Motor Vehicle Collision Crash Frequency and Demographic Characteristics in New York City, 2020

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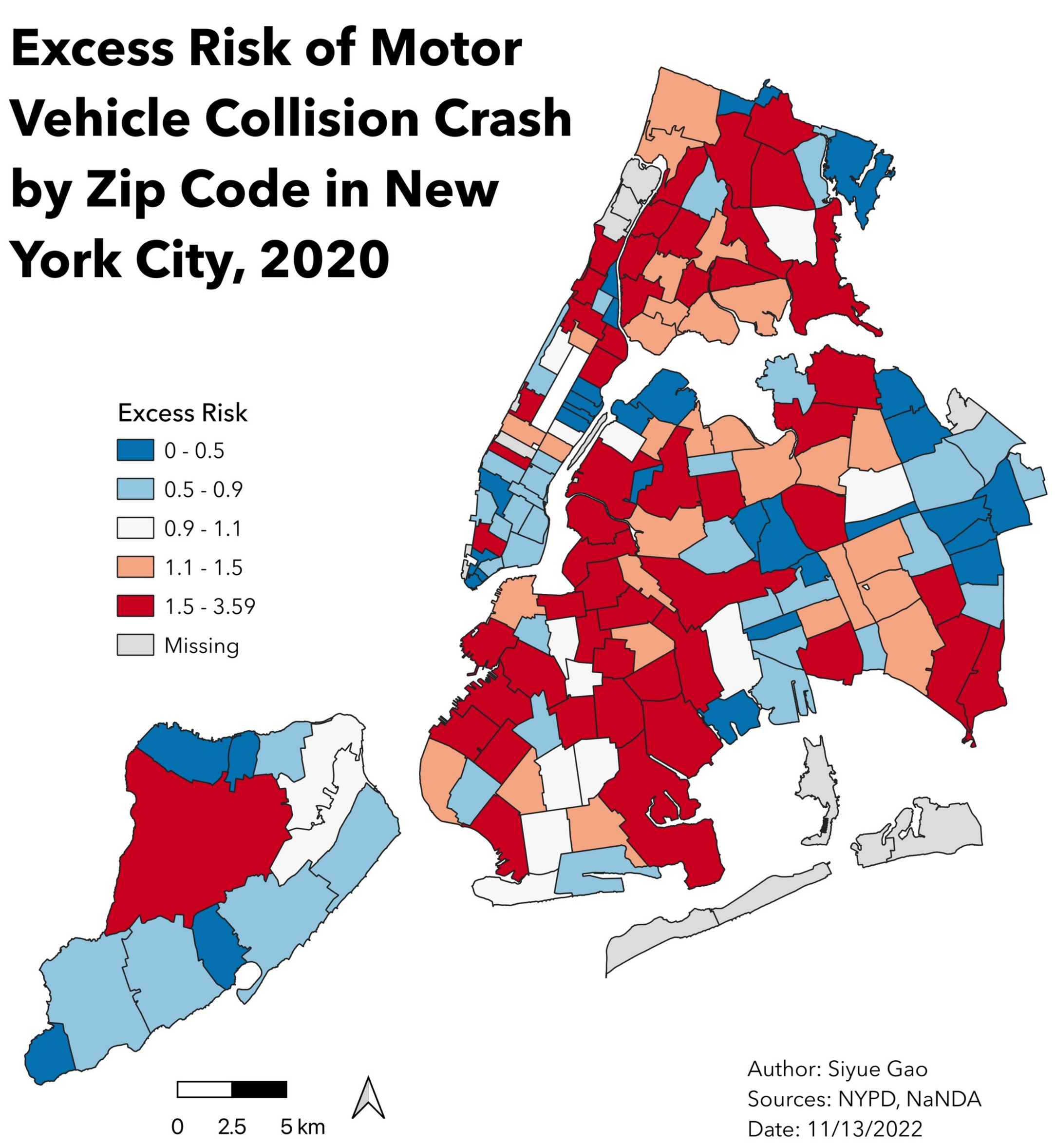
Background

