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Progress Report #2

Senior Pedestrians in NYC: A Diff-in-Diff Approach to Evaluating Safe Streets for Seniors

Abstract

Urban senior populations are expected to grow significantly in the coming decades. As these demographic trends shift, new challenges will arise for cities to meet the needs of senior residents. Adjustments to policy and infrastructure will need to be made, including improvements to street walkability. New York City has implemented its Safe Streets for Seniors (SSfS) program, which includes identifying Senior Pedestrian Focus Areas (SPFAs) and making structural improvements designed to improve safety for senior pedestrians. Initial analysis conducted by the NYC Department of Transportation suggests that the program is working, however, further analysis is warranted. Our study will provide evidence as to whether or not the SPFAs actually improved safety for seniors. While existing research is only descriptive, our analysis will be the first study providing causal evidence. Should this analysis produce a causal link between SPFAs and improved safety for senior pedestrians, NYC's policy and strategy could be exported to other cities, thereby promoting the health and safety of seniors across the country and potentially across the globe. On the other hand, if no causal link is established between SPFAs and senior safety, our team will recommend amendments to NYC's methodology for SPFA implementation.

Introduction

Motivation

Nations around the world are continuing to see more and more people flocking to cities. The year 2008 marked the first time in human history when more than half of the global population could be found in cities or towns rather than rural environments (Netherland et al. 2011). And that number is only expected to grow: by 2030, two thirds of the global population will reside in cities (Buffel et al. 2016).

At the same time, many countries are aging. In member nations of the Organization for Economic Co-operation and Development, the proportion of citizens aged 65 and older has grown from 7.7% in 1950 to 17.8% in 2010 and will reach 25% by 2050 (Buffel et al. 2016). This same trend applies directly to New York, where the number of senior citizens will grow to 1.35 million by 2030 (Buffel et al. 2016). And with more seniors expected in urban environments come new demands on urban infrastructure and policy. At present, some cities are better equipped than others to handle rising populations of seniors. For example, some may have more high-quality healthcare services available while others may have well-established housing programs in place to ensure that seniors can affordably age in place.

To understand how cities compare in terms of their livability for senior populations, in 2010, the World Health Organization created its Global Network for Age-friendly Cities and Communities program ("About the Global Network for Age-Friendly Cities and Communities"). The program aims to recruit cities and provide them with the information they need in order to become more age friendly. And in 2010, New York City joined the WHO program.

Creating an age-friendly NYC, however, is no easy task. As Buffel and Phillipson illustrated in their study of cities across the globe, significant obstacles inhibit the realization of age-friendly policies and urban design. Austerity measures have been taken in many cities including New York, which saw a drop of $36 million in local funding for senior services between 2009 and 2012, representing a 20% decrease. And between the years 2005 and 2012, NYC also saw its share of funding from the Older Americans Act decline by 16%. Other pressures like housing redevelopment and gentrification and the shift in control over public spaces from city authorities to corporate entities as a result of public-private partnerships add additional resistance to the realization of age-friendly policies (Buffel et al. 2016).

Pedestrian Safety as a Key Aspect of Senior Health

It should be clear at this point that major challenges exist for New York City to accommodate the impending growth of its senior population. And these challenges will come from many different angles, whether it be access to affordable housing, medical care, or adequate transportation options, to name a few. One critical aspect of the age-friendliness of NYC will be the walkability of its streets. Many New Yorkers spend a significant part of each day walking to a variety of destinations. Seniors, too, require the same level of accessibility. Whether it is for work, grocery shopping, visiting friends, or just for exercise, seniors need adequate access to NYC sidewalks.

Studies have helped to reveal the challenges that seniors face in NYC when it comes to navigating the city on foot. A study by Nicaj, Wilt, and Henning highlights the discrepancy between pedestrian accidents in NYC and the rest of the nation. Senior pedestrians suffer higher fatality rates in pedestrian accidents in NYC than any other part of the US: while NYC and the rest of the US have similar percentages of senior residents, the rate of senior pedestrian deaths in NYC is 16% higher than the rest of the nation. Pedestrians, more generally, are particularly vulnerable in the City - while 12% of all motor vehicle deaths in the U.S. are pedestrians, that rate jumps to 50% in NYC ("Motor Vehicle Crash Pedestrian Deaths in New York City: The Plight of the Older Pedestrian", 2019).

