MAPPING HEALTHCARE ACCESSIBILITY AND RELATIONSHIP WITH SEVERE DISEASE MORBIDITY IN NEW YORK CITY

Geographic Information System

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“Accessibility is seen as being concerned with the opportunity available to an individual or type of person at a given location to take part in a particular activity or set of activities.”

-SR. Jones, 1981

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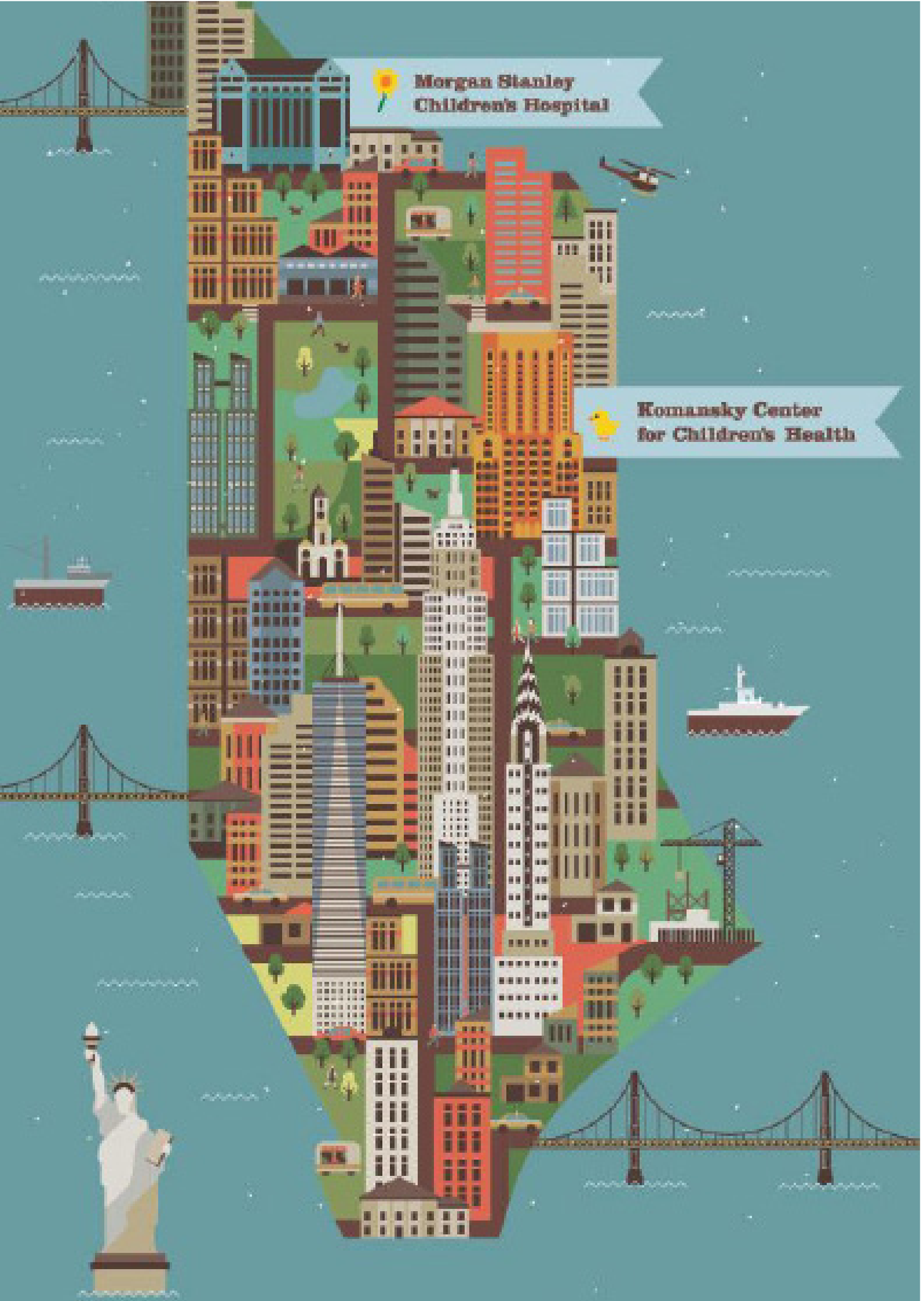


01 BACKGROUND

As one of the most serious cities affected by COVID, New York City has drawn attention to health care from the world. Though, in a city as class polarization and culture fusion as NYC, there is a significant difference between different groups in reaching medical resources, so called accessibility in health care. The accessibility inequity can occur between different income groups, aged people etc.

It is been calculated that severe diseases are having different infection/mobidity rate among different groups. We assume that one of the important factors can be the ease to reach medical resources.

This study is mainly looking into the health care accessibility in NYC in recent years (all data calculated are collected between 2015-2020), and how this health accessibility is related to health outcome which is measured by morbidity rate of several severe diseases.

DEFINITION

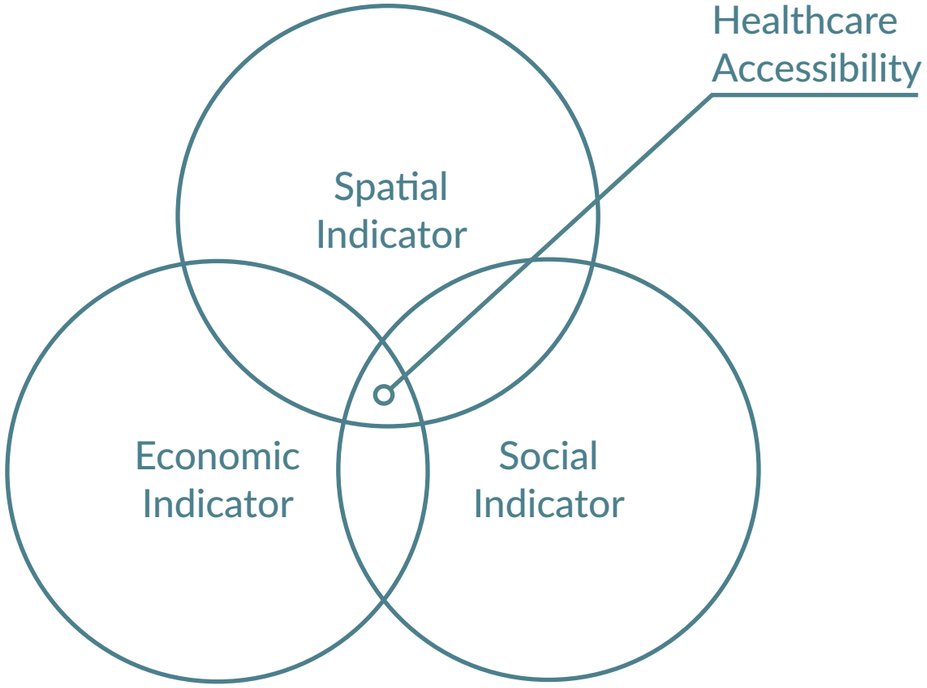
Generally, accessibility has been defined as some measure of spatial separation of human activities. Essentially it denotes the ease with which activities may be reached from a given location using a particular transportation system (Morris, 1979).

We find that in the literature, the index “accessibility” usually refers to the spatial relation between objectives, but lacking consideration of economic and social factors, Therefore, our team is trying to analyze accessibility in spatial, economic, and social dimension in New York City by calculating key factors, and integrating findings.

RESEARCH SCOPE

For the health outcome part, we choose four chronic deseases as a potential outcome of health care accessibility, we anticipate that high morbidity rate of this four severe diseases is somehow related to health outcome.

For the Health Care Accessibility part, we use 3 indicators as well as 9 indexes to calculate, including eoconomic, social, and spatial dimensions.



