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# Violence in the Big Apple throughout the COVID-19 pandemic: A borough-specific analysis

Kevin T. Wolff<sup>a,\*</sup>, Jonathan Intravia<sup>b</sup>, Michael T. Baglivio<sup>c</sup>, Alex R. Piquero<sup>d,e</sup>

<sup>a</sup> John Jay College of Criminal Justice. United States of America

<sup>b</sup> Ball State University, United States of America

<sup>c</sup> Youth Opportunity/University of South Florida, United States of America

<sup>d</sup> University of Miami, United States of America

<sup>e</sup> Monash University, Australia

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#### ABSTRACT

In early 2020, the world faced a rapid, life-changing, public health crisis in the form of the Coronavirus (COVID-19) pandemic. The pandemic and its associated social-distancing measures collided with a period of social unrest following the murder of George Floyd at the hands of Minneapolis police and persisted for nearly two years following its emergence. The current study adds to existing research by examining the effect of these events on the incidence of violence (shootings and assaults) in New York City (NYC) over a longer period of time, both in the city as a whole and at the borough-level. To accomplish this, the current study draws from publicly available data using series of analytical techniques to account for underlying trends, seasonality, and temperature while also estimating borough-specific effects. Results indicate that the prevalence of COVID-19 cases, associated social-distancing mandates, and the period of social unrest following Floyd's murder were associated with violence in NYC. Further, findings suggest while a number of the factors explored had consistent effects across each of NYC's five boroughs there was some evidence of heterogeneity. The implications for future research on the COVID-19 pandemic are discussed.

#### 1. Introduction

In early 2020 the world became gripped by the COVID-19 pandemic, leading to dramatic changes in everyday life for billions of people across the globe. Following the proliferation of positive COVID-19 cases in cities, strict lockdown orders were quickly implemented in numerous countries around the world. One such order took place in New York City (NYC), where a state of emergency was declared on March 12 and by March 22 the city enacted a "shelter-in-place" order which required residents to restrict their travel (Dave, Friedson, Matsuzawa, & Sabia, 2020). In the end, this order was extended months longer than originally anticipated, until June 8, 2020, in an attempt to flatten the curve of COVID-19 infections (Schneider, 2020). This initial lockdown period was followed by a series of structured reopening "phases" which were soon confounded with second and third "waves" of higher infection rates. These unprecedented mandates (Hale, Angrist, Goldszmidt, Kira, Petherick, 2021), coupled with variation in the incidence of the disease,

quickly became the 'new normal', not just in American cities such as NYC, but around the world, contributing to dramatic social changes including interpersonal interactions and routine activities.

Soon thereafter, researchers in the hard and social sciences began to assess the impact of the COVID-19 pandemic on daily life. A growing amount of literature has since emerged, examining the impact of the pandemic on a wide array of outcomes, including crime in particular (Stickle & Felson, 2020; Payne and Morgan, 2020). For present purposes, we focus on the extent to which various policies associated with containing the spread of COVID-19 may have affected violence in NYC. Our interest in this area of research is not entirely novel, as many have started to examine how the pandemic may have impacted rates of crime (Abrams, 2021; Campedelli, Aziani, & Favarin, 2021; Piquero, Riddell, Narvey, Reid, & Piquero, 2020; Payne, Morgan, & Piquero, 2020), including crime in NYC (Koppel, Capellan, & Sharp, 2022). So as to not simply be yet another COVID and crime study, however, the current investigation goes beyond prior research in a number of important ways.

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<sup>\*</sup> Corresponding author at: 524 W. 59th Street, 63104T. New York, New York, 10019, USA.

E-mail addresses: kwolff@jjay.cuny.edu (K.T. Wolff), jintravia@bsu.edu (J. Intravia), michael.baglivio@youthopportunity.com (M.T. Baglivio), axp1954@miami. edu (A.R. Piquero).

First, we examine a longer time period by assessing impacts dating from the beginning of the pandemic through the first three quarters of the second year of the pandemic (2021) in order to capture longer-term shifts in gun violence and assaults occurring in NYC. Secondly, in addition to modeling the stay-at-home restrictions as others have done in the past, we incorporate novel information on the daily incidence of COVID-19 cases during this period to capture any potential unique differences. Additionally, we explore whether the association between the COVID-19 pandemic and the incidence of assault and gun violence may vary by area across the five boroughs in NYC. This latter feature of our work is especially important as evidence has emerged that the nature and patterning of crime during the COVID-19 era varies within cities (see e.g., Campedelli, Favarin, Aziani, & Piquero, 2020; Felson, Jiang, & Xu, 2020). Finally, we consider the extent to which social and racial justice protests in the aftermath of the George Floyd murder on May 25, 2020 affected the outcomes of interest (shootings and assaults) due to the historic gravity of those demonstrations which were not only observed in NYC, but throughout the U.S. and around the globe (Cobbina-Dungy, Chaudhuri, LaCourse, & DeJong, 2022).

In short, while existing research has been critical to addressing the newly emerging issues including increasing rates of community gun violence in cities across the country (Rosenfeld & Lopez, 2022), further efforts are required to understand how COVID-19 (and related governmental mandates/restrictions) is associated with the longer-term patterns in gun violence occurring in the nation's largest metro area. Additionally, by including information on infection rates and other major events during the analysis period, the current analysis attempts to better identify any association between lockdown orders and the incidence of both assault and shootings across the city and does so by focusing on two of the most common forms of violence, shootings and assaults, across the five NYC boroughs to advance our understanding of both the etiology of shootings and assaults with respect to the pandemic by better taking into account the impact of "place" on crime, as well as to inform policy in efforts to develop effective interventions (Anselin, Cohen, Cook, Gorr, & Tita, 2000). Prior to describing the current study, we provide some background on the emergence and proliferation of COVID-19 in NYC, as well as the protests which resulted from the tragic killing of George Floyd, and finally rates of violence observed during this period. We go on to review existing research on the association between the onset of the pandemic and rates of crime and violence and discuss the theoretical connections which exist, providing support for the idea that these associations may differ across the boroughs within the city.

# 1.1. Setting the stage: New York City, COVID-19, George Floyd protests, & violence

A novel coronavirus (COVID-19), which originated in Wuhan, China at the end of 2019, quickly spread around the world impacting numerous countries, cities, communities, and institutions. In January of 2020, the first COVID-19 case was confirmed in the United States (Centers for Disease Control and Prevention, 2021a). Soon after, the coronavirus affected virtually every city in the U.S. and by spring 2020 New York City (NYC), the study site for the present investigation, became the nation's epicenter of the COVID-19 pandemic and accounted for roughly 25% of the COVID-19-related deaths in the U.S. (NBC New York, 2020). In fact, from March 17, 2020 to May 17, 2020, NYC reported over 190,000 positive COVID-19 cases and nearly 16,000 deaths (NYC Health, 2022). As of May 5, 2022, public COVID-19 data illustrates that among NYC residents, there have been approximately 2.38 million positive cases (confirmed and probable), 165,355 hospitalizations, and a total of 40,227 deaths (NYC Health, 2022).

