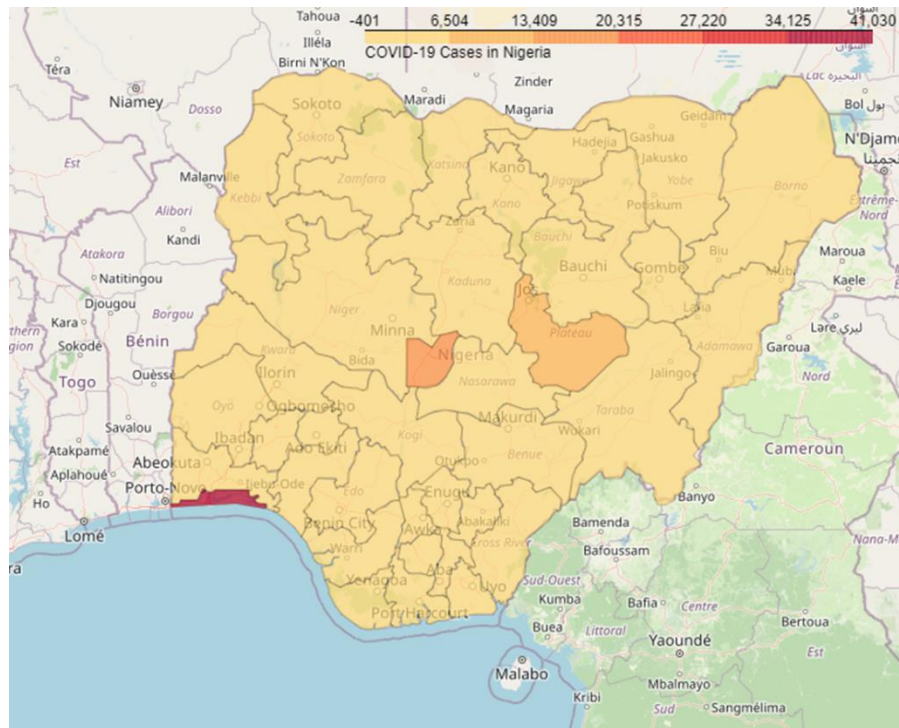


Figure 2a. COVID-19 Cases in Nigeria

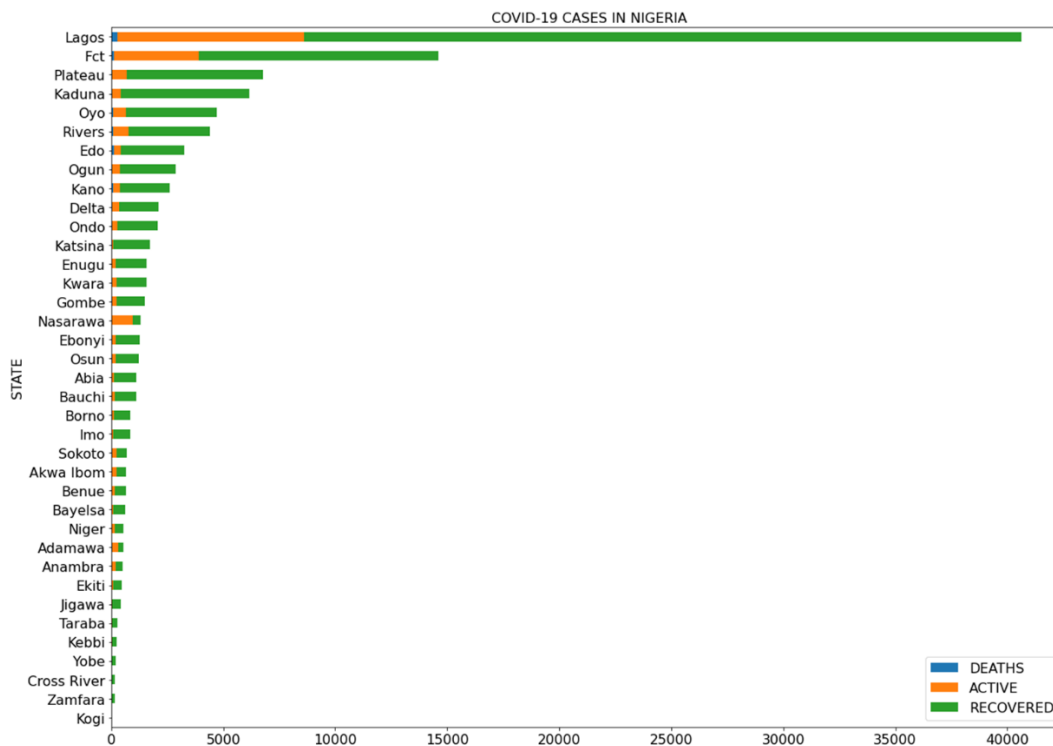


Figure 2a. COVID-19 Cases in Nigeria by States