02 RESEARCH QUESTION

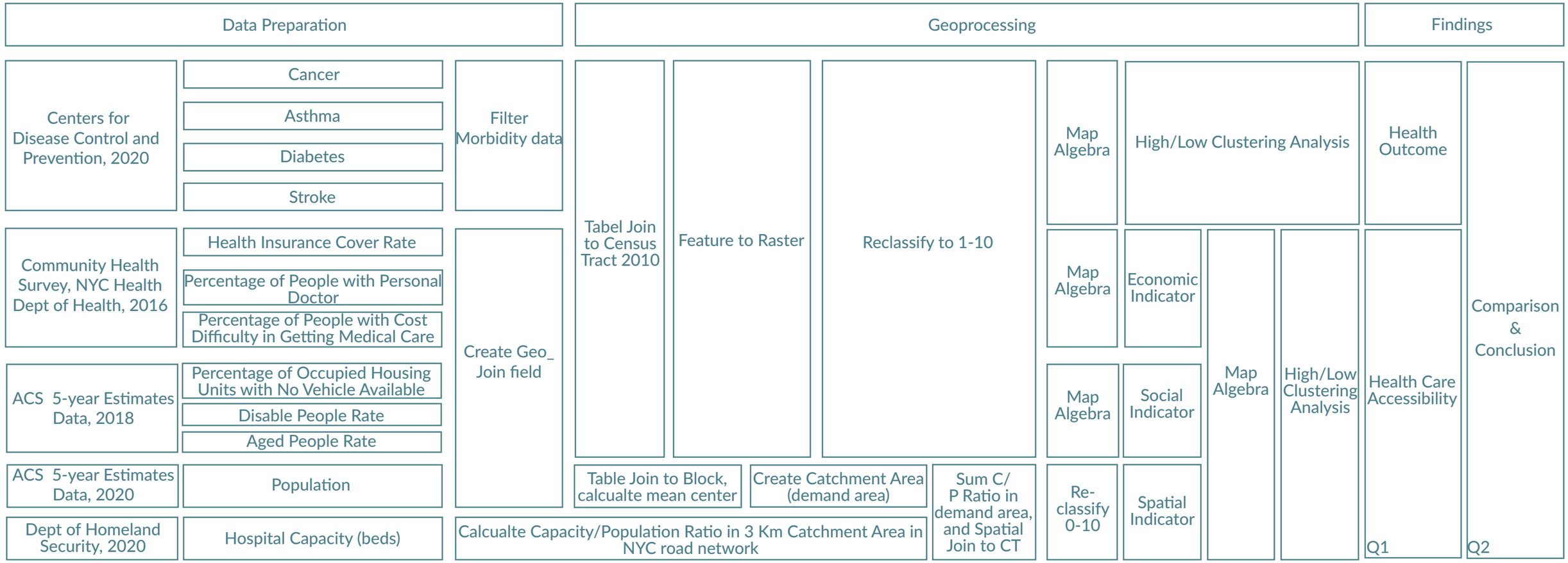
Q1 What is Healthcare Accessibility in New York City?

We assume that Manhattan area has a relatively high Health Care Accessibility, based on the census data, but the condition of other boroughs still remains unclear.

Q2 What is the Relationship between Healthcare Accessibility and Health Outcome?

The hypothesis is that high Health Care Accessibility area should be able to explain the Health Outcome in parts of the NYC, we do not expect all tracts of NYC are showing significant relationship, since the complex socio- and economic factors are quite different.

03 METHODOLOGY



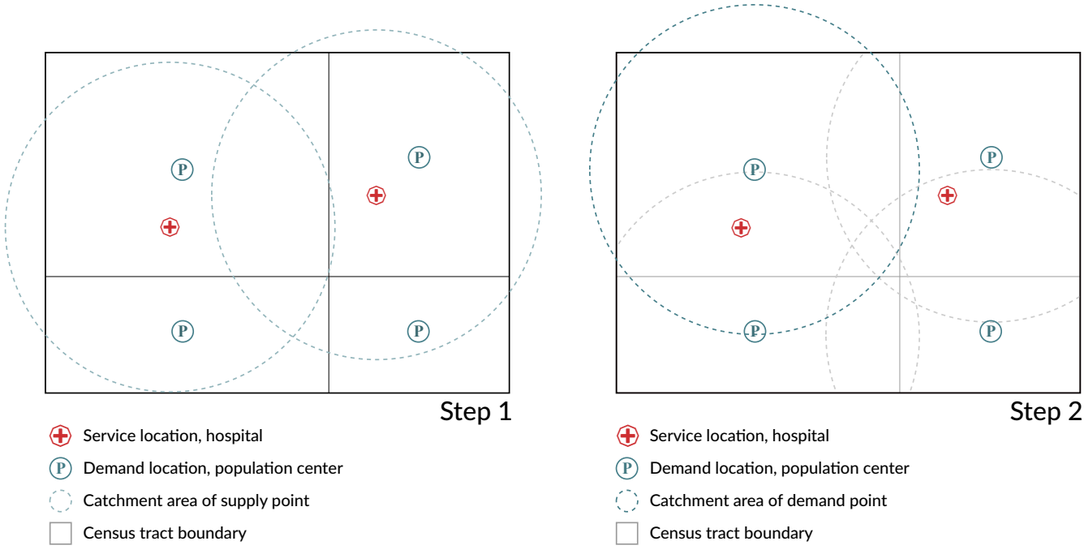
Q1 What is Health Care Accessibility in New York City?

Q2 What is the relation ship between Health Care Accessibility and Health Outcome?

Analysis One

04 MAPPING ACCESSIBILITY TO HEALTHCARE IN NYC

2SFCA Operating Step



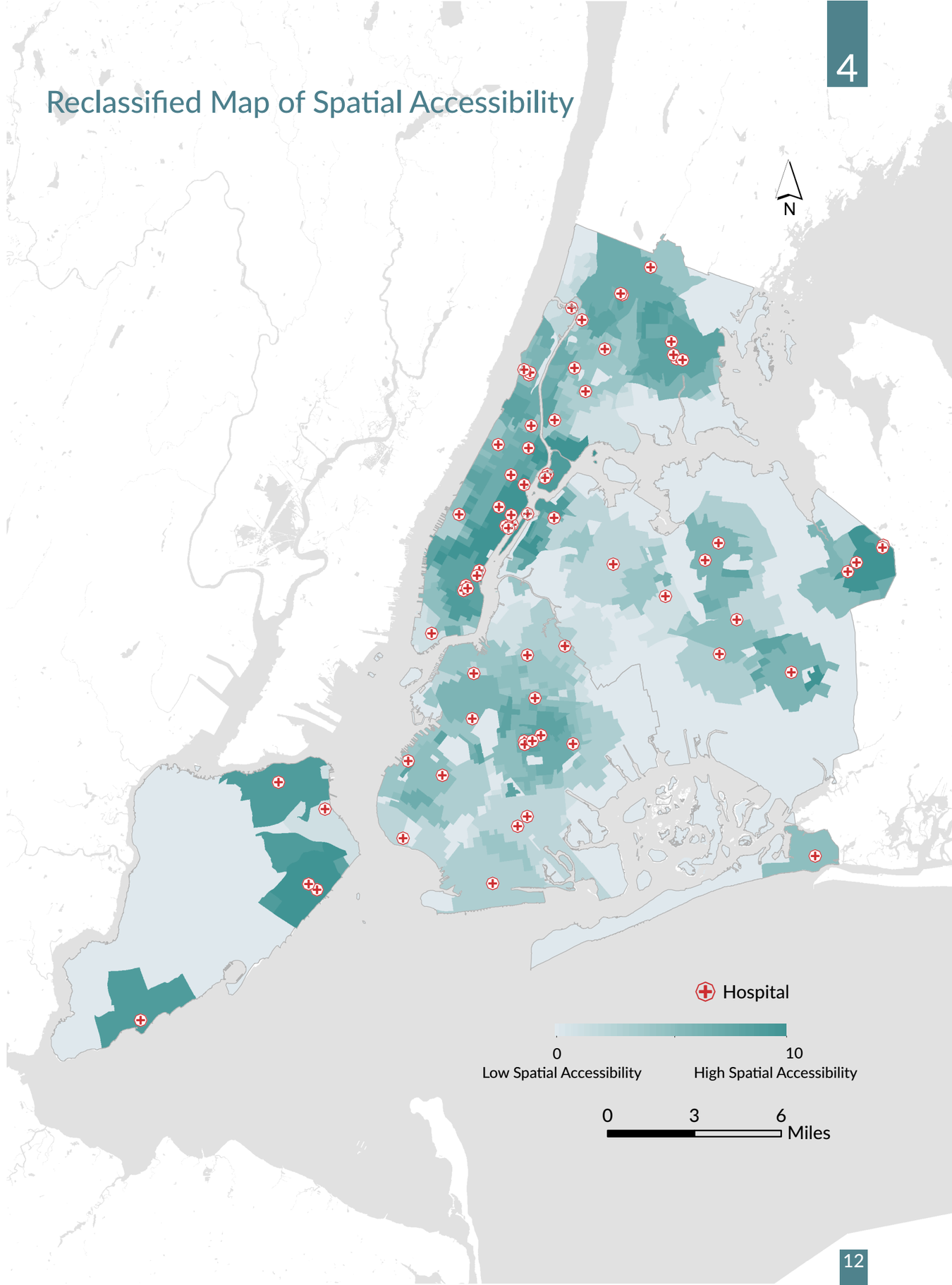
4.1 SPATIAL ACCESSIBLITY

For spatial accessibility, we use the two step floating catchment are (2SFCA) method and build the catchment area for both demand and supply locations. It involves three components and datasets: first, the number of beds for each hospital represents the capacity of healthcare services; second, the total population for each census tract represents the potential demand for healthcare services; third, distance as the travel impedance based on NYC road network with vehicle available represents the transport network performance.