As an early epicenter of the coronavirus outbreak, NYC experienced many social changes that were largely echoed throughout the country (and world). On March 7, 2020, then New York Governor Andrew Cuomo declared a state of emergency, resulting in the closure of NYC public schools on March 16th, closure of bars and restaurants on March 17th, and on March 22nd the "New York State on Pause" executive order went into effect resulting in 100% closure of non-essential businesses and for residents to stay at home as much as possible. Strategic plans, or four "phases," were put in place to slowly reopen NYC based on prioritization of industries and institutions that pose the lowest risk of infection for residents with Phase 1 beginning on June 8, 2020, and eventually Phase 4 beginning on July 19, 2020.

In addition to the onset of the COVID-19 pandemic, and prior to the first phase of reopening in NYC, the country experienced tremendous civil unrest stemming from a viral video filmed in Minneapolis, MN, on May 25, 2020, which showed the killing of George Floyd, a 46-year-old African American male, being handcuffed and pinned to the ground with a knee to his neck by Derek Chauvin, a white police officer (Taylor, 2021). Immediately following the death of George Floyd, protests began in Minneapolis and quickly spread across the nation despite social distancing recommendations, including in NYC (New York Times, 2020). Public opinion polls illustrated that approximately 15 million to 26 million adult citizens participated in the George Floyd protests over the death of George Floyd and other minorities who have been killed by the police (Buchanan, Bui, & Patel, 2020), raising calls to not only declare racism a public health crisis, but also causing concern for the spread of the novel coronavirus (Kennedy, Kirka, & Gorondi, 2020). In recent years, researchers have shown that similar events were followed by an increase in crime, often referred to as the "Ferguson effect," including robberies (Pyrooz, Decker, Wolfe, & Shjarback, 2016), shootings (Arthur & Asher, 2016; Morgan & Pally, 2016), and murders (Arthur & Asher, 2016; Morgan & Pally, 2016). Recent research has also suggested that the social unrest which occurred after the killing of George Floyd may have also played a role in the increased rate of homicides observed across a sample of U.S. cities, although local conditions continue to be salient (Rosenfeld & Lopez, 2022; Sganga, 2022).

Importantly, prior to spring of 2020, most large U.S. cities had seen declining violent crime rates, with 2019 crime rates representing only a small fraction of what they were in the early 1990s. However, in the years leading up to the outbreak of COVID-19, there was some evidence that this decline was beginning to slow, and by the summer of 2020 there were indications that many cities in the United States were experiencing substantial increases in gun violence. This was also true in NYC, where the New York Police Department (NYPD) reported 167 shooting incidents across the City in the first quarter of 2020 (January-March) which represented a significant increase over the previous year. Shootings more than doubled to 361 during the second quarter (April-June 2020), and by the third quarter (July-September 2020), police reported 634 separate shooting incidents (Butts & Espinobarros, 2021). By the time the ball dropped in Times Square on December 31, 2021, the NYPD had investigated 485 murders — 17 more than the 468 reported in 2020. The total was a 3% increase over 2020 and a large 52% jump from prepandemic levels in 2019, when 318 murders occurred (Thomas, 2022), and has led newly elected Mayor Adams to usher in new anti-crime measures (CBS News, 2022).

Recently, Koppel, Capellan, & Sharp (2022) completed a thorough analysis of recent trends in crime and violence in NYC, examining the association between New York's stay-at-home orders as well as accounting for the social unrest that followed the death of George Floyd. In addition to exploring the various periods under question, their models accounted for daily temperature, policing activity in the form of arrests, as well as the prevalence of social distancing as measured by Google location services data. The authors found that consistent with routine activities theory, New York City's stay-at-home restrictions were associated with a decrease in residential burglary, felony assault, grand larceny, rape, and robbery, but were associated with increases in non-residential burglary and motor vehicle theft and were unrelated to the incidence of shootings or murder.

#### 1.2. Association of COVID-19 onset with crime and violence

A burgeoning research agenda has begun to document the overwhelmingly detrimental impacts of the COVID-19 pandemic and related governmental restrictions and lock-down policies on more serious forms of antisocial and offending behavior (Stickle & Felson, 2020). An increase in domestic violence perpetrated by adults appears has been well documented, with initial increases reported in Australia, Argentina, Brazil, China, India, Italy, Mexico, Spain, Sweden, and the U.S. (e.g., Campbell, 2020; Nix & Richards, 2021; Piquero, Jennings, Jemison, Kaukinen, & Knaul, 2021; Richards, Nix, Mourtgos, & Adams, 2021), though the limited examination of juvenile-perpetrated family violence points to a decreasing trend (Baglivio, Wolff, Reid, Jackson, & Piquero, 2022). Additional increases in violence directly related to the pandemic include incidents of hate crimes specifically targeting Asians (Gover, Harper, & Langton, 2020). Law enforcement data indicates official anti-Asian hate crimes across 13 U.S. cities increased by 145% in 2020, while other hate crimes decreased 6% during the same year (CSU Center for the Study of Hate & Extremism, 2021). New York City, specifically, saw a 38% drop in total hate crimes, but an astonishing 833% increase in anti-Asian hate crimes in 2020 (CSU Center for the Study of Hate & Extremism, 2021).

Regarding crime in the U.S. in particular, police departments across the country altered tactics and policies (Jennings & Perez, 2020), often deemphasizing arrests of some types of non-violent crimes, such as minor drug offenses (Melamed & Newall, 2020; Sisak, Bleiberg, & Dazio, 2020), while court processes slowed, judicial caseloads backed up, and criminal justice policies were created aimed at early release and slowing the influx of new inmates into jails and prisons as viral infections spread rapidly throughout custodial facilities (Piquero, 2021). Stay-at-home orders and other governmental restrictions/mandates likely further affected the prevalence of specific crime types as citizens' daily activities were dramatically altered, consistent with expectations from Cohen and Felson's (1979) routine activity theory. Rosenfeld and Lopez (2022) detail weekly crime rates per 100,000 city residents of ten offense types from January 2018 (far prior to the pandemic onset) through the end of 2021 across 27 U.S. cities. These authors report that homicide rose 5% between 2020 and 2021, with a total which was 44% higher than in 2019. Similarly, rates of assault and gun assault also increased in 2020, while rates of property crime (excluding vehicle theft) were marginally lower than observed in 2020.

Earlier analyses by these authors suggested robbery rates meanwhile have decreased during the pandemic, as have residential burglary, larceny, and drug offenses, while nonresidential burglaries decreased in the early months of the pandemic, increased dramatically in last week of May 2020, and reverted to prior levels the week after then continuing to fall (Rosenfeld & Lopez, 2021). In contrast, homicides, aggravated assaults, and aggravated assaults with firearms all rose after the May 2020 George Floyd murder (exceeding prior cyclical patterns), remaining high throughout that summer, decreased in winter months of 2020 then rose again in 2021, but at a slower pace than the 2020 increase (Rosenfeld & Lopez, 2022). Similarly, Abrams (2021) leveraged data from 25 large U.S. cities to uncover a large decline in drug offenses, residential burglaries, theft, and many violent crimes with the onset of the pandemic. Abrams (2021) observed that homicides and shootings did not change in relation to the pandemic onset. Assault with a deadly weapon and homicide trends did not significantly change from prepandemic through the end of March 2020 in Los Angeles either (Campedelli et al., 2021). However, examining shootings from 2017 to October 2020 in Buffalo, NY, Kim and Phillips (2021) showed a gradual permanent increase in non-fatal shootings with injury and without injury as well as gang-related shootings, as a well as temporary increase in fatal shootings.

