

Shifting Shadows of the Six: Decoding Toronto's Crime Trends from 2014 to 2023*

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January 24, 2024

In this study, we conducted a comprehensive analysis of crime trends in Toronto, utilizing a dataset detailing various criminal activities from 2014 to 2023. Our investigation focused on the evolution of different types of crimes, with a specific emphasis on contrasting violent crimes, such as assault and robbery, against non-violent offenses like theft. The findings reveal significant patterns in both categories, highlighting an evolving landscape of criminal behavior in Toronto. This research is crucial as it sheds light on the changing dynamics of urban crime, providing valuable insights for policymakers, law enforcement agencies, and community leaders in developing targeted strategies for crime prevention and enhancing public safety in metropolitan areas.

1 Introduction

Urban crime, a multifaceted issue impacting communities worldwide, poses significant challenges to public safety and social stability. Toronto, Canada's largest city, is no exception. The broader context of urban crime in Toronto is critical in understanding its impact on the city's development, public perception, and policy formulation. Despite extensive research in urban criminology, there remains a gap in comprehensively understanding how different types of crimes, especially violent and non-violent, have evolved over recent years in Toronto. This gap is crucial for developing effective crime prevention strategies and enhancing public safety.

This paper presents a detailed analysis of crime trends in Toronto from 2014 to 2023. The study focuses on two primary crime categories: violent crimes, such as assault and robbery, and non-violent crimes, including theft and fraud. By leveraging a comprehensive dataset, we delve into how these crime categories have changed over time and their implications for urban safety and policing strategies. The analysis not only uncovers patterns and trends in these

*Code and data are available at: <https://github.com/leoyliu/STA302-Paper-1>.

crime categories but also offers a comparative perspective, highlighting the distinct trajectories of violent and non-violent crimes.

The findings of this study are significant for several reasons. First, they provide a nuanced understanding of the crime dynamics in a major urban center, offering insights that are vital for policymakers, law enforcement, and community leaders. The patterns observed suggest shifts in criminal behavior and possibly reflect broader social and economic changes in the city. Second, the comparative analysis between violent and non-violent crimes offers a unique perspective on the nature of criminal activities, contributing to a more targeted approach in crime prevention and community safety initiatives.

The paper is structured to facilitate a comprehensive understanding of the study and its implications. Following this introduction Section 1, the second section presents the data Section 2, detailing the data sources, analytical techniques, and the rationale behind the chosen methods. The third section discusses the results Section 3, elaborating on the observed trends and patterns in crime data. The fourth section provides an in-depth discussion Section 4 of these findings, exploring potential factors influencing these trends, drawing connections to broader urban issues, and suggestions for future research in this area.

2 Data

2.1 Overview

This section Section 2 aims to offer an insightful understanding of the dataset utilized in our analysis, focusing on its content, origin, and the methods applied for data manipulation and visualization.

2.2 Source of the Data

The dataset comprises crime statistics in Toronto, spanning from 2014 to 2023. The dataset analyzed in this report was obtained in csv format from the City of Toronto Open Data Portal(n.d.) using the R package `opendatatoronto`(Gelfand 2020). The dataset was last updated on January 14th, 2024. This dataset is publicly available and is often used for academic and policy research due to its reliability and comprehensive coverage.

2.3 Alternative Dataset Consideration

Although alternative datasets were considered, this specific dataset was selected for its detailed year-wise breakdown and the diversity of crime types it encompasses. Other datasets either lacked the temporal detail or the variety of crime categories present in our chosen dataset.

2.4 Data Manipulation and Cleaning in R (R Core Team 2020)

The data was processed and cleaned using R(R Core Team 2020), a powerful statistical programming language. Key operations included:

- **Data Cleaning:** Addressing missing values, standardizing formats, and filtering out irrelevant variables using the `tidyverse`(Wickham et al. 2019) package(e.g., removing rate-based columns and NAs).
- **Data Transformation:** Converting the dataset from a wide format to a long format for easier manipulation using the `tidyr`(Wickham, Vaughan, and Girlich 2023) package.
- **Aggregation:** Summarizing the data by year and crime type using the `dplyr`(Wickham et al. 2023) package.
- **Data Visualization:** For visual representation, `ggplot2` (Wickham 2016), a versatile package in R for data visualization, was employed. It was used to create comprehensive line plots depicting the trends of various crime categories over the years.
- **Paper Generation:** The packages `knitr` (Xie 2021) is used to generate the R markdown report.

2.5 Variables Explanation

The dataset includes various crime categories, such as assault, theft, and other types, with each variable representing the annual count of reported cases for each crime type. This longitudinal data provides a detailed view of the crime trends in Toronto over a decade.

Table 1: Crime Incidents Summary by Year

Crime Type	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Assault	5,971	6,567	6,843	7,390	7,683	7,750	6,674	7,124	7,864	9,147
Auto Theft	1,244	1,085	1,095	1,209	1,681	1,817	1,835	2,078	3,043	3,660
Bike Theft	1,228	1,253	1,516	1,630	1,756	1,524	1,290	1,300	1,293	1,387
Break and Enter	2,155	2,155	1,976	2,183	2,465	2,814	2,258	1,954	1,980	2,396
Homicide	18	25	27	19	30	28	26	26	22	57
Robbery	1,311	1,326	1,392	1,539	1,380	1,289	1,045	838	1,052	1,094
Shooting Incidents	45	84	124	124	138	145	127	134	135	130
Theft from Motor Vehicles	3,613	3,153	2,814	2,948	3,144	3,496	3,355	2,658	3,021	2,830
Major Theft	367	397	400	423	481	522	437	424	526	680

Table 1 organizes data into a clear format where each row indicates a specific type of crime. The columns are segmented by year, spanning from 2014 to 2023. Each cell within the table provides a count of the incidents reported for that particular crime in the corresponding year.