In detail, we take the hospital locations with the data of the number of beds as supply locations and population-weighted mean centers in each census tract based on the population of block groups as demand locations. For the size of the catchment area, we build the 3km service area based on the road network. After completing this process, we reclassify the map of spatial accessibility in NYC based on the quantile method and assign the score from zero to ten to get the decision layer of spatial accessibility.

From this part of the analysis, we can find that overall Manhattan has the best access to healthcare than other boroughs. Also, the coverage of health services in Brooklyn and Bronx is very high and basically, all census tracts have access to healthcare within 3km. But as we can see, the inequity of access to health care is obviously more serious in Staten Island and Queens with many census tracts have low access.

Reclassified Map of Spatial Accessibility

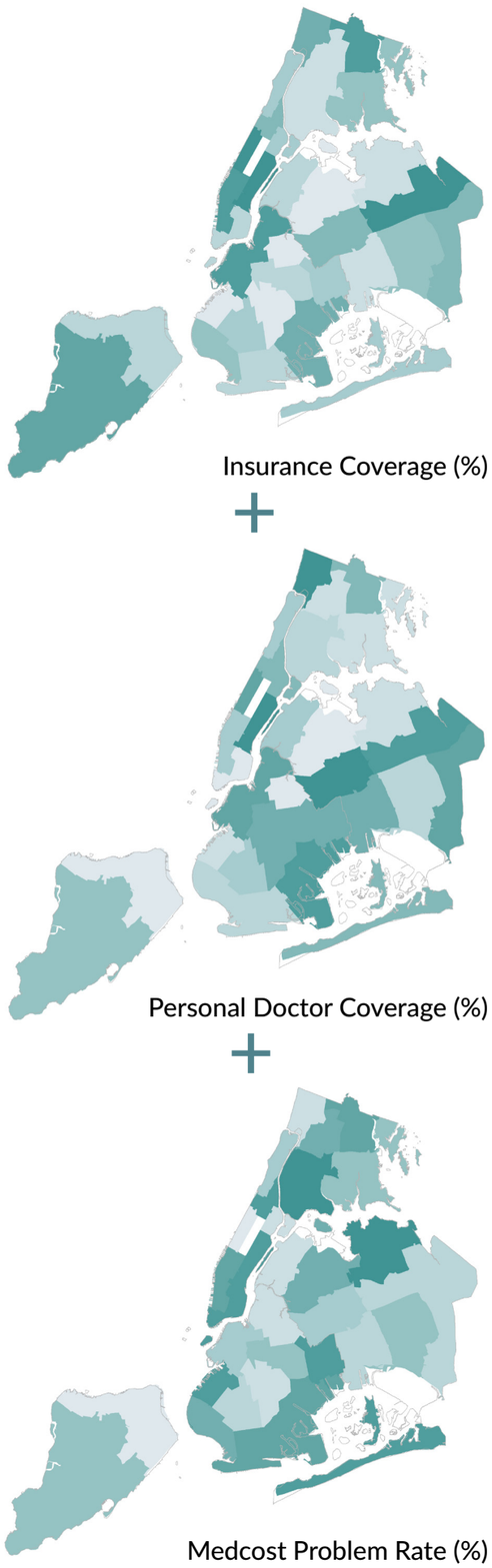


4.2 ECONOMIC ACCESSIBLITY

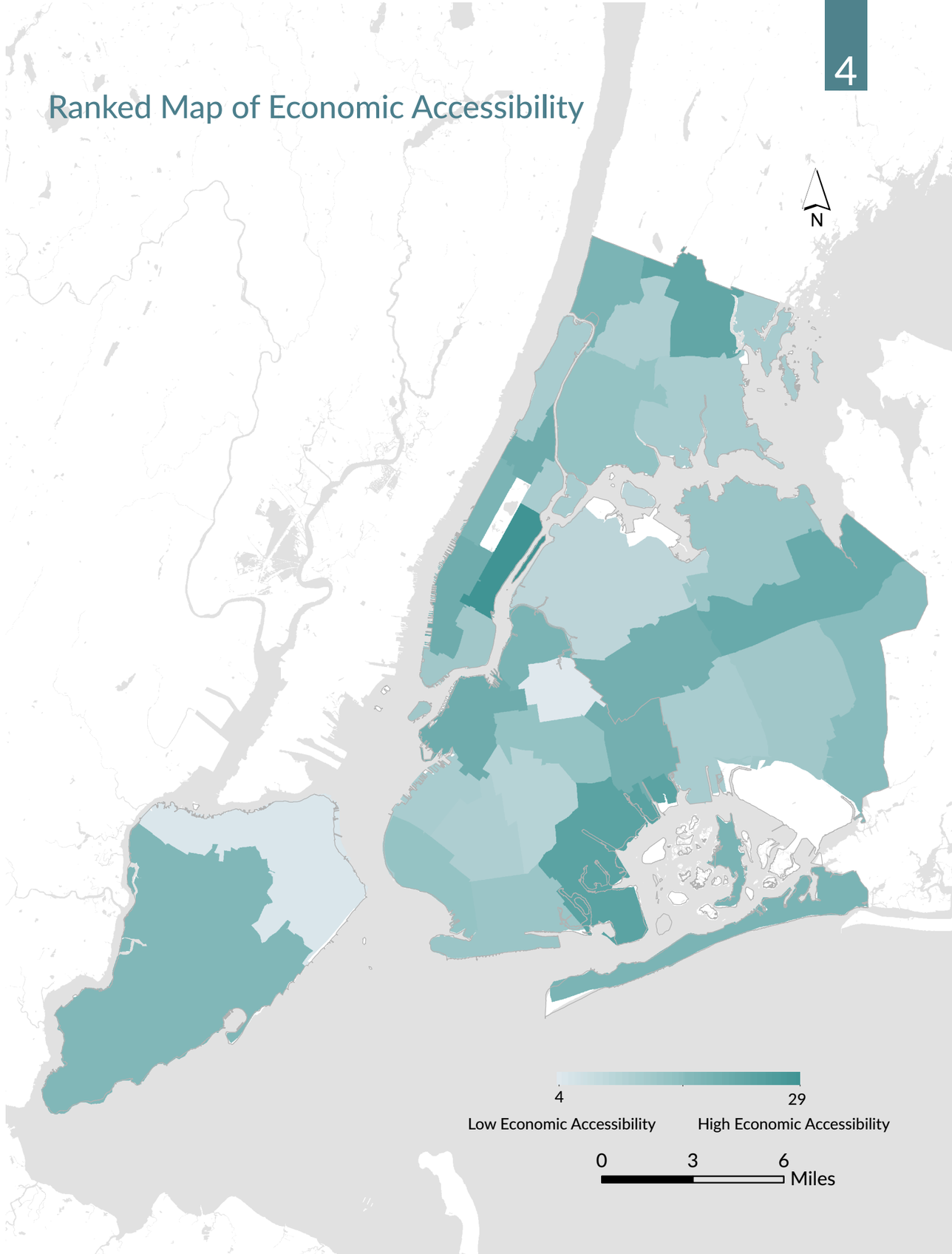
The data of economic indicators we use to evaluate healthcare accessibility was provided by the NYC Department of Health through the Community Health Survey. We use the three major questions in this survey. These three questions are whether people have health insurance, whether they have a personal doctor and whether they have difficulty in getting medical care due to costs. We assume that higher rate in insurance and personal doctor coverage means higher economic accessibility. The higher rate in people with cost difficuilty means lower economic accessibility.

