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EFFECT OF COVID-19 ON THE VEHICLE ACCIDENT SEVERITY: A CASE STUDY NEW YORK CITY

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M.Sc.THESIS

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Approval

We certify that we have read the thesis submitted by **Abdikarim Abubakar IBRAHIM** titled **"EFFECT OF COVID-19 ON THE VEHICLE ACCIDENT SEVERITY: A CASE STUDY NEW YORK CITY"** and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Educational Sciences.

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Declaration

I hereby declare that all of the information, documents, analysis, and results in this thesis have been collected and presented in accordance with the academic and ethical rules of the Near East University Institute of Graduate Studies. I also admit that, as per these rules and conduct requirements, I have granted complete references and citations for all information and data that wasn't produced for this study.

Abdikarim Abubakar IBRAHIM

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ABSTRACT

EFFECT OF COVID-19 ON THE VEHICLE-VEHICLE ACCIDENT SEVERITY: A CASE STUDY NEW YORK CITY

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According to the WHO, traffic-related fatalities rate as the eighth-leading reason for death world and are especially common among children and young adults (ages 5 to 29). A large number of these deaths are people who were walking, riding bikes, or driving motorcycles.

The covid-19 pandemic had a big effect on the severity of accidents, with a decrease in overall accidents due to reduced traffic levels and travel restrictions. However, there was also the possibility that the severity of accidents may have increased due to changes in driving behavior and conditions such as stress, anxiety, or distractions related to the pandemic. The main goal of this research is to examine the effect of covid-19 on the overall vehicle accident severity in New York City (NYC). Our data was obtained from a police record in New York City, and we arranged the Microsoft Excel tool to analyze traffic accidents under three different circumstances; before Covid-19, during Covid-19, and after Covid-19.

The results obtained show that the fatality number increased during covid-19 while the injury was decreased. Before the covid-19, in 2018 the fatality number was 19.26%, while in 2019 rose to 20.6%. The outbreak of the covid-19 in 2020 resulted in an increase in the fatality to 22.25% and 23.35% in 2021. The end of Covid-19 shows a reduction in fatality to 14.5%.

Keywords: Traffic Collision, Accident severity, pandemic, Covid-19, Over Speeding, Vehicle Accidents, fatality, Injury.

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List of Abbreviations

WHO: World Health Organization

RTAs: Road Traffic Accidents

NSC: National Safety Council

NHTSA: Analysis of National Highway Traffic Safety Administration

FARS: Fatality Analysis Reporting System

STRADA: Statistical Road Accident Data Analysis

RLR: Red Light Running

MVCs: Motor Vehicle Collisions

TAMS: Traffic Accident Management System

NYC: New York City

CFR: Case Fatality Rate

CHAPTER I
Introduction

1.0 Background

According to the WHO, produces a new edition of the Global Status Report on Roads every year. This report includes updated data about road traffic fatality, both globally and country. With an estimated 1.35 million traffic fatalities annually, these numbers continue to be extremely high. This amounts to nearly 3,700 individuals dying on roadways every day. Along with these fatalities, vehicle accidents cause an estimated 50 million injuries or disabilities each year (WHO, 2018).

Traffic-related deaths are the eighth-highest cause of mortality globally and the leading cause of death for children and young people, according to the WHO (ages 5 to 29). A large number of these deaths are people who were walking, riding bikes, or driving motorcycles.

According to WHO (2020) says that most traffic deaths around the world happen to vulnerable road users like cyclists, motorcyclists, and pedestrians. People between the ages of 5 and 29 die most often from injuries they get in car accidents around the world. Many countries are putting in place laws and rules about speeding and driving while drunk, building safer cars, and evaluating and improving their road infrastructure to make driving safer.

According to Lord and Washington (2018), it is extremely difficult to maintain high mobility while also improving traffic safety. This is because many accidents are user-related. When making a transportation network, you have to think about more than just safety. You have to think about things like efficient throughput, traffic, different kinds of users, and connecting different kinds of transportation.

The following human factors increase the likelihood of an accident occurring on the road: the driver's age, use of alcohol, use of a cell phone while driving, distraction

from billboards, and the health of the driver and pedestrians. Fog, ice rain, and rain are three weather conditions that have been linked to car accidents and will have a bigger effect on how often they happen (Mahmoodi Khaniabadi, Shadi, and et al. 2022).

Accident analysis based on road type and environmental exposure showed that bad weather was a major cause of road accidents (Martinez, Sebastian, Raul, and Patricia, 2019). The study found that the texture depth and skid resistance rating of the road surface have a bigger effect on how likely an accident is.

Population increase and technological advancements are responsible for the increase in the number of motor vehicles. Accidents are more likely to happen as mobility increases. Road users, cars, road conditions, road geometry, environmental factors, etc. are the fundamental components of traffic accidents. Road features including road width, a lack of super-elevation, a lack of site distance, the radius of a horizontal curve, etc. are the primary causes of traffic accidents. Although they cannot entirely be avoided, traffic engineering safety strategies and management methods can help to lower the accident rate. Common city roads nevertheless experience several issues, such as traffic congestion that waste valuable time, even after an accident.

1.1 Problem Statement of the Study

Transportation is just one of many socio - economic factors that the COVID-19 outbreak has had a big influence on. One potential effect of the pandemic on vehicle accident severity is that there may be fewer accidents overall due to reduced traffic levels and travel restrictions. However, there is also the possibility that the severity of accidents may increase due to changes in speed. Therefore, the main goal of this study is to investigate the impact of Covid-19 on vehicle collisions.

1.2 Aim of the Study

The aim of a study on the effect of COVID-19 on vehicle accident severity would be to examine how the pandemic has impacted the severity of accidents involving vehicles.

1.2.1 Objectives of the study

The objective of this research is to establish how covid-19 affects the severity of vehicle accidents.

- To analyze accident severity before covid-19, During Covid-19 and after covid-19.
- To determine how the incidence, severity, and type of crash involvement varies between vehicle accidents.
- To calculate severity indices of vehicle accidents at different Locations in New York.
- To examine the impact of COVID-19 on the severity of vehicle accidents, by collecting and analyzing data on accident rates and severity before, during and the post the COVID-19 epidemic

1.3 Research Question

1. What is the impact of COVID-19 on the severity of vehicle accidents in New York City?
2. How do the incidence, severity, and type of crash involvement vary between vehicle accidents; before, during, and after the COVID-19 pandemic in New York City?

1.4 Significance of the Study

The significance of this study lies in the examination of the impact of COVID-19 pandemic on the vehicle accident severity in New York City. The study will provide valuable insights into how the pandemic has affected the number and severity of accidents involving vehicles. The research will help to identify the potential factors that may have contributed to changes the accident severity during the pandemic, including changes in driving behavior, changes in the types of vehicles on the road, changes in infrastructure, changes in weather patterns, and the impact of public health measures.

The study will also provide important information on how the incidence, severity, and type of crash involvement vary between vehicle collisions. This information can help to

inform the development of safety measures and policies to reduce the number and severity of accidents in New York City.

1.5 Scope of the Study

The purpose of this study is to determine how the COVID-19 outbreak has affected the incidence of vehicle accidents in New York. The research will focus on analyzing accident severity before, during, and after the pandemic, and determining how the incidence, severity, and type of crash involvement vary between vehicle collisions. The study will also calculate severity indices of vehicle collisions at different locations in New York City to understand the variation in accident severity across the city. This study will examine the impact of COVID-19 on severity of the vehicle accidents by collecting and analyzing data on accident rates and severity before, during, and after the pandemic. The research will also identify potential factors that may have contributed to changes in accident severity during the COVID-19 pandemic, including changes in driving behavior, changes in the types of vehicles on the road, changes in infrastructure, changes in weather patterns, and the impact of public health measures. The study will be limited to the New York City area and the time frame of the pandemic.

1.6 Limitation of the Study

The study on the effect of COVID-19 on vehicle accident severity in New York City may be limited by several factors, including the data availability, data accuracy, temporality, sample size, external factors, causality and data analysis. The availability of data on vehicle accidents in New York City may be limited, which can affect the scope and completeness of the study. Additionally, the accuracy of the data may be a concern and may affect the validity of the findings. The study will also be limited by its temporal scope, only being able to analyze data from specific time periods during the pandemic, before and after, which may not capture the full extent of the impact. As a small number of participants may not be representative of the population and may not be generalizable to other regions or historical periods, it could simply be a limitation. External factors such as changes in weather patterns, road conditions, or infrastructure may also affect

accident severity and may not be fully captured by the data. The study will also be limited by the ability to establish causality between the impact of COVID-19 and the accident severity, as it will be based on observational data. The methods used for data analysis may also affect the interpretation of the results.

CHAPTER II
Literature Review

2.0 Introduction

This chapter discusses the impact of Covid-19 on traffic collisions, models used to study accident severity, factors that influence the severity of vehicle collisions, and an analysis of the Covid-19 lockdown in New York.

2.1 Concepts about Road Accident

Road accidents are defined as collisions between two or more vehicles, collisions with external objects, or vehicle skidding that result in fatalities or serious injuries and potentially lead to third-party claims. Road traffic accidents can also be described as incidents or mistakes involving cars, vehicles, pedestrians, animals, road debris, or other obstructions like poles, buildings, or trees. Accidental losses can be measured mainly in terms of money, resources, injuries, or fatalities. The most important thing is human life, so we should prioritize safety over wealth.

There are many things that can cause accidents on the road. A variety of variables can be taken into account, including the weather, pedestrians, the driver's experience (including age), the vehicle's condition (including kind, number of wheels, size, age, and speed), the travel day, volume of traffic, state of the road, amount of light, and the location (urban, rural, or junction). Varied elements will have different effects on the accident, particularly for tasks that require predicting accidents. Accidents on the road can be caused by things called "traffic attributes." The driver is the main person who can prevent or deal with an accident. As a way or tool to help the driver, analyzing the situation and warning about possible outcomes (like traffic accidents) may be helpful. As a secondary actor, traffic offices can also keep track of vehicles that are likely to cause traffic accidents in real time. (Andeta 2021).

2.1.1 Accident severity:

Accident Severity: is an important measure of road safety, as it reflects the harm or damage that is sustained in a collision or accident involving vehicles. In general, more severe accidents are associated with higher levels of injury and death, and can have significant economic and social impacts.

The intensity of the injury to the individual who has been affected the most determines whether an accident is classified as fatal, serious, slightly, or not injured.
An experienced investigator can compare the degree of damage and applicable crashworthiness (either between vehicles or vehicle to the barriers) to determine the severity of the accident; this process is referred to as performing a "crush analysis."

Table 1 classification of injury crash

Fatal injury crash	At least one person, either the driver or a passenger, died from injuries they got in the crash within 30 days.
Major injury crash	At least one person was hurt and taken to the hospital, but there were no deaths.
Minor injury crash	At least one person needed medical care, but there were no deaths or injuries that required a hospital stay.
Minimal injury crash	At least one person was hurt, but they didn't need medical care and no one else was hurt too badly.

2.2 Factors Influencing Accident Severity

There are a number of factors that can influence the severity of vehicle accidents, including the speed of the vehicles at the time of the collision, the size and weight of the vehicles, the type of vehicles involved (e.g. passenger cars, trucks, buses, motorcycles), and the form of the accident (e.g., head-on, rear-end, side-impact), over speeding, distracted driving, drinking alcohol, red light jumping, weather condition, road condition, vehicle defects, road users.

2.2.1 Over speeding

The impact of excessive speeding on vehicles, highways, and drivers is investigated. A driver who is moving too quickly will have less time to react to a hazardous situation and prevent an accident. Additionally, it makes it more difficult for road safety devices such as guardrails, concrete walls, impact attenuators, crash cushions, median chambers, and median dividers to effectively protect drivers and passengers from harm in an accident.

