# The Impact of Vision Zero Initiatives on Road User Safety in New York City

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Despite modern vehicles, improved transportation infrastructure, and advanced traffic signals, more than 36,000 Americans die from traffic crashes every year[1]. With the goal of reducing traffic fatalities to zero, New York City (NYC) adopted Vision Zero (VZ) initiatives in 2014 and has deployed 23 categories of countermeasures ranging from road improvements to training and community outreach programs[2]. In this research, trend analysis and hypothesis tests were done on NYC traffic fatality data for three main categories of roadway users: motorists, cyclists, and pedestrians, to evaluate the success of the VZ initiatives. It was found that annual fatalities of both motorists and pedestrians declined significantly after the deployment of VZ initiatives, while fatalities of cyclists increased significantly. These findings indicate that current VZ efforts in NYC were not effective in improving cyclist safety. A comparative trend analysis was done on the relationship between summonses issued by New York Police Department (NYPD) and traffic fatalities. It was found that law enforcement was ineffective in improving traffic safety. Additional effective countermeasures should be deployed to reduce the frequency and severity of cyclist-involved crashes. Recommended potential measures include additional bike lanes in dense urban areas, wider bike lanes, and law enforcement focused on bicycle helmet usage.

## Introduction

Vision Zero (VZ), a traffic safety project originating in Sweden, has been adopted by cities and states in the United States[3]. VZ places the responsibility for traffic fatalities on inadequate facilities for all users and unsafe roadway designs. This program promotes legislative actions, law enforcement, and innovative roadway improvement solutions to increase roadway safety. The VZ project successfully reduced the number of fatalities caused by road accidents in Sweden by half in 20 years[4]. In 2005, VZ was adopted in Poland, a nation with a high number of traffic fatalities per one-hundred thousand residents. According to a study on the effectiveness of VZ in Poland, traffic fatalities fell by 31% after five years[5]. After years of only battling traffic fatalities as a city with no dedicated program, New York City (NYC) started the VZ program in their battle against unsafe roadways under leadership of Mayor Bill de Blasio in 2014[3]. To be recognized as a VZ community, NYC developed an action plan and created a task force to lead fatality-reducing efforts and evaluate progress[3]. The initiatives deployed in NYC include decreasing speed limits in arterial roads and neighborhood areas, installing speed cameras at school zones, and increased overall traffic enforcements[3]. In addition, roadway improvements (i.e., bike facilities, speed cushions, improved crosswalk facilities) across the city were completed to improve traffic safety.

With over 8 million residents in NYC and another 900 thousand daily commuters[6,7], it is important to evaluate successes and failures of implemented road safety initiatives. The objective of this study is to evaluate the effectiveness of VZ initiatives in reducing traffic fatalities among three groups of road users (i.e., motorists, cyclists, and pedestrians) after initiation of VZ in NYC since 2014.

## Methods

### Trend Analysis

Motor vehicle crash data collected by NYPD

| Year | Vehicle Occupant Fatalities | Cyclist Fatalities | Pedestrian Fatalities |
|---|---|---|---|
| 2012 | 122 | 18 | 136 |
| 2013 | 107 | 11 | 168 |
| 2014 | 101 | 19 | 130 |
| 2015 | 93 | 14 | 128 |
| 2016 | 71 | 18 | 134 |
| 2017 | 89 | 20 | 113 |
| 2018 | 78 | 10 | 110 |
| 2019 | 74 | 24 | 115 |
| 2020 | 118 | 27 | 94 |
| Average (2012 to 2020) | 94.8 | 17.9 | 125.3 |

**Table 1. NYC Traffic Crash Fatalities (2012-2020)**

was used in this study[8,9]. Annual fatalities were calculated for three categories of roadway users: motorists, cyclists, and pedestrians for the years 2012 to 2020. A lack of reported crash data prior to 2012 limited the extent of how far in the past this research could investigate crash statistics. The crash statistics are summarized in Tables 1-3, and by locations within NYC (Figures 1-3). The beginning of the VZ program in NYC (i.e., year 2014) was highlighted in each figure for before and after comparison purposes. These steps were repeated in the case of each NYC borough (i.e., Bronx, Brooklyn, Manhattan, Queens, Staten Island). The yearly fatality frequency as well as average annual fatality levels in NYC are shown in Table 1.