Map of health insurance rate displays Midtown Manhattan has the highest insurance coverage compared to other areas. On the contrary, the area with the lowest insurance coverage locates more in Brooklyn. The percentage of people with a personal doctor is higher in Brooklyn and Queens. Map of people with cost difficulty rate shows Staten Island has the most cost difficulty when people were seeking medical care.

Then, we created the ranked decision map of economic accessibility after reclassifying these factors and combining three decision layers in the same weight. Overall, Manhattan has the better economic accessibility to healthcare compared to other boroughs and Midtown Manhattan has the best value among all the areas. On the contrary, the of economic accessibility in Staten Island is worse, especially the north Staten Island has the lowest economic accessibility. Besides, inequity access is more obvious in Brooklyn.



Ranked Map of Economic Accessibility

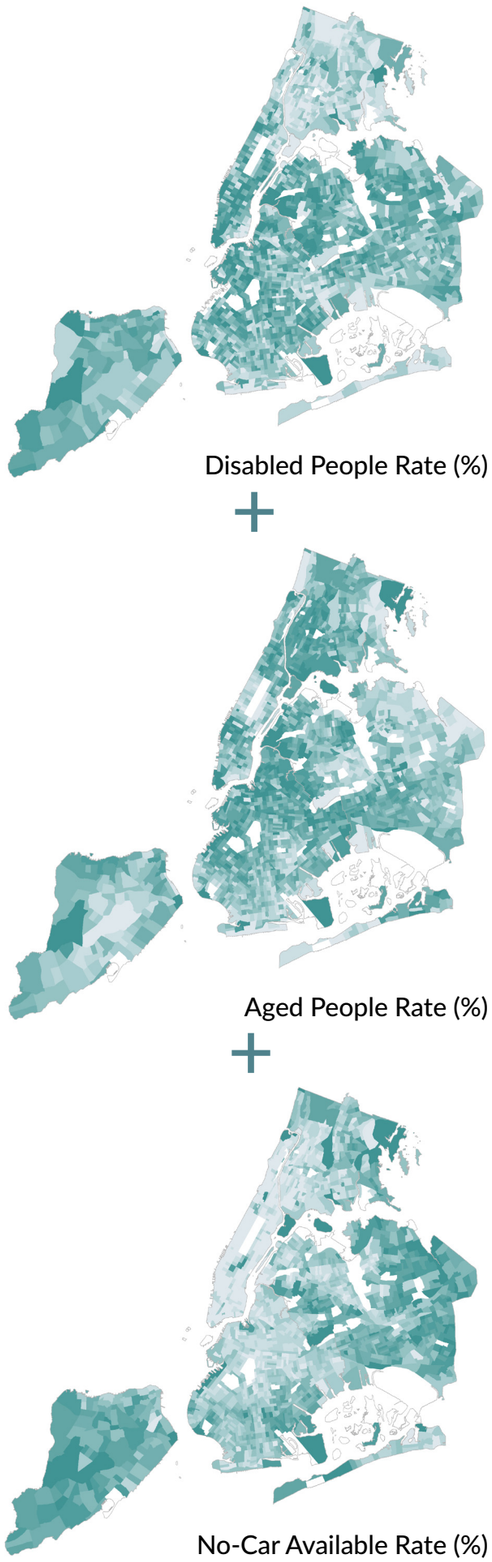


4.3 SOCIAL ACCESSIBLITY

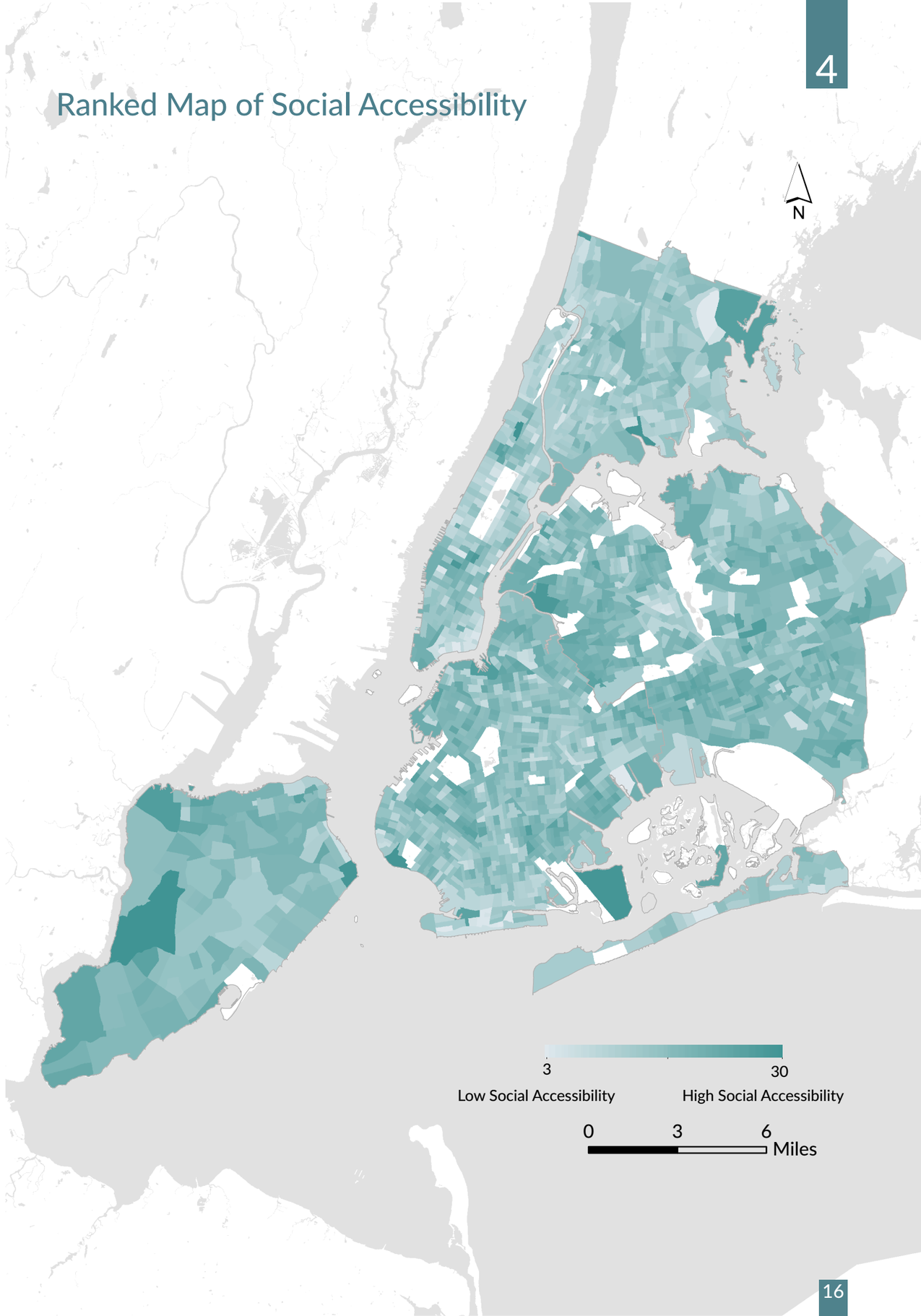
For social indicators, the data was provided by the American Community Survey. We use the data of disabled people rate (DPR), aged people rate (APR) and no-car available rate (NCAR) at the census-tract level to evaluate the social accessibility in NYC. We assume that for each census tract, the higher rate of these three datasets, the lower the social accessibility.

