New York City's Gunshot Fatality Rate Data Findings

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Introduction: New York City has recorded an unprecedented drop in gun violence since 2005, but the proportion of people who have died from gunshots in certain areas has risen in recent years. Using data obtained from the New York Police Department (NYPD) for all fatal and nonfatal shooting incidents known to police, we mapped the fatality rate for gunshot wounds in relation to trauma centers and other hospitals to better understand the factors that may contribute to gun homicide.

Findings: Between 2010 and October 2018, the proportion of people who suffered a gunshot wound (GSW) in Queens and subsequently died was significantly higher than the average citywide gunshot fatality rate six of the nine years[1]–more than any other borough. Among areas that see a high volume of shootings, three of the eight precincts with fatality rates above 18 percent are in a contiguous grouping in southern Queens (the precincts below Hillside Avenue). Among the areas that consistently see a high volume of shootings, southern Queens is also the largest land area that has the lowest trauma care coverage by level I and II trauma centers, which include specialized facilities, staff, and equipment and provide 24-access critical care specialists.[2] Queens also has the lowest number of intensive care beds in trauma centers per capita. For instance, it has half as many as the Bronx, the next lowest borough.[3] There appears to be a strong association between GSW fatality, distance from trauma centers, and the number of ICU beds available to neighborhood populations. There does not appear to be a strong relationship between increased fatality and other neighborhood-level determinants of health such as race, income, or insurance coverage (link).

[1] Refer to Appendix A
[2] Refer to Appendix B
[3] Refer to Appendix C

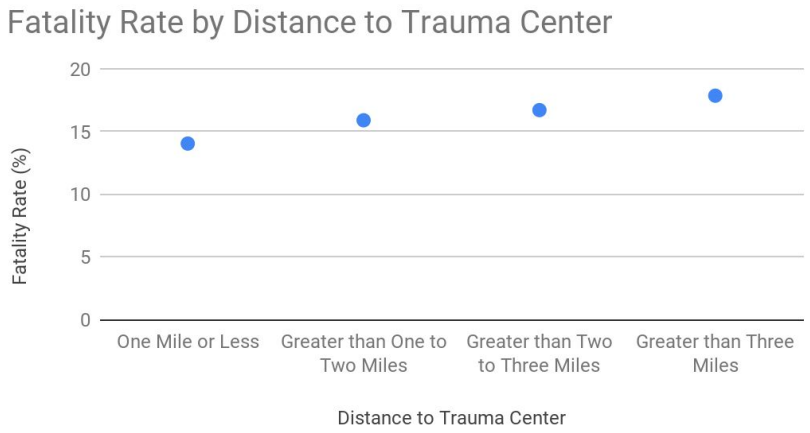

Figure 1: *The fatality rate at varying distances from level I and II trauma centers.*

From our analysis, we found that fatality rates are significantly associated with both the distance from level I and II trauma centers, which offer 24-hour access to critical care specialists, and the number of ICU beds at level I and II trauma centers within a 3-mile coverage area. The fatality rate is 3.81 percentage points higher in areas more than three miles from a trauma center than in areas within a mile of a trauma center. This difference is significant at a 95% confidence level. Additionally, the fatality rate is higher in areas with zero trauma center ICU beds within three miles than in areas with 50-75 trauma center ICU beds within that distance. There is a 3.01 percentage point increase in case fatality for those shot in a 0-bed zone compared to those shot in a zone within three miles of 50-75 trauma center ICU beds. The fatality rate in areas with 75 or more ICU beds is very similar to that in areas with 50-75 ICU beds (0.03 percentage points lower). The 95% confidence intervals of the fatality rates in 0-bed zones and 75-or-more-bed zones slightly overlap by 1.19 percentage points.[4]