In 2020, speeding was the cause of 29% of all traffic deaths, or 11,258 deaths. This is an average of over 30 deaths per day. Speeding is a factor in an accident if the driver was accused of a violation related to speeding as a result of running, exceeding the posted speed limit or driving fast for road conditions.

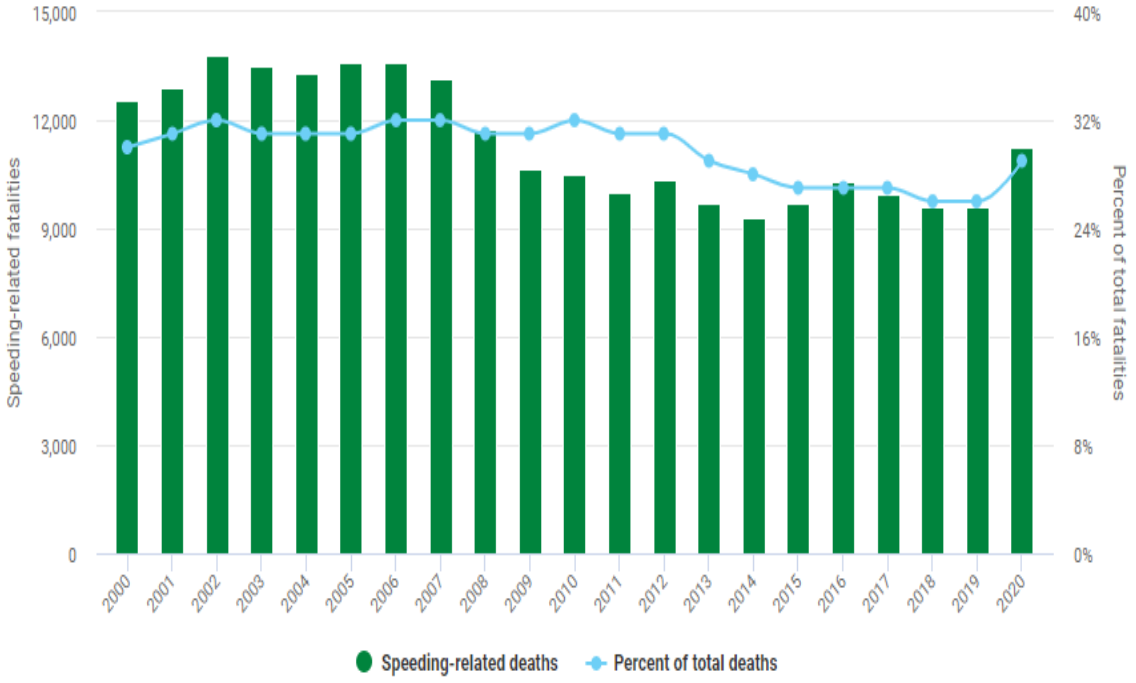


Figure.1 (National Safety Council (NSC), Analysis of the Fatality Analysis Reporting System (FARS) data from the National Highway Traffic Safety Administration (NHTSA), 2020).

Drowns: Drowsiness happens when someone drives a car when they are too tired or sleepy to stay awake. This makes the driver less aware of what is going on around them. Drowsy driving is a big problem that puts not only the driver but also everyone else on the road in danger. Affects in a bad way many of the mental skills that are needed for safe driving. When a person is tired or drowsy, their coordination, reaction time, ability to focus, judgment, and memory are all affected. So, drivers who are tired may not be able to pay attention or stop or turn in time to avoid a crash. It is dangerous to drive a car when you are tired or drowsy. It is thought that drivers who are too tired cause up to 100,000 accidents and 1,550 deaths each year (Feng et al. 2016).

2.2.2 Distracted driving

Distracted driving: is a condition in a car where the driver is doing his or her main job, which is driving or controlling the car, but also doing something else on purpose. It is one of the main causes of car accidents. Reaching, dialing, texting, and reaching for a cell phone are all considered as the major distractions for drivers. People also think that eating, drinking (non-alcoholic beverages), and looking at things on the side of the road are big distractions. With a probability value of 8.32, dialing a phone is the second riskiest action for novice drivers. This suggests that 8.32 accidents or close calls occur for every normal driving performance. Reaching for something other than the phone comes next rate ratio: 8.0, followed by reaching for the phone 7.05, and finally, looking at something on the other side of the road 7.05. Odds ratio of 5.00. (8.32 Ratio of Probability) (Percentage of return: 3.90) Reaching for an object while driving still ups the chance of a collision by 2.49 times, even among experienced drivers (Klauer, 2014).

2.2.3 Drunk driving Alcohol

Traveling or being in transportation while intoxicated or under the influence of drugs is another factor that puts you in danger. Figure 2 depicts the increase in road accidents where the person who was injured was positively identified as having consumed alcohol at the time of the accident during the course of the pandemic, as per accident data from STRADA. The graph depicts the number of accidents caused by

drunk drivers in Stockholm, together with the modes of transportation they were utilizing before to (January 2018 to February 2020) and during the epidemic (March 2020- December 2020).

Figure.2 the percentage of people involved in car accidents who were drunk at the time of the accident

	Jan 2018-Feb 2020	Mar 2020-Dec 2020
Cycling	0,60%	1,17%
Walking	1,52%	1,39%
Moped	0,58%	0,00%
Car	0,05%	0,19%
Other	2,08%	6,56%
TOTAL	0,78%	1,02%

According to accident data, no documented traffic collisions involving alcohol have occurred for other forms of transportation. The overall percentage has climbed during the pandemic, as can be observed.

Car prices have increased four times more than they did prior to the pandemic. Alcohol use during the pandemic may have increased, especially among adults, as a result of lost jobs and potential depression, which may also be the cause of the rise in the number of cars. (Johansson, S., & Vasireddy, S. 2021).

2.2.4 Red Light jumping

Red light running is a major traffic infraction since it frequently leads to collisions at signalized intersections. Because of related speeds, forces, and collision directions, accidents involving red light violations may be catastrophic. Vehicles frequently pass across junctions without stopping for a traffic light. Most people who

run red lights do it to save time. The general consensus is that it's a waste of time and fuel to stop at a red light. Running a red light endangers both the lives of the person doing it and other motorists. When one driver does something, it inspires other motorists to follow suit, which ultimately causes chaos at intersections.

The red light running crashes happen when a car drives into an intersection after the light has turned red and hits one or more cars that have the right of the way (i.e., a green light). (Shaaban et al. 2021).

According to the National Highway Transportation Safety Administration, intersections account for more than 45% of accidents in the US (NHTSA; 2016).In urban centers, running a red light is the most common reason for crashes, though there are many various types.

2.2.5 Weather Condition

When it rains, snows, or ices, the roads become slippery. This makes it harder for tires to grip the road, which can cause cars to skid of the road or hit other vehicles. Weather-related accidents can also be triggered by fog, water levels, and wind speed. Weather has an impact on walking as an active mode of transportation. This means that extreme weather events like heat waves, storms, and heavy rain are happening more often. One of the most important environmental factors that lead to pedestrian accidents is the weather. (Vilaca, Silva, and Coelho, 2017) found that pedestrians are 77% less likely to get into an accident than cyclists when the weather is good.

Vehicle accidents in poor visibility are typically the result of a variety of complex circumstances, including issues relating to the driver, such as recognition mistakes, decision errors, performance errors, and others. Despite the fact that a decrease in vision affects driving, there is an indication showing that not all motorists are affected in the same way (Wu et al. 2018). Additionally, some genders are more likely than others to be involved in car accidents when it's dark and difficult to see. Due to their impacts on the severity of traffic accidents and injuries sustained in low-visibility

situations, environmental factors are also of exceptional importance. The weather has been mentioned as one of these aspects that need to be taken seriously. There is a wide body of research showing that the severity of collision injuries varies depending on the weather (Wang et al. 2022).

2.2.6 Road Condition

Road Condition has the impact of vehicle collisions such as: lack of maintenance roads, road type (one line, two lines), horizontal and vertical curvature, turning (Left and Right). Inadequately maintained roads make it more likely that a tire will blow out and make it harder for drivers to brake effectively.

2.3 Models used in the analysis of Accident Severity

Road accidents are among the major causes of injuries and fatalities globally, making them an important subject for research into the application of cutting-edge algorithms and approaches to evaluate, predict, and identify the primary causes of traffic accidents. This research on traffic accident prediction and evaluation aims to address the issue of providing tools to enhance the environment for safe mobility and, ultimately, save lives (Feng et al. 2016).

According to Taamneh et al. (2017), they used data, 5973 reports of traffic incidents that occurred in Dubai between 2008 and 2018, models (Decision tree, rule-based PART), and data to determine the most crucial factors for forecasting the intensity of accidents. The results demonstrate that the age, gender, country of origin, and the year of the accident have an effect on the accident's intensity.

In their 2016 study entitled "Conviction of the Most Important Factors for Forecasting the Severity of Road Traffic accidents," Castro and Kim look at artificial neural networks, Decision tree trees, and Bayesian networks. We used information from vehicle crashes in England during 2010 and 2012 to evaluate 451,462 traffic accidents. The findings show that using a sample of 81,690 data points, the Bayesian network

produced the model that was the most accurate. The degrees of lighting, the nature of the road, and the movement of individuals all have an effect on the accident.

Hashmienejad and Hasheminejad (2017) use a model to predict the seriousness of injuries received in vehicle crashes on both urban and rural roadways that incorporate artificial networks, algorithms, and pattern searches. Between 2008 and 2013, the Iranian police recorded 14,211 accidents both on rural and urban routes. The information given was made up of these accidents. Using a set of rules, a decision tree algorithm (ID3, CART, and C4.5) was produced. These trees plus a testing data set were then used to assess the efficacy of the proposed rules.

2.3.1 Conclusion

It might be argued that using multiple analytical techniques together produces the most conclusive results, strengthening the evaluation of the findings obtained (Park et al., 2016). Results obtained by combining a genetic algorithm with a rule system, a decision tree, and a rule system (Hashmienejad, 2017) or a bayesian network with a rule-based- based system (Castro and Kim, 2016) are more precise and dependable than results obtained by utilizing just one technique. The field of road traffic forecasting will have a wider range of recommended models and forecasts after the incorporation of multiple data sources, such as geographic data, information from traffic volume and statistics, information from video, sound, and text, as well as the sentiment from social media. This will improve the accuracy and precision of the analysis and forecasts, according to various authors. The rising unpredictability of the subject makes forecasting road accidents difficult and constrained because many characteristics of human personality and behavior cannot be perfectly recreated in the datasets, methods, and algorithms that are now accessible.

2.4 Effects of COVID-19 on Traffic Collisions

During the pandemic, many individuals in various nations stayed at home (Lu, Zhue, & Wang, 2020). Because more individuals stayed at home during the epidemic,

according to Qureshi et al. (2020), Missouri had decreased traffic. The number of trucks on the roadways, however, remained constant and occasionally increased slightly. Even though more people are shopping online instead of going to stores, the number of trucks has not gone down. Qureshi et al. (2020) also found that at the start of the pandemic, the total number of car accidents went down. But it was found that only small and medium-sized accidents went down. The number of accidents that killed or hurt people did not change. Qureshi et al. (2020) try to figure out why the number of deaths has stayed the same during the pandemic. One reason is that since the number of cars on the road has gone down and there has been less traffic, people can drive faster, which increases the chance of crashing and makes the crash worse. Qureshi et al. (2020) also think that during the pandemic, it's possible that more people were using drugs or alcohol while driving, which could be another reason. Vingilis et al. (2020) give a number of reasons why the number of traffic deaths and serious injuries has not gone down during the pandemic.