#### 2. Summary

As these studies show, substantial differences exist in the extent to which COVID-19 and related lock-down policies have affected offending across specific crime types. Herein, we focus on two of the most common forms of violence (assault and shootings) in NYC, as several studies indicate increases in violent incidents at the onset of the pandemic and for some time thereafter. Furthering the importance of focusing on shootings is the record-breaking 44,824 gun-related violence deaths in the U.S. in 2020 (Gun Violence Archive, 2021). Additionally, as discussed by Piquero (2021), pandemic-related changes in crime trends are intertwined with the concurrent aftermath of the murder of George Floyd and ensuing racial justice protests. Finally, as extant research has pointed to the importance of unique crime patterning during the COVID-era within cities, it is possible that the association between these events and the incidence of violence may vary between the five unique boroughs that comprise NYC, a possibility that we highlight below.

## 2.1. Borough-specific realities

The focus on spatial effects, similarities, and differences across place are essential in further understanding the impact of the pandemic on offending. Offending, and changes in offending, are intertwined with the characteristics of individuals within spaces (such as NYC boroughs), but also with the characteristics of the spaces themselves and the kinds of places within those spaces (e.g., Kubrin & Weitzer, 2003; Shaw & McKay, 1942). The racial/ethnic make-up, socioeconomic situation/ social disorganization, political affiliations, social unrest, social support, relationship with law enforcement, current trends in offending/offense types, concentration of individuals, extent of use and means of public transportation, resources and access to healthcare, medical supplies, and food, and many other factors coalesce to the uniqueness of any given space. As such, examining variation in the effect of phenomenon (such as a global pandemic) on outcomes (such as violent offending) is critical. The extent to which similarities exist lends to universal policy implications and public health interventions (including those surrounding criminal offending), while extensive differences illuminate the need for location-specific and targeted implications and intervention.

New York City is a unique environment, comprised of five distinct boroughs that include the Bronx, Brooklyn, Manhattan, Queens, and Staten Island. Importantly, these boroughs vary across social, economic, and ecological factors. For example, Manhattan is characterized by the highest population density, whereas the Bronx has more than twice the poverty rate and half the median income than Staten Island or Queens. Brooklyn, Queens, and Manhattan are also more ethnically diverse than Staten Island and the Bronx. These differences, and their ramifications for the spread of COVID-19 and rates of violence became even more apparent at the onset of the pandemic. For instance, pronounced geographic differences in hospitalization and mortality rates have emerged with deaths and hospitalizations due to COVID-19 nearly twice as high in the Bronx as in Manhattan (Kissler et al., 2020). This is likely the result of differences in residents' ability to work from home, as well as a reliance on public transportation which is associated with a higher risk of exposure (Sy, Martinez, Rader, & White, 2021). Relatedly, The New York Times reported that within the wealthiest neighborhoods in NYC, at least 40% of residents fled the city after the pandemic took hold, whereas fewer residents from lower income neighborhoods were able to leave (Quealy, 2020). Residents in these areas also live in more densely populated neighborhoods as well as in households with a greater number of people and are often forced to travel further for basic needs such as groceries (Walker, 2009). These differences result in increased risk of exposure to COVID-19 as well as a greater historical risk of exposure to violence (Fagan, Zimring, & Kim, 1997). Recently, Kim (2022) has highlighted that the increases in gun violence observed in NYC were unequally distributed, and that neighborhoods with a greater number of racial/ethnic minorities, those with higher rates of poverty, and those

which are more densely populated saw the largest increases during this period.

Importantly, these borough-specific realities may further exacerbate existing disparities in health and public safety and lead to variation in the association between stay-at-home orders, social unrest, and the incidence of violence across boroughs in NYC. As well, the impact of the killing of George Floyd and subsequent social unrest could also be expected to vary across NYC boroughs. Socioeconomic factors, racial/ ethnic differences, pre-Floyd relationship between citizens and law enforcement, and political affiliation likely impact the extent of participation in protests, as well as escalation of violence within those communities. As the Floyd-related protests did not occur with the same frequency (and outcomes) in each of the boroughs, exploring the extent to which the protests may have been related to crime is pertinent.

#### 2.2. Current focus

Although a growing body of literature suggests that the onset of the COVID-19 pandemic is likely associated with the surge in various forms of (violent) crime observed in NYC, to date, existing research has yet to evaluate how various lockdown measures and the actual incidence of infection are associated with the prevalence of serious violence observed across the city. The current analysis examines these issues, while also accounting for the period of social unrest following the killing of George Floyd, and other confounding factors such as the daily temperature and the volume of policing activity (i.e., rates of arrest). Finally, we examine the borough-specific associations present between these various factors and the incidence of violence (both assaults and shootings) in NYC for nearly a two-year period since the onset of the pandemic.

#### 2.3. Data & methods

Daily data on the number of shooting incidents were drawn from New York's open data portal (opendata.cityofnewyork.us). More specifically, data on shooting incidents known to police were taken from both this "historic" and "year to date" file provided by the NYPD. This data is updated quarterly and covers the period between January 1, 2006 and September 30, 2021. These incident-level files were then appended together and aggregated in order to compute a total count of shooting incidents which occurred in each of the boroughs of New York City (both individually and citywide) between January 1, 2019 and September 30, 2021. During this time period a total of 4446 shooting incidents were recorded within the 5 boroughs of NYC, with an average daily count of 4.85 shootings (Min = 0, Max = 47). Also important is evidence of significant differences in the rate of shootings across the 5 boroughs, with the Bronx evidencing significantly higher shooting rates when compared to every other borough, while Staten Island recorded significantly fewer shootings than the rest of the city.

Our second dependent variable, the daily count of assault incidences was similarly taken from the historic and year-to-date complaint files provided by the NYPD. Again, after selecting out all misdemeanor (i.e., simple) and felony assaults from the broader universe of criminal activity, these incident-level files were appended together and aggregated in order to compute a total count of violent incidents which occurred in each of the NYC boroughs (both individually and citywide) between January 1, 2019 and September 30, 2021. As may be anticipated, assaults tended to occur at a much higher rate than shootings across the city, with an average of 190.9 (sd = 38.2) assault complaints occurring per day. There is also evidence of substantial variation across boroughs, as the average count of assault complaints in Brooklyn (53.3 per day) far exceeded the average in Staten Island (6.6 per day).

Also taken from the open data portal was a daily count of COVID-19 cases, updated daily by the Department of Health and Mental Hygiene (DOHMH). Among other metrics, this dataset includes information on the number of individuals who tested positive for COVID-19 for each day since February 29, 2020 (the date of the first known case in New York

State). Between the time of the first positive result and the end of the time period being examined, there had been a total of 895,039 positive cases recorded within the city. The daily average during this period was 1543.8 positive cases, while at its peak the city recorded a maximum of 6602 new cases in a single day.<sup>1</sup> For the citywide analyses, described below, we use a daily count of Coronavirus infections (in thousands), while in the borough-specific analyses which follow we convert to a daily rate of infection (per 100,000 residents) in order to account for differences in population size between boroughs. Again, there is evidence of significant variability across the boroughs of NYC, with the more densely populated boroughs (the Bronx, Brooklyn, and Queens) experiencing significantly higher rates of COVID-19 positive cases when compared to Manhattan and Staten Island.