The cost of pedestrian crashes cannot be overstated. In a separate study, Miller et al quantified the cost of pedestrian accidents involving relatively serious bodily injuries (i.e. to the head, torso, and legs). The authors found that the cost of pedestrian accidents are varied in nature and include several factors, from the cost of treating the injuries themselves, to lost work and productivity, and overall decreases in quality of life. Their research found that people younger than 5 years old face the greatest injury risks and the greatest cost, estimated at $269,590 per child per accident. Seniors, however, were also found to have the highest hospitalization and fatality rates and an estimated cost of $135,563 per senior per accident. (However, these costs are arbitrary, as they are dependent more on the cost of quality of life and productivity than on the cost of medical treatments.) Overall, their research suggests that NYC should analyze the pedestrian accidents involving seniors not only in terms of the raw numbers of pedestrian accidents and fatalities but also in terms of the significant economic cost that these accidents cause (Miller et al. 2004).

NYC Policy and Relevant Literature

The NYC Department of Transportation is not ignorant of the danger that senior pedestrians face. A study conducted by the DOT acknowledged that senior pedestrians suffer fatalities four times more often than younger pedestrians ("NYC DOT - Safe Streets for Seniors", 2019). To combat this problem, NYC DOT came up with its Safe Streets for Seniors program (SSfS), which is designed to reduce traffic accidents that result in serious injuries to or the death of senior pedestrians. Since 2008, the DOT has implemented changes in 41 "Senior Pedestrian Focus Areas" (SPFAs), which the agency identified as areas with high densities of vulnerable senior pedestrians based on the density of crashes involving senior pedestrians, senior pedestrian traffic, and the locations of senior centers and senior housing.

Once SPFAs had been identified, the DOT added new structural changes (called "Street Improvement Projects" aka SIPs) to these SPFAs, such as "extending pedestrian crossing times at crosswalks to accommodate slower walking speeds, constructing pedestrian safety islands, widening curbs and medians, narrowing roadways, and installing new stop controls and signals" ("NYC DOT - Safe Streets for Seniors", 2019). And according to the DOT, SSfS is working. Senior pedestrian fatalities have decreased citywide while pedestrian injuries within SPFAs has also seen a significant decrease ("NYC DOT - Safe Streets for Seniors", 2019).

Researchers have been less quick to declare the program a success. In their 2013 paper examining the effectiveness of NYC's SPFAs, Chen et al found parts of the program to be effective in reducing pedestrian accidents and accidents overall (increased pedestrian crossing time, new signal installations for drivers and pedestrians, and transforming car lanes to bike lanes) while other implementations (midblock pedestrian fencing) were found not to reduce senior pedestrian accidents (Chen et al. 2013).

A separate study, although not focused entirely on NYC's SPFAs, found 10 candidate community districts in NYC with relatively high concentrations of senior residents that had not been targeted as SPFAs. These same districts had high traffic fatality and injury rates in the year 2016, suggesting that the City has failed in some cases to effectively target neighborhoods for the SSfS program. ("Aging with Dignity: A Blueprint for Serving NYC's Growing Senior Population").

Problem Statement

Our team became interested in building on prior research into the SSfS program and the SPFAs that have been implemented as a part of that program. Previous research, however, has neglected to apply diff-in-diff methodology specifically to the analysis of SPFA effectiveness despite the apparent applicability of the method to this subject area. We therefore decided to analyze traffic accidents in NYC involving senior pedestrians using a diff-in-diff methodology, where we would compare accident rates over time between neighborhoods that received the SPFA "treatment" and those that did not.

Data

Our diff-in-diff analysis relies primarily on two data sets - traffic fatality data collected from the National Highway Traffic Safety Administration (NHTSA) and SPFA spatial data (see Figure 1 for an overview of the NHTSA and SPFA datasets).