Beyond an investigation into traffic fatality levels, analysis was also done on summonses (i.e., traffic violation tickets issued by law enforcement). Summonses were issued for speeding, failure to yield right-of-way, cell-phone usage, and missing driving requirements (expired/no license, no car insurance, or no registration). Data was compiled from NYPD's annual summonses data issued by specific summon types[8]. Figure 4 presents the trend graphs, showing how levels of the specific summons types, from 2012 to 2020. To determine the relationship between summonses and fatalities, general yearly trends were studied. For this, NYC open source data[9] was used to determine how many persons were fatally injured by contributing factors (i.e., cell phone usage, driver inexperience, failure to yield right-of-way). These factors can be categorized as those which the summonses investigated in this research aim to prevent. The fatalities for each year were depicted as a line with summonses levels as bar graphs (Figure 5) to show relative trends over time. Trend lines for both summonses and fatalities were then included. Table 2 shows the data used in comparison of summonses issued and fatality levels.

### Hypothesis Test

In addition to trend analysis, hypothesis tests were performed to identify whether the average fatality levels, and average law enforcement levels (i.e., summonses) before and after VZ were significantly different or not. Hypothesis testing is a procedure in which data is used to decide which of two hypotheses is more likely to be true. The steps to be followed to perform a hypothesis test are: 1) state null hypothesis, $H_0$, 2) state alternate hypothesis, $H_A$, 3) decide on significance level (alpha), 4) calculate appropriate test statistics, 5) find the p-value of the test statistics, and 6) make decision and state conclusion. For this study, the null and alternate hypothesis were set as follows:

| Year | Total Summonses | Summonses for Failing to Yield Right-of-Way | Pedestrian and Cyclist Deaths | Summonses for Uninspected/ Uninsured/ Unlicensed/ Unregistered | Deaths Caused by Driver Inexperience | Summonses for Speeding | Summonses for Phone Usage | Deaths Caused by Distracted Driving |
|---|---|---|---|---|---|---|---|---|
| 2012 | 1020754 | 11698 | N/A | 131471 | N/A | 71305 | 141816 | N/A |
| 2013 | 1036942 | 14888 | 17 | 135205 | 0 | 83202 | 126422 | 15 |
| 2014 | 1062504 | 33577 | 20 | 122842 | 6 | 117767 | 106503 | 23 |
| 2015 | 1003043 | 39853 | 14 | 98155 | 5 | 134438 | 84630 | 38 |
| 2016 | 1042703 | 42385 | 28 | 99916 | 1 | 137260 | 75900 | 29 |
| 2017 | 1059256 | 51763 | 15 | 88679 | 7 | 149955 | 72276 | 48 |
| 2018 | 1066376 | 54477 | 26 | 83053 | 3 | 152368 | 49161 | 22 |
| 2019 | 985057 | 81615 | 26 | 74508 | 3 | 148776 | 37237 | 38 |
| 2020 | 510342 | 35257 | 10 | 49879 | 9 | 125011 | 15401 | 28 |

**Table 2. Dataset for comparing summonses and fatalities**

| Fatality Type | Minimum | Median | Maximum | Mean | Standard Deviation | Coefficient of Variation |
|---|---|---|---|---|---|---|
| **Pedestrians** | 94 (2020) | 128 | 168 (2013) | 125.3 | 19.760 | 16.72 |
| **Cyclists** | 10 (2018) | 18 | 27 (2020) | 17.9 | 5.280 | 31.30 |
| **Motorists** | 71 (2016) | 93 | 122 (2012) | 94.8 | 17.586 | 19.68 |

**Table 3. Descriptive statistics for traffic fatalities in New York City**

$H_0$: The mean fatality/summonses level before VZ is $\mu_0$

$H_{A1}$: The mean fatality/summonses level after VZ, $\mu_1 > \mu_0$

$H_{A2}$: The mean fatality/summonses level before VZ, $\mu_1 < \mu_0$

$H_{A1}$ was assumed when the average fatality or summonses increased after VZ and $H_{A2}$ was assumed when average fatality decreased. The significance level was set to 95% (i.e., alpha = 0.05). As the sample size is small (n < 30), t-test was performed instead of z-test. The results of the hypothesis test are presented in Table 5.