To account for variation in law enforcement behavior during this period we generated a daily count of arrests drawn from additional NYPD data available on NYC's open data portal. During the period examined there were an average of 468.4 arrests per day (sd = 157.8). In order to account for differences in population across boroughs, these daily counts were converted to rates per 100,000 residents in the borough-level analyses described below. Again, we observed substantial variation across the boroughs, with a minimum rate of 5.1 arrests per 100,000 in Queens to a high of 8.8 per 100,000 residents in the Bronx.

As ambient temperature has been shown to be associated with rates of violence, and thus represents an important confounder between rates of COVID-19 infection and the incidence of violence in NYC (Anderson, 1987; Tiihonen et al., 2017), daily information on the ambient temperature for NYC as a whole and for each borough individually was taken from VisualCrossing.com, a global weather data and forecasting website. Beyond a measure of average daily temperature, used in the current study, this website provides information on wind and precipitation down to the hourly level. Using their query builder, daily information on the ambient temperature for the city as a whole and for each borough individually was collected and combined with information on shooting incidents, assault incidents, and positive COVID-19 cases for the period between January 1, 2019 and September 30, 2021 (n = 1004).

Beyond the information gathered from these publicly available websites (weather data was purchased for a nominal fee), we generated a number of variables designed to capture key periods associated with social distancing restrictions, their subsequent relaxation, and the period of social unrest which followed the death of George Floyd. Each of these variables were binary in nature and set equal to one during the period specified. The first measure captures the onset of the New York State Pause Program (March 22–June 8, 2020) during which former New York governor Andrew Cuomo declared that all non-essential workers were to stay home. Although initially expected to be rather short in duration, the NYS Pause was extended multiple times during the spring of 2020.

In addition to the measure related to social distancing restrictions enacted during the onset of the pandemic we include a binary measure designed to capture the social unrest that followed the death of George Floyd on May 25, 2020. Starting on May 28, 2020 protests occurred at several sites throughout the five NYC boroughs in reaction to Floyd's death. Although most of these protests were peaceful in nature, some sites experienced violence as protestors and police clashed. At the same time looting began to occur as stores were shuttered following the governor's stay-at-home orders leading to the city being placed under a curfew from June 1 until the morning of June 8, 2020. Accordingly, this measure is set equal to one for the period of May 28, 2020 – June 7, 2020.

Finally, as rates of infection surged during the last few months of

<sup>&</sup>lt;sup>1</sup> Note that this maximum occurred prior to the onset of the Omicron variant which witnessed significantly higher daily totals due to increased transmissibility.

2020, new restrictions were placed on indoor dining within NYC. Eventually, on December 14, 2020 Cuomo suspended indoor dining in the city, a restriction that was retained until restaurants were allowed to open at 25% capacity on February 11, 2021. We capture this period in the models estimated using a binary variable, coded 1 for the period during which indoor dinning was suspended for a second time.

This process resulted in two distinct analysis files. One which included time-series data for the city as a whole, and a second which included a series for each of the five boroughs within the city limits. For each, the period under study was identical (January 1, 2019 - September 30, 2021), allowing us to more accurately model the incidence of shootings and assault during the pre-pandemic period. Given the universal nature of the stay-at-home restrictions the indicator variables were coded identically for each of the analyses presented. Descriptive statistics for each of the measures included in the current study are displayed in Table 1. Additionally, daily shooting and assault counts, average temperature, and a count of COVID-19 cases are displayed graphically in Fig. 1, along with vertical lines which demarcate the time periods associated with social distancing restrictions and the social unrest following the murder of George Floyd. Importantly, within the figure the count of shooting incidents has been multiplied by ten in order to better align the axis with the daily temperature and assault.

## 2.4. Analysis

Prior to assessing whether the prevalence of violence across NYC was impacted by the restrictions associated with the onset of the COVID-19 epidemic, some preprocessing of the raw crime data provided by the NYPD was necessary. Following Hodgkinson and Andresen (2020), we use the Hodrick and Prescott (1997) filter to extract the trend portion of the time series, effectively smoothing the data and removing the

#### Table 1

Descriptive statistics	for analysis of	violence &	COVID-19 in New	York City.
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Variables	Mean	SD
Daily Shooting Count (Citywide)	4.4	4.1
Manhattan	0.7	1.2
Brooklyn	1.7	2.2
The Bronx	1.3	1.8
Queens	0.7	1.1
Staten Island	0.1	0.4
Daily Assault Count (Citywide)	190.9	38.2
Manhattan	39.3	10.8
Brooklyn	53.3	12.3
The Bronx	51.8	11.9
Queens	39.9	11.2
Staten Island	6.6	3.0
Daily Arrest Count (Citywide)	468.4	157.8
Manhattan (per 100 k residents)	7.8	3.3
Brooklyn	5.5	1.9
The Bronx	8.8	3.2
Queens	5.1	1.7
Staten Island	5.4	2.4
Daily COVID-19 Confirmed Positive Cases (in thousands;		
Citywide)	0.9	1.4
Manhattan (per 100 k residents)	8.7	12.8
Brooklyn	11.6	17.3
The Bronx	13.8	23.2
Queens	13.1	20.9
Staten Island	19.1	30.2
Daily Temperature (Citywide)	57.3	16.9
Manhattan	57.3	16.9
Brooklyn	57.4	16.9
The Bronx	57.3	16.9
Queens	57.7	17.7
Staten Island	57.5	17.2

NYC Pause: March 22nd - June 8th, 2020.

Social Unrest Associated with George Floyd's Death: May 25–June 7, 2020. Second Wave Indoor Dining Restrictions: December 14, 2020 - Februrary 11, 2021 volatility present in the daily shooting and assault counts. Doing this allows us to more confidently identify deviations in the trend, during the period under investigation and assess whether these deviations are related to the focal variables included in the analysis. One benefit of the Hodrick and Prescott filter is that it smooths the data without any loss of observations which occurs when using more traditional time-series methods such as moving average calculations, allowing us to both visualize and evaluate the trend in shooting and assault incidents for the entire period analyzed (January 1, 2019 – September 30, 2021). Beyond the data smoothing procedure, we account for the known seasonality of crime data by including day of the week, monthly, and yearly indicator variables in the estimation of our time-series and panel regression models described below. In addition to accounting for the underlying trend in the model, the inclusion of these "dummy" variables picks up any seasonality or period-specific shocks that are present in the data.

To assess the association present between the independent measures and the incidence of violence in NYC, we employed Auto Regressive Integrated Moving Average (ARIMA) models which account for temporal dependencies of time series data. The first, and arguably the most important step in constructing a time-series model is to assess stationarity and examine temporal autocorrelation (Chatfield, 2003). Several unit roots tests were performed for the presence of non-stationarity, including the Augmented Dickey-Fuller, Phillips-Perron, and Kwlatkowski-Phillips-Schmidt-Shin tests. Based on the results of these tests conducted on the pre-pandemic trend, and the examination of the autocorrelation function (ACF) and partial autocorrelation function (PACF), it is very unlikely that either measure of violence occurring in NYC during the sample period should be modeled using first and/or seasonal differences. This was true of both the citywide time-series as well as the borough-specific trends in both assaults and shootings. Following this initial assessment, various ARIMA processes-autoregressive (AR) and moving average (MA) parameters-were estimated using the pre-pandemic time series in order to identify the best fitting model. A final model with a chosen AR term and an appropriate MA term was then selected, and then the focal measures were then added to the full model. Assessing the goodness of fit measures (i.e., the AIC and BIC scores) for the preliminary ARIMA models, the best fitting model was determined to be one without either a differenced or moving average structure (i.e., ARIMA 0,0,0) for shootings, and a model including a single period (i.e., AR-1) for the incidence of assault. Finally, residuals were checked for normality and independency using the ACF and PACF from the fitted models. Given evidence of heteroscedasticity present within the residuals, robust standard errors are presented.