[4] Refer to Appendix D for data tables with standard errors

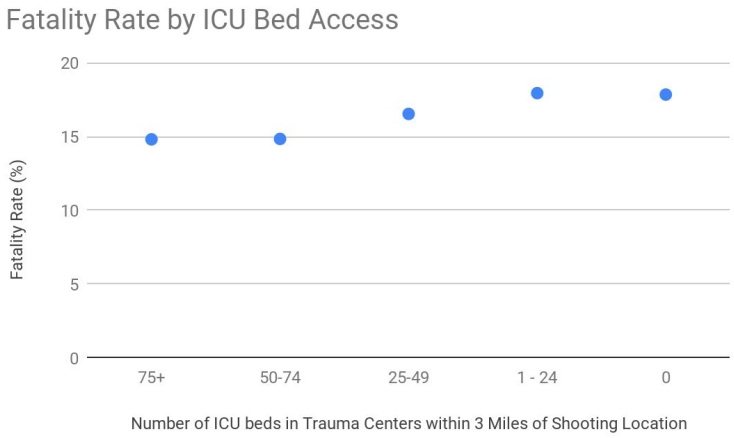

Figure 2: *The fatality rate of shooting incidents clustered by number of ICU beds within three miles of level I and level II trauma centers.*

There are no strong associations with increased GSW case fatality rates and neighborhood demographic factors such as race, insurance coverage, or median household income.

We calculated the fatality rates on a borough-by-borough basis and compared the case fatality rates in Queens to the rest of the city in the years before and after the closure of St. John's Queens Hospital in Elmhurst and Mary Immaculate Hospital in Jamaica, the latter of which held a level I trauma center. Both hospitals closed their emergency rooms on February 14, 2009. In the two years following the closures, the case fatality rose by more than 45.5 percent –increasing from 15.96 percentage points to 23.23 percentage points. The average GSW case fatality rate in the borough also rose after the closures.

It is worth noting that while the fatality rates in the city were observed to be increasing in recent years, the overall volume of both fatal and nonfatal shootings substantially declined over the time period used for this analysis. In 2010, there were a total of 1,454 nonfatal gun injuries and 321 fatal shootings. By 2017, the last complete year represented in our data, the counts had declined to 790 nonfatal and 146 fatal gunshots.

Reasons for investigation: Using the data we obtained from the NYPD, we identified police precincts with fatality rates that were higher than other areas. Queens experienced a spike in its gunshot fatality rate in 2010, which coincides with the closure of a trauma center in Southeast Queens. Since then, the case fatality rate for the borough has been consistently above the citywide average. In particular, precincts in southern Queens had high rates.

Today, the region has just one level I trauma center, which is housed in Jamaica Hospital. Aside from the Rockaway Peninsula's St. John's Episcopal Hospital, which does not have a trauma center, there is

no other hospital in the southern Queens region. Once we identified disparities in the proportion of people dying from gunshots based on location, we set out to try to understand why.

Figure 3: *The location of hospitals (orange) and level I and II trauma centers (red). Explore the map further here.*

Research in other U.S. cities has found a similar association between gunshot wound fatality, and how it correlates with distance to trauma care. In 2013, surgeon and trauma care expert Marie Crandall examined nearly 12,000 gunshot patients between 1999 and 2009 (link) and found that increasing distance from trauma centers resulted in higher GSW mortality. Crandall identified a "trauma desert" in the Southeast side of Chicago, where a large proportion of the city's shootings had taken place, which was adversely affecting GSW mortality. In 2016, Crandall followed up her research with a study focusing on how the closure of the Martin Luther King Jr./Drew Medical Center in South Los Angeles affected trauma care. Her findings were in line with her previous conclusions for GSW mortality (link). Earlier this year, criminologist Giovanni Circo published an analysis using data obtained from the Detroit Police Department that also found that the survival rate of shooting victims decreased with distance from trauma centers (link). That paper's findings state that "distance to the nearest trauma center was associated with an estimated 22% increase in fatal outcomes per mile."