## Results and Discussion

Descriptive statistics for traffic fatalities in NYC is presented in Table 3. Pedestrians are consistently the most fatally injured group in NYC followed by motorists and cyclists. Despite having the lowest fatality levels, cyclists were the only group with their maximum yearly level after VZ implementation in 2014. This group of fatalities also experienced the largest fluctuation in yearly levels as shown by its coefficient of variation.

Figure 1 shows annual pedestrian fatality levels from 2012 to 2020 in NYC. Overall, annual rates of pedestrian fatalities trended downwards since the implementation of VZ. The fatality levels after VZ were at or below the nine-year average (Figure 1(a)). As Brooklyn, Queens, and Staten Island experienced pedestrian fatality trends that were similar to the citywide trend, their trend graphs are not included in Figure 1. Pedestrian fatalities for Bronx and Manhattan demonstrated a contrasting trend compared to the citywide trend (Figure 1(b), 1(c)) and included in Figure 1. These two boroughs experienced larger fluctuations than the relatively constant decrease observed in entire NYC. Hypothesis test results in Table 5 confirms that the pedestrian fatality after VZ was significantly lower than before VZ in NYC.

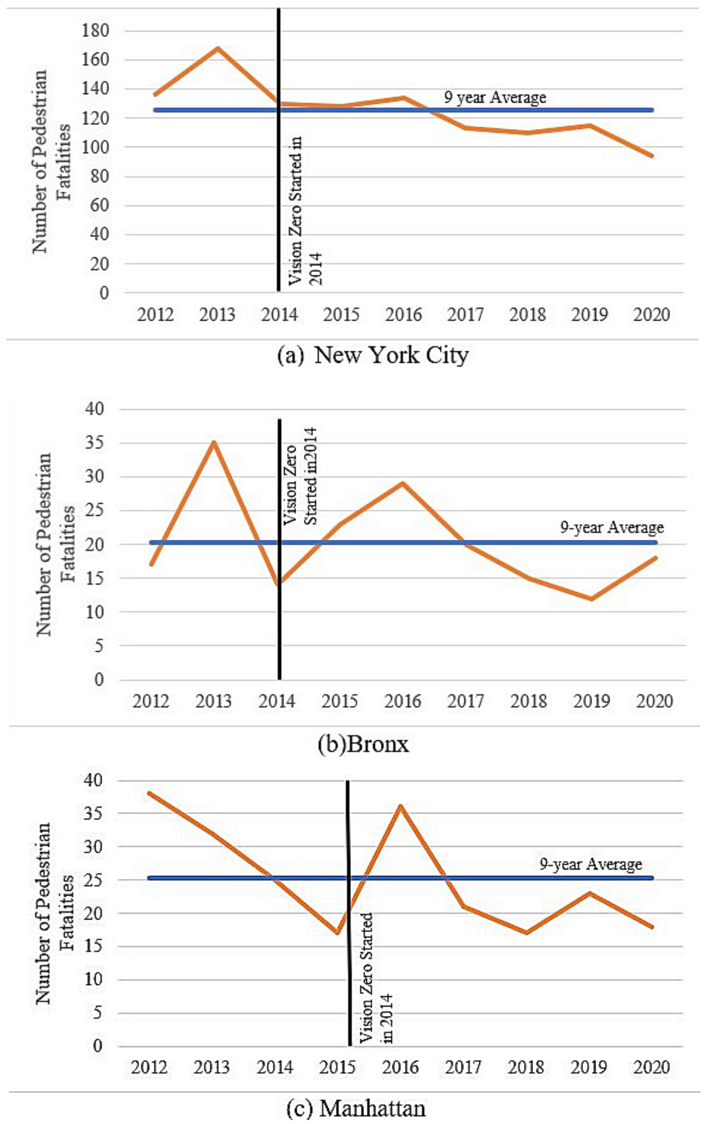


**Figure 1. Vision Zero Initiatives' relationship to pedestrian fatalities in NYC and two of its bouroughs**

Figure 2 shows annual cyclist fatality levels from 2012 to 2020 in NYC. It is evident that the city experienced a large increase in cyclist fatality from 2018 to 2019 and a further increase from 2019 to 2020 (Figure 2(a)). Hypothesis test results in Table 5 also