After establishing the relationships between our focal measures and the daily count of shooting and assault incidents across the city, we use negative binomial panel regression models to assess the potential for the relationship between our key measures and the two measures of violence to vary across the five boroughs. To do this, we first estimate a negative binomial panel regression model that includes a series of interaction effects between each key variable and each borough, with Manhattan serving as the reference category. Negative binomial regression represents the appropriate modeling specification here given the over dispersion present in daily violent incidents observed across boroughs. Specifically, negative binomial regression models do not assume mean/variance equality and avoid the issue of inefficient (but consistent) estimates resulting from the more traditional Poisson model (Osgood, 2000). Prior researchers have noted that criminological data, such as counts of gun violence, often exhibit signs of over dispersion, leading to the increased popularity of negative binomial regression in contemporary studies of crime (MacDonald & Lattimore, 2010).

Finally, it is important to note that recent methodological advances suggest that caution is necessary when interpreting the significance of interaction terms within non-linear regression models. Following recent recommendations in the literature (Mize, Doan, & Long, 2019; Mustillo, Lizardo, & McVeigh, 2018), we evaluated the differences in the



Fig. 1. Shootings (10×), Assaults, COVID-19 Cases and Daily Temperature between January 1, 2020 and September 30, 2021.

association between each of our key independent measures and the daily count of shooting and assault incidents using adjusted predictions rather than statistical significance of the coefficient of the product term alone. More specifically, in order to probe the between-borough differences in the association between various stay-at-home measures, COVID-19 case counts, and daily temperature, we assessed the "second differences" (i. e., second derivatives) of the marginal effects of each measure between the five areas being explored (Brooklyn, Bronx, Manhattan, Queens, and Staten Island; Mize et al., 2019). Results of these analyses are described below, followed by a discussion of their implications for future research on the effects of the COVID-19 pandemic on rates of violence within NYC and beyond.

#### 3. Results

#### 3.1. Citywide associations

Table 2 presents the results of our time-series model which explores the association between each of our crime outcomes, shootings and assaults, along with our main covariates of interest: daily COVID-19 cases, associated restrictions enacted during the first year of the pandemic, and the period of social unrest that occurred following the murder of George Floyd, while also accounting for several other factors shown in recent research to be associated with the incidence of violence in NYC during this period. Results suggest that the daily COVID-19 case count was significantly and negatively related to the count of shooting incidents, but unrelated to the count of assaults during this period. Additionally, the first NYC Pause stay-at-home order was significantly and negatively associated with both of the outcomes examined. Conversely, the period of social unrest associated with the murder of George Floyd had a significant and positive effect on both the incidence of shootings and assaults. The second wave of indoor dinning restrictions which occurred in the fall/winter of 2020 were also negatively associated to shootings but were unrelated to the incidence of assault. The same was true for the rate of arrests carried out by the NYPD, while the daily ambient temperature was positively associated to both outcomes examined. Overall, these results are fairly consistent with the body of existing research which has examined the association between social distancing orders and the incidence of violence in NYC, yet our results add to the knowledge in this

## Table 2

ARIMA model predicting daily shooting and assault incidents in NYC January 1,	
2019 - September 30, 2021.	

	Model 1	Model 2 Smoothed H—P Trend in Assault		
	Smoothed H—P Trend in Shootings			
	b / 95% CI	b / 95% CI		
COVID-19 Daily Case Count	-0.179**	0.021		
	[-0.290,-0.068]	[-0.502,0.544]		
NYC Pause	-2.766***	-7.731***		
	[-3.345,-2.186]	[-10.464,-4.998]		
Social Unrest following Floyd	1.143*	5.157***		
	[0.227,2.059]	[2.476,7.838]		
Second Wave Indoor Dinning				
Restrictions	-0.477*	-1.532		
	[-0.882, -0.071]	[-4.331, 1.267]		
Contemporaneous Assault				
Incidents	0.002	_		
	[-0.003,0.007]	_		
Contemporaneous Shooting	- , -			
Incidents	_	0.045*		
	_	[0.002.0.088]		
NYPD Arrests	-0.006***	0.001		
	[-0.007,-0.004]	[-0.002,0.004]		
Daily Temperature	0.016*	0.126***		
	[0.002.0.031]	[0.088.0.164]		
Lag of Daily Assaults	_	0.994***		
<u> </u>	-	[0.980,1.009]		

Note: ARIMA: Auto-regressive moving average. Model includes day-of-week, month- and year-effects as well as robust standard errors to account for heter-oskedasticity. \*p < .05, \*\*p < .01, \*\*\*p < .001 (two-tailed test).

area by explicitly modeling the association between the incidence of COVID-19 and these outcomes. Next, we turn to the important feature of our work, exploring variability in the two violent outcomes across areas of NYC.

## 3.2. Borough-specific associations during COVID-19

Table 3 explores the borough-specific associations between each of our focal measures and the count of shooting incidents using negative

#### Table 3

Borough-specific associations between key measures and shooting incidents in NYC

	COVID-19 Cases		NYS Pause		Floyd Social Unrest		Indoor Dinning Restrictions	
	b	95% CI	b	95% CI	b	95% CI	b	95% CI
COVID-19 Daily Case Count	-0.000	[-0.010,0.010] [-0.689,-	-0.000	[-0.005,0.004] [-1.013,-	-0.000	[-0.005,0.004]	-0.000	[-0.005,0.004]
NYC Pause	-0.385*	0.082]	-0.537*	0.062]	-0.404**	[-0.705,-0.103]	-0.400**	[-0.700,-0.099]
Social Unrest following Floyd	0.118	[-0.275,0.511]	0.130	[-0.258, 0.519]	0.032	[-0.868,0.932]	0.128	[-0.265, 0.520]
Second Wave Indoor Dinning								
Restrictions	-0.029	[-0.308, 0.250]	-0.047	[-0.319, 0.224]	-0.048	[-0.320, 0.223]	-0.022	[-0.509,0.466]
Contemporaneous Assault Rate	0.329***	[0.256,0.401] [-0.069,-	0.318***	[0.246,0.389] [-0.070,-	0.321***	[0.249,0.392]	0.323***	[0.251,0.394]
Arrest Rate	-0.036*	0.003]	-0.036*	0.003]	-0.036*	[-0.069,-0.004]	-0.036*	[-0.069,-0.003]
Daily Temperature	0.008*	[0.001,0.014]	0.008*	[0.001,0.014]	0.008*	[0.001,0.014]	0.008*	[0.001,0.014]
COVID-19 Cases (Reference =								
Manhattan)	_	_						
COVID-19 Cases # Bronx	0.002	[-0.007, 0.012]						
COVID-19 Cases # Brooklyn	-0.003	[-0.012, 0.007]						
COVID-19 Cases # Queens	-0.004	[-0.014,0.007]						
COVID-19 Cases # Staten Island	0.000	[-0.012, 0.012]						
NYC Pause = 1 (Reference = Manhattan)			_	-				
NYC Pause = 1 # Bronx			0.070	[-0.494,0.634]				
NYC Pause = 1 # Brooklyn			0.112	[-0.379,0.603]				
NYC Pause = 1 # Queens			0.235	[-0.435,0.905]				
NYC Pause = 1 # Staten Island			0.692	[-0.546,1.931]				
Social Unrest following Floyd = 1 (Referen Manhattan)	nce =				_	_		
Social Unrest following Floyd = 1 $\#$								
Bronx					0.046	[-1.044, 1.136]		
Social Unrest following Floyd = 1 $\#$								
Brooklyn					0.369	[-0.548, 1.287]		
Social Unrest following Floyd = 1 $\#$								
Queens					-0.053	[-1.252, 1.146]		
Social Unrest following Floyd = 1 $\#$						[-14.850,-		
Staten Island					-13.814***	12.777]		
Indoor Dinning Restrictions = 1								
(Reference = Manhattan)							-	-
Indoor Dinning Restrictions $= 1 \#$ Bronx							0.192	[-0.375,0.758]
Indoor Dinning Restrictions = 1 $\#$								
Brooklyn							-0.192	[-0.690,0.307]
Indoor Dinning Restrictions = 1 $\#$								
Queens							-0.079	[-0.746,0.588]
Indoor Dinning Restrictions = 1 # Staten								F 4 400 4 44
Island							-0.158	[-1.432,1.115]