While recent research has illuminated where trauma deserts for non-white individuals exist in New York City (link), there has yet to be a comprehensive analysis of the association between GSW fatality rates and distance from trauma centers across the city.

Methodology: We obtained data on all shooting incidents known to the New York City Police Department, Housing Police, and Transit Police from January 1, 2005 through October 31, 2018. The data was exported by the NYPD from two different data systems, the "Shooting-Homicide Database" (SHDB) used specifically to record shooting and homicide incidents, and the "Omniform System" (OMNI) that is used to record all cases. The records from each system were obtained as separate files for all shootings and all homicides. The data were then joined in their respective system exports, and reconciled against each other to verify incident details.

After removing justified shootings, suicides, and records present in the OMNI datasets that could not be verified in the SHDB. The yearly totals for homicides and nonfatal shootings were checked against data from the FBI's Uniform Crime Reporting Program (UCR) (link), online data published by the NYPD (link), emergency medical service dispatch data published by the Fire Department of the City of New York (FDNY) (link), the Major Cities' Chiefs' Association annual violent crime surveys (link), and media reports aggregated by the Gun Violence Archive website (link).

We limited our analysis to all incidents from 2010 onward because two hospitals closed in Queens in 2009, one of which, Mary Immaculate Hospital, had a level I trauma center[5]. The closure of these hospitals reduced the overall trauma coverage in the borough and provided a sample representative of the region's current level of trauma care. Limiting the timeframe to 2010 onward gave us a sample size of 12,140 incidents (1,939 fatal, 10,201 nonfatal).

We conducted distance from trauma center calculations using the Service Area tool in the Network Analysis toolbox in QGIS. This algorithm enabled us to calculate the distance along the street grid, so we could approximate the path from a gunshot incident to a hospital. The grid calculation did not take into account street directionality, or other factors that would influence vehicle travel such as street-level construction or traffic congestion.

[5] St. Vincent's Hospital Manhattan closed in April of 2010. This trauma center was included in the analysis for shootings that occurred in the first four months of the sample. Brooklyn openings of trauma centers in Maimonides Medical Center and New York-Presbyterian Brooklyn Methodist Hospital were accounted for in the same manner.

The NYPD data also included information on the circumstances surrounding each shooting, whether the incidents stemmed from gang or domestic violence, and whether a shooting occurred indoors. These factors are likely associated with case fatality rates. So, we checked to see if there were relationships between these factors and the distance from trauma centers (which we found was associated with fatality rates). For most of these factors, the nature of the shootings did not show a direct relationship with our distance groupings. More shootings occurred indoors 3-plus miles away from trauma centers than within a 1-mile distance or a 1- to 2-mile distance. This is the only circumstance that showed a trend similar to our findings for case fatality rates (link). While indoor shootings were found to be more fatal, the same trend of increasing fatality with increasing distance to trauma centers was present, even when looking just at shootings that occurred outdoors.

The NYPD data lacked information on where the bullet struck the body and the number of times each victim was shot. To account for this limitation in our data we coded 396 media reports on shootings in Queens between 2014 and October 31, 2018. We utilized news stories that the Gun Violence Archive began collecting in 2014. Of these, 308 contained information on where the bullet struck the victim's body. Based on these reports, there does not appear to be a difference in injury location between areas of Queens with low and high fatality rates. However, the sample size was too small to test for significance.

Our primary findings are on street distances from trauma centers. Our review of media reports found that some victims were taken to non-trauma center hospitals, so we also examined the effect of ICU beds available in any adult hospital. We did not feel, however, that we had enough data on each individual hospital to account for the non-trauma centers' interaction with the trauma landscape, or how individual hospital ICU bed counts may have changed over time. That being said, our preliminary interrogation of distance ICU beds in any hospital suggests similar relationships exist as with ICU beds contained in trauma centers only.