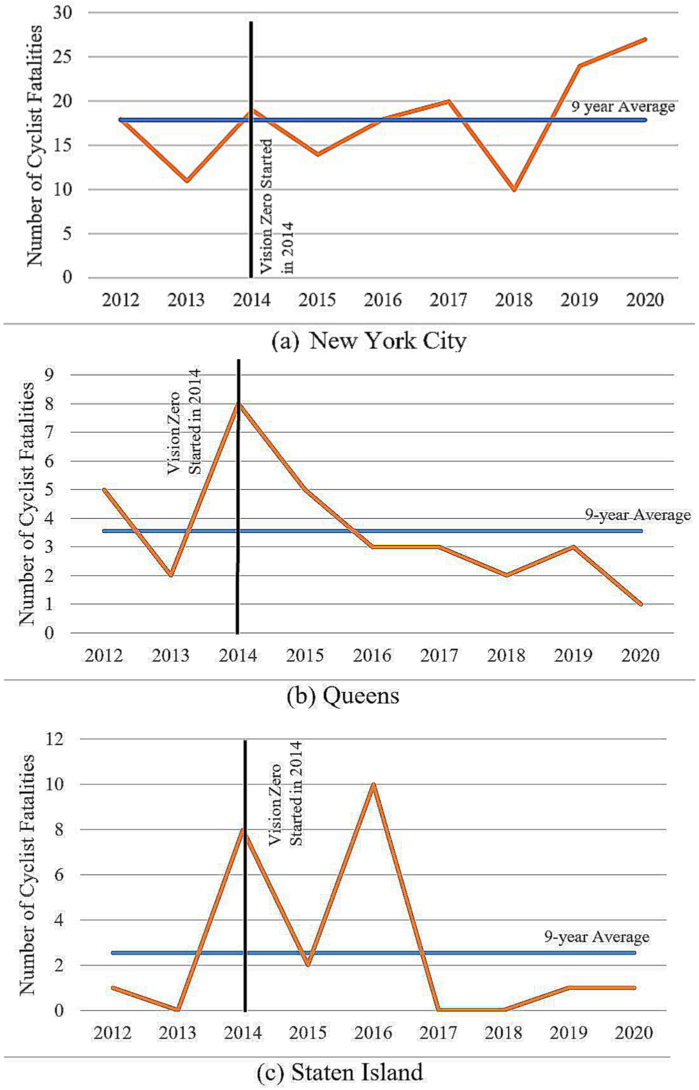


**Figure 2. Vision Zero Initiatives' relationship to cyclist fatalities in NYC and two of its boroughs.**

confirmed that the cyclist fatality levels after the VZ program increased significantly compared to before VZ. However, Queens experienced a strong decline in cyclist fatalities since 2014 (Figure 2(c)). Staten Island experienced large fluctuations but had very few yearly cyclist fatalities since 2017 (Figure 2(b)). Due to Brooklyn, Bronx, and Manhattan experiencing cyclist fatality trends that mirrored the citywide trend, their trend graphs are not included in Figure 2.