Note: Model includes day-of-week, month- and year-effects as well as robust standard errors to account for heteroskedasticity. \*p < .05, \*\*p < .01, \*\*\*p < .001 (two-tailed test).

binomial regression. Here, the unit of analysis is the borough-day. A total of four models were estimated in which interactions between borough indicators and each independent variable were included. Results shown in Model 1 of Table 3 suggest that the association between daily COVID-19 cases and the count of shootings observed was unlikely to vary between the five boroughs of NYC as denoted by the nonsignificant coefficients for each of the interaction effects. Similar results were observed for the NYS Pause stay-at-home order where a significant negative effect was observed and there was no evidence of heterogeneity in the effect across boroughs. However, the results of the third model suggest that the unrest following George Floyd's murder were less likely to result in shootings within Staten Island as compared to Manhattan (the reference category). These results were confirmed using an analysis of marginal effects, where the second derivative of the association between the period of social unrest was compared across boroughs (Mize, 2019). Results of this ancillary analysis suggest that this period was associated with a sizeable decline in shootings within Staten Island, but increases in each of the other boroughs, with significant differences between Staten Island and Brooklyn, the Bronx, and

Manhattan.<sup>2</sup> Finally, no differences in the association between the second wave of indoor dinning restrictions and the incidence of shootings were observed. Overall, with the exception of the protests surrounding the murder of George Floyd, there is relatively little evidence that the effects of the factors explored differentially impacted the incidence of shootings across the boroughs on NYC. It is important to bear in mind that these borough-specific associations were independent of other variables, including the arrest rate, daily temperature, and the contemporaneous assault rate.

Much like the previous table, Table 4 presents our results related to the incidence of assault across the five boroughs of NYC. Similar to the results presented for shootings, the association between assault and the rate of COVID-19 cases did not differ between boroughs as indicated by the non-significant interaction terms shown in model 1. Importantly, however, the results related to the NYS Pause stay-at-home order shown in model 2 suggest that while the lockdown order was negatively associated with assault in Manhattan, this reduction was unequally felt across the other four boroughs. More specifically, the stay-at-home order had much smaller negative effects across each of the remaining

<sup>&</sup>lt;sup>2</sup> The method utilized examines the second derivatives in the predicted probabilities obtained from the regression models presented. Here the borough-specific effects (i.e. first derivatives) are compared to assess whether they differ from one another. For more information see Mize et al., 2019.

#### Table 4

Borough-specific associations between key measures and assault in NYC

	COVID-19 Cases		NYS Pause		Floyd Social Unrest		Indoor Dinning Restrictions	
	b	95% CI	b	95% CI	b	95% CI	b	95% CI
COVID-19 Rate (per 100 k)	-0.001*	[-0.003,- 0.0005]	-0.001***	[-0.002,-0.001]	-0.001***	[-0.002,- 0.000] [-0.225 -	-0.001***	[-0.002,- 0.001] [-0.223 -
NYC Pause	-0.186***	[-0.224,-0.149]	-0.323***	[-0.385,-0.261]	$-0.188^{***}$	0.151]	-0.185***	0.148]
Social Unrest following Floyd	0.035	[-0.029,0.098]	0.031	[-0.028,0.091]	-0.118	[-0.286,0.049]	0.034	[-0.029,0.097]
Second Wave Indoor Dinning						[-0.100,-		[-0.162,-
Restrictions	-0.050*	[-0.098,-0.002]	-0.042	[-0.089,0.004]	-0.053*	0.007]	-0.100**	0.038]
Contemporaneous Shooting Rate (per								
100 k)	0.238***	[0.187,0.289]	0.239***	[0.188,0.290]	0.238***	[0.187,0.290]	0.238***	[0.187,0.289]
Contemporaneous Arrest Rate (per								
100 k)	0.028***	[0.023,0.032]	0.028***	[0.024,0.031]	0.028***	[0.024,0.032]	0.027***	[0.023,0.032]
Daily Temperature	0.005***	[0.005,0.006]	0.005***	[0.005,0.006]	0.005***	[0.005,0.006]	0.005***	[0.005,0.006]
Lagged Assault	0.002***	[0.001,0.002]	0.002***	[0.001,0.002]	0.002***	[0.001,0.002]	0.002***	[0.001,0.002]
COVID-19 Cases (Reference =								
Manhattan)	-	-						
COVID-19 Cases # Bronx	0.001	[-0.000, 0.002]						
COVID-19 Cases # Brooklyn	0.000	[-0.001, 0.001]						
COVID-19 Cases # Queens	-0.000	[-0.002, 0.001]						
COVID-19 Cases # Staten Island	-0.000	[-0.002, 0.001]						
NYC Pause = 1 (Reference =								
Manhattan)			-	-				
NYC Pause $= 1 $ # Bronx			0.241***	[0.168,0.314]				
NYC Pause = $1 \#$ Brooklyn			0.145***	[0.069,0.220]				
NYC Pause $= 1 \#$ Queens			0.152***	[0.076,0.228]				
NYC Pause = 1 # Staten Island			0.127*	[0.005,0.250]				
Social Unrest following $Floyd = 1$ (Refe	erence =							
Manhattan)					-	-		
Social Unrest following Floyd = 1 $\#$								
Bronx					0.247**	[0.065,0.428]		
Social Unrest following Floyd = 1 $\#$								
Brooklyn					0.175	[-0.009,0.359]		
Social Unrest following Floyd = 1 $\#$								
Queens					0.152	[-0.050,0.354]		
Social Unrest following Floyd = 1 $\#$								
Staten Island					0.155	[-0.139,0.448]		
Indoor Dinning Restrictions $= 1$								
(Reference = Manhattan)							-	-
Indoor Dinning Restrictions = 1 $\#$								
Bronx							0.117**	[0.029,0.206]
Indoor Dinning Restrictions = 1 $\#$								
Brooklyn							0.053	[-0.035, 0.140]
Indoor Dinning Restrictions = 1 $\#$								
Queens							0.013	[-0.077,0.103]
Indoor Dinning Restrictions = 1 $\#$								
Staten Island							-0.006	[-0.149, 0.138]

Note: Model includes day-of-week, month- and year-effects as well as robust standard errors to account for heteroskedasticity. \*p < .05, \*\*p < .01, \*\*\*p < .001 (two-tailed test).

boroughs. For example, to obtain the estimate of the effect in the Bronx one would take the coefficient obtained for the reference category and add it to the estimate obtained for the Bronx (-0.323 + 0.241 = -0.082). So, while still negative, the association between NYS Pause and incidence of assault in the Bronx was of a significantly smaller magnitude than in Manhattan. These borough-specific associations can be seen in Fig. 2 and suggest that much of the negative association between NYS pause and the incidence of assault observed at the city level is likely driven by activity in Manhattan during this period, although the observed association is also negative across each of the geographies examined.