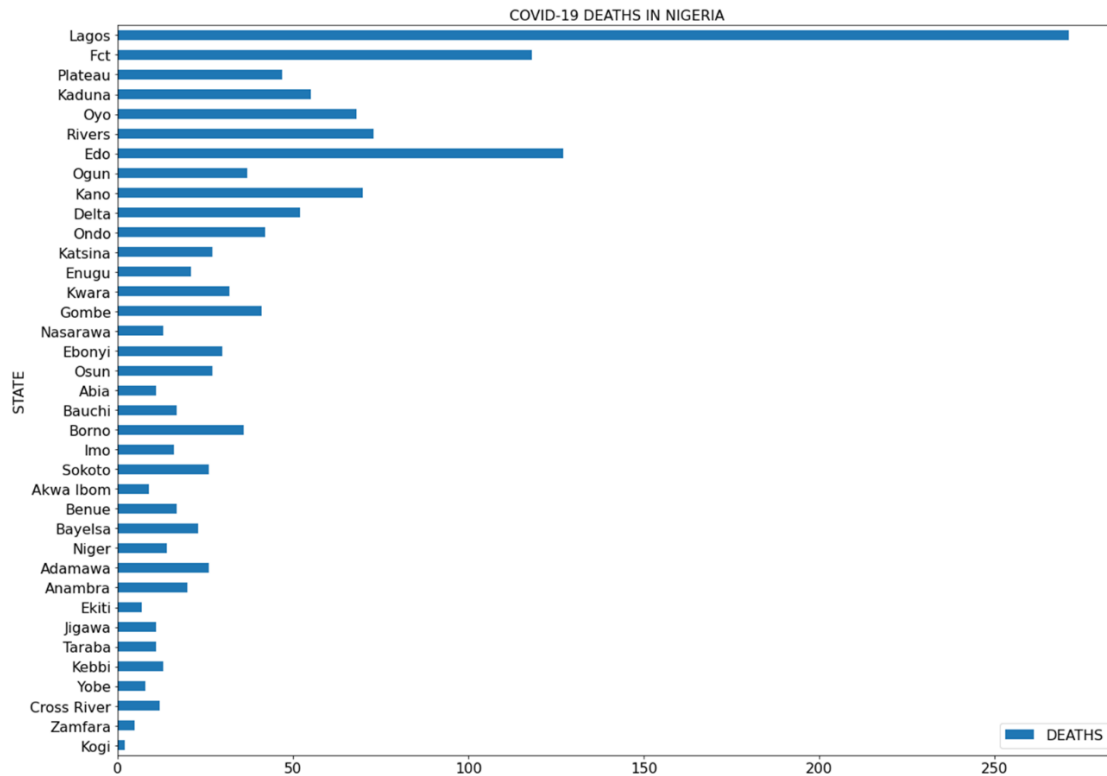
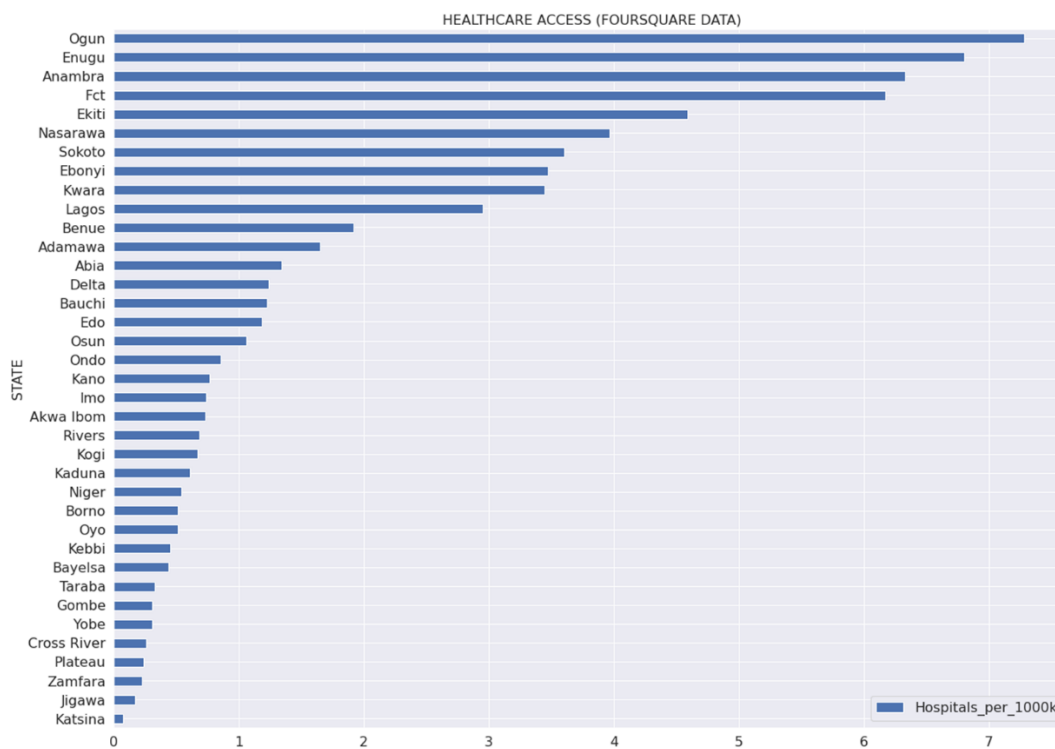
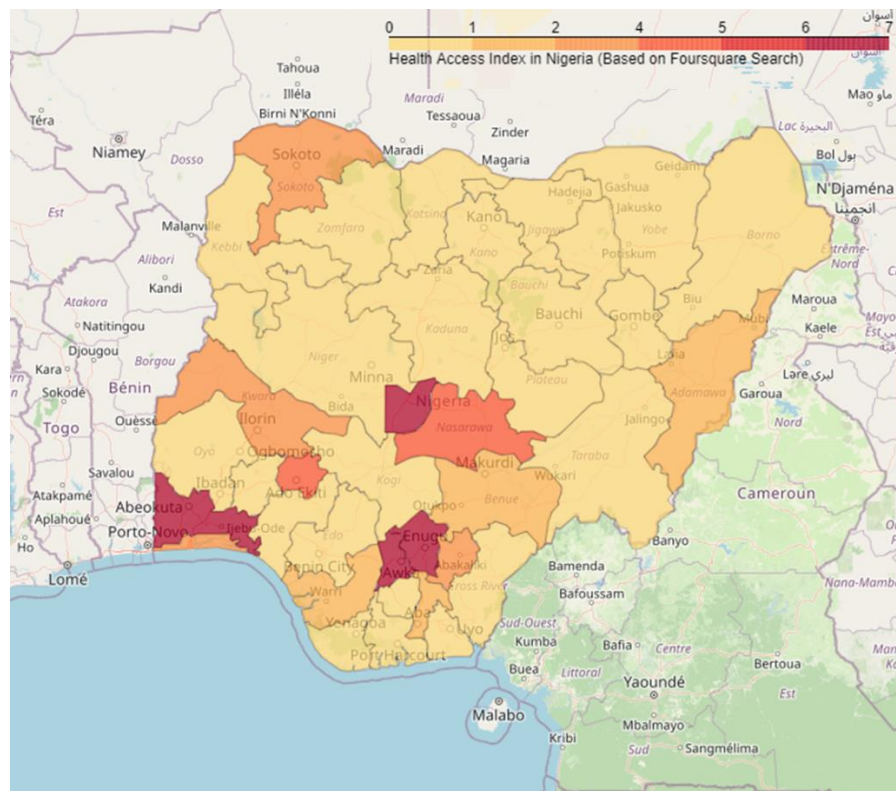


Figure 2b. COVID-19 Deaths in Nigeria by States

Note that Lagos State has the highest number of deaths from COVID-19, followed by Edo State, and the Federal Capital Territory (FCT).