EMS records from 2013 through 2018 demonstrate that for calls pertaining to shootings, Queens had the highest average overall response time, the highest average time-to-scene, and the highest average time from the scene of the incident to the hospital among New York City's five boroughs.[6] Our analysis found also found that the Bronx, Manhattan and Staten Island logged lower overall response times to gunshot-related calls than the all-borough mean. In Brooklyn, the findings in relation to the all-borough mean were not statistically significant. Overall response time is the time between EMS dispatch indicating that they received a shooting-related call and a victim arriving at a hospital.

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[6] Refer to Appendix E

Appendices

Appendix A

We utilized a script in R to determine the standard deviations for the fatality rate in each borough and the citywide average. Through this, we found that the fatality rate in Queens was higher than the citywide average for six of the nine years we examined.

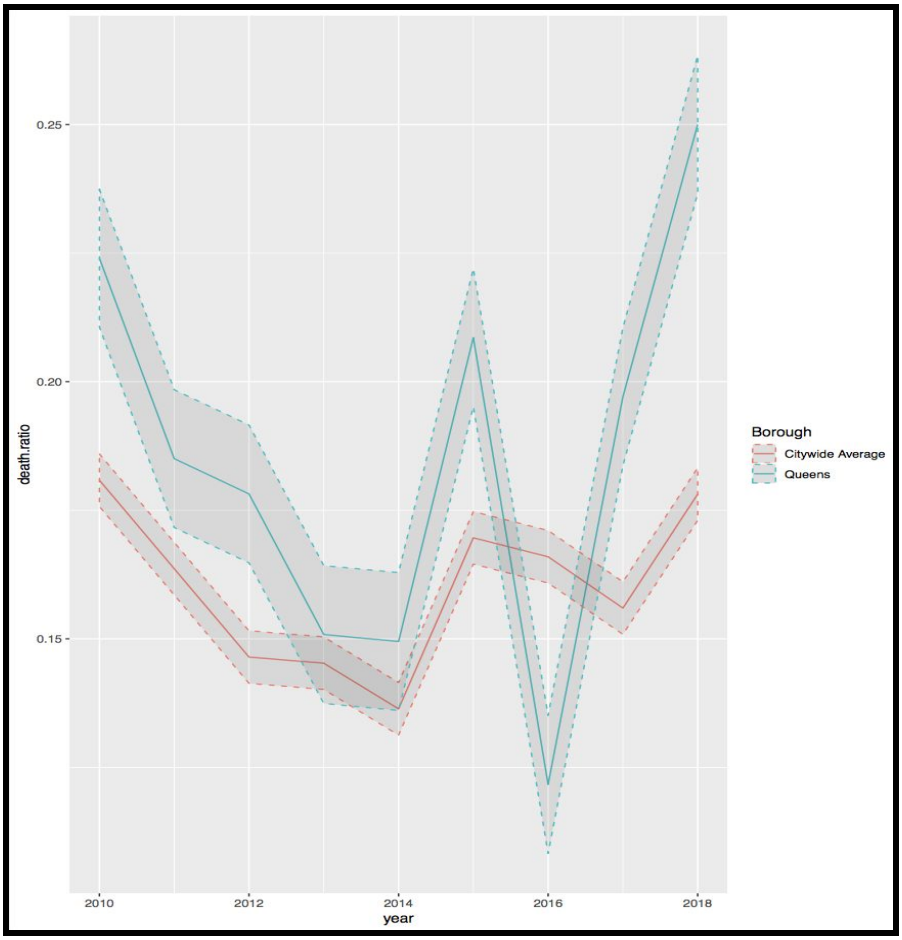

Figure 4: *The fatality rate in Queens compared to the citywide fatality rate with confidence bands. The rate in Queens is significantly higher than the citywide average in six of nine years.*