Similar to the results associated with NYS Pause, the findings presented in the third model of Table 4 suggest that the increases in assault observed during the period of social unrest were likely driven by events in the Bronx, where there was evidence of a larger increase in assault during this period (shown in Fig. 3). The marginal effects analysis suggests the effect observed in the Bronx was significantly larger than in Manhattan, as well as Staten Island. Finally, while the second wave of indoor dining restrictions was negatively associated with assault in Manhattan (and did not differ significantly in Brooklyn, Queens and Staten Island) this period was actually associated with a small increase in assault in the Bronx (shown in Fig. 4) suggesting some variation in this effect between boroughs as the pandemic dragged on. In short, the Bronx seemed to be experiencing assault in some unique ways compared to other boroughs in these analyses.<sup>3</sup>

## 3.3. Sensitivity analyses

Next, we conducted several sensitivity analyses to enhance the confidence in the findings presented above. Certainly, the pandemic encouraged an onslaught of out-migration of residents from NYC (among those with access and resources to do so). In that respect, we included an estimate in the change in ambient population by leveraging

<sup>&</sup>lt;sup>3</sup> Of the five counties that comprise NYC, the Bronx has the highest rates of family poverty and unemployment and the lowest levels of education and median family income. This heighted level of disadvantage has been shown to be related to rates of violence within much of macro-level research on crime and delinquency, and highlights the importance of examining these trends at the borough-level.



#### Borough-Specific Association between NYS Pause and Assault Counts

Fig. 2. Borough-Specific Association between NYS Pause and Incidence of Assault between January 1, 2020 and September 30, 2021.



Following George Floyd's Murder

Fig. 3. Borough-Specific Association between Social Unrest and Incidence of Assault between January 1, 2020 and September 30, 2021.

data from the Metro Transit Authority (MTA) on changes in ridership across several service types in NYC. These data (available from March, 1, 2020 until the present day) included an estimate of daily changes in ridership from the pre-pandemic period and include estimates of subway and bus usage, the Long Island Rail Road and Metro-North commuter train usage, as well as Access-A-Ride calls and traffic estimates on bridges and tunnels. The sensitivity analysis used the average of the daily estimates across transportation means (which are a proportion of that day's travel compared to the pre-pandemic period). All days prior to the pandemic were coded as 1 (100% of the pre-pandemic travel level). Importantly, this measure was highly correlated (r = 0.602) with the daily positive COVID case count, meaning that including this sensitivity measure of daily travel in addition to other independent variables would lead to instability in the results. As such, we performed two additional sensitivity tests. First, we substituted the daily COVID case count measure with the measure of change in ridership, and for the second test, we computed an index of the measure of change in ridership and daily positive COVID case count measure (first reversing the measure of ridership), standardizing both measures, and adding them together. For this composite measure, higher values correspond to increased positive COVID case counts and lower levels of ridership. Results of these ancillary analyses are available in the supplemental materials provided



#### Borough-Specific Association between Indoor Dinning Restrictions and Assault

Fig. 4. Borough-Specific Association between Secondary Indoor Dining Restrictions and Incidence of Assault between January 1, 2020 and September 30, 2021.

alongside the focal results. Importantly, the results of our main focal variables (NYC Pause and the protests surrounding George Floyd's murder) did not change with the addition of the additional measures.

Additionally, we conducted further sensitivity analyses accounting for political changes, which, perhaps, could have impacted the violent outcomes explored herein. Specifically, ancillary models (results available upon request) included a measure of 1) results of the U.S. Presidential election, 2) the January 6th attack on the U.S. Capitol, and 3) President Biden's inauguration to assess their impact on the relationships observed. While a dichotomous indicator of President Biden's election victory had a significant negative association with shootings in NYC, it was unrelated to the incidence of assaults. Importantly, inclusion of each of these ancillary measures did not impact the results of the focal measures of the NYC Pause or the protests surrounding George Floyd's murder.

## 4. Discussion

Since the onset of the COVID-19 pandemic, criminologists have paid significant attention to changes in both the nature and frequency of criminal—especially violent—activity that has affected many parts of the United States. Further, the pandemic and its ensuing closings and reopenings have been linked to various types of criminal behavior in different ways across different cities and even variability within cities. Yet, it is also important to bear in mind that this global health crisis also collided with the murder of George Floyd, which was associated with a number of social and racial justice protests that have also been linked to some forms of antisocial behavior in many cities throughout the U.S. (and the rest of the world). Thus, studying changes in criminal behavior—as well as system response to these twin pandemics—cannot be divorced from one another (cf. Piquero, 2021).

Accordingly, the current study built off of a recent study in NYC by examining the effects of COVID-19 and associated lockdown measures (both initial restrictions and subsequent restrictions upon resurgence of positive COVID-19 cases) on the prevalence of two violent offenses (assaults and shootings) across NYC, while accounting for (1) the daily number of daily number of positive COVID-19 cases, (2) the daily count of NYPD arrests (to account for variation in law enforcement behavior), and (3) the social unrest and protests following the murder of George Floyd. Further, in recognition of the research documenting variability in criminal activity within cities during the pandemic (e.g., Campedelli et al., 2020) we considered borough-specific associations, which offers some further insight into the nature and patterning of violence within NYC through September 2021. Our study generated a number of findings.

First, in considering the extent of positive COVID-19 cases to advance from prior work, we found that the average daily COVID-19 case count had a significant negative association with shooting incidents vet was unrelated to assaults. Related to lockdown restrictions, while the first stay-at-home order of all non-essential workers was negatively associated with both shootings and assaults, the restrictions on indoor dining and dining capacity restrictions that occurred in late 2020 as a result of the COVID surge were associated with fewer shootings, but unrelated to assaults. Second, and consistent with prior work examining NYC felony assaults (Koppel et al., 2022), and violence generally (e.g., Anderson, 1987; Tiihonen et al., 2017), increases in daily temperature were associated with increases in shootings and assaults. Third, both shootings and assaults increased in the aftermath of the murder of George Floyd and the social and racial justice protests that followed. Fourth, when examining differences across the five boroughs, we observed that the effects of both daily COVID-19 case counts and the NYS Pause stay-at-home order on shootings was "universal" (a negative association) across boroughs. Alternatively, the unrest following George Floyd's murder resulted in a sizeable decline in shootings in Staten Island, while the period brought increased shootings to all other boroughs. Together, these findings demonstrate relative consistency across boroughs in factors related to changes in shootings, with the exception of the George Floyd protest period, in which the decrease in Staten Island shootings were unique.