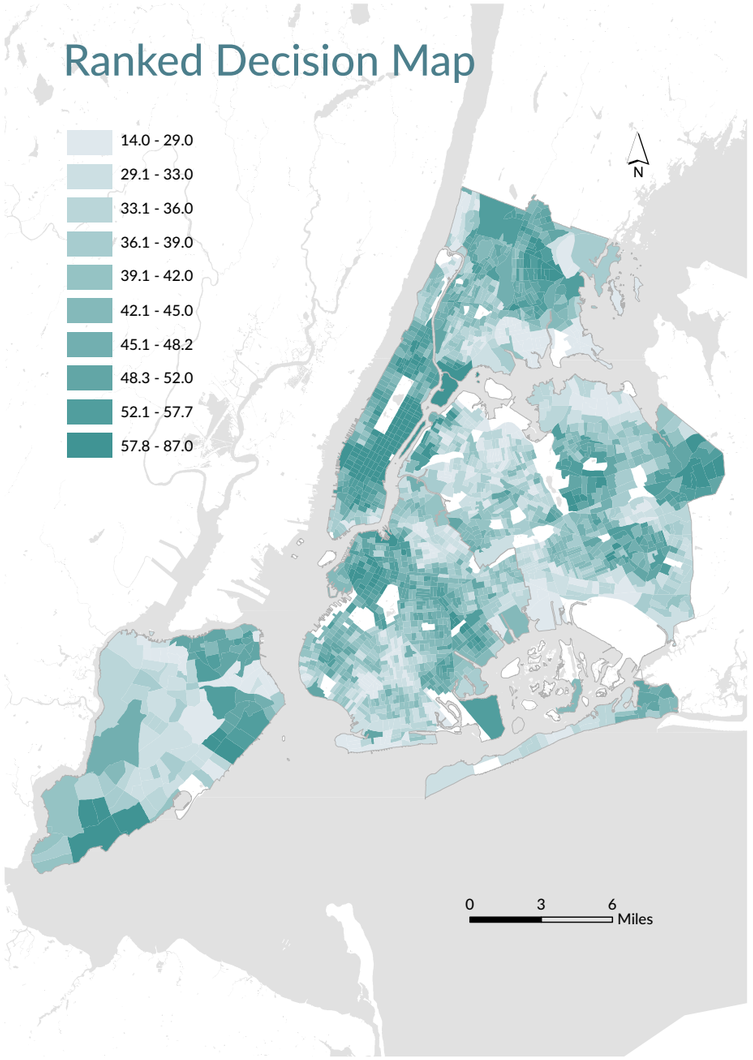
In terms of disabled people, the high DPR census tracts are clustered in south coast side of Queens, and north Brox. In terms of aged people, high APR census tracts are clustered in Upper Manhattan, west Brooklyn, west Queens, and Statan Island. In terms of car availibity, high NCAR tracts are all centered in the Lower and Midtown Manhattan, indicating the low accessibility in this area.

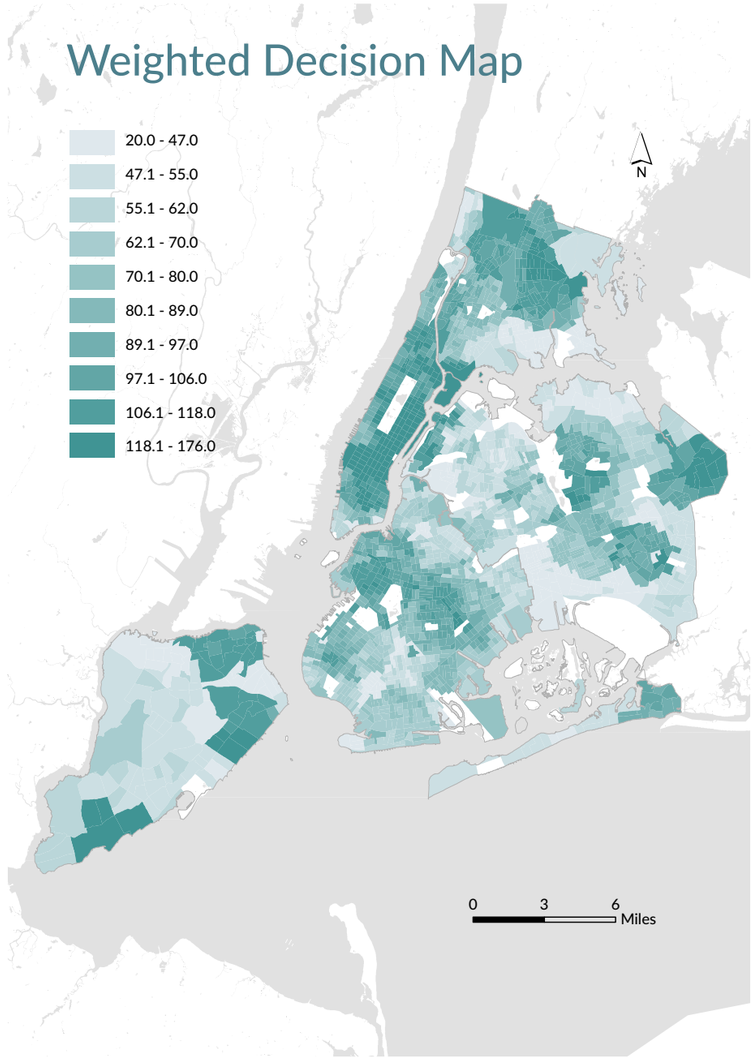
Combining all three aspects, evenly weighted MCDA method is used to calculated overall social accessibility, and it is quite clear that relatively high social accessibility tracts are located in Statan Island, northeast Bronx, and Queens.



Ranked Map of Social Accessibility







Spatial Accessibility	X	3
Insurance Coverage (%)	X	1
Personal Doctor Coverage (%)	X	1
Medcost Problem Rate (%)	X	1
Disabled People Rate (%)	X	1
Aged People Rate (%)	X	1
No-Car Available Rate (%)	X	1

Spatial Accessibility	X	9
Insurance Coverage (%)	X	2
Personal Doctor Coverage (%)	X	2
Medcost Problem Rate (%)	X	2
Disabled People Rate (%)	X	1
Aged People Rate (%)	X	1
No-Car Available Rate (%)	X	1

4.4 OVERALL ACCESSIBILITY

Based on the reclassified raster map of 7 decision layers above, we make two weighted decision-making maps of overall accessibility to health care. In the first map, the spatial accessibility index is considered as 3 times as other layers. The purpose of this map is to consider three indicators in the same weight, while the maximum of social indicator and economic indicator is 30, 3 times larger as the original spatial accessibility indicator.

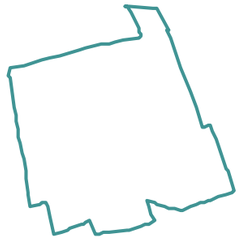
In the second map, the spacial indicator is multiplied 9 and the economic indicator is multiplied 2. Thus, the influences of spacial indicator, economic indicator and social indicator are given 3:2:1. This proportion is decided by our team by literature review and experience. The purpose of this map was to intensify the influence of physical and economic access to healthcare. And the second weighted map is the map for comparing in the following steps.

We can notice that areas display similar distribution in both maps. The midtown and downtown of Manhattan, the north of Bronx, the east of Queens represent the most accessiblilty to health care. However, the southeast of Bronx, the south of Queens and the north of Staten Island represent the least accessibility to health care. Additionally, these areas show the character of clustering.

Lowest Accessibility Neighborhood

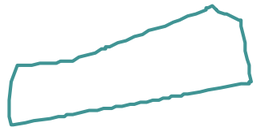
42.81

Hunters Point-Sunnyside-West Maspeth



43.98

Woodhaven



50.71

Soundview-Bruckner

Mean: 80.73

Neighborhood Name	Code	Spatial	Med Problem	Personal Doc	Insured	Aged	Disabled	No Car	Overall Accessibility
Soundview-Bruckner	BX55	0.64	5.01	2.00	4.99	6.74	2.84	3.45	42.81
Woodhaven	QN53	0.00	3.02	7.00	2.01	7.10	6.62	6.20	43.98
Hunters Point-Sunnyside-West Maspeth	QN31	1.21	3.67	3.17	1.72	8.84	9.68	4.18	50.71
Seagate-Coney Island	BK21	1.64	8.00	3.00	2.10	4.61	3.66	4.16	53.42
Jackson Heights	QN28	2.00	8.00	1.00	1.00	5.40	6.71	3.58	53.68
Bensonhurst West	BK28	1.91	6.28	3.43	4.57	4.98	5.24	4.19	60.13
West Farms-Bronx River	BX08	2.67	6.55	2.31	3.76	6.82	2.33	2.69	61.12
Bensonhurst East	BK29	2.35	7.29	3.18	3.35	4.31	4.85	4.27	62.21
Flatbush	BK42	3.05	2.71	5.93	2.07	6.45	5.81	3.44	64.56
East Williamsburg	BK90	2.54	2.01	5.04	6.39	8.00	5.77	2.06	65.55