In Yasin, Y. J., Grivna, and Abu-Zidan, F. M. (2021), the researchers investigate how the COVID-19 pandemic impacts the frequency, trends, and severity of injuries in traffic accidents. According to reports, COVID-19 has a considerable impact on how serious the problem of road accidents is.

The COVID-19 pandemic, the researchers conclude, has resulted in a decline in the general number of traffic collisions. Also, Covid-19 makes it harder to move around when there are empty lines, lessens crowding, and speeds things up, which leads to injuries and deaths. During the COVID-19 lockdown, speed was the main cause of crashes that killed people.

In the study by Inada, Ashraf, and Campbell (2021), the researchers looked into how the COVID-19 lockdown measures affected fatal motor vehicle accidents in Japan that were caused by speeding violations. To examine data from the National Police Agency of Japan from January 2010 to February 2020, the authors employed a time-series design. While Japan was under lockdown for COVID-19, we forecasted the

amount of fatal MVCs that would occur every day between March and May 2020. The authors examined the estimated and actual monthly numbers of fatal MVCs caused by speed. They repeated this using the ratio of fatal MVCs caused by speed to those not caused by speed as the outcome variable. Researchers created the speeding violations that resulted in deadly MVCs during a portion of the lockdown, according to the analysis. People who use the roads and law enforcement officers need to know that drivers who stay on the road during a lockdown may be more likely to do things that lead to MVCs that kill people.

In Klauer, S. G., Guo, F., Simons-Morton, B. G., Ouimet, M. C., Lee, S. E., & Dingus, T. A. (2014). The goal of the researchers is to find out if there is a link between driving while distracted and the risk of car accidents for both new and experienced drivers. The authors used data from the Second National Highway Research Program's Naturalistic Driving Study. In this study, 3,500 drivers were selected as a sample, and their driving behaviors were observed over a period of several months using video cameras and other sensors installed in their vehicles, the study's results indicated that distracted driving was a highly significant predictor of the likelihood of car accidents for both inexperienced and experienced drivers. They also demonstrated that secondary activities that require drivers to divert their attention from the road in front of them, such as talking on the phone or texting, pose a serious risk of collisions and near-collisions, particularly for inexperienced drivers. The authors found that drivers who were visually or physically distracted were much more likely to get into a crash or almost get into a crash than drivers who weren’t distracted.

The authors of Barnes, S. R., Beland, L. P., Huh, and Kim (2020) concentrated on how the COVID-19 lockdown restrictions affected traffic accidents and mobility in Louisiana, USA. In order to examine how movement and traffic collisions altered during the lockdown towards how they had been before the lockdown, the authors collected data from the U.S. Department Of transportation, the Louisiana Transportation Department and Development, and Google Mobile Reports, among other sources. The

study’s results showed that during the COVID-19 lockdown in Louisiana, there was a big drop in both mobility and car accidents. The authors found that the decrease in mobility was more noticeable in cities than in rural areas and that traffic accidents went down more in places where there was more mobility before the lockdown.

In 2020, Vanlaar, W. G., Lyon, C., & Robertson, R. D., Woods-Fry, H., the primary research areas focus on how the COVID-19 epidemic has affected travel behavior and traffic safety. The authors used information from the surveying of Canadian drivers to compare which was before levels to variations in travel behaviors and attitudes about road safety. The study's conclusions indicate that the COVID-19 outbreak had a significant effect on Canadian travel behavior and road safety. According to the authors, the epidemic caused travel to decline and shift toward more local travel, with fewer long-distance excursions and a greater reliance on private vehicles. In addition, they discovered that during the epidemic, drivers expressed greater worries about road safety, placing a higher priority on their own security and reducing dangerous behaviors like speeding and driving under the influence. The study’s overall findings highlight the effects of the COVID-19 pandemic on travel behavior and traffic safety and a hint that the pandemic may have helped to reduce unsafe driving behaviors.

In Qureshi, A. I., Huang, W., Khan, S., Lobanova, I., Siddiq, F., Gomez, C. R., & Suri, M. F. K. (2020). In this study discussed the impact of mandated societal lockdowns on road traffic accidents. The number of traffic collisions during enforced lockdowns in various nations as compared to pre-lockdown levels was examined by the authors using information from the World Health Organization's Global Health Observation and the World Bank's World Development Indicators. According to the study's findings, mandatory societal lockdowns were linked to a sharp decline in the frequency of traffic accidents. The authors found that the reduction in accidents was particularly pronounced in countries with high levels of mobility prior to the lockdown and in countries with strict lockdown measures.

2.5 Analysis of COVID-19 lockdown in New York

One of the locations in the United States that has had the greatest rate of contagious disease transmission is New York City (NYC). The following table gives an overview of the time that passed during Covid-19 in New York City.

The epidemic caused by COVID-19 has had a huge influence not just on New York, but also on a great many other locations throughout the world. The lockdown measures that were adopted as a response to the pandemic, such as orders for people to stay at home and the closure of enterprises that were not essential, were aimed to preserve public health and restrict the spread of the virus. Although many people may find these precautions to be inconvenient and challenging, they are frequently required as a means of preventing the spread of infectious diseases.

Table 2 summarizing timeline in history of Covid-19 in New York City

11 January 2020	First COVID-19 death reported in China
21 January 2020	The first case of COVID-19 reported in the United States.
29 February 2020	The first COVID-19 death reported in the United States.
1 March 2020	The first COVID-19 case in the state of New York
March 12, 2020	Events with more than 500 people must be canceled or postponed
March 12, 2020	Broadway shuts down
March 14, 2020	First two COVID-19 deaths in NYS
March 16, 2020	NYC public schools are closed down
March 17, 2020	Bars and restaurants in NYC closed, except delivery
March 22, 2020	All non-essential employees must remain at home as the NYS on Pause Program begins.
March 28, 2020	Governor Cuomo stops all unnecessary construction projects in New York State
March 31, 2020	NYC exceeds 1,000 COVID-19 deaths

April 15, 2020	Gov. Cuomo mandates the use of face masks or covers in public areas
April 30, 2020	Governor Cuomo announces midnight to five in the morning subway closures in New York City.
May 23, 2020	Governor Cuomo approves social gatherings of no more than 10 people.
May 27, 2020	U.S. COVID-19 deaths pass 100,000
June 8, 2020	NYC's Phase 1 reopening has begun.
June 22, 2020	NYC's phase 2 reopening has started.
July 6, 2020	U.S. COVID-19 deaths surpass 130,000
July 6, 2020	Phase 3 of NYC's reopening begins without indoor dining
July 19, 2020	Phase 4 of NYC's reopening begins, excluding malls, museums, and indoor restaurants and bars.
July 24, 2020	NYC reports 227,517 COVID-19 cases and 22,934 deaths to date
September 2, 2020	NYC gyms reopen, while indoor group exercise and swimming pools remain closed.
September 9, 2020	NYC malls reopen with 50% of their original patronage and no indoor eating. With 25% of their original patronage, casinos reopen all around New York State.
September 29, 2020	Elementary students at NYC's public schools return to classes.
September 30, 2020	NYC's indoor dining is back, with a 25% availability restriction.
October 5, 2020	In NYC, there have been 252,000 COVID-19 incidences and 23,861 deaths.
November 19, 2020	NYC schools switch to all-remote

CHAPTER III
Methodology

3.0 Overview

The methodology for this study on the impact of COVID-19 on the severity of vehicle accidents is described in this chapter, along with the study region that was chosen. Data on a vehicle accident that happened before, during, and after the COVID-19 pandemic were collected and analyzed.

3.1 Case Study

New York City is the biggest city in the United States. It is in the state of New York. It is a center for business, entertainment, and the arts around the world, and it has many famous landmarks like; The Statue of Liberty, Times Square, and Central Park.
New York City is one of the most crowded places on Earth, with more than 8 million people living there. It is known for its many different kinds of people and its lively culture. Many different languages, cultures, and nationalities are spoken there.
The New York City Department of Transportation says that there were about 259,000 traffic accidents in the city in 2020. About 4,000 people were seriously hurt and 214 people died because of these accidents.

The most common causes of traffic accidents in New York City are driver error and failure to yield. Distracted driving, such as texting while driving, is also a significant contributor to traffic accidents in the city.
In an effort to reduce the city's traffic accident rate, the New York City Department of Transportation has implemented a number of initiatives, including improving infrastructure and engineering, educating the public about safe driving practices, and enforcing traffic laws. The city has also put into effect the Vision Zero plan of action, which aims to completely eradicate traffic fatalities and severe injuries in the city.