As reported, road traffic mortality is the fifth leading cause of death in the world. According to the Global Status Report on Road Safety 2018, the number of annual road traffic deaths has reached 1.35 million. This burden falls disproportionately on low- and middle-income countries. However, traffic mortality is a great problem for the United States as well, where, in 2015, a 7.2% increase in traffic deaths was observed from the previous year. In 2020, over 100,000 motor vehicle collision crashes were recorded in New York City. Within developed countries such as the U.S., people with lower socioeconomic status are more likely to be involved in these "accidents". This project aims to explore the spatial clustering in crashes, and to examine the relationship between demographic characteristics and crash frequency at a zip code level in NYC, 2020.

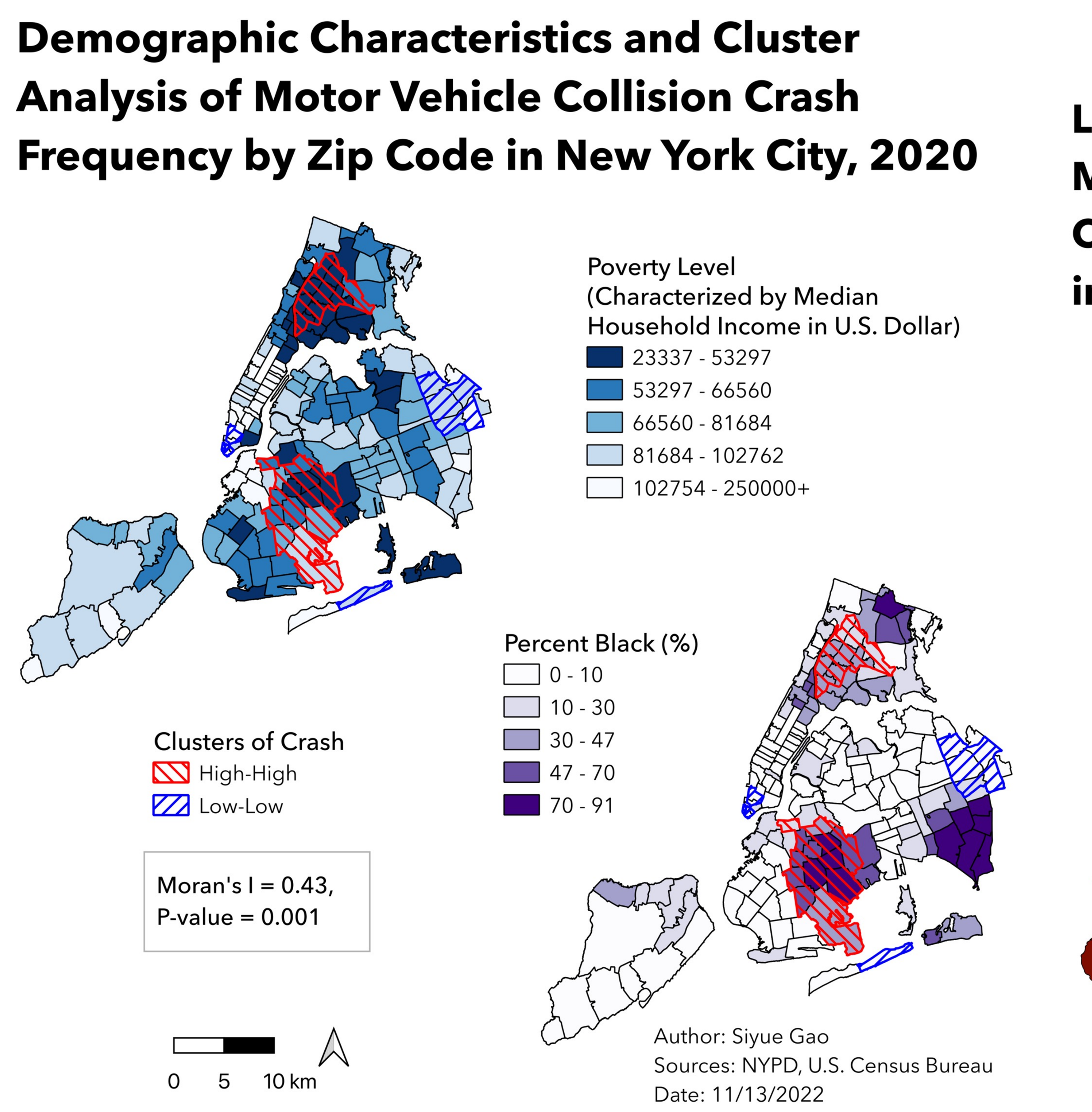
Methods

Motor vehicle collision data was obtained from NYC OpenData, originally provided by New York Police Department (NYPD).
Demographic data (median household income, Black or African American alone and total population) was obtained from the American Community Survey, U.S. Census Bureau.
Expected motor vehicle collision values were calculated based on traffic volume by zip code. Risk was calculated as observed divided by expected crash counts. Traffic volume data was obtained from National Neighborhood Data Archive (NaNDA). The most recent records for zip codes in NYC were from the year of 2016.
Data preprocessing and regression analyses were achieved by RStudio. Maps were generated by QGIS and RStudio. Cluster analysis including Moran's I and p-value were completed by GeoDa.