4.5 ANALYSIS & SUGGESTION

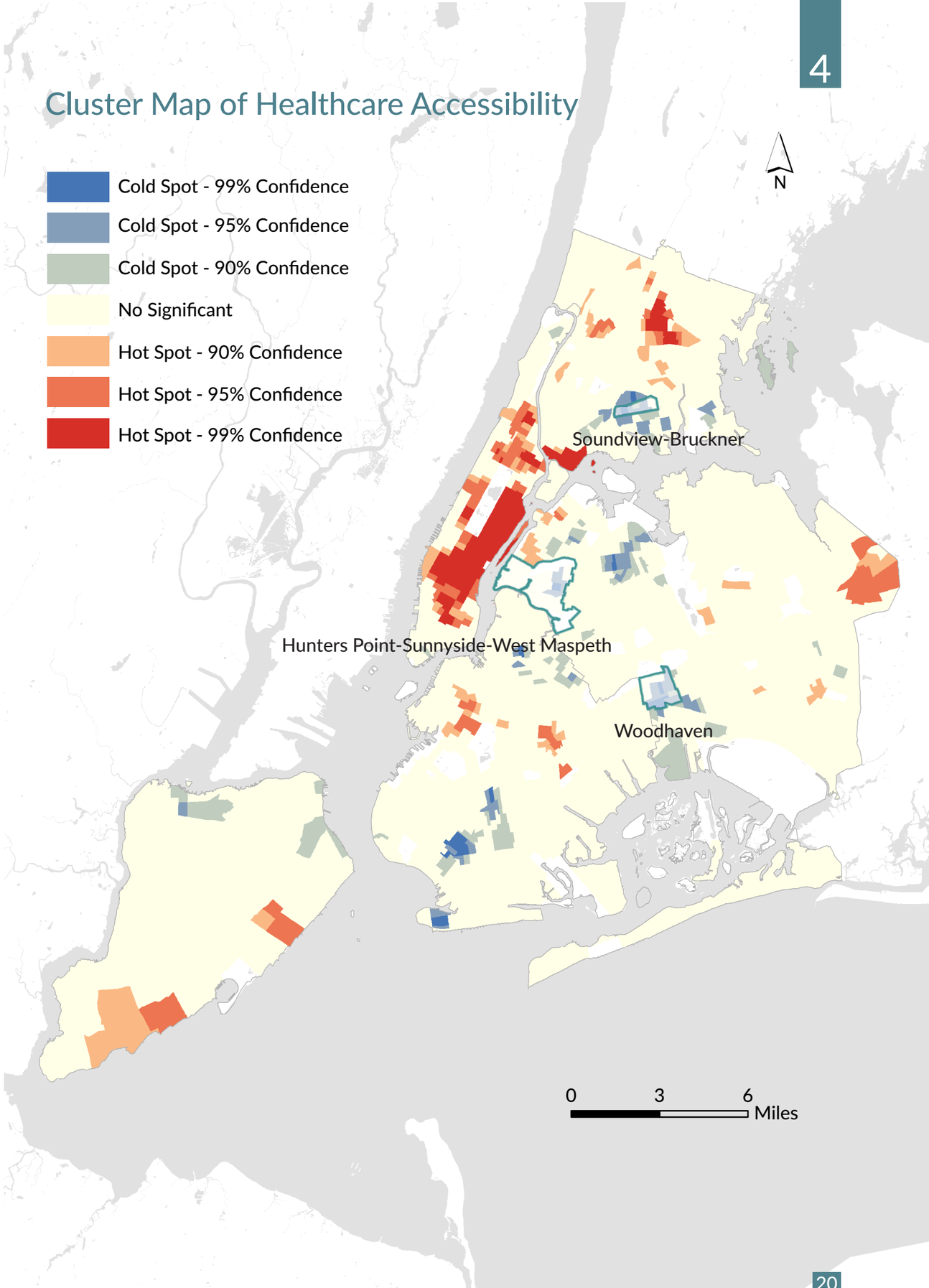
In order to give suggestions to improve neighborhoods' access to healthcare, we choose 3 neighborhoods with lowest average accessibility out of all neighborhoods with cold spots of accessibility. There are Soundview-Bruckner, Woodhaven and Hunters Point-Sunnyside-West Maspeth, and we regard the items lower than 3 demonstrate a neighborhood should optimize these items.

As for Soundview-Bruckner, it has low value of spatial accessibility, personal doctor rate and disabled rate. Thus, a new hospital should be built nearby or enlarge existing nearby hospital. And subsidy should be provided for residents to hire personal doctors. Then, nearby hospitals or other organizations should prepare special infrastructure for disabled population.

As for Woodhaven, it has low value of spatial accessibility, and insurance rate. Considering its spatial accessibility is 0, there is no hospital in its 3 kilometers. Thus, a new hospital is highly recommended to be built here. And subsidy should be provided for residents to buy insurance.

As for Hunters Point-Sunnyside-West Maspeth, it has low value of spatial accessibility, and insurance rate. Thus, a new hospital should be built nearby or enlarge existing nearby hospital. And subsidy should be provided for residents to buy insurance.