In terms of health-care access, the map and the bar chart below show the distribution of healthcare access as determined utilizing Foursquare location data (Figure 3). As can be seen, the states of Ogun, Enugu, Anambra, the FCT, and Ekiti State lead the way in accessibility to healthcare. Recall that this healthcare index is determined by the Number of Hospitals (or Medical centers) per 1000k people for each state.

For comparison, the Health-care access index data accessed from the Bureau of Statistics is shown in Figure 4. Note that this index is not determined in the same way as the Foursquare data-based index – a relative comparison of Figure 3 and Figure 4 show the clear differences in health-care access. For this study, the Foursquare data-based health care access index will be utilized for correlation study.



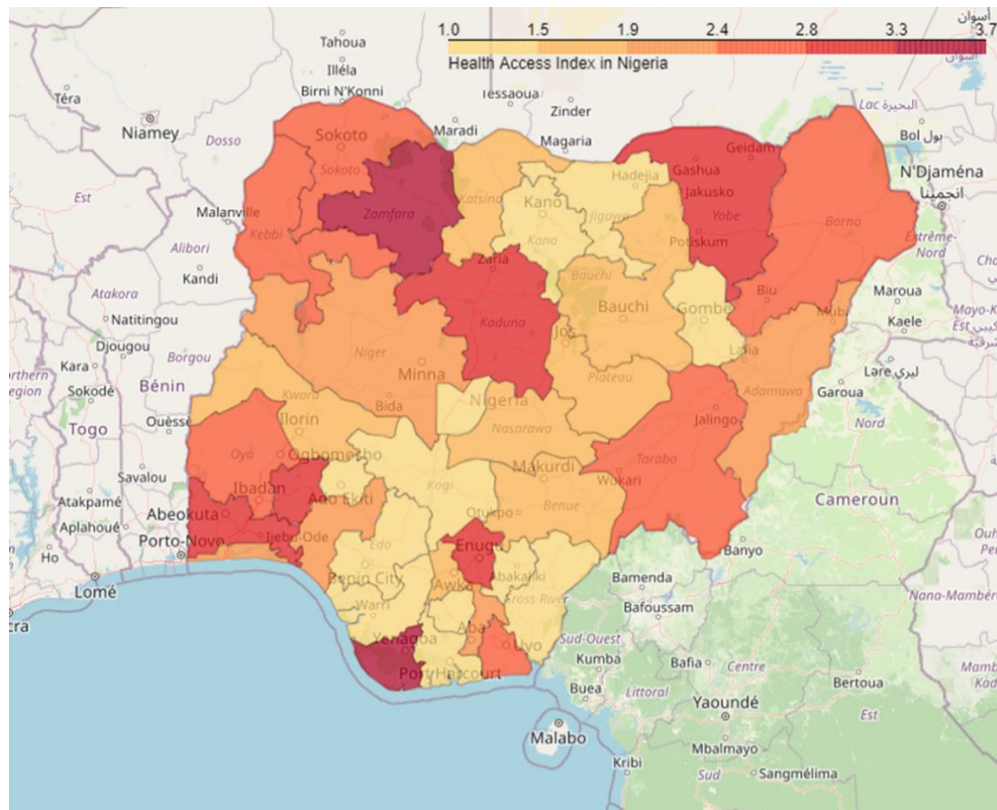