Figure 3 shows annual motorist fatality levels from 2012 to 2020 in NYC. From 2012 to 2019, annual rates of motorist fatalities trended downwards with an increase to pre-VZ levels in 2020. Hypothesis test results in Table 5 showed that the motorist fatality was significantly lower after VZ. The fatality levels after VZ were at or below the nine-year average, with the exception of 2020 (Figure 3(a)). Motorist fatalities in Staten Island and Manhattan increased when the citywide averages were below the nine-year average (2015 in Staten Island, 2017 in Manhattan) and both experienced below average levels in 2020 when the citywide total increased (Figure 3(b)(c)). Due to Brooklyn, Bronx, and Queens

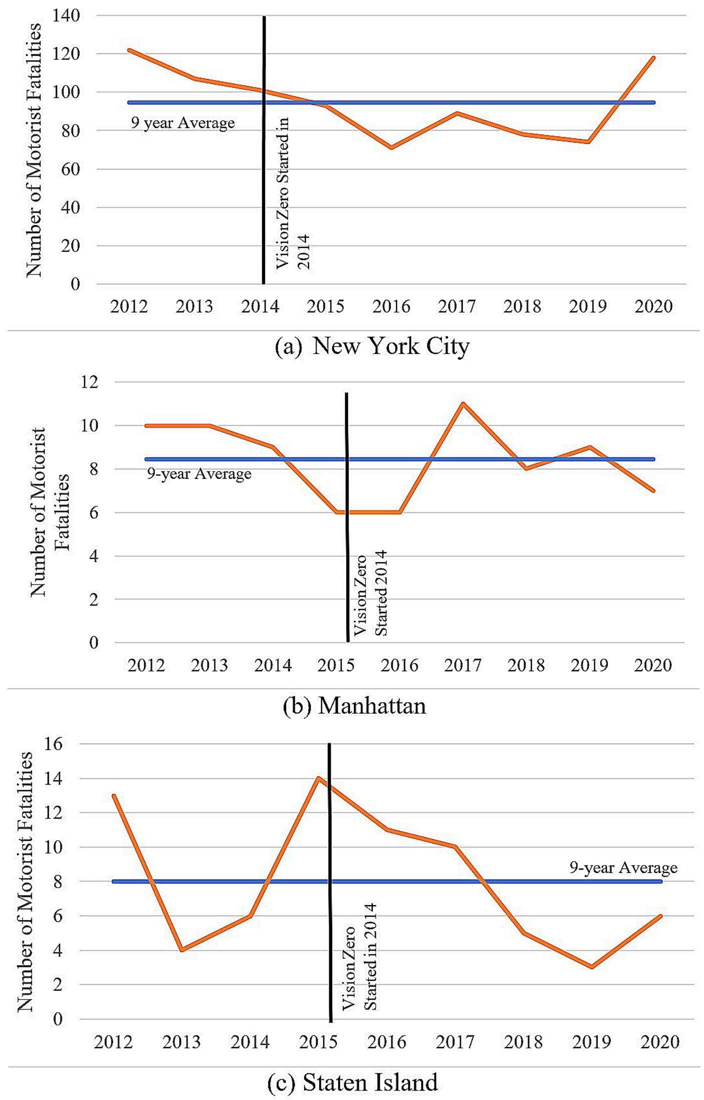


**Figure 3. Vision Zero Initiatives' relationship to motorist fatalities in NYC and two of its boroughs**

experiencing motorist fatality trends that mirrored the citywide trend, their graphs are not shown in Figure 3.

Figure 4 shows the annual number of summonses issued to drivers for various violations from 2012 to 2020 in NYC. Total annual summonses did not change much since the inception of VZ in 2014 (except in the case