Cluster Map of Healthcare Accessibility

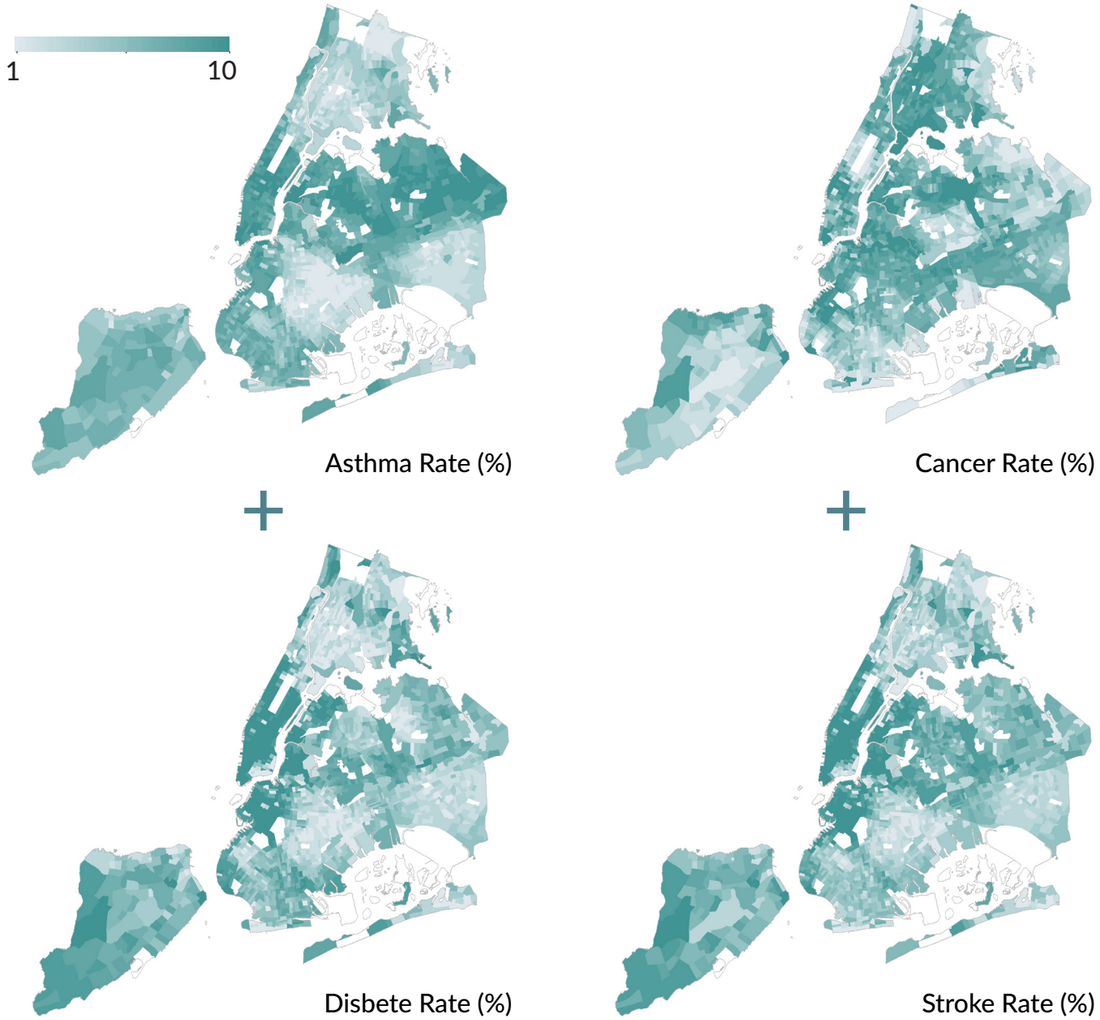


Analysis Two

05 RELATIONSHIP TO HEALTH OUTCOME

5.1 Mapping Health Outcome in NYC

5.2 Comparsion



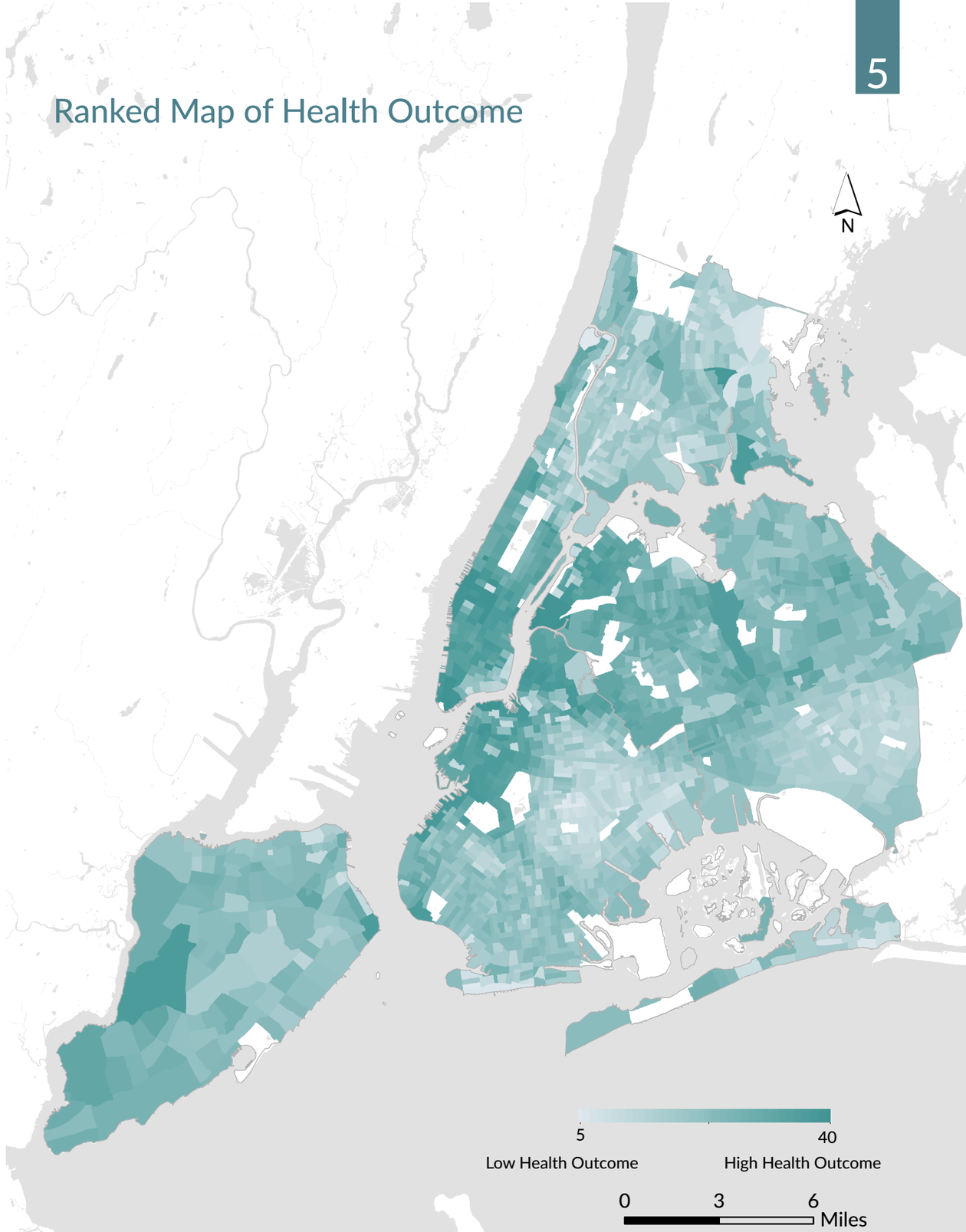
5.1 MAPPING HEALTH OUTCOME

The health outcome is a decision making map based on disease morbidity. The diseases we choose are cancer, stroke, diabetes and asthma, and their data are provided by the 500 cities project of the Centers for Disease Control and Prevention. The first three diseases are three of the causes which lead most deaths of American, and the latter is a common acute disease.

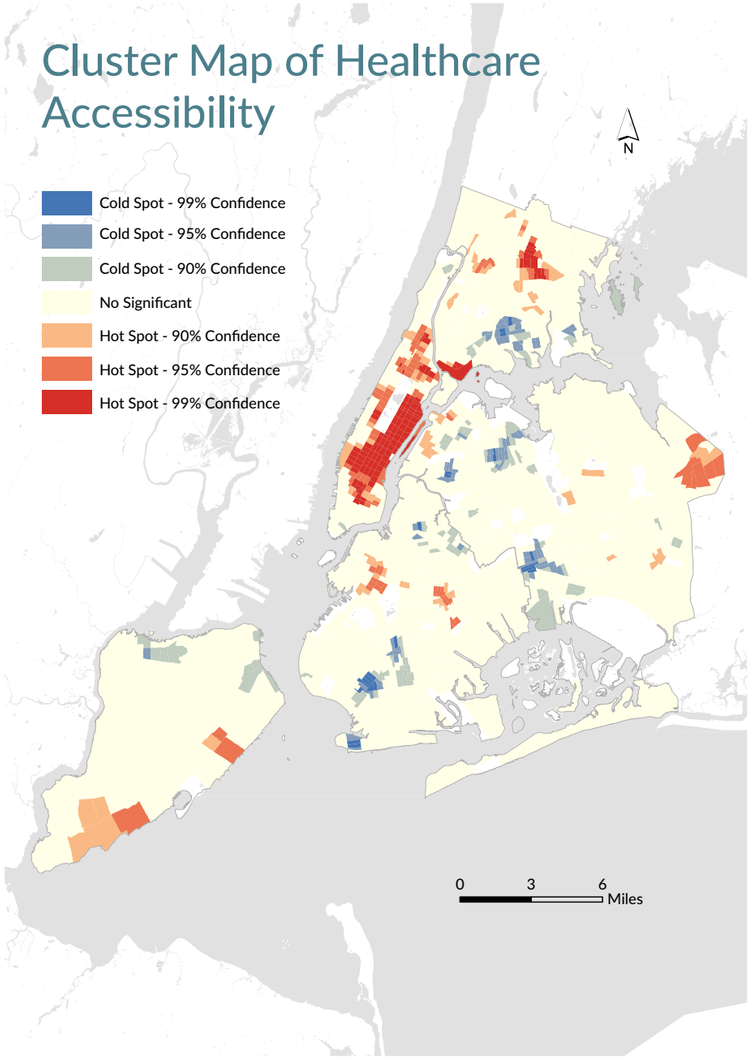
The map of cancer rate display areas in the South Bronx and North Queens have low case rates. The map of stroke rate shows downtown and midtown of Manhattan and north Brooklyn has low case rates. The map of diabetes rate shows the same character. The map of asthma rate displays downtown and midtown of Manhattan and Queens have low case rates, while east Brooklyn and North Bronx have a high case rate.

A ranked decision map was created from the reverse value reclassification of all disease rates to create an overall decision map for the health outcome. This decision map shows areas with fewer disease rates with a higher value. In this analysis, downtown and midtown Manhattan and its east coast have greater health outcome.