Figure 4a. Health Care Access Index distribution in Nigeria

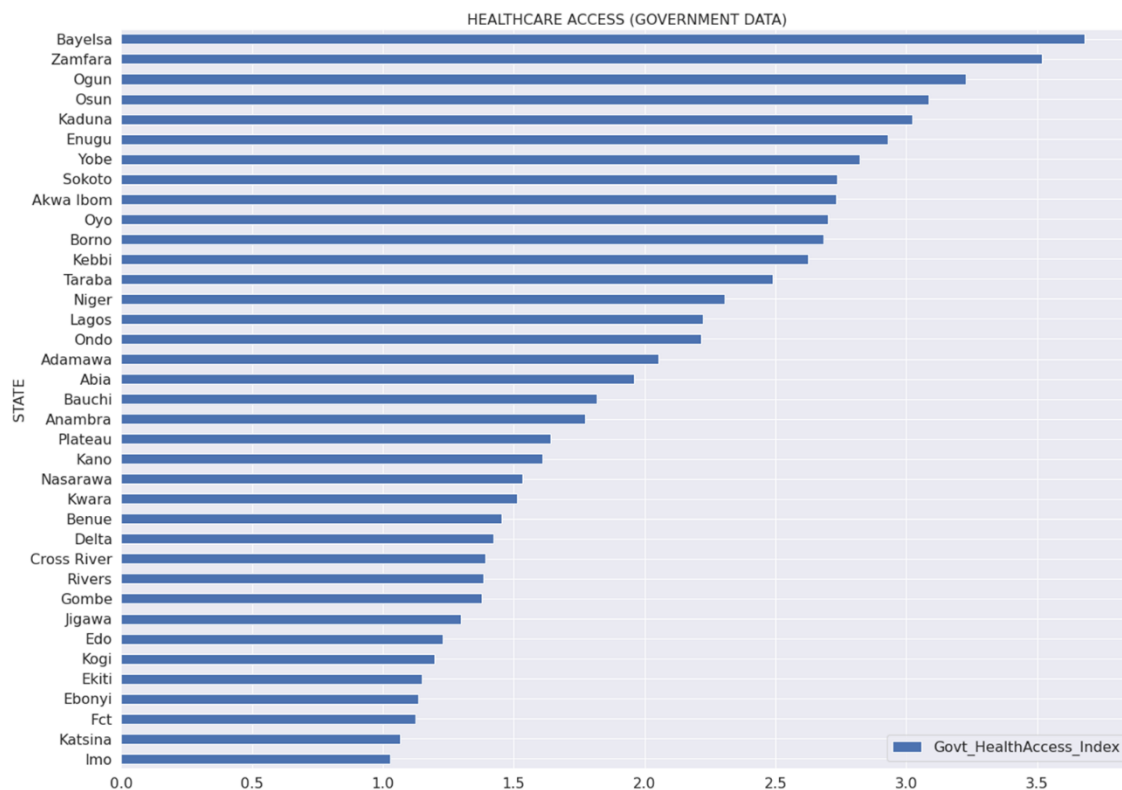


Figure 4b. Health Care Access Index in Nigeria by States

Pearson correlation tests were conducted for the COVID-19 cases and deaths against socio-economic indicators such as unemployment rate and Consumer Price Index (CPI). Figure 5 below shows the results of the correlation test. Table-1 below also shows results of the correlations.

Other tests conducted include a test for correlation between COVID-19 cases and deaths, and population density. Figure 6 shows the results of this correlation test. A test of correlation between COVID-19 deaths and health-care access index from Foursquare location data is also shown in Figure 7. For reference, a similar correlation test is conducted with the healthcare access index data retrieved from the Bureau of Statistics.