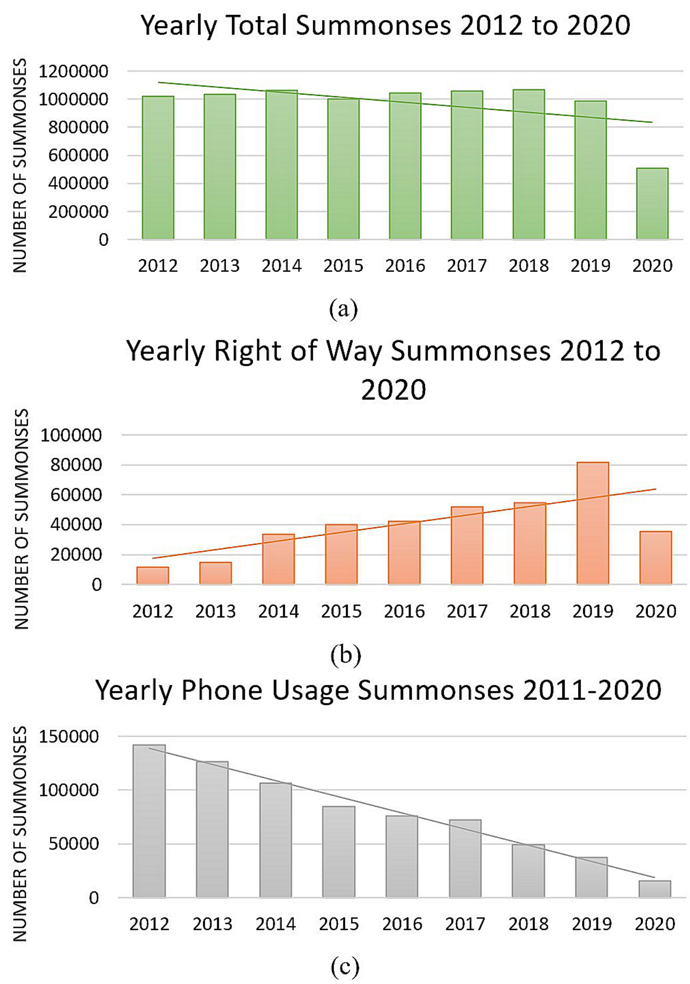


**Figure 4. Vizion Zero Initiatives' relationship to traffic law enforcement.**

of 2020) which was supported by hypothesis test (Table 5). It could be interpreted that low numbers of summonses in 2020 was due to the Covid-19 pandemic related travel restrictions. In terms of types of summonses (Figure 4, Table 4), failure to yield right-of-way and speeding experienced significant increases over the past nine years while summonses issued for cell-phone usage and missing driving requirements were decreased. Hypothesis test supported significant drop/increase in number of summonses differences before and after VZ (Table 5).

Figure 4 and Table 4 indicate that law enforcement in VZ did not lead to any increase in overall traffic related policing of the streets or quantity of summonses issued, but rather implemented law enforcement that targets violators of especially dangerous driver behaviors, such as speeding and failing to yield right of way. The "precision policing approach" was how NYPD attempted to improve overall safety through law enforcement[10]. Due to this targeted law enforcement practice, total summonses remained relatively stable, while specific types of summons saw significant increases or decreases.

Figure 5 shows the relationships between the number of summonses issued and the number of related fatalities over the period of 2012 to 2020. In the cases of cell-phone usage and missing driving requirements, summons levels declined, and related fatalities saw a relative increase. In the case of pedestrian/cyclist-harm preventing summonses, yearly counts increased but fatalities did not have a consistent change in either positive or negative directions. While this might not reveal causal relationship, this is evidence that VZ law enforcement was not making significant impacts on pedestrian/cyclist safety. One potential reason could be a focus on non-life-threatening traffic infractions rather than more serious violations One example is the documented focus of NYPD on stopping electric bicycle usage which has not been shown to cause fatalities[11].

The average annual pedestrian fatality level has decreased by 13.8% and average annual motorist fatality level has decreased 12.7%, but

| Summonses Type | Avg. Before VZ | Avg. After VZ | Percent Change |
|---|---|---|---|
| **Total** | 1028848 | 961325.9 | -6.56% |
| **Right of Way** | 13293 | 48418.1 | +264.24% |
| **Missing Driving Requirements** | 133338 | 88147.4 | -33.89% |
| **Speeding** | 77253.5 | 137939.3 | +78.55% |
| **Phone Usage** | 134119 | 63015.4 | -53.02% |