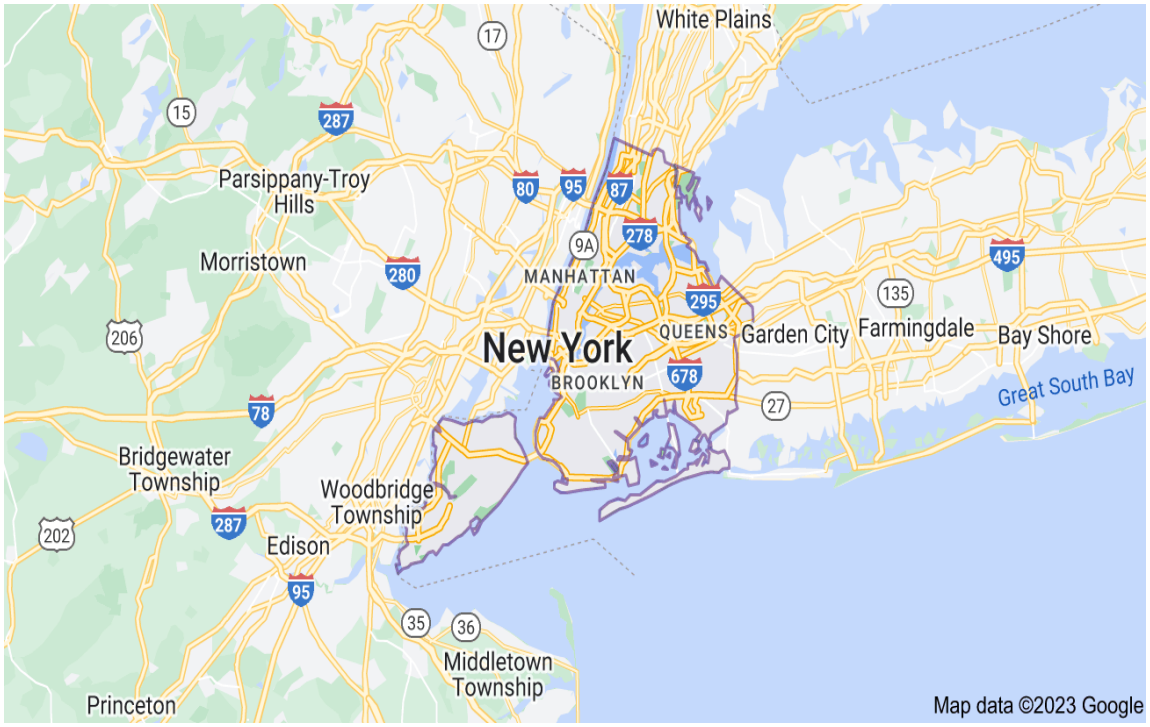


Figure.3 New York City Map

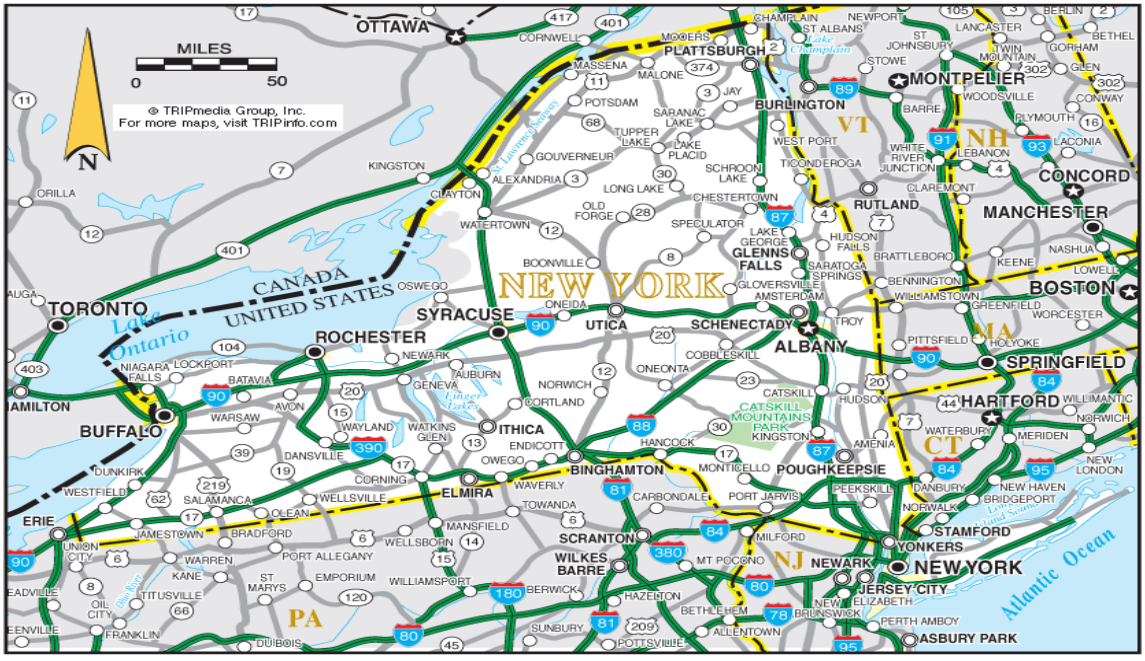


Figure.4 New York City Road map on Google

3.2 Research Design

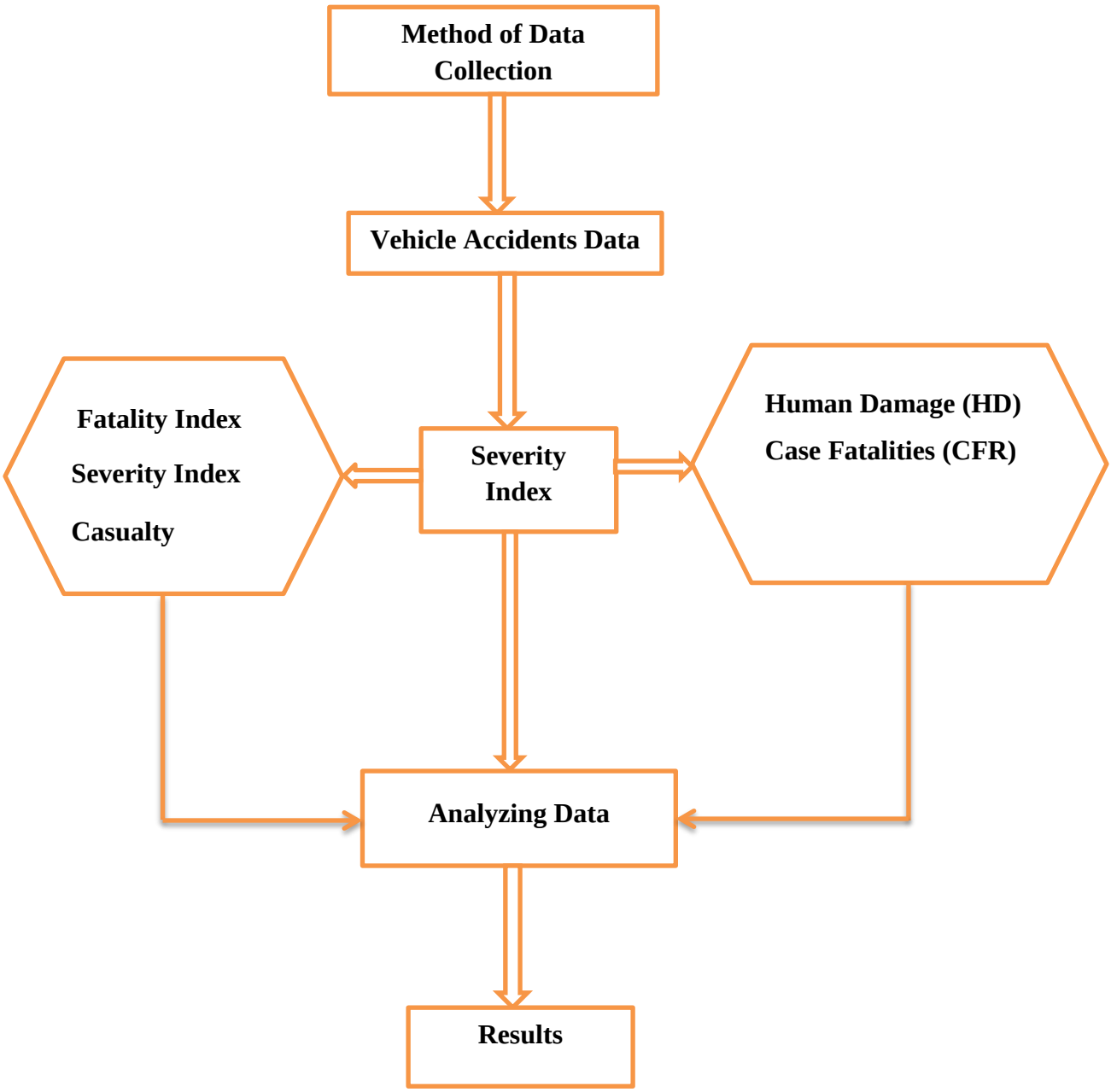


Figure.5 Flow chart of methodology

3.3 Data Collection

Data collection procedures will involve gathering and organizing the relevant data sources, and analyzing the data using severity indices formula to identify trends and patterns in accident severity. This will include examining the differences in severity between accidents that occurred during the COVID-19 pandemic and those that occurred in the pre-pandemic period, as well as exploring the potential relationships between accident severity and various COVID-19 related factors.

The Motor Vehicle Collisions crash table contains information regarding the crash incident. Each row represents a crash-related occurrence.

The data was duly opened from New York State open source database and organized excel tool by using severity indices formula to analyze vehicle accident data that occurred in New York City in the last five years.

Excel tool is a pre-programmed spreadsheet application that may be utilized by the user as a visualization tool for the purpose of organizing and editing data. Excel sheets give us the ability to carry out a diverse range of actions, such as calculating and modifying data. We are able to convert the raw data into 2-D and 3-D visualization figures with the assistance of the Charts tool in Excel. One of Excel's best features is that it can be used as a database tool. This lets us use Excel as backend support for a wide range of applications (Jeleel Adekunle, 2010).

3.4 Assessment of accident severity

Severity indices are used to measure the severity of traffic collisions and the resulting injuries or damages. There are several different severity indices that can be used, depending on the specific information that is available and the goals of analysis.

The Injury Severity Score (ISS), commonly known as the severity index, is used to evaluate the severity of the injury suffered by those involved in a traffic collision. The ISS is calculated based on the Abbreviated Injury Scale (AIS) ratings for each body region that has been injured. A higher ISS indicates a more severe injury.

The Fatality Analysis Reporting System (FARS), used by the National Highway Traffic Safety Administration (NHTSA) in the United States to evaluate the circumstances involving fatal traffic incidents, is another illustration of a severity index. FARS collects information on the factors contributing to the collision, such as the type of vehicles involved, the road and weather conditions, and the actions of the drivers.

Severity indices can be useful for identifying trends and patterns in traffic collisions, and for developing strategies to prevent or reduce the severity of future collisions.

Each accident was classified according to its severity by the analysis into one of three categories:

- fatal,
- major,
- minor,
- Property damage.

At least one death resulted from a fatal accident. Accidents classified as "major" result in severe injuries but no fatalities. Any accident that results in minor injuries isn't really a massive worry, but destroyed cars are also considered to be damaged property.

The assessment of accident severity in this study is used two formulas to analyze the severity index which are:

Formula 1 (Case Fatality Rate and Human Damage)

Formula 2 (Casualty, Fatality index. Severity index, Casualty Index and Non-survival Index).

3.4.1 Human Damage and Case Fatality Rate

In this study, human damage (HD) and case fatality rate are established as two parameters for analyzing the severity of traffic accidents (CFR). They are frequent have frequently used indices in epidemiology and have the following definitions.

HD = (F+I)/A

CFR = F/ (F+I)

HD stands for "Human Damage and CFR stands for "Case Fatality Rate."

F represents all fatalities, I represent all injuries, and A represents all accidents. Maintain in mind that serious accidents like scrapes wouldn't be taken into consideration and that CFR only relates to occurrences or accidents that hurt people. HD stands for "average human damage per accident," as its abbreviation indicates. However, we also agree that the CFR index is necessary since, in our perspective; focusing just on the big picture while ignoring the "real" lethality of incidents is far from sufficient. However, HD and CFR are also available. Hayakawa et al. (2000) evaluated the accident death rate using a similar methodology. The percentage of "cases" (people with a medical ailment) who die while the disease is still active is known as the case fatality rate. "Injured or died within/after a traffic collision" is the term used in this study. (Y. Zhang, L. Ma, D. Wang, and H. Cong, 2019).

3.4.2 Fatality, Casualty and Severity Index

Based on these data, we examined different ways to show changes in the requirements of society: A = accident; F = fatality; S = serious injuries; SL = slight injuries; and C = F+ S+ SL = casualty. If we assume that all relevant values would grow linearly over time for the pre-independence period and gradually build up for the post-independence period, we get very good fits. Using the least squares method, all curves were fitted.

C = F+ S+ SL

Where A stands for accidents, F for fatalities, S for serious injuries, SL for minor injuries, and C for casualties.

Fatality Index (If)= $\frac{F}{A}$, Severity Index (Is)= $\frac{F}{C}$, Casualty Index (Ic)= $\frac{C}{A}$

Non-Survival Index (Ins) = $\frac{F}{S}$

These above two formulas will be used to analyze the severity index of vehicle accident data that occurred in New York City in the last five years, and we will divide into three periods. Two years before covid-19, two years during covid-19 and one year Post covid-19 pandemic to understand how covid-19 impacted traffic accidents in New York City.

CHAPTER IV
Results and Findings

4.0 Introduction

This chapter will discuss the data analysis of the accident severity of vehicle accidents in NYC between 2018 and 2022, and the data is classified into three parts: two years before COVID-19, two years during COVID-19, and one year after COVID-19.

4.1 Accident Severity Analysis

The assessment of accident severity in this study is used two formulas to the analyze severity index which are:

In Formula 1, we determined these factors for analyzing the severity index: fatality, casualty, severity indexes, casualty indexes, and non-survival indexes.

Table 3 summarizes the accident analysis of New York City vehicle collisions from 2018 to 2022, stating that there is a difference between the years in terms of vehicle accidents and how COVID-19 lockdown affects vehicle traffic collisions.