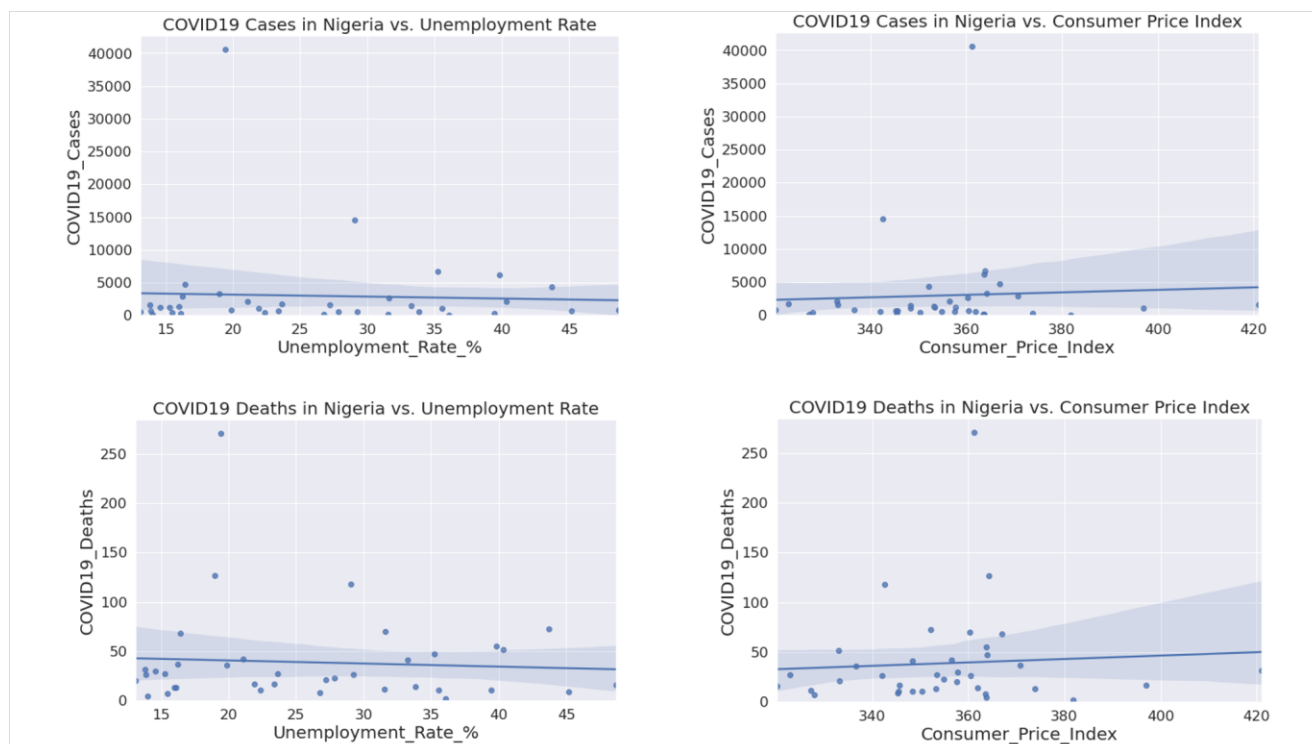


Figure 5. Correlation between COVID-19 Cases and Deaths vs Unemployment Rate and CPI

Table – 1. Pearson Correlation Results Matrix

	Hospitals_per_1000k	COVID19_Cases	COVID19_Deaths	Unemployment_Rate_%	Consumer_Price_Index	Govt_HealthAccess_Index	Population_per_sqkm	COVID19_Tests
Hospitals_per_1000k	1.000000	0.178827	0.128498	-0.408891	0.009807	-0.019579	0.223142	0.207749
COVID19_Cases	0.178827	1.000000	0.919447	-0.044533	0.053523	-0.025956	0.817813	0.949769
COVID19_Deaths	0.128498	0.919447	1.000000	-0.066245	0.069273	-0.112641	0.720981	0.914559
Unemployment_Rate_%	-0.408891	-0.044533	-0.066245	1.000000	-0.345866	-0.187732	0.020904	0.050344
Consumer_Price_Index	0.009807	0.053523	0.069273	-0.345866	1.000000	0.137046	-0.125587	0.009333
Govt_HealthAccess_Index	-0.019579	-0.025956	-0.112641	-0.187732	0.137046	1.000000	-0.071793	-0.109483
Population_per_sqkm	0.223142	0.817813	0.720981	0.020904	-0.125587	-0.071793	1.000000	0.767300
COVID19_Tests	0.207749	0.949769	0.914559	0.050344	0.009333	-0.109483	0.767300	1.000000