**Table 4. Descriptive statsitics for traffic summonses in NYC.**

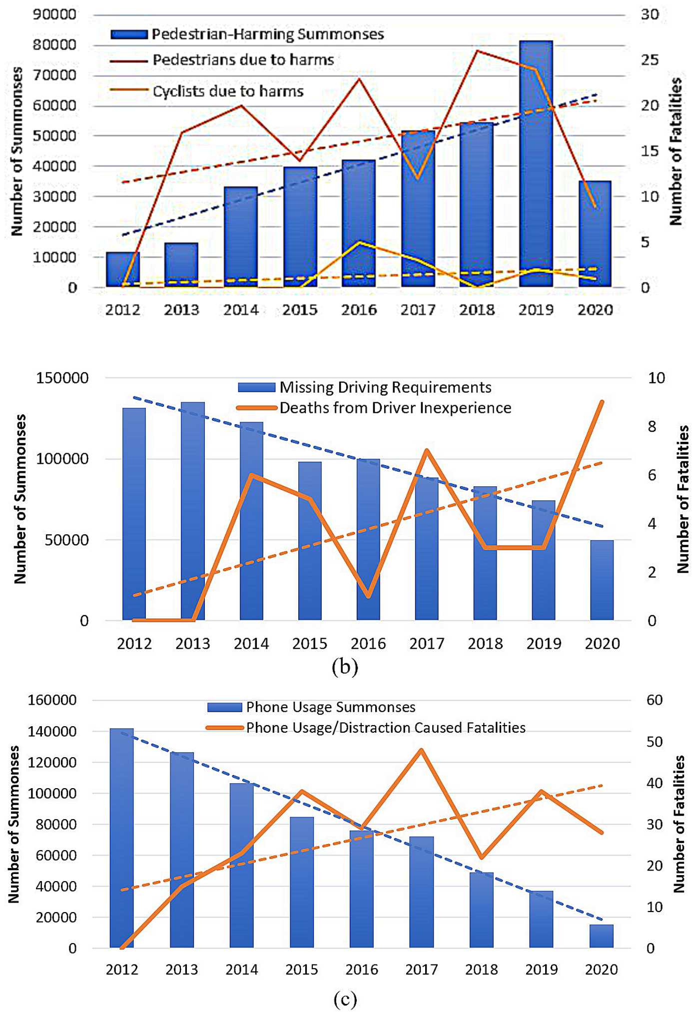


**Figure 5. Trend of traffic law enforcement in relation to traffic fatalities in NYC.**

cyclist fatalities have increased by 35.7% since the VZ program in 2014. Due to the increase in cyclist fatalities despite VZ countermeasures, this category of traffic safety was investigated further. Cyclist fatalities could increase due to different factors. Despite a number of street improvement projects (SIPs), roadway designs and conditions may continue to be inadequate for overall cyclists' safety. One reason for this may be bike lane obstructions (e.g., trash bags, shopping carts, people, motorcycles, trucks). One study reported 233 bike lane obstructions in Manhattan with an average of 6.6 obstructions per mile[12]. All bike routes studied were protected from roadway traffic- meaning they were on/along the roadway, were designed for cyclist use only and provide physical separation[12].

Obstruction types were divided into three categories: object, pedestrian, and vehicle; and proportion of total obstructions were 53.2%, 28.3%, and 18.5% respectively[12]. The high level of obstructions per mile indicates that despite the availability of protected bike lanes, cyclists still do not have a completely safe way to travel. When obstructions block the intended path of the cyclists, cyclists may divert their routes onto vehicle lanes or pedestrian-oriented facilities posing a danger to themselves and the other road users[13]. Streets with bicycle facilities are far less likely to have cyclist fatalities than those without any bicycle facilities. In NYC, only 11% of total cyclist fatalities occurred on roads with existing cyclist facilities[14].

Another safety concern from inadequate cycling facilities is the risk of dooring. Dooring is where a driver or passenger of a parked car opens their door when a parallel moving cyclist cannot stop in time and runs into the door. The best way to prevent dooring is with increased distance between bike lanes and parking lanes. To keep cyclists outside of the range in which dooring can occur, the bicycle tire must be at least 12 feet from the curb[15]. It was found that bike and parking lanes with 12 feet of width rarely kept cyclists out of traffic and away from possible dooring, but a striped buffer zone between parking and biking could be the more effective solution[15]. Dooring accounts for 12%-27% of urban bicycle-vehicle crashes in NYC[16]. Also, reducing the number of travel lanes while installing bike lanes reduces corridor injuries and fatal crashes by 70%[16].