NHTSA Data

The NHTSA publishes nationwide motor vehicle crash data going back decades as part of its Fatality Analysis Reporting System (FARS). Crashes reported in FARS "must involve a motor vehicle traveling on a trafficway customarily open to the public and must result in the death of at least one person (occupant of a vehicle or a non-motorist) within 30 days of the crash" ("Fatality Analysis Reporting System", 2016). The NHTSA publishes data on each accident (date, time, and location of the crash, for example) along with other, related data (number of motorists and pedestrians involved, the age and health outcome of each person involved in the crash, etc.). We collected crash data from 2001 to 2017 along with data on individuals involved in each crash. Using the unique case identifier for each crash, we were able to join the two datasets and pinpoint the number of senior pedestrians involved in all crashes within NYC.

In addition to critical variables such as the date, location, and age of pedestrians involved in crashes, we kept data from other variables to control for other influencing factors. Without controlling for these variables, we would not be able to attribute changing trends in pedestrian accidents to SPFAs as opposed to other factors. For example, the presence or absence of intoxicated individuals in an accident would likely have an impact on pedestrian accidents. (Intuitively, one would assume that intoxicated pedestrians or drivers are more likely to be involved in vehicular accidents involving pedestrians.)

We therefore created a series of dummy variables in order to control for similarly confounding factors and to add validity to our study. These variables include the following: whether or not each accident involved at least one person who was under the influence of drugs or alcohol, the total number of pedestrians involved in each accident (since with larger numbers of pedestrians involved in a given accident, the odds of a pedestrian fatality resulting increase), age and gender, and the severity of the injuries suffered by each person.

It should be noted that our study has an inherent limitation due to the NHTSA's FARS data. Since FARS only includes accidents that involved at least one fatality (whether it was a motorist, pedestrian, or cyclist), out study will not capture all accidents that are relevant to NYC's SSfS program. As previously stated, SSfS is designed to reduce all accidents resulting not only in fatalities but also serious injuries. While our data captures the former, it does not capture every crash resulting in a serious injury to a pedestrian. Despite this limitation, we are confident that our analysis will have meaningful implications for NYC's SSfS program.

SPFAs

As previously mentioned, SPFAs are specific areas in NYC that have been identified by NYC DOT as especially dangerous for senior pedestrians living in those areas. DOT has identified 41 SPFAs in total and has undertaken various infrastructure projects to improve the safety of these areas. Spatial data that describes SPFAs is published online by NYC Open Data. We have collected this data and used it for visualization and initial descriptive statistics (see Figures 5-7).

It should be noted that there is some limitation to the data available online. SPFAs have been implemented in three rounds: 25 in 2008, 12 in 2012-2013, and 4 in 2017. The information published by the DOT online does not provide more specific information as to the timing of this program. Because our analysis focuses on accident rates before and after specific safety projects were implemented, more precise date information will be needed to determine the effect of SPFAs on pedestrian crashes. We are currently in communication with DOT to acquire this data, which would aid in our analysis of the SSfS program's effectiveness.

It should also be noted that our analysis will be focused on the first two rounds of SPFAs (2008 and 2012-2013). The NHTSA has not published FARS data for 2018 or 2019. We are therefore unable to determine any observed effect on pedestrian crashes following the third round of SPFA implementation that took place in 2017.

Methodology

Difference-in-difference

The difference-in-difference (diff-in-diff) method is a statistical technique used in econometrics and quantitative research in the social sciences that attempts to mimic an experimental research design using observational study data by studying the differential effect of a treatment on a 'treatment group' versus a 'control group' in a natural experiment.It calculates the effect of a treatment on an outcome by comparing the average change over time in the outcome variable for the treatment group, compared to the average change over time for the control group. （"How Much Should We Trust Differences-In-Differences Estimates?"）

Diff-in-diff is well-suited to our research question since we are trying to study the effect of a treatment on a real-world, non-randomized population. In the analytical phase of our research, we will compare trends in senior pedestrian accident rates in SPFAs over time with trends in parts of the city outside SPFAs. If our analysis shows a significant change in trends in SPFAs post-treatment (after SPFA implementation), then our analysis will suggest that SPFAs have had a causal effect on improved safety for senior pedestrians. If, on the other hand, pedestrian accident rates see similar trends in SPFAs and in non-treated parts of the city, then the City may need to readjust its methodology for selecting SPFAs or infrastructure improvement projects.