Figure 6. Correlation test for COVID-19 Cases and Deaths vs Population Density

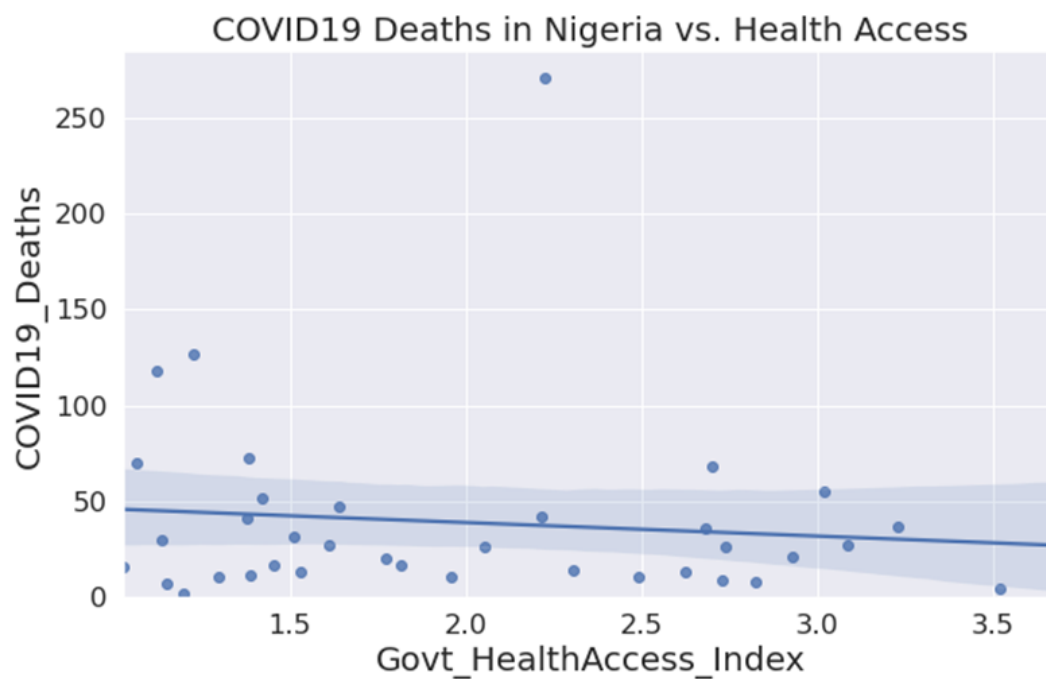
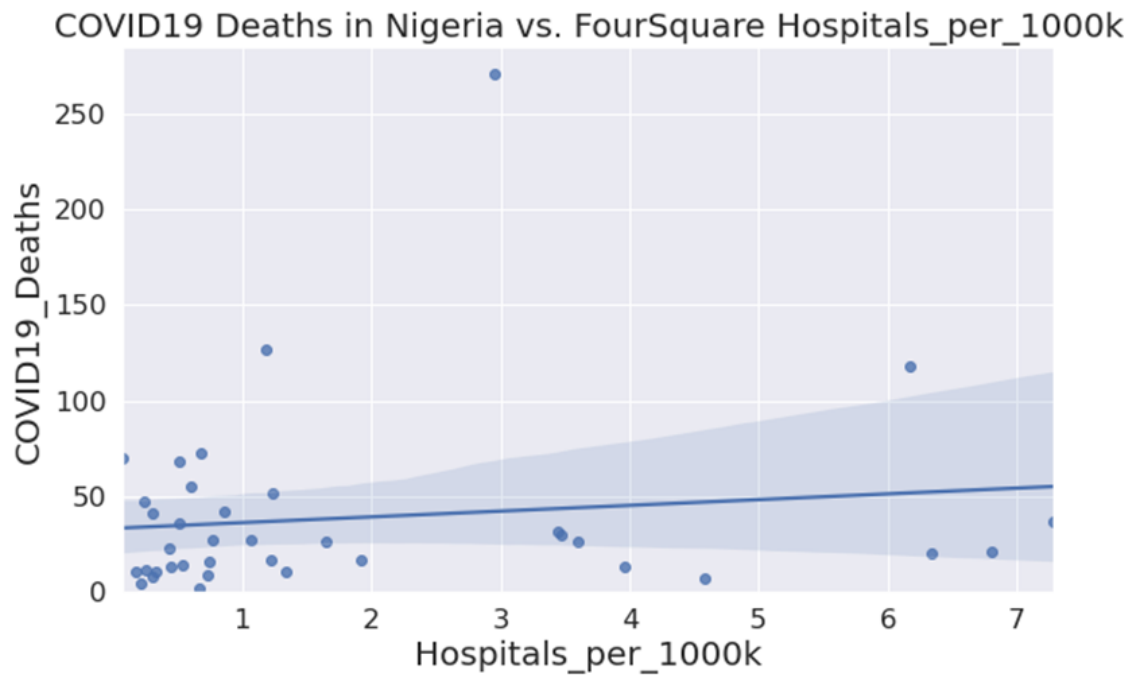


