Getting to Zero: Evaluating the Impact of Vehicle Speed Reduction Measures on New York City Pedestrian and Bicyclist Injuries

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Introduction

Since originating in Sweden in the 1990s, Vision Zero programs -- meant to eliminate traffic fatalities and severe injuries -- have been adopted by a growing number of cities in the U.S. as well as in Europe,[1] often paired with measures to promote alternative forms of mobility. Speed-reduction measures play a particularly prominent role in these programs, and are widely recommended as a means of reducing vehicle-related injuries among drivers and pedestrians;[2] because higher vehicle speeds make for deadlier crashes, it is intuitive that lower speeds should reduce fatalities.[3] However, evidence of these measures' effects is mixed and, where present, often weak.[4]

This study seeks to evaluate the impact of two elements of New York City's Vision Zero program, officially launched in 2014, on pedestrian and bicyclist injuries and fatalities. The first, Neighborhood Slow Zones (NSZs), are primarily residential areas in which various traffic-calming measures (including speed limit reductions, speed humps, and other infrastructural changes) have been implemented.[5] These areas are nominated by local community organizations, and are evaluated for inclusion in the program based on several factors, including historical collision data, the presence of schools, and the logical merits of the chosen boundaries. The second element under examination is signal retiming to match a 25 mile-per-hour speed limit on specific streets (Signal Retiming Corridors, or SRCs).[6] Specifically, I explore whether the introduction of these measures is associated with declines in total collisions between vehicles and pedestrians or bicyclists, as well as injuries and deaths among these groups, in the targeted areas.

Data and Methods

This analysis focuses primarily on a dataset of persons involved in motor vehicle collisions in New York City from 2012 to present, obtained from the New York City Open Data Portal. Three geodatasets from the NYC Department of Transportation were used to associate collisions and resultant injuries with specific areas: a layer of Neighborhood Slow Zones, a layer of Signal Retiming Corridors, and a layer of City Street Centerlines. Collision points were snapped to the nearest road feature (centerline), and were then clipped to either NSZ polygons or 1-foot buffers created for SRC lines to associate them with treatment units.

To estimate the aggregate effects of the introduction of NSZs and signal retiming in SRCs on various types of pedestrian- and bicyclist-involved traffic incidents, I compare adjusted injury and fatality rates for pedestrians and bicyclists in the designated geographies. This is done using an extended difference-in-difference model:

$$Y_{it} = a_t + c_i + \beta D_{it} + \epsilon_{it}$$

Where Y_{it} represents the number of incidents that occurred in a particular geography during a particular year; a_t represents fixed effects for each year in the study window; c_i represents fixed effects for each geography; and D_{it} is a binary variable indicating whether a geography had been treated in a particular time period. β, then, is the effect we seek – the impact of introducing either traffic-calming measures or signal retiming on the type of incident included in the model.

To estimate the interventions' impact in each geography (shown in the map to the far right), incident totals across geographies for each year are first centered around the mean total for that year (with NSZs and SRCs handled separately), thus controlling for the fact that city-wide incident totals differ year by year in a way that suggests that incident reporting became more common over time. These demeaned data are then averaged across the pre- and post-implementation period for each geography. For example, in an NSZ created in 2015, the pre-intervention average represents the average of the centered total values for 2012, 2013, and 2014, while the post-intervention average represents the corresponding figure for 2015, 2016, 2017, 2018, and 2019.

Separately, 1-foot buffers were created for all street centerlines and used to count pedestrian- and bicyclist-involved collisions associated with each street segment in the years 2012 to 2014 (which presumably informed NYC's Vision Zero plan update in 2015). This count was then normalized by road segment length, and used to conduct a city-wide hotspot analysis using a Getis-Ord Gi* statistic, shown to the right. Areas shown in red represent hotspots (i.e., high-collision segments surrounded by other high-collision segments) at various levels of statistical significance.

Results

Controlling for area-specific factors and year-specific effects, the creation of a Neighborhood Slow Zone is estimated to reduce the number of pedestrian-involved collisions in a designated area by 6.95, and to reduce the number of injuries by 3.08. While there was no statistically significant effect on total bicyclist-involved collisions, the number of bicyclist injuries is estimated to decline by 1.55 with the introduction of an NSZ.

Signal retiming is associated with a decrease in pedestrian-involved collisions of 2.48 and a decline in pedestrian injuries of 1.41. No other outcomes are shown to change significantly in these areas.