Another possible factor in increasing cyclist crash fatality could be that more people have chosen to ride their bicycles on the road due to improvement in bicycle facilities. This could lead to higher chances of cyclist crashes because of a higher number of cyclists on the road. From 2014 to 2018, NYC's cyclist population increased by over 660,000 with contributions from campaigns for cleaner transportation and the introduction of Citi Bike's bike share program in the city.

Helmets have been proven to reduce the danger of head impact, the most dangerous injury a cyclist can face. It was found that around 85% of Citi Bike users do not wear

| | Fatalities | | | Summonses | | | | |
|---|---|---|---|---|---|---|---|---|
| | Motorist | Cyclist | Pedestrian | Right of Way | Missing Driving Req. | Speeding | Phone Usage | Total |
| $\mu_0$ | 114.50 | 14.50 | 152.00 | 13293.00 | 133338.00 | 77253.50 | 134119.00 | 1028848.00 |
| $\mu_1$ | 89.14 | 18.86 | 117.71 | 48418.14 | 88147.43 | 137939.29 | 63015.43 | 961325.86 |
| Std dev. After VZ | 16.69 | 5.73 | 13.98 | 16599.02 | 22800.24 | 13271.41 | 30913.15 | 201318.58 |
| $H_0$: $\mu_0$ = | 114.50 | 14.50 | 152.00 | 13293.00 | 133338.00 | 77253.50 | 134119.00 | 1028848.00 |
| $H_A$: | $\mu_1 < \mu_0$ | $\mu_1 > \mu_0$ | $\mu_1 < \mu_0$ | $\mu_1 > \mu_0$ | $\mu_1 < \mu_0$ | $\mu_1 > \mu_0$ | $\mu_1 < \mu_0$ | $\mu_1 < \mu_0$ |
| α | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| Test Stat., t | -4.02 | 2.01 | -6.49 | 5.60 | -5.24 | 12.10 | -6.09 | -0.89 |
| p-value | 0.003479 | .045577 | 0.000318 | 0.00069 | 0.000969 | 0.00001 | 0.000446 | 0.203866 |
| Decision: Reject $H_0$, if p<=α | p<=α Reject $H_0$ | p<=α Reject $H_0$ | p<=α Reject $H_0$ | p<=α Reject $H_0$ | p<=α Reject $H_0$ | p<=α Reject $H_0$ | p<=α Reject $H_0$ | p > α Can't reject $H_0$ |

**Table 5. Hypotheses test results for change in fatalaties and summonses after VZ in NYC**

helmets[17], and half of all other cyclists do not wear a helmet[18]. While the overall number is better than the observed trends for Citi Bike users, having only half of bike users wearing helmets still shows an unsafe behavior that puts cyclists at a higher risk for serious injury when accidents occur.

To protect cyclists on the streets of NYC and decrease associated fatality, initiatives and roadway redesigns targeted at cyclist safety should be considered. Enforcement to improve helmet usage has the potential to save lives of cyclists involved in head trauma-inducing collisions. Road redesigns that add bike lanes or improve upon existing bike infrastructure should be prioritized. Furthermore, the removal of yielding left turns on green by automobiles should be implemented to prevent cyclist-vehicle crashes caused by failure to yield, as law enforcement did not appear to be effective in reducing this type of crashes.

## Conclusions

In this research, open-source data from NYC were used to conduct trend analysis hypothesis tests, and an evaluation of the effectiveness of VZ initiatives in NYC. Average annual fatality levels for both pedestrian and motorist were reduced in the post-VZ years. While this study did not specifically identify what specific VZ actions were helping and to what degree, the combined impact of all initiatives was evaluated. A different trend was observed in the case of cyclist fatalities as fatality levels trended upward compared to motorist and pedestrian fatalities since VZ. This might not reveal a causal relationship between VZ programs and cyclist fatality increases but suggests that VZ programs need to implement more focused initiatives (e.g., bike lanes, helmet usage enforcement) to reduce cyclist fatalities in NYC. Moreover, further research should investigate what factors and safety strategies could improve cyclist safety and develop safe transportation systems for sustainable modes such as bicycles.

## Competing Interests

The author declares no competing interests.

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