In 2018, there were 230,163 car crashes, resulting in 452 fatalities and 121,797 injuries for a total of 122,249 casualties, and the fatality number of accidents is low compared to the injury number. In 2019, the number of car crashes decreased to 210,109, resulting in 484 fatalities and 120,615 injuries for a total of 121,099 casualties. The trend continues to increase in 2020, with 111,838 car crashes, 522 fatalities, and 87,556 injuries for a total of 88,078 casualties. In 2021, a total of 109,262 car crashes occurred, resulting in 548 fatalities and 99,444 injuries for a total of 99,992 casualties. Accidents decreased between these two years as a result of the COVID-19 lockdown. However, the decrease in traffic volume and accidents did not lead to a reduction in the number of fatalities and injuries. In fact, the number of pedestrian and cyclist fatalities increased in 2020 compared to 2019, as many drivers were taking more risks with less traffic on the road and also because people were walking and cycling more due to the lockdown. Additionally, as the amount of traffic decreased, the speed at which cars were traveling rose, increasing the severity of collisions.

In 2022, the number of car crashes decreased to 68,447, resulting in 340 fatalities and 65,479 injuries for a total of 65,819 casualties.

Table 3. Road Traffic Accidents 2018-2022

Number of Years	Number of Accident	Fatality	Fatality Percentage (%)	Injury	Injury Percentage (%)	Casualty
2018	230163	452	19.26%	121797	24.61%	122249
2019	210109	484	20.6%	120615	24.37%	121099
2020	111838	522	22.25%	87556	17.69%	88078
2021	109262	548	23.35%	99444	20.1%	99992
2022	68447	340	14.5%	65479	13.23%	65819
Total	**729819**	**2346**	**100**	**494891**	**100**	**497237**

Figure 6 Total Numbers of Accidents in 2018-2022

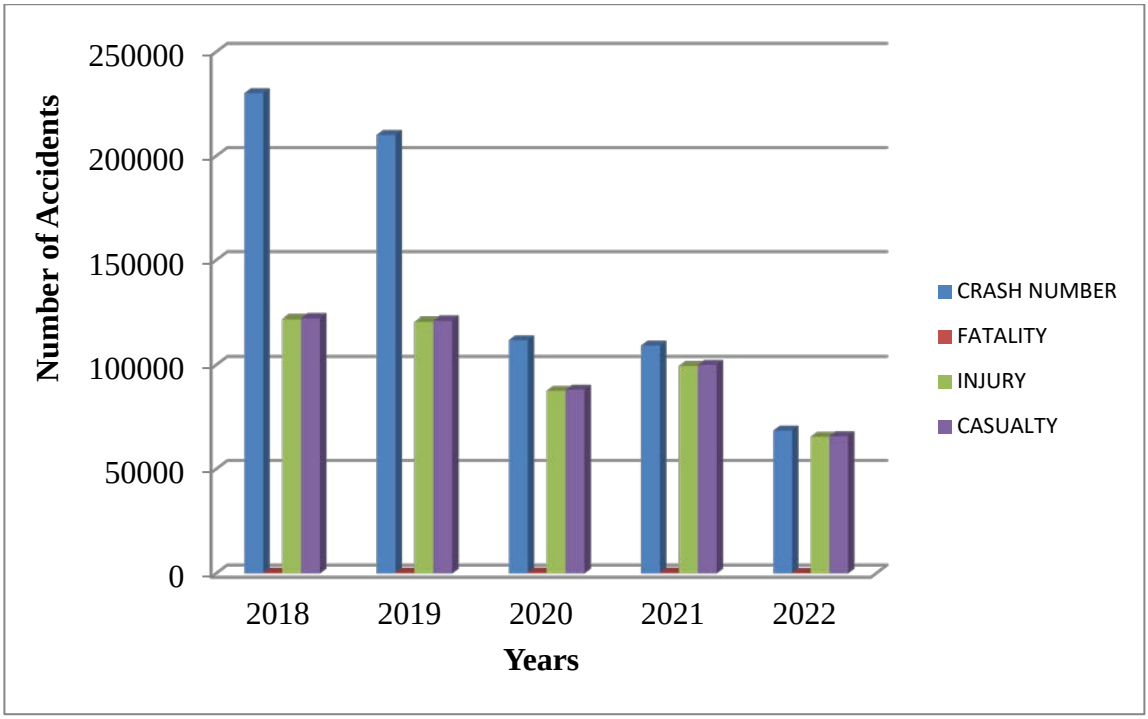


Figure 7. Road Accidents, in 2018-2022

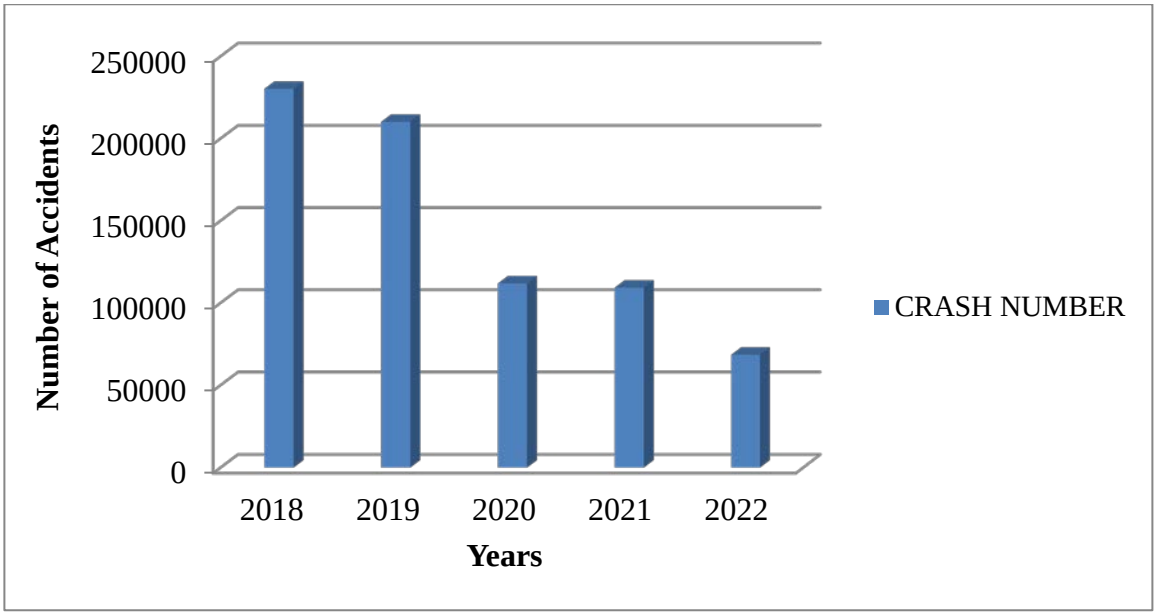


Table 4. Road Accidents Fatalities, 2018-2022

Number of Years	Number of Fatalities	Percentage (%)
2018	452	19.26%
2019	484	20.6%
2020	522	22.25%
2021	548	23.35%
2022	340	14.5%
Total	**2346**	**100**

Figure 8 below shows that the fatality number increased during the two years of the COVID-19 lockdown in 2020 and 2021. Because of the lockdown, the reduction in traffic volume caused a rise in accident severity as the speed of vehicles on the road increased.

Figure 8 Fatality Numbers in 2018-2022

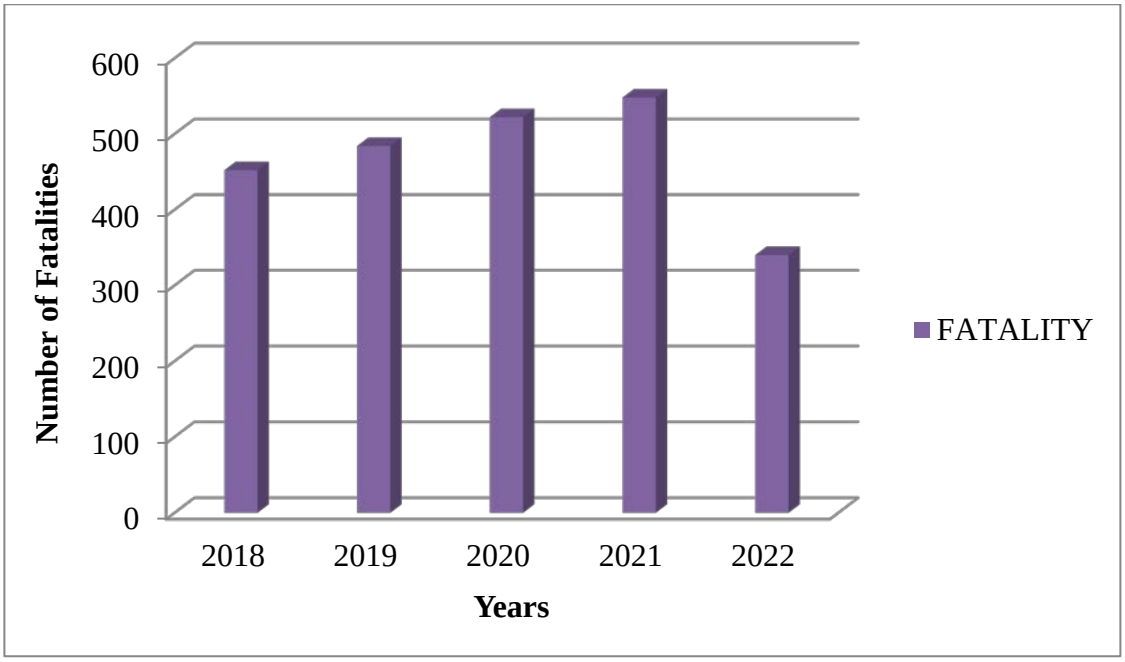
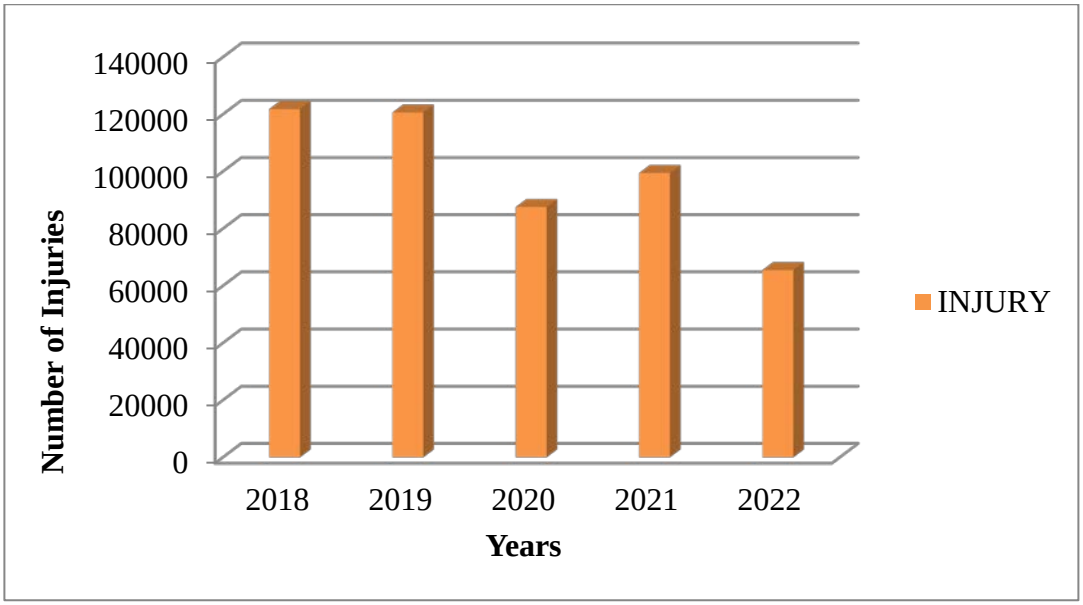


Table 5 Number of Injuries in 2018-2022

Number of Years	Number of Injuries	Percentage (%)
2018	121797	24.61%
2019	120615	24.37%
2020	87556	17.69%
2021	99444	20.1%
2022	65479	13.23%
Total	**494891**	**100**

Figure 9. Table 3 Total Number of Injuries in 2018-2022



4.1.1 Fatality Index (If)

The Fatality Index (FI) is a measure used in the analysis of the severity of vehicle collision incidents. It is a ratio that evaluates the probability of fatality in several collision types by comparing the number of fatalities to the number of accidents.