Appendix B

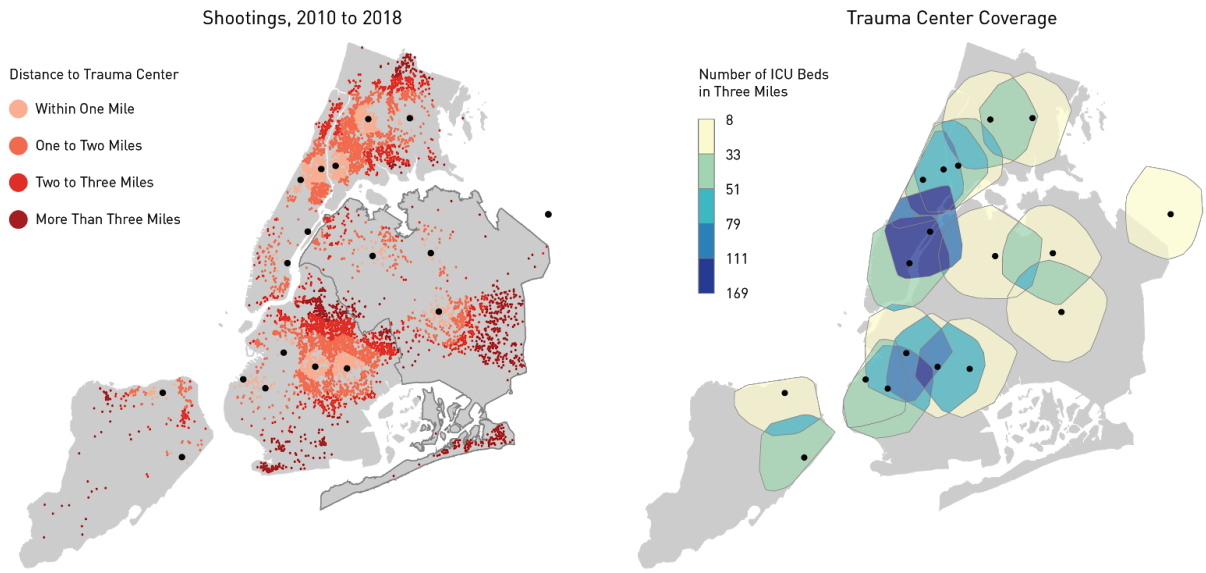

Figure 5: *Maps of New York City with shootings colored by distance to the nearest trauma center, and overlapping areas indicating the number of trauma center ICU beds within three miles. The grey areas are outside the three-mile radius of a trauma center. Note that nearly one third of Staten Island's land area is parkland that can never be developed.*

Appendix C

We aggregated the number of ICU beds for each hospital and trauma center in New York City using information collected and provided by the New York State Department of Health (available here).

Table 1: *All ICU beds available in New York City boroughs for the most current year.*

Borough	ICU Beds	Population (ACS 2017)	ICU Beds Per Capita	Beds per 10,000
Bronx	205	1,471,160	0.0001393	1.393
Brooklyn	359	2,648,771	0.0001355	1.355
Manhattan	654	1,664,727	0.0003929	3.929
Queens	191	2,358,582	0.000081	0.81
Staten Island	64	479,458	0.0001335	1.335

Table 2: *Trauma center ICU beds available in New York City boroughs for the most current year.*

Borough	ICU Beds	Population (ACS 2017)	ICU Beds Per Capita	Beds per 10,000
Bronx	73	1,471,160	0.0000496	0.496
Brooklyn	136	2,648,771	0.0000513	0.513
Manhattan	163	1,664,727	0.0000979	0.979
Queens	57	2,358,582	0.0000242	0.242
Staten Island	56	479,458	0.0001168	1.168

Appendix D

Table 3: *Fatality rate by distance to trauma center with standard errors and confidence intervals.*

Distance to Nearest Trauma Center	Shots	Deaths	Fatality Rate	Standard Error	95% Margin of Error	Lower Confidence Interval	Upper Confidence Interval
One Mile or Less	2516	353	0.140302	0.006924	0.013571	0.126731	0.153873
Greater than One to Two Miles	5061	804	0.158862	0.005138	0.010071	0.148791	0.168933
Greater than Two to Three Miles	2809	469	0.166963	0.007037	0.013792	0.153171	0.180755
Greater than Three Miles	1754	313	0.178449	0.009142	0.017919	0.160530	0.196368