Then, we want to categorize our data into one of two groups: ‘Violent’ or ‘Non-Violent’. This categorization was based on the nature of the crime. For example, crimes like ‘ASSAULT’, ‘HOMICIDE’, etc., were categorized as ‘Violent’, while others like ‘THEFT’, were categorized as ‘Non-Violent’. After categorization, the dataset was aggregated based on these two new categories. This involved summing up the incident counts for each category (Violent and Non-Violent) for every year.

Table 2: Crime Incidents Summary by Year

Crime Type	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Non-Violent	6,452	5,888	5,825	6,210	7,062	7,359	6,917	6,460	7,883	8,557
Violent	9,500	10,157	10,362	11,255	11,696	12,026	10,130	10,076	11,053	12,824

Table 2 organized view of crime statistics over a range of years, specifically differentiated into two main categories: ‘Violent’ and ‘Non-Violent’ crimes. Each row in the table represents one of these two categories. The columns of the table are divided by year, ranging from 2014 to 2023. Under each year’s column, the table displays the total number of reported incidents for each crime category. For example, under the column for 2014, you will find the total number of violent crimes reported in that year followed by the total number of non-violent crimes for the same year.

2.6 Summary Statistics and Relationship Analysis

The dataset was summarized using basic statistical measures (mean, median, standard deviation) to provide an overview of each crime category. Further, the relationships between different crime types were explored to understand correlated trends, if any.

3 Results

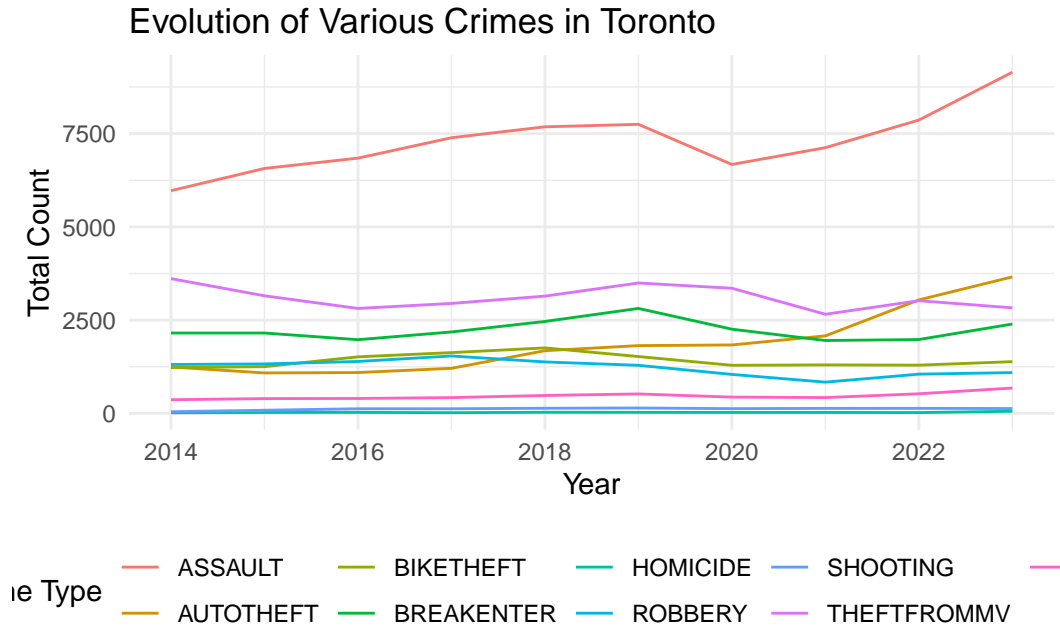


Figure 1: Trends in Crime Cases in Toronto (2014-2023)

Figure 1 reveals distinct trends for various crime types in Toronto over the years. We notice that assault crimes have been on the rise in recent years, this could signal a growing concern in public safety and might prompt law enforcement to investigate the underlying causes, such as increased urbanization, changes in population density, or other socio-economic factors. Conversely, there is a noticeable decline in theft-related crimes, it could reflect the success of recent crime prevention initiatives, improved security measures, or increased public awareness.

Figure 2 compares the number of cases reported for violent and non-violent crimes from 2014 to 2023. The x-axis represents the years, and the y-axis indicates the number of cases.

The red line represents violent crimes, and the blue line represents non-violent crimes. The plot shows distinct trends for both categories over the specified time frame.

- **Violent Crimes (Red Line):** There is an overall increasing trend in the number of violent crime cases over the years. There are some fluctuations, with a noticeable dip occurring in one of the years, but the general direction is upwards, especially towards the end of the period, indicating a rise in violent crimes or an increase in reporting.
- **Non-Violent Crimes (Blue Line):** The trend in non-violent crime cases shows some variability but does not have as clear an increasing pattern as violent crimes. There are years where the rate has increased or decreased, but the last year shows a notable increase, suggesting a possible upward trend at the end of the period.

Evolution of Violent and Non-Violent Crimes Over the Years