The Fatality Index is equal the number of fatalities divided by the total number of accidents. Increasing values indicate a higher risk of fatality in a collision, and it is frequently expressed as a percentage or ratio. For instance, a FI of 0.1 indicates a 10% likelihood of death in an accident, but a FI of 0.01 indicates a 1% chance of death in an accident.

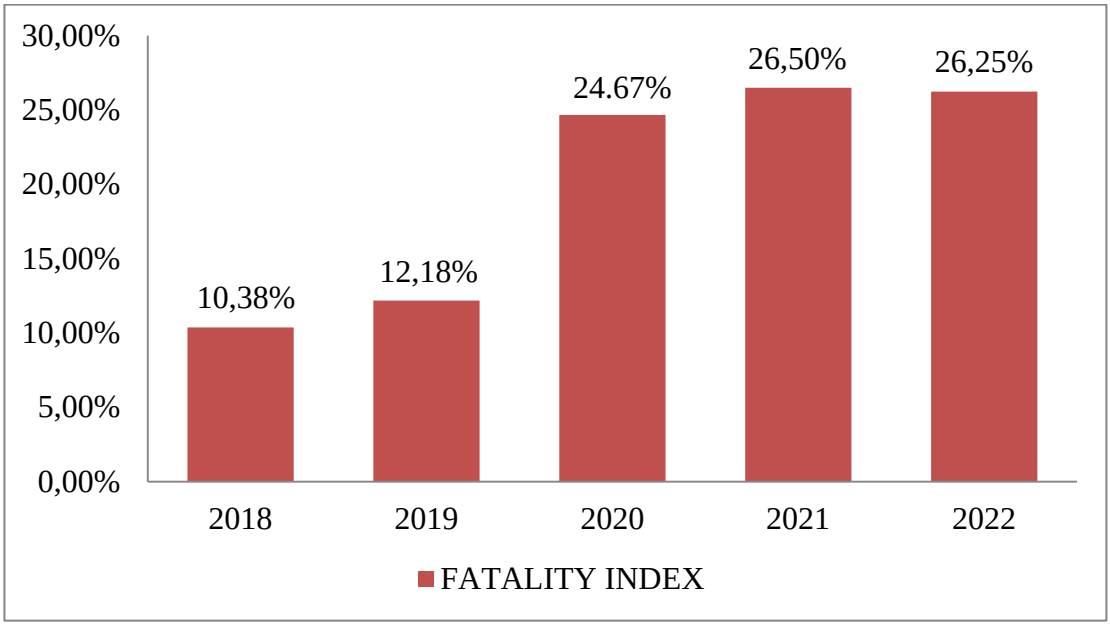
Fatality Index (If) $= \frac{F}{A}$, where F is the number of fatalities and A is the number of accidents.

Table 6. Fatality Index of Road Accidents in 2018-2022

Number of Years	Fatality Index	Percentage (%)
2018	0.001963826	10.38%
2019	0.002303566	12.18%
2020	0.004667465	24.67%
2021	0.005015467	26.50%
2022	0.004967347	26.25%
Total	**0.018917672**	**100**

In the figure 10 below declares that the fatality index increases between the covid-19 pandemic as we see in the figure.

Figure 10. Fatality Index of Road Accidents in 2018-2022



4.1.2 Casualty Index

The casualty index is a measure of the severity of an accident in terms of the number of casualties (fatalities and injuries) that occur as a result of the collision. It can be calculated by adding the number of fatalities and the number of injuries together, and then dividing that number by the total number of vehicles involved in the collision.

Casualty Index (Ic)= $\frac{C}{A}$ where is C= Casualty, C=F+I

I-Number of Injury, F-Number of Fatality,

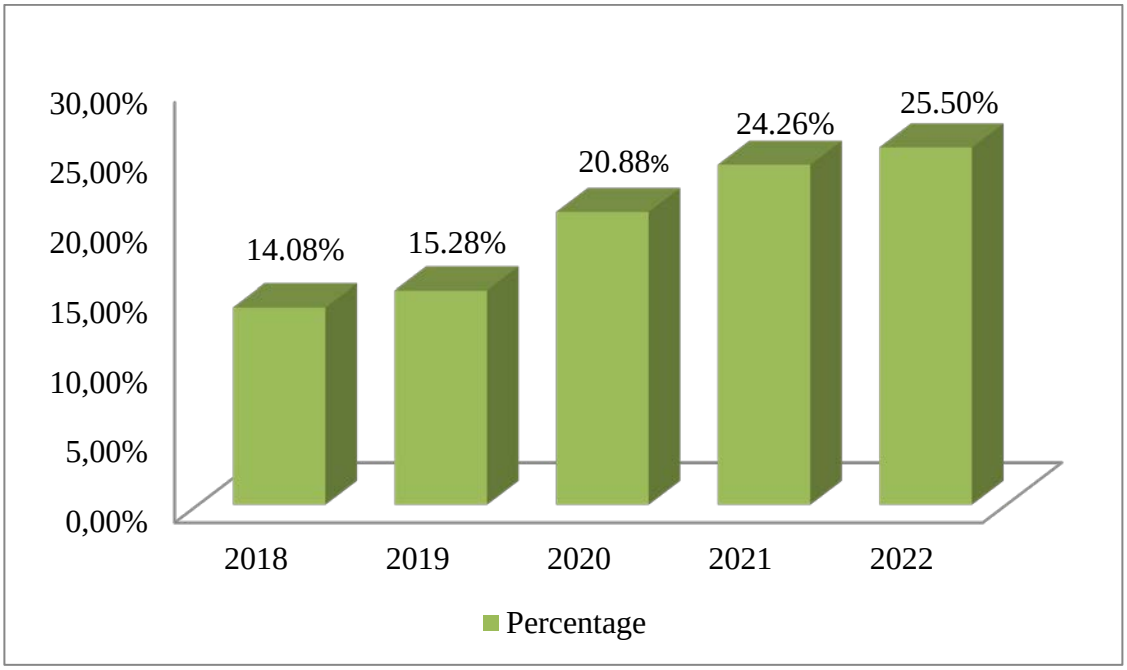
A- Total Number of Accidents.

Table 7 Total Number of Casualty in 2018-2022

Number of Years	Casualty Index	Percentage (%)
2018	0.531140974	14.08%
2019	0.576362745	15.28%
2020	0.787549849	20.88%
2021	0.91515806	24.26%
2022	0.96160533	25.5%
Total	**3.771816958**	**100**

In this figure 11 shows that casualty index increases during covid-19 lockdown compared as before covid-19 pandemic, due to the increase of fatality and injury.

Figure 11. Total Number of Casualty in 2018-2022



4.2 Human Damage and Case Fatality Rate

In the analysis of the severity of accidents, the number of fatalities and injuries that happen from vehicle crashes is often used to evaluate the effect on people.

HD= (F+I)/A and CFR= (F+I)

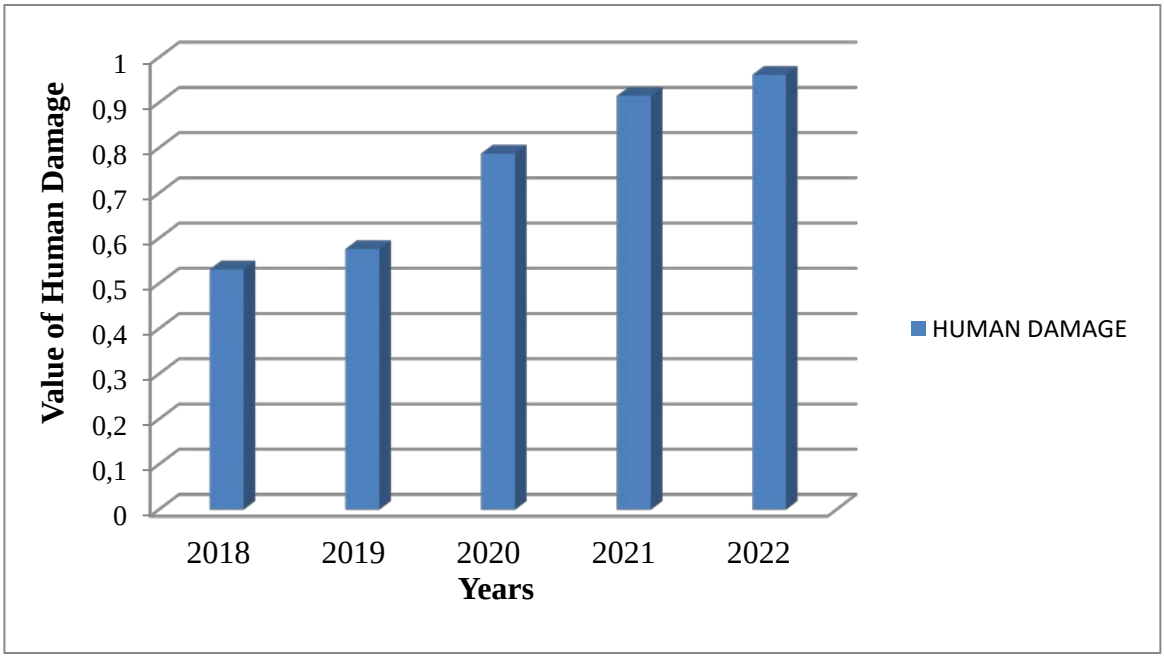
HD stands for "Human Damage and CFR for "Case Fatality Rate", F stands for total fatalities, I for total injuries, and A for total accidents.

In the figure below explains that there is increase of human damage during covid-19 as compared to the result of two years before Covid-19. Because of restricted lockdown and decreasing traffic volume leads increasing speed of vehicles that causes mare fatality.

Table 8. Human Damage in 2018-2022

Number of Years	Human Damage
2018	0.531140974
2019	0.576362745
2020	0.787549849
2021	0.91515806
2022	0.96160533

Figure 12. Human Damage in 2018-2022



4.2.1 Case Fatality Rate (CFR)

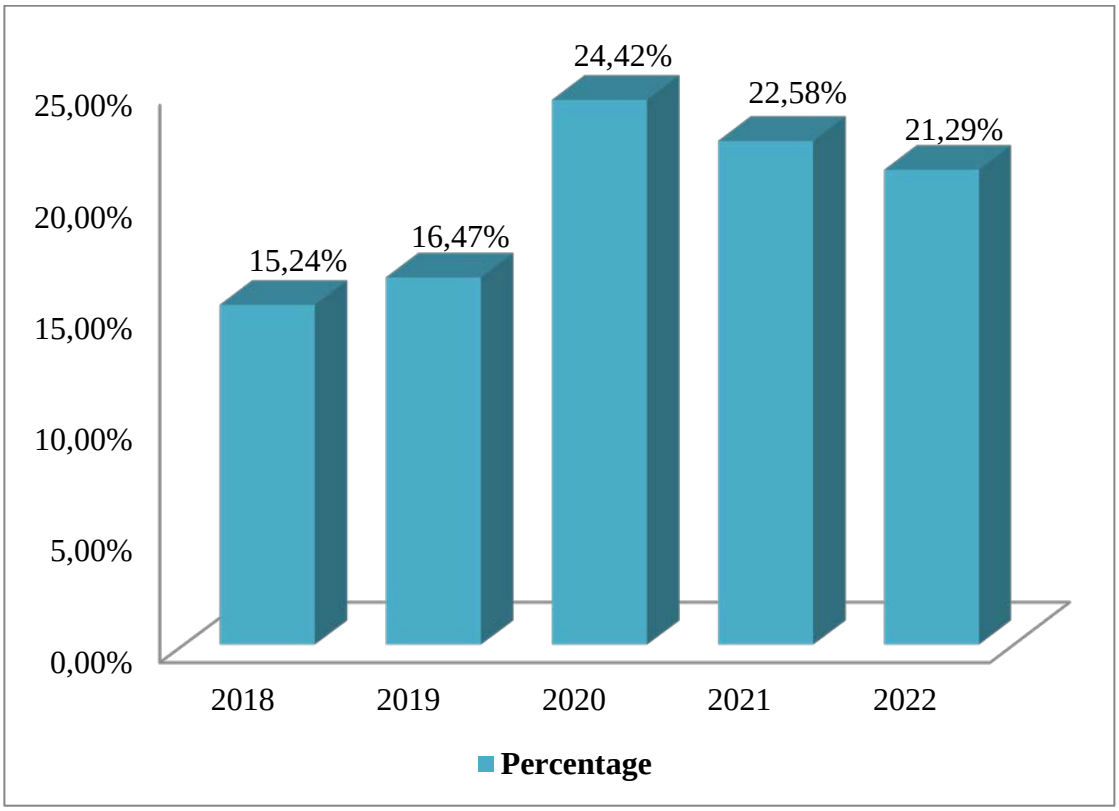
The case fatality rate of vehicle-vehicle collisions is a measure of the proportion of individuals who die as a result of a collision involving vehicles out of the total number of individuals who are involved in such collisions.