Neighborhood Slow Zones

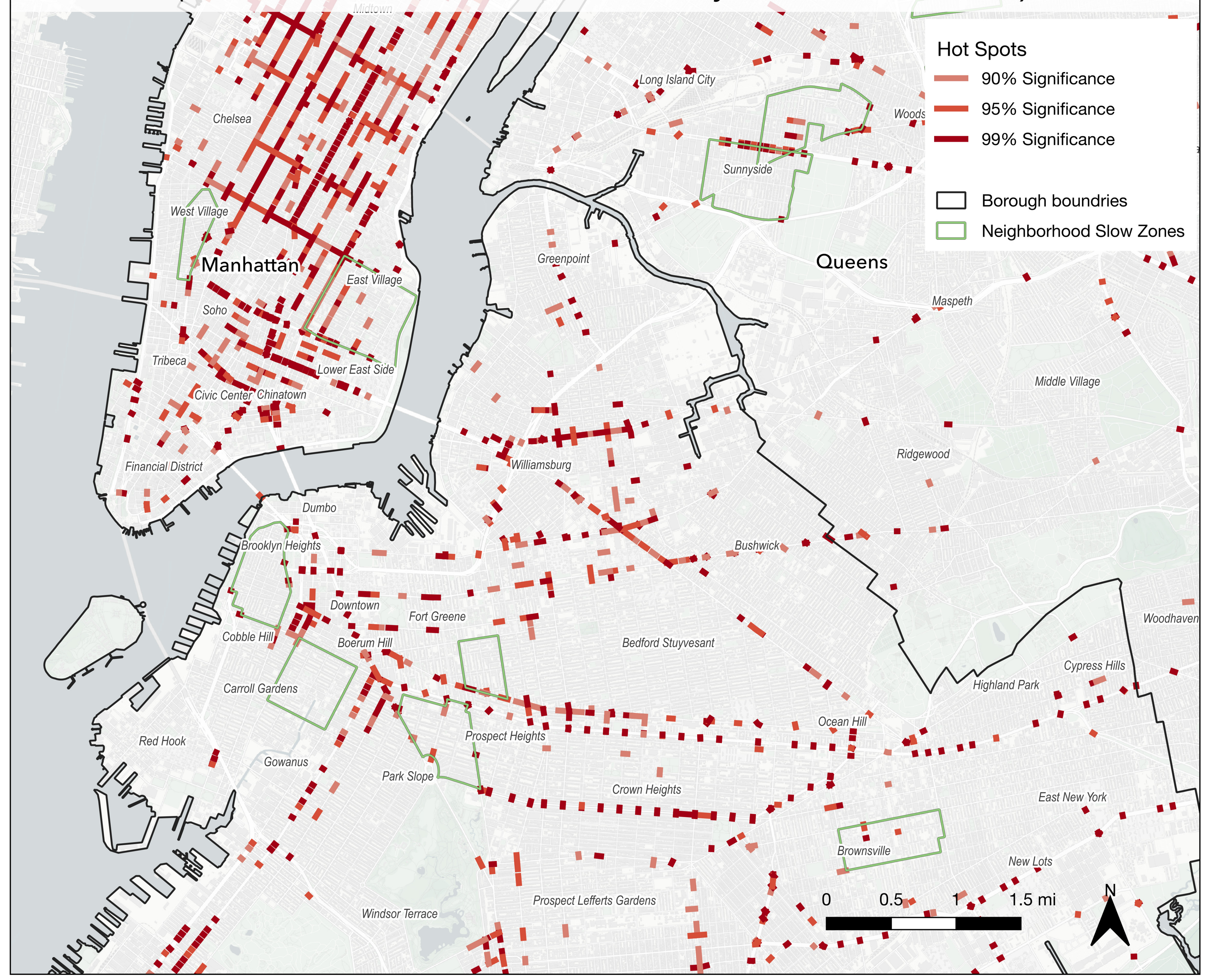
	All Ped. Incidents	Ped. Injuries	Ped. Deaths	All Bike Incidents	Bike Injuries	Bike Deaths
Treatment Effect	-6.9504*	-3.0822*	0.0493	-1.019	-1.5464*	0.0156
P-value	(0.001)	(0.007)	(0.435)	(0.165)	(0.000)	(0.620)
N	224	224	224	224	224	224
R-Squared (Overall)	0.5755	0.2312	0.0403	0.0934	0.1621	0.004

Signal Retiming Corridors

	All Ped. Incidents	Ped. Injuries	Ped. Deaths	All Bike Incidents	Bike Injuries	Bike Deaths
Treatment Effect	-2.4829*	-1.4089*	-0.0725	-0.4971	0.5289	-0.0167
P-value	(0.000)	(0.002)	(0.102)	(0.527)	(0.454)	(0.358)
N	1,920	1,920	1,920	1,920	1,680	1,920
R-Squared (Overall)	0.0301	0.0175	0.0318	0.0113	0.0139	0.0185

Note: All models inlude unit and year fixed effects, and use data from the years 2012 to 2019.
** Result is statistically significant at the 95% level or higher*

Pedestrian and Bicyclist Injury Hot Spots, 2012 -- 2014 (Lower Manhattan, Northern Brooklyn, Western Queens)



Discussion

The degree to which the creation of NSZs and signal retiming improve pedestrian and bicyclist safety varies greatly across geographies. As the map to the right suggests, NSZs' and SRCs' effectiveness in reducing collisions may be dependent on other geographically correlated factors: "high-performing" NSZs, for example, are clustered in Queens and the Bronx, and often (but not always) are bounded by collision hotspots, which may give them more room to improve on outcomes than other areas. Conversely, much-improved SRCs are often those that include few collision hotspots in the pre-intervention period, suggesting that the overall effect of these interventions city-wide may come largely from improvements along corridors that were already relatively safe.

Generating a more thorough explanation of how neighborhood factors and other spatial covariates enhance or mitigate the effects of Vision Zero measures will require additional study. A first step would be to obtain overall traffic flow data for street segments and intersections throughout the city, and to estimate daytime population in the vicinity of these units. These and other potentially relevant factors could then be incorporated into a comparative interrupted time series model or similar, allowing their effects and that of various interventions to be estimated simultaneously. The interactions between these factors could then be used to prioritize intervention in the areas most likely to benefit, helping New York realize its vision of complete pedestrian safety.

References

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Data Sources

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Change in Pedestrian- and Bicyclist-Involved Collisions Post-Intervention (Adjusted for Report Volume)