With respect to assaults, we find many more relative differences across boroughs. Universally, COVID case counts resulted in decreased incidents of assault across boroughs (and no differences between boroughs). However, the NYS Pause stay-at-home order decreased assaults in Manhattan, but had much more negligible impact across the other four boroughs, demonstrating the overall citywide effect of decreased assaults brought on by stay-at-home order was driven predominately by Manhattan. Further, it was only in Manhattan where the later indoor dining restrictions evidenced decreases in assaults. Additionally, we found the increases in assault incidents during the social unrest following the killing of George Floyd was driven by the Bronx, which evidenced salient increases over the time period examined.

Together, the shooting and assault comparisons across boroughs, while yielding several similarities, demonstrate the need for caution in examining city level effects when exploring the impact of COVID-related restrictions (and periods of social unrest) on violence. Citywide crime and violence statistics may mask contextual differences that exist within geographically smaller, and contextually dissimilar, areas, as was the case for what we detected in Manhattan and especially the Bronx which points to the importance of examining even further variability within the borough to examine locale-specific patterning (see also Kim, 2022). In sum, the extent to which associations between lockdown restrictions and social unrest with offending and violence differ across -and potentially within - areas with dissimilar socioeconomic, political, resource availability, racial/ethnic, relationships between citizens and police, and immigrant concentration conditions is essential to further our understanding of how violence waxed and waned within cities throughout the pandemic period.<sup>4</sup>

While the effects of the initial NYC Pause were near universal across boroughs (decreased shootings), the unrest following George Floyd's murder was associated with increased shootings across four of the five boroughs, while Staten Island had a sizeable decline. The public healthrelated government restrictions (the NYC Pause) had universal effects, while for the effects of social and racial unrest post-Floyd's murder, location matters. Similarly, increasing positive COVID-19 cases decreased assaults across boroughs, yet only Manhattan had decreased assaults after the initial NYC Pause and the later indoor dining restrictions. Further, the Bronx seemed to drive the NYC increase in assaults following the killing of George Floyd. In short, while understanding the similarities and differences across boroughs in the effect of government restrictions predicated on public health and of civil unrest in response to police brutality can help guide future policies, public health, and intervention efforts, additional work is needed to uncover the specific aspects within boroughs that may be driving the differences found (socioeconomics, racial/ethnic composition, distrust of the government, political affiliation, etc.).

Several limitations should be noted in the current study, including the data emanating from open data portals (Marteache, Bichler, & Fujita, 2021). As is true of much of the work surrounding in this general area of research, our use of shooting incidents, daily count of NYPD arrests, and daily COVID-19 positive case counts were all garnered from open data portals. Further, while assaults and shootings are clearly policy-relevant and important indicators of the extent of violence, future study should expand to examining additional crime types. In keeping with routine activities theory (Cohen & Felson, 1979), there were reports at the beginning of the initial COVID-19-related lockdown and stay-at-home orders of a rapid rise in NYC theft and break-ins of businesses and restaurants as fewer capable guardians were present to deter those (motivated offenders due to lost wages) attempting to steal valuable commodities (suitable targets; Esposito & King, 2021).

Notably, the current study focused exclusively on two of the most

common forms of serious violence: assaults and shootings. The focus on all shooting incidents (rather than just those that resulted in death) is consistent with the realization that intentional gun violence is a serious threat to public health which should be monitored and addressed (Cochran & Worden, 2022; Ritter, 2009). Additional outcomes/types of offending, while explored in prior work (e.g., Rosenfeld & Lopez, 2022) would benefit from additional analyses with considerations similar to the current study (positive daily COVID-19 case counts, ambient temperature, the murder of George Floyd and the unrest that followed) in addition to governmental restrictions. Additionally, with the historic 30% increase in homicides in President Trump's final year during 2020 (CDC, 2021b), the continued increase thereafter, and the longstanding uniqueness of gun crimes in the United States compared to other developed countries (Zimring & Hawkins, 1997), it was pertinent to bring our methodological advancements to the study of shootings.

## 5. Conclusion

Positive daily COVID-19 case counts, initial and subsequent lockdown restrictions, and daily temperature affected violence in NYC. While researchers continue to uncover impacts of the public health emergency and related restrictions brought on by the pandemic, including on crime on violence, the gravity and size of the social unrest following the killing of George Floyd must be considered in tandem to elucidate the drivers of such changes (see Piquero, 2021). The current study demonstrates many consistent impacts of both pandemic-related factors and governmental policies and impacts of extensive social unrest in NYC, yet illuminates differences across boroughs, showing violence in some boroughs is at times contradictory to the overall citywide trends and that changes in a single borough may be driving changes in city level trends. It is essential that we continue to explore contextual factors underlying changes in violent incidents related to governmental policies and social responses to governmental actions deemed unjust and immoral to better understand the impact of such phenomena and better inform policy-makers of potential unintended consequences. As well, a more qualitative examination of what was happening within certain areas that witnessed both increases and decreases in certain types of criminal behavior will be especially illuminating and welcomed as researchers continue to document how crime and criminals responded to the twin-pandemics of the 2020 time period—and beyond.

And it goes without saying, that a thorough understanding of the unintended consequences of the coronavirus pandemic on the criminal justice system and those involved within it is something that remains largely absent from the research literature. Yet, it is also the case that not a single part of the system was prepared for the virus and how it affected policing (e.g., lack of PPE, vaccine hesitancy, COVID-19 responsible for over two-thirds of all deaths in 2020 and 2021), the courts (e.g., trials stopped, virtual processes, backlog of cases), and corrections (e.g., viral spreading, hospitalizations and deaths, early releases). And while some lessons and playbooks have emerged from these experiences (see Piquero, 2021), the onset of COVID-19 and the George Floyd murder brought to the fore the interlocking of public health, social, and racial justice like never before. Recognition of these issues is one thing but doing something about them is another. It remains critical that, going forward, the health and justice systems need to be fully prepared and ready for the next pandemic or world-wide event, this includes dedication to shared interests as well as collective behavior, the reduction of gross disparities, increases in programs aimed at promoting public welfare, and reforms aimed at increasing accountability for those who misuse their power.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jcrimjus.2022.101929.

<sup>&</sup>lt;sup>4</sup> It is important to realize the heterogeneity across boroughs and the extent to which they are in many ways vastly different. For example, the total population varies from a low of 475,596 in Richmond County (Staten Island) to 2,576,771 (nearly 5.5 times larger) for Kings County (Brooklyn). Similarly, the population of Staten Island is 9.2% non-Latino Black, while Brooklyn has the largest proportion of non-Latino Blacks at 29.3%. The largest proportion of Latinos reside in the Bronx (56% of the Bronx), compared to less than 19% of the populations of Staten Island and Brooklyn, while Queens has the largest proportion of foreign born (47%). Related to socioeconomics, the Bronx has the lowest proportion with a bachelor's degree (12.9%), highest proportion living in poverty (23%, nearly 3 times higher than the 8.6% in Staten Island), highest unemployment rate (10%), and lowest median household income (under \$42,000, compared to nearly 90,000 in Manhattan).

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