Should time and resources allow for it, we will conduct a further experiment using diff-in-diff to compare pedestrian accident rates between seniors and younger people to determine if there are any significant similarities or differences between the two groups.

Results

Thus far, we have conducted initial descriptive analysis of our data, which has revealed the following:

- Between 2001 and 2007, all accidents reported in FARS involving a senior pedestrian saw no seniors surviving (see Figure 2).
- The number of senior pedestrians involved in traffic accidents has remained below the number seen in 2008 since SPFAs were first implemented (see Figure 2).
- The number of accidents involving senior pedestrians that occurred in SPFAs is much more lower than the number of accidents occurred outside of the SPFAs (see Figure 3).
- One of the reason might be the total area of SPFAs only counts a little proportion compare to NYC (see Figure 4).

Our initial analysis has shown that we can proceed with our intent to utilize a diff-in-diff model to analyze senior pedestrian accidents. Diff-in-diff analyses require that the data being analyzed meet the "parallel trend assumption." The parallel trend assumption is that the two populations under study, the control and experimental groups, will show similar trends in the topic of study (in our case, senior pedestrian accident rates) before the treatment has been implemented ("Difference-in-Difference Estimation | Columbia University Mailman School of Public Health", 2019).

Note that the requirement says that both groups must show very comparable trends but do not have to overlap in terms of actual observed values. In other words, for our study to meet the parallel trend assumption requirement, our experimental group and control group do not have to have the same number of senior pedestrian accidents each year. Instead, they simply must show similar trends over time (both groups should show either increases or decreases at similar rates during the same time periods).

Figure 3 reveals that our analysis will meet this requirement. In this figure, we one plotted line represents accidents that occurred in SPFAs (the treatment group) while the other plotted line represents accidents that occurred outside of SPFAs (the control group). Before the initial implementation of SPFAs in 2008, both trends show very similar spikes and drops in the number of accidents per year. Following the policy implementation in 2008, the plots take on different trends: while the control group continues to fluctuate between relatively high and low number of accidents per year, the treatment group maintains a relatively low and constant number of accidents per year. The behavior of these two trends before and after the policy implementation implies that the data we have collected satisfies the parallel trend assumption requirement.

Updated Research Plan

Now that we have collected and cleaned our primary data sets and performed some initial descriptive statistical analysis, our research is ready to move to the next phase, which will be focused on our diff-in-diff analysis.

Although the plot in Figure 3 of our control and treatment groups before and after the SPFA policy implementation suggests that our data meets the parallel trend assumption, we suspect that some covariance may exists within the data that we plan to address through linear regression. Our regression models will include an interaction term between time and the treatment as well as covariance terms for the dummy variables previously described (e.g. presence/absence of drugs/alcohol, total number of pedestrians involved in accident, etc.):

$$Y = \beta0 + \beta1 \times Time + \beta2 \times Treatment + \beta3 \times (Time \times Treatment) + \beta4 \times Covariates + \varepsilon$$

Should our linear regression models satisfy the parallel trends assumption (as our simple plot of accidents over time currently does), then we will proceed with our plan to utilize diff-in-diff methodology to analyze SPFA effectiveness. If our linear regression models fail to meet this assumption, we will revise our analytic approach accordingly.

Assuming that the linear regression model does satisfy the requirement, our model will thereby reveal the causal relationship between SPFAs and senior pedestrian accidents. This analysis will indicate whether or not any, all, or no SPFAs have been effective in reducing senior pedestrian accidents. Unless all 41 SPFAs are found to be effective, our analysis will likely spur us on to further analyze the DOT's selection procedures for SPFAs and infrastructure improvements. After we have conducted our initial analysis, we plan to contact the DOT to acquire further information regarding their methodology for selecting SPFAs in order to determine potential improvements.

Team collaboration statement

- Pengzi Li - Data cleaning, data visualization and statistical analysis.
- Po-Yang Kang - Researching policies on the city, state, and country levels, and cleaning datasets corresponding to those policies.
- Sam Burns - Report writing, communications with outside organizations, project coordination, analysis.
- Asilayi Bahetibieke - Data searching, data cleaning, unify data format, report writing.