Table 4: *Fatality rate by the number of trauma ICU beds available within three miles of a trauma center with standard errors and confidence intervals.*

ICU Bed Groupings	Shots	Deaths	Fatality Rate	Standard Error	95% Margin of Error	Lower Confidence Interval	Upper Confidence Interval
0	1754	313	0.17845	0.00914	0.01792	0.16053	0.19637
1 - 24	1293	232	0.17943	0.01067	0.02092	0.15851	0.20034
25-49	2649	438	0.16535	0.00722	0.01415	0.15120	0.17949
50-74	5627	835	0.14839	0.00474	0.00929	0.13910	0.15768
75+	817	121	0.14810	0.01243	0.02436	0.12375	0.17246

Appendix E

We calculated the EMS response time to all calls pertaining to "SHOTS", as encoded by the Fire Department of New York. We only examined the times for calls that resulted in someone being taken to a hospital or trauma center.

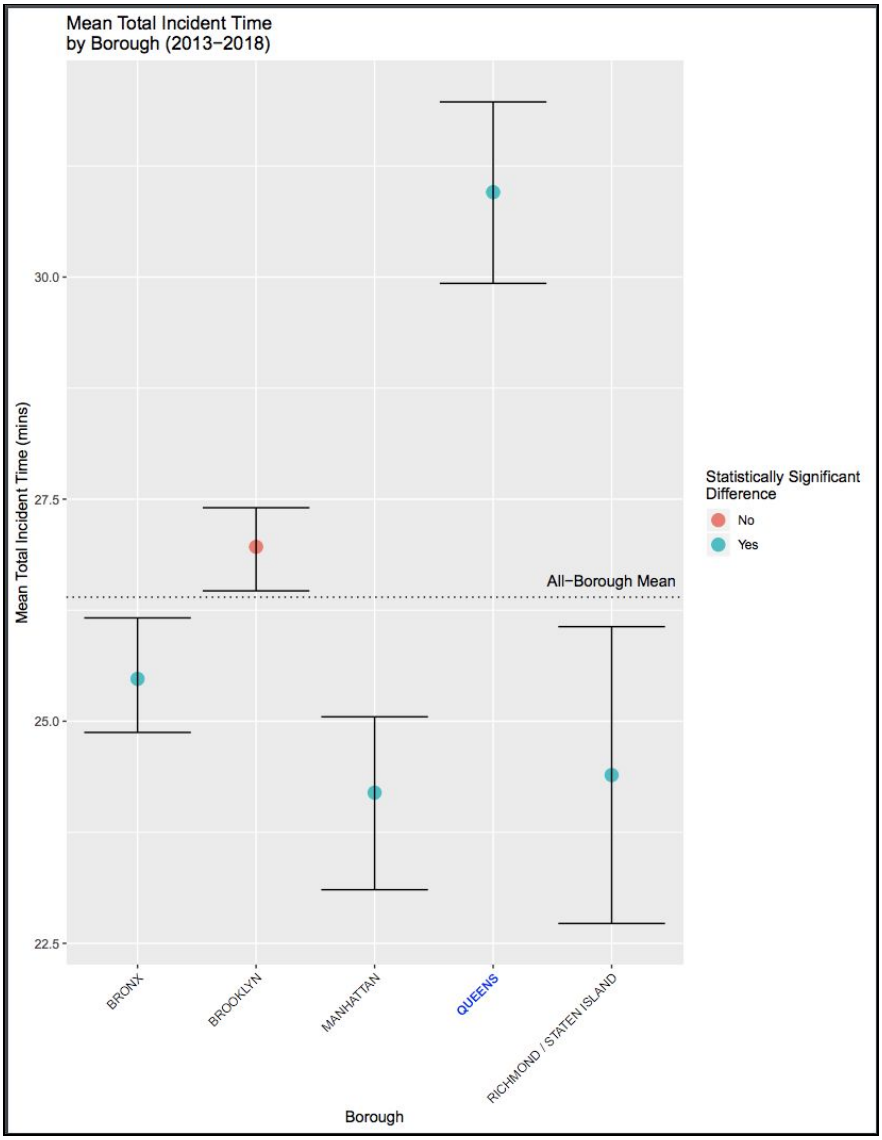

Figure 6: *The average time for EMS first responders to reach a GSW victim and transport the victim to a hospital is significantly longer in Queens. The statistical significance was tested utilizing a two-sided T-Test. The confidence intervals are displayed on the graph.*

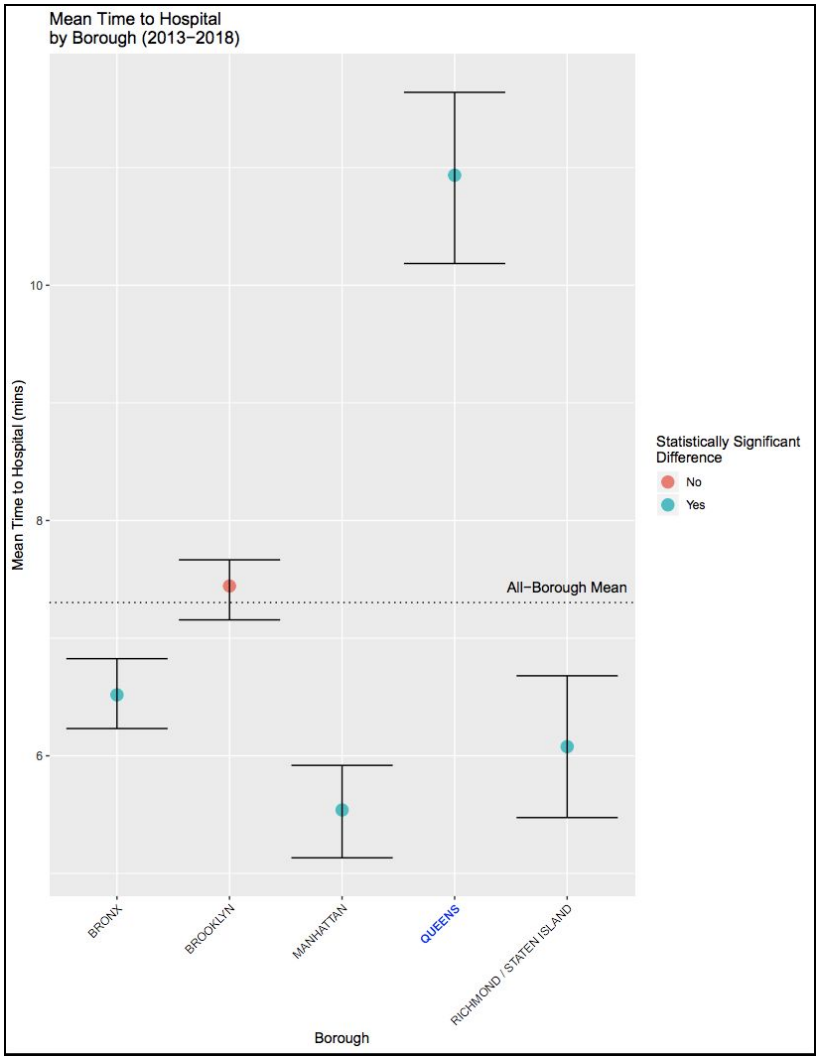

Figure 7: *The average time for EMS first responders to transport a victim from the scene of a shooting to a hospital is significantly longer in Queens. The statistical significance was tested utilizing a two-sided T-Test. The confidence intervals are displayed on the graph.*