CFR = F/ (F+I)

Table 9. Number of Case Fatality Rate

Number of Years	Case Fatality Rate	Percentage (%)
2018	0.003697372	15.24%
2019	0.00399673	16.47%
2020	0.005926565	24.42%
2021	0.005480438	22.58%
2022	0.005165682	21.28%
Total	**0.024266787**	**100**

Figure 13. Number of Case Fatality Rate



CHAPTER V
Discussion

5.0 Introduction

The COVID-19 pandemic has had a significant impact on many aspects of life, including transportation and traffic accidents. This study analyzed vehicle accidents in New York City from 2018 to 2022 and found that there was a difference in the number of accidents and the severity of accidents between years, and that the pandemic had a notable effect on these trends.

In 2018, there were 230,163 car crashes in New York City, and the fatality rate was relatively low compared to the number of injuries. The number of accidents decreased slightly in 2019, with 210,109 crashes, and this trend continued in 2020, with 111,838 accidents. This decrease in accidents in 2020 is likely due to the effect of COVID-19 lockdowns and reduced traffic volume. However, the decrease in accidents did not lead to a decrease in fatalities and injuries. In fact, the number of pedestrian and cyclist fatalities increased in 2020 compared to 2019, likely due to drivers taking more risks with less traffic on the road and people walking and cycling more due to the lockdown.

The number of accidents in 2021 remained relatively low, with 109,262 crashes, but the fatality rate continued to increase, reaching 23.35%. This trend is concerning, as it indicates that the pandemic may have contributed to a more dangerous environment on the roads, with fewer accidents but a higher rate of severe accidents.

The decrease in accidents in 2020 is consistent with findings from other studies that have examined the impact of the pandemic on traffic accidents. A study conducted in Italy found that the number of traffic accidents decreased by 74% during the first wave of the pandemic in 2020, while another study conducted in Spain found a 69% reduction in accidents during the lockdown period. These findings suggest that

lockdowns and reduced traffic volume can have a significant impact on the number of traffic accidents.

However, the increase in fatality rates in 2020 and 2021 is concerning and highlights the need for further research into the underlying causes of this trend. One possible explanation is that drivers were taking more risks due to the reduced traffic volume, leading to a higher rate of severe accidents. Another possible explanation is that people were walking and cycling more due to the lockdown, leading to a higher rate of pedestrian and cyclist fatalities.

Finally this study shows that the Covid-19 has had impact on vehicle accidents with a decrease in overall accident rates, but an increase in the severity of accidents due to changes in speed, which leads to increase the fatality number during covid-19.

CHAPTER VI
Conclusion and Recommendation

6.0 Conclusion

In conclusion, the research aimed to understand how COVID-19 affected the severity of vehicle accidents in New York City. Through the analysis of accident severity before, during, and after the pandemic, the study aimed to determine how the incidence, severity, and type of crash involvement varies between vehicle accidents, and to calculate severity indices of vehicle accidents in New York City. The study found that the pandemic had a significant impact on accident severity, with a decrease in overall accident rates, but an increase in the severity of accidents due to changes in speed, which leads to increase the fatality number during covid-19.

The summarizing accident analysis of vehicle accidents of NYC in 2018 to 2022, also declares that there is a difference between years according to accidents and how covid-19 lockdown effect vehicle traffic collisions.

In 2018, there were 230,163, car crashes, and the fatality number of accidents is low compared to the injury number. In 2019, the number of car crashes decreased to 210,109, the trend continues for the increase in 2020, with 111,838, car crashes. In 2021, the total 109,262, car crashes occurred, In between these two years, the accidents decreased due to the effect of covid-19 lockdown. However, the decrease in traffic volume and accidents did not lead to a decrease in the number of fatalities and injuries. In fact, the number of pedestrian and cyclist fatalities increased in 2020 compared to 2019, as many drivers were taking more risks with less traffic on the road, and also people were walking and cycling more due to lock down. In 2022, the number of car crashes decreased to 68,447.

Before the covid-19, in 2018 the fatality number was 19.26%, while in 2019 rose to 20.6%. The outbreak of the covid-19 in 2020 resulted in an increase the fatality to 22.25% and 23.35% in 2021. The end of the Covid-19 shows a reduction in fatality to 14.5%.

6.1 Recommendation

- Further research should be conducted to obtain a larger accident analysis in order to increase the generalizability of the findings.
- The data analysis methods used in this study should be reviewed to ensure that they are appropriate for the type of data collected.
- The study should be expanded to include a comparison of accident severity between different types of vehicles, such as cars, trucks, and motorcycles, to determine if there are any differences.
- The research should also try to establish causality between the impact of COVID-19 and accident severity by using advanced methods like experimental designs.
- The city should also consider implementing measures to improve road safety, such as advancing implementation of traffic regulations, enhancing the safety of the infrastructure, and providing information about safe driving behavior.
- Implement measures to discourage speeding and reckless driving, such as increasing fines for speeding and implementing speed cameras in high-risk areas.
- Evaluate and improve road infrastructure, particularly in areas where there has been an increase in accidents involving pedestrians and bicycles. This could include adding dedicated bike lanes, increasing signage, and improving street lighting.
- Consider the impact of the pandemic on different segments of the population, such as older adults, people with disabilities, and low-income communities, and take steps to ensure that traffic safety measures are equitable and accessible for all.

REFERENCES

Alkheder, Sharaf, Madhar Taamneh, and Salah Taamneh. 2017. “Severity Prediction of Traffic Accident Using an Artificial Neural Network.” 108(April 2016):100–108. doi: 10.1002/for.2425.

Alkheder, S., Taamneh, M., & Taamneh, S. (2017). Severity prediction of traffic accidents using an artificial neural network. Journal of Forecasting, 36(1), 100-108.

Andeta, Jemal Ahmed. 2021. “Jemal Ahmed Andeta.”

Ehsani, Johnathon P., and D. Ph. 2020. “Adolescent Driver Testing During the COVID-19 Pandemic.” *Journal of Adolescent Health* 67(6):743–44. doi: 10.1016/j.jadohealth.2020.08.033.

Feng, Shumin, Zhenning Li, Yusheng Ci, and Guohui Zhang. 2016. “Risk Factors Affecting Fatal Bus Accident Severity : Their Impact on Different Types of Bus Drivers.” *Accident Analysis and Prevention* 86:29–39. doi: 10.1016/j.aap.2015.09.025.

Ihueze, C.C. and Onwurah, U.O. (2018) Road Traffic Accidents Prediction Modelling: An Analysis of Anambra State, Nigeria. Accident Analysis & Prevention, 112, 21-29.

Johansson, S., & Vasireddy, S. (2021). Analysis of Mobility and Traffic Safety with Respect to Changes in Volumes; Case Study: Stockholm, Sweden.

Li, Q., He, H., Liang, H., Bishai, D. M., & Hyder, A. A. (2016). One outcome, many trends: Understanding national data sources for road traffic fatalities in China. American Journalof Public Health, 106(10), 1793–1795.

Olemo, C.D. (2016) Exploring the Major Causes of Road Traffic Accidents in Nairobi County, University of Nairobi, Nairobi.

Shaaban, Khaled, Iman Gharraie, Emanuele Sacchi, and Inhi Kim. 2021. “Severity Analysis of Red-Light-Running-Related Crashes Using Structural Equation Modeling.” *Journal of Transportation Safety & Security* 13(3):278–97. doi: 10.1080/19439962.2019.1629137.

Shah, S. A. R., & Khattak, A. (2013). Road Traffic Accident Analysis of Motorways in Pakistan‖. International Journal of Engineering Research & Technology (IJERT), 2(11), 3340-3354.

Tefek, Mehmet Fatih. 2022. “Highway Accident Number Estimation in Turkey with Jaya Algorithm.” *Neural Computing and Applications* 34(7):5367–81.

Vilaça, Mariana, Nélia Silva, and Margarida C. Coelho. 2017. “ScienceDirect Statistical Analysis of the Occurrence and Severity of Crashes Involving Vulnerable Road Users.” *Transportation Research Procedia* 27:1113–20. doi: 10.1016/j.trpro.2017.12.113.

Wang, Kun, Weihua Zhang, Lai Jin, Zhongxiang Feng, and Dianchen Zhu. 2022. “Diagnostic Analysis of Environmental Factors Affecting the Severity of Traffic Crashes : From the Perspective of Pedestrian – Vehicle and Vehicle – Vehicle Collisions.” *Traffic Injury Prevention* 23(1):17–22. doi: 10.1080/15389588.2021.1995602.

Wang, D., Liu, Q., Ma, L., Zhang, Y., & Cong, H. (2019). Road traffic accident severity analysis: A census-based study in China. Journal of safety research, 70, 135-147.

Yahaya, Mahama, Runhua Guo, Wenbo Fan, Kamal Bashir, Yingfei Fan, Shiwei Xu, and Xinguo Jiang. 2021. “Bayesian Networks for Imbalance Data to Investigate the Contributing Factors to Fatal Injury Crashes on the Ghanaian Highways.” *Accident Analysis and Prevention* 150(December 2020):105936. doi: 10.1016/j.aap.2020.105936.