Figures and Tables

Type of Data	***Datasets***	***Relevant Fields***
FARS Data	**Accident Dataset**	**ST_CASE, Date, Latitude, Longitude**
FARS Data	**Person Dataset**	**Age, Sex, Person Type, Date of Death, Drinking involvement, Drug involvement, Related Factors, Dead at scene or not, Injury severity**
SPFA Data	**SPFA shapefile**	**SPFA Name, SPFA Implementation Round, Shape area, Longitude, Latitude**

Figure 1: Table describing each of the two primary data sets used in our analysis of NYC's SPFAs.

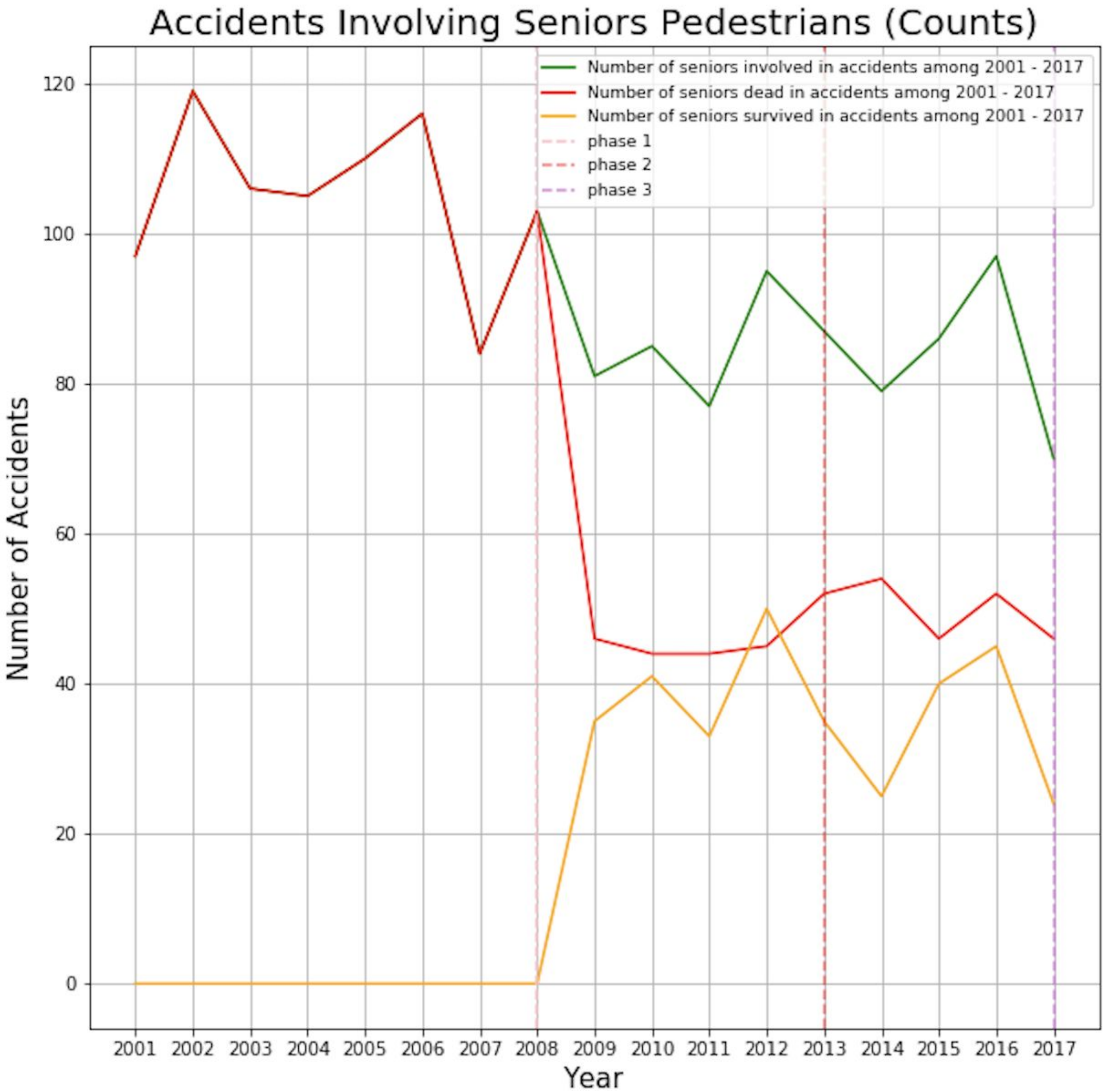

Figure 2: Count of vehicular accidents involving senior pedestrians between 2001 and 2017.