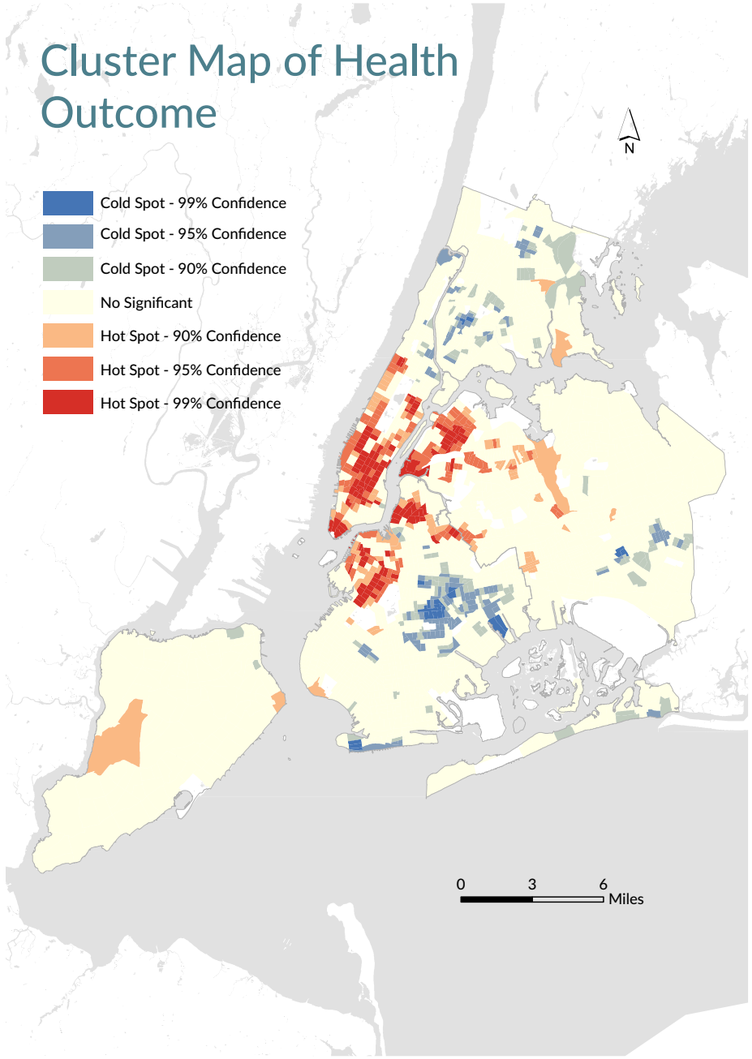
Ranked Map of Health Outcome



Cluster Map of Healthcare Accessibility



Cluster Map of Health Outcome



Cluster Analysis – Healthcare Accessibility

Neighborhood Name	Code
Hot Spot – Neighborhood	
Hudson Yards-Chelsea-Flatiron-Union Square	MN13
Midtown-Midtown South	MN17
Murray Hill-Kips Bay	MN20
Gramercy	MN21
East Village	MN22
West Village	MN23
Yorkville	MN32
East Harlem South	MN33
Upper East Side-Carnegie Hill	MN40
Brooklyn Heights-Cobble Hill	BK09
Park Slope-Gowanus	BK37
DUMBO-Vinegar Hill-Downtown Brooklyn-Boerum Hill	BK38
Other 14 Neighborhoods	
Cold Spot – Neighborhood	
Seagate-Coney Island	BK21
Bensonhurst West	BK28
Bensonhurst East	BK29
Flatbush	BK42
Other 6 Neighborhoods	QN53

Cluster Analysis – Health Outcome

Neighborhood Name	Code
Hot Spot – Neighborhood	
Hudson Yards-Chelsea-Flatiron-Union Square	MN13
Midtown-Midtown South	MN17
Murray Hill-Kips Bay	MN20
Gramercy	MN21
East Village	MN22
West Village	MN23
Yorkville	MN32
East Harlem South	MN33
Upper East Side-Carnegie Hill	MN40
Bushwick South	BX31
DUMBO-Vinegar Hill-Downtown Brooklyn-Boerum Hill	BX39
Hudson Yards-Chelsea-Flatiron-Union Square	BX44
Other 6 Neighborhoods	
Cold Spot – Neighborhood	
Seagate-Coney Island	BK21
Prospect Lefferts Gardens-Wingate	BK60
Crown Heights North	BK61
Ocean Hill	BK79
Other 6 Neighborhoods	

5.2 COMPARSION

To compare their geometric statistics features, we analyze their concentration and focus on whether the same neighborhoods are hotspots or coldspots in both maps. We use hot spot analysis by fixed distance band method with the average distance between nearest census tracts.

The map of overall accessibility displays 18 neighborhoods with 99% confidence hotspot, and 15 of them are located in Manhattan, 3 of them are located in Bronx. The map of health condition displays 26 neighborhoods with 99% confidence hotspot, and 15 of them are located in Manhattan, 7 of them are located in Brooklyn, 4 of them are located in Queens. As shown by the table, 9 out of 18 neighborhoods with hotspots of accessibility coincide with the neighborhood with hotspots of health condition, which means 50 percent accuracy.

The map of health condition displays 10 neighborhoods with 99% confidence coldspot, and 5 of them are located in Brooklyn, 2 of them are located in Bronx, 3 of them are located in Queens. The map of health condition displays 10 neighborhoods with 99% confidence coldspot, and 7 of them are located in Brooklyn, 2 of them are located in Bronx, 1 of them is located in Queens. As shown by the table, 1 out of 10 neighborhoods with coldspots of health condition coincide with the neighborhood with hotspots of health condition, which means 10 percent accuracy.

06 CONCLUSION

In general, considering the effect of predicting the clustered neighborhood with good or bad health outcome, the overall accessibility we create has a good effect on forecasting the hotspots of health outcome, while it has a bad good effect on forecasting the coldspots of health outcome.

Thus, we should consider other variables or adjust the weight of the decision-making map if we would like to optimize the correlationship to health condition value.

IMPLICATION

For the high-related area like Manhattan, it is quite crucial to improve health care accessibility in spatial, economic, and social part.

For the spatial part, NYC Dept of Health should deploy private and public hospital in low spatial accessibility area.

For the economic part, it should be promoted that the compensation on health care, and health insurance cover rate.

For the neighborhoods with low value in aged population rate or disabled rate, department of health are supposed to prepare the medical instrument for aged people or disabled people.

LIMITATION

1. First, in this process, we use distance based on the road network in NYC to build the catchment area and ignore the real transport performance, like the speed and direction of each road.

2. Second, when we consider what kind of hospitals can be seen as the service locations, we ignore the difference of types and qualities of hospitals, like private hospitals or public hospitals. Also, we ignore the effect of hospitals out of the NYC boundary.

3. Third, when patients living in an area with lots of hospitals to choose from, we ignore their choice behavior and the competition between hospitals in the catchment area.

4. Concerning the data that we used in this project, another limitation is the created time of these data sources is different and we use the data from the latest year without the missing data.

5. Lastly, 2SFCA method ignores the main travel vehicle of different boroughs, which may cause bias in accessibility. E.g. Statan Island is mainly car-oriented while people in Manhattan are mostly walking.

07 APPENDIX

Data Source

Hospital dataset including information on bed numbers, 2020, Dept of Homeland Security
Total population by census tracts in New York City, 2018, ACS 5-year Estimates Data
Percentage of people with health insurance, 2016, Community Health Survey, NYC Health Department of Health
Percentage of people with personal doctor, 2016, Community Health Survey, NYC Health Department of Health
Percentage of people with difficulty in medical cost, 2016, Community Health Survey, NYC Health Department of Health
Percentage of occupied housing units with no vehicle available, 2018, ACS 5-year Estimates Data
Aged people rate (over 65 years old), 2018, American Community Survey 5-year Estimates
Disabled people rate, 2018, American Community Survey 5-year Estimates
Percentage of people with cancer, 2019, Centers for Disease Control and Prevention
Percentage of people with diabetes, 2019, Centers for Disease Control and Prevention
Percentage of people with stroke, 2019, Centers for Disease Control and Prevention
Percentage of people with asthma, 2019, Centers for Disease Control and Prevention

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THANK YOU