APPENDICES

APPENDIX A

Fatality, Casualty and Severity Index in 2018

CRASH DATE	CRASH NUMBER	FATALITY	INJURY	CASUALTY	SEVERITY INDEX	FATALITY INDEX	CASUALTY INDEX	NON-SURVIVAL INDEX
Jan	17991	24	8712	8736	0.002747253	0.001334	0.485576121	0.002754821
Feb	15849	32	7906	7938	0.004031242	0.002019055	0.500851789	0.004047559
Mar	19158	36	9324	9360	0.003846154	0.001879111	0.488568744	0.003861004
Apr	18106	33	9242	9275	0.003557951	0.0018226	0.512261129	0.003570656
May	20737	28	11173	11201	0.002499777	0.001350244	0.540145633	0.002506041
Jun	20692	42	11084	11126	0.003774942	0.00202977	0.537695728	0.003789246
Jul	19615	34	10870	10904	0.003118122	0.001733367	0.555901096	0.003127875
Aug	19541	36	10969	11005	0.00327124	0.00184228	0.563174863	0.003281976
Sep	19150	59	10992	11051	0.005338883	0.00308094	0.577075718	0.00536754
Oct	20682	38	11095	11133	0.003413276	0.001837346	0.538294169	0.003424966
Nov	19301	46	9837	9883	0.004654457	0.002383296	0.512046008	0.004676222
Dec	19341	44	10593	10637	0.004136505	0.00227496	0.549971563	0.004153686
TOTAL	**230163**	**452**	**121797**	**122249**	**0.044389802**	**0.02358697**	**6.361562561**	**0.044561593**

Fatality, Casualty and Severity Index in 2019

CRASH DATE	CRASH NUMBER	FATALITY	INJURY	CASUALTY	SEVERITY INDEX	FATALITY INDEX	CASUALTY INDEX	NON-SURVIVAL INDEX
Jan	16803	44	8650	8694	0.005060962	0.00261858	0.517407606	0.005086705
Feb	15945	28	8154	8182	0.003422146	0.001756036	0.513138915	0.003433897
Mar	17652	32	9118	9150	0.003497268	0.001812826	0.518354861	0.003509542
Apr	16737	40	9486	9526	0.004199034	0.002389915	0.569158153	0.00421674
May	19469	44	11272	11316	0.0038883	0.002260003	0.581231702	0.003903478
Jun	19423	46	11724	11770	0.003908241	0.002368326	0.605982598	0.003923576
Jul	18318	42	11152	11194	0.00375201	0.002292827	0.611092914	0.003766141
Aug	17121	44	10848	10892	0.004039662	0.002569943	0.636177793	0.004056047
Sep	17442	42	10476	10518	0.003993155	0.002407981	0.603027176	0.004009164
Oct	17485	36	10336	10372	0.003470883	0.002058908	0.593194166	0.003482972
Nov	16829	36	9335	9371	0.003841639	0.002139165	0.556836413	0.003856454
Dec	16885	50	10064	10114	0.004943642	0.002961208	0.598993189	0.004968203
TOTAL	**210109**	**484**	**120615**	**121099**	**0.048016942**	**0.027635717**	**6.904595486**	**0.048212919**

Fatality, Casualty and Severity Index in 2020

CRASH DATE	CRASH NUMBER	FATALITY	INJURY	CASUALTY	SEVERITY INDEX	FATALITY INDEX	CASUALTY INDEX	NON-SURVIVAL INDEX
Jan	14250	40	8288	8328	0.004803074	0.002807018	0.584421053	0.004826255
Feb	13594	38	7910	7948	0.004781077	0.002795351	0.584669707	0.004804046
Mar	10986	16	6190	6206	0.00257815	0.001456399	0.564900783	0.002584814
Apr	4090	28	2572	2600	0.010769231	0.006845966	0.635696822	0.01088647
May	6113	24	5036	5060	0.004743083	0.003926059	0.827744152	0.004765687
Jun	7586	62	7168	7230	0.00857538	0.00817295	0.953071447	0.008649554
Jul	9190	44	8580	8624	0.005102041	0.004787813	0.938411317	0.005128205
Aug	9727	44	9302	9346	0.004707896	0.004523491	0.960830677	0.004730166
Sep	9506	72	9236	9308	0.007735281	0.007574164	0.97917105	0.007795583
Oct	9598	52	8524	8576	0.006063433	0.005417795	0.893519483	0.006100422
Nov	8923	60	8076	8136	0.007374631	0.006724196	0.911800964	0.007429421
Dec	8275	42	6674	6716	0.006253722	0.005075529	0.811601208	0.006293078
TOTAL	**111838**	**522**	**87556**	**88078**	**0.073487001**	**0.06010673**	**9.645838663**	**0.073993698**

Fatality, Casualty and Severity Index in 2021

CRASH DATE	CRASH NUMBER	FATALITY	INJURY	CASUALTY	SEVERITY INDEX	FATALITY INDEX	CASUALTY INDEX	NON-SURVIVAL INDEX
Jan	14250	40	8288	8328	0.004803074	0.002807018	0.584421053	0.004826255
Feb	13594	38	7910	7948	0.004781077	0.002795351	0.584669707	0.004804046
Mar	10986	16	6190	6206	0.00257815	0.001456399	0.564900783	0.002584814
Apr	4090	28	2572	2600	0.010769231	0.006845966	0.635696822	0.01088647
May	6113	24	5036	5060	0.004743083	0.003926059	0.827744152	0.004765687
Jun	7586	62	7168	7230	0.00857538	0.00817295	0.953071447	0.008649554
Jul	9190	44	8580	8624	0.005102041	0.004787813	0.938411317	0.005128205
Aug	9727	44	9302	9346	0.004707896	0.004523491	0.960830677	0.004730166
Sep	9506	72	9236	9308	0.007735281	0.007574164	0.97917105	0.007795583
Oct	9598	52	8524	8576	0.006063433	0.005417795	0.893519483	0.006100422
Nov	8923	60	8076	8136	0.007374631	0.006724196	0.911800964	0.007429421
Dec	8275	42	6674	6716	0.006253722	0.005075529	0.811601208	0.006293078
TOTAL	**111838**	**522**	**87556**	**88078**	**0.073487001**	**0.06010673**	**9.645838663**	**0.073993698**

Fatality, Casualty and Severity Index in 2022

CRASH DATE	CRASH NUMBER	FATALITY	INJURY	CASUALTY	SEVERITY INDEX	FATALITY INDEX	CASUALTY INDEX	NON-SURVIVAL INDEX
Jan	7754	39	6058	6097	0.006396588	0.005029662	0.786303843	0.006437768
Feb	7243	50	6336	6386	0.007829627	0.006903217	0.881678862	0.007891414
Mar	8738	30	8078	8108	0.003700049	0.00343328	0.927901122	0.003713791
Apr	8433	19	7955	7974	0.002382744	0.002253053	0.945570971	0.002388435
May	9328	53	8971	9024	0.005873227	0.005681818	0.967409949	0.005907926
Jun	9341	35	9506	9541	0.003668379	0.003746922	1.021410984	0.003681885
Jul	8687	68	9227	9295	0.007315761	0.007827789	1.06998964	0.007369676
Aug	8219	40	8681	8721	0.00458663	0.004866772	1.06107799	0.004607764
Sep	652	4	613	617	0.006482982	0.006134969	0.946319018	0.006525285
Oct	30	2	30	32	0.0625	0.066666667	1.066666667	0.066666667
Nov	22	0	24	24	0	0	1.090909091	0
TOTAL	**68447**	**340**	**65479**	**65819**	**0.110735988**	**0.11254415**	**10.76523814**	**0.115190611**

Fatality, Casualty and Severity Index in 2018-2022

CRASH DATE	CRASH NUMBER	FATALITY	INJURY	CASUALTY	SEVERITY INDEX	FATALITY INDEX	CASUALTY INDEX	NON-SURVIVAL INDEX
2018	230163	452	121797	122249	0.003697372	0.001963826	0.531140974	0.003711093
2019	210109	484	120615	121099	0.00399673	0.002303566	0.576362745	0.004012768
2020	111838	522	87556	88078	0.005926565	0.004667465	0.787549849	0.005961899
2021	109262	548	99444	99992	0.005480438	0.005015467	0.91515806	0.005510639
2022	68447	340	65479	65819	0.005165682	0.004967347	0.96160533	0.005192504

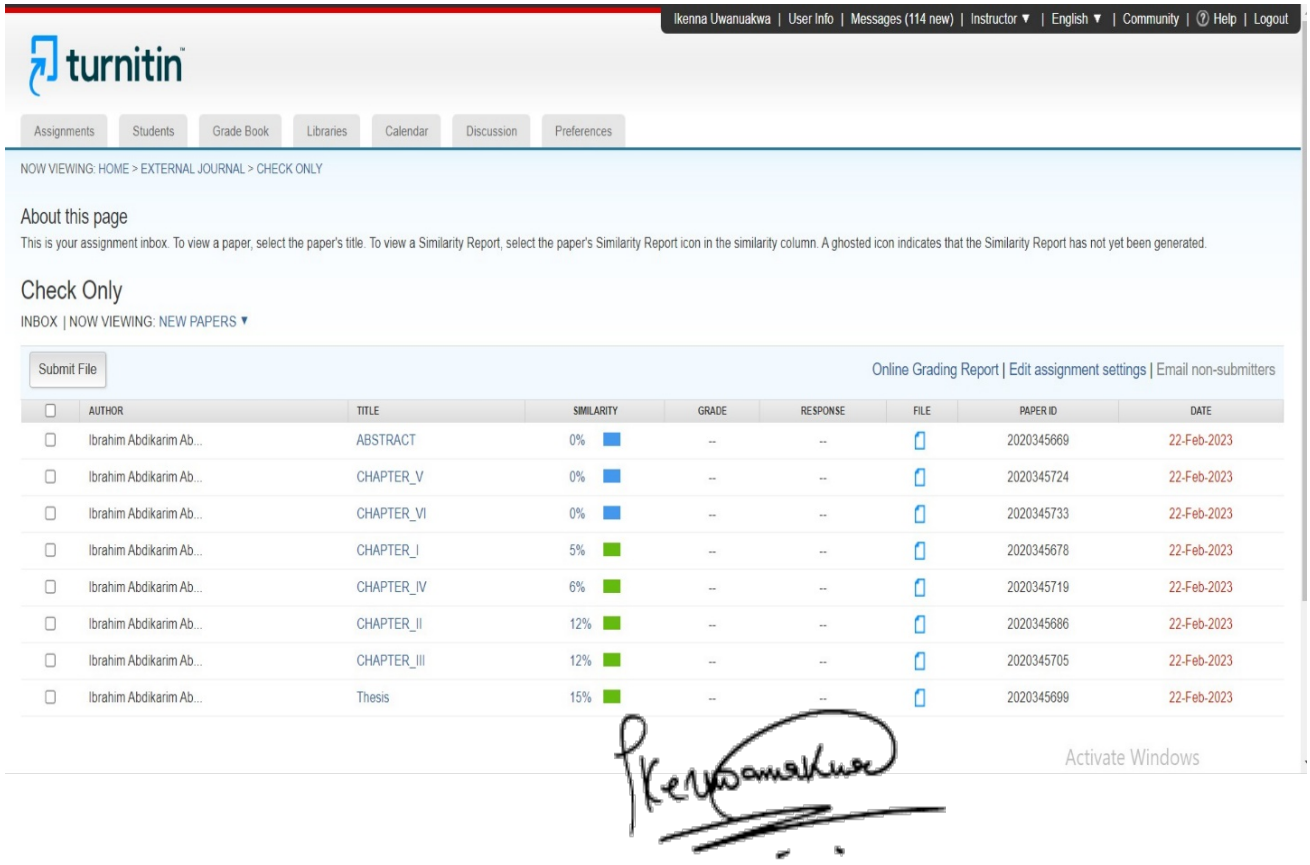
APPENDIX B

Human Damage and Case Fatality Rate

CRASH DATE	CRASH NUMBER	FATALITY	INJURY	HUMAN DAMAGE	CASE FATALITY RATE
2018	230163	452	121797	0.531140974	0.003697372
2019	210109	484	120615	0.576362745	0.00399673
2020	111838	522	87556	0.787549849	0.005926565
2021	109262	548	99444	0.91515806	0.005480438
2022	68447	340	65479	0.96160533	0.005165682

APPENDIX C

Turnitin Similarity Report



APPENDIX D

December 30, 2022

Letter of Ethics

INSTITUTE OF GRADUATE STUDIES

REF: 20213727 ABDIKARIM ABUBAKAR IBRAHIM

The aforementioned student thesis carried out his Master thesis under my supervision titled:
“EFFECT OF COVID-19 ON THE VEHICLE ACCIDENT SEVERITY: A CASE STUDY NEW YORK CITY”
The date was duly opened from New York State open source database.

Feel free to contact me if you like any further clarification.

Best regards,

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