Figure 7. Correlation test for COVID-19 Deaths vs Access to Healthcare

Discussion

A correlation test of the COVID-19 data versus population density shows a positive correlation. This is expected since the spread of the virus is known to occur when people are closest together physically. However, some of the more densely populated states, like Anambra, Imo, Akwa Ibom, and Abia, do not show high amounts of COVID-19 infections. The reason for this observation is not known. It is possible that there is lack of adequate testing in these states, or COVID-19 data from the states are not appropriately captured. Lagos State, which has the highest population density, also has the highest number of COVID-19 cases (infections, recovery and deaths). Lagos State is home to the city of Lagos, which is the business capital of the country, and attracts people from all over the world. Other states, like the Federal Capital Territory -FCT, Plateau State, Kaduna State, Oyo State, have high number of COVID-19 cases, but are not nearly as densely populated as Lagos State.

COVID-19 Cases and deaths in Nigeria show a weak negative correlation with unemployment rate. This observation may be counter-intuitive, but it can be explained from the lens of mobility. The more people that are employed, the more likely they are to get in proximity to other people - fellow employees at the offices, or with other people in transit to and from their offices. Therefore, there will be more avenues to spread the virus.

A weak positive correlation is shown between COVID-19 cases and deaths, and the consumer price index (CPI). More than the unemployment rate, the CPI is a better, albeit indirect, indicator for relative comparison of household economic capacity. The higher the CPI, the more a household must pay for goods and services. And in Nigeria, where wages have remained stagnant for decades, the CPI is a good indicator for the challenge that households have in meeting basic needs. States that have a higher CPI value are likely to have more people below the poverty line and who do not have the financial capacity to take precautionary measures to protect against the COVID-19 virus. Hence, the higher the CPI, the higher COVID-19 case and death counts.

Access to health care, defined as Hospitals per 1000k persons using data from Foursquare location API, shows a weak positive correlation to COVID-19 deaths. This observation is also counter-intuitive, and it is likely that inadequate information on the number of medical facilities per state are not fully accessible online. By comparison, Health-care access data from the Bureau of Statistics shows a weak negative correlation to COVID-19 deaths. The fewer people that have access to healthcare, the higher the death rates from COVID-19.

A correlation test between population density and COVID-19 tests amounts show a strong positive correlation. This observation indicates that the government is correctly focusing its resources in high population cities and municipalities to avoid continuous spread of the virus. However, the Federal Government of Nigeria needs to identify those States that have widespread COVID-19 cases but that are not high population density states, as described above. These states likely have big urban hubs or cities that are densely populated, even though the entire state is not necessarily densely populated.

Conclusion

Socio-economic considerations need to be assessed by the government of Nigeria in order to draft a strategic plan to fight the COVID-19 pandemic, as well as prepare for any future pandemics or epidemics. This study has shown that there is not a lot of data that exists in the National database for economic indicators for the different States. Nonetheless, the limited data that exist has shown that states with poorer economic circumstances tend to do worse when it comes to COVID-19

prevention and recovery. The government should do more to shore up these states economically. This will empower the populace to take measures to protect one another.

Access to health care needs to be improved. The government must develop a strategic plan to increase access to health care over time. This should allow more people to seek and find medical help and should reduce the death count from such pandemics in the future.

The data utilized in this study is limited. However, the study shows that the Federal Government of Nigeria has a huge role to play in allocating resources to fight the current pandemic, and empower States and the population to be ready for whatever future pandemic may occur.

References

1. Nigeria COVID-19 Data by States,
https://opendata.arcgis.com/datasets/9ca1fdd1841543b7b079ba97e52df85a_0.geojson
2. Nigeria Consumer Price Index,
https://nigerianstat.gov.ng/resource/cpi_1NewNOVEMBER2020.xls
3. Nigeria Unemployment Data,
<https://nigerianstat.gov.ng/resource/Unemplyment%20Data%20Series%20by%20State%20-%20q2%202020.xlsx>
4. Nigeria Population Data,
<https://nigerianstat.gov.ng/resource/POPULATION%20PROJECTION%20Nigeria%20sgfn.xls>
5. Nigeria Health Facility Access Data,
https://opendata.arcgis.com/datasets/ceabba4071a64c0ca2420ee3656b37ae_0.geojson
6. Watson-Studio Notebook,
https://github.com/ChukGit/Coursera_capstone_CE/blob/master/COVID-19%20in%20Nigeria.ipynb