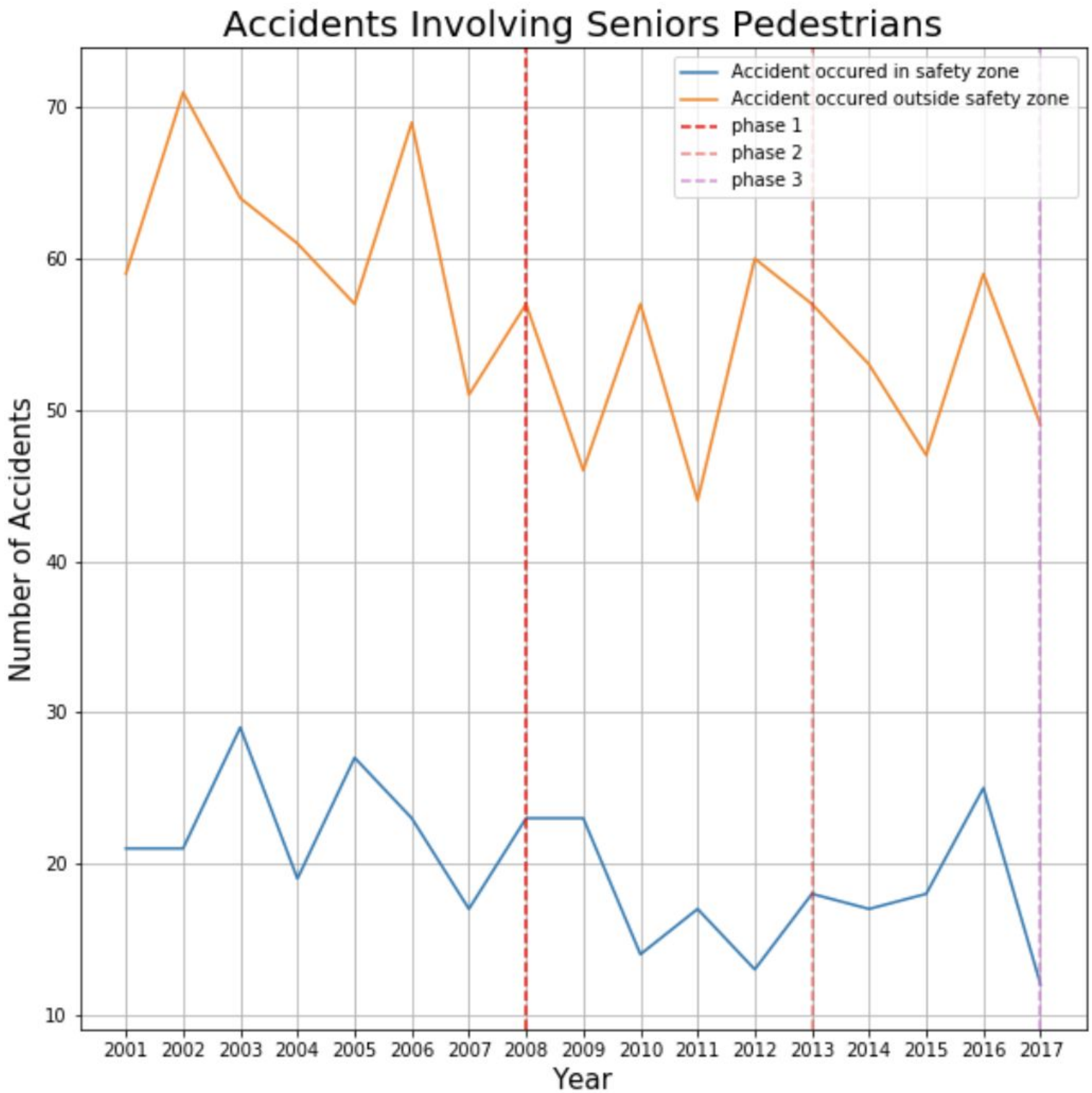

Figure 3: Accidents that occurred inside and outside of SPFAs from 2001 to 2017.