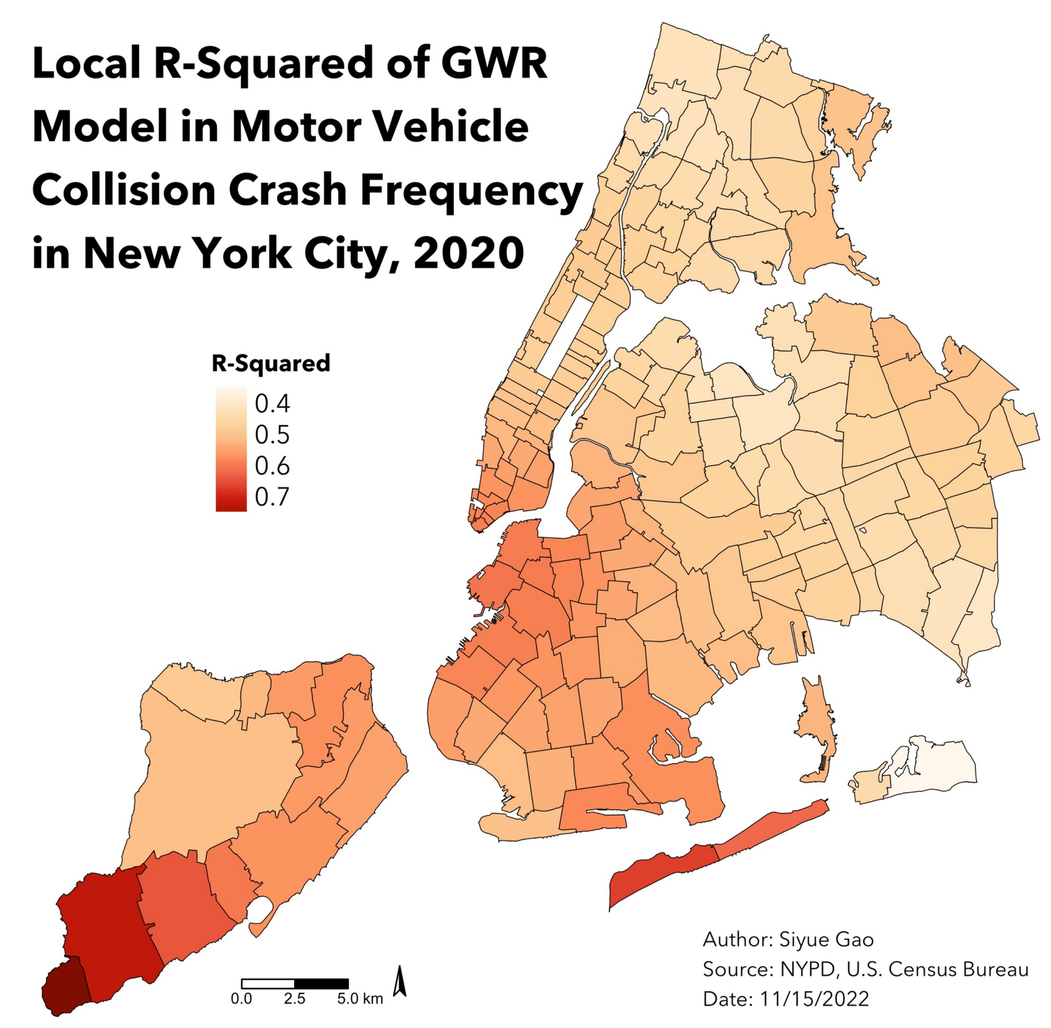
Results



Map 1. Excess Risk of Motor Vehicle Collision Crash by Zip Code in New York City, 2020.



Map 2. Demographic Characteristics with Significant Spatial Clustering of Crash Frequency in New York City, 2020.



Map 3. Local R-Squared of Geographically-Weighted Regression Model of Motor Vehicle Collision Crash Frequency in New York City, 2020.

Discussions

Variable	Estimate	Std. Err.	Test Statistic	P-value
(Intercept)	7.60e+02	7.53e+01	10.10	3.81e-19
Median Household Income	-3.68e-03	7.02e-04	-5.25	4.41e-07
Percent Black	4.67e+00	1.10e+00	4.25	3.53e-05
Population Density	3.64e-04	6.82e-04	0.53	5.94e-01

Table 1. OLS Regression Results (Multiple R-Squared = 0.3045).

Risk of motor vehicle collision crash ranged from 0.02 to 3.59 across 162 zip codes with valid traffic volume value records in New York City.
Regarding the spatial variation in crash frequency, significant clustering of hot spots were identified in central Bronx and east Brooklyn, and cold spots were in Lower Manhattan and east Queens (Moran's I = 0.43, p = 0.001).
Approximately 30.5% of variation in crash frequency could be explained by poverty level, percent Black, and population density. The OLS regression results indicated that median household income was negatively related to crash frequency, and percent Black was positively related. On average, a 1,000-dollar increase in median household income led to a 3.68 unit decrease in crash frequency ($t = -5.25$, $p < 0.001$), while a one-percent increase in percent Black led to a 4.67 unit increase in crash frequency ($t = 4.25$, $p < 0.001$). Relationship between demographic characteristics and crash frequency varied spatially. The local R-squared of GWR results indicated that the fitted model could explain as little as 34.3% or as much as 79.5% of variation in crash frequency.
Limitations included incomplete data of traffic volume values for some zip codes, leading to the missing of corresponding relative risk of motor vehicle collision crash (as colored in gray in Map 1). Traffic volume data was from 2016, while all the other data was collected in 2020 – the expected crash counts estimated based on traffic volume in 2016 might not perfectly represent the situations in 2020.

Conclusions

There were significant spatial clusters regarding spatial variation in crash frequency in New York City, 2020, and these clusters were strongly and significantly related to some demographic predictors, including poverty level and percent Black. This project can guide interventions for both public health and urban planning professionals that aim to reduce the burden on individuals from lower socioeconomic class.
As next steps, more results from GWR model, such as the spatial variance in coefficient for each predictor, could be mapped out, and some other possibly relevant determinants of crash frequency could be investigated for a more exhaustive study of the relationship thereof.

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