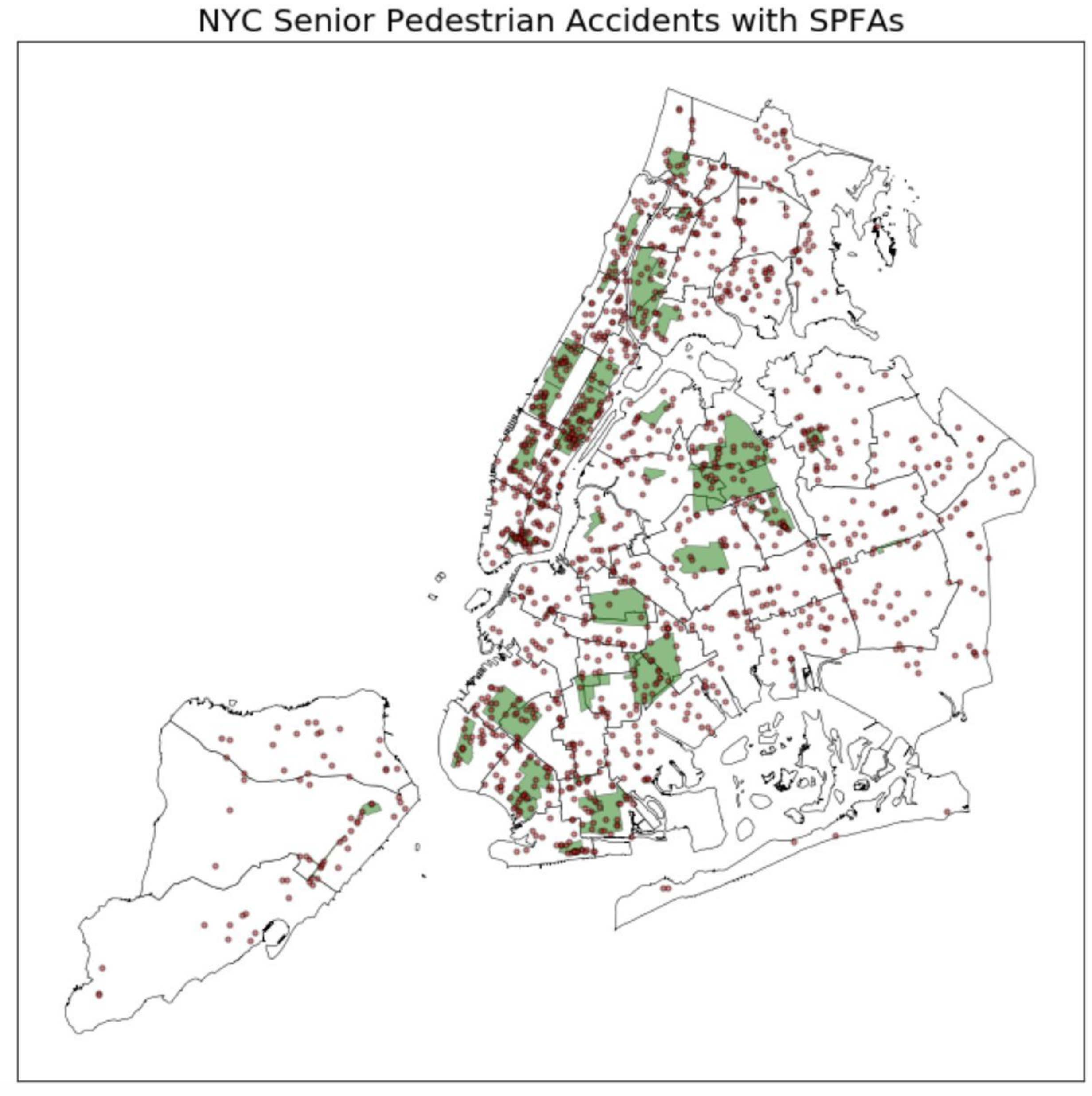

Figure 4: Choropleth of NYC senior pedestrian accidents with SPFAs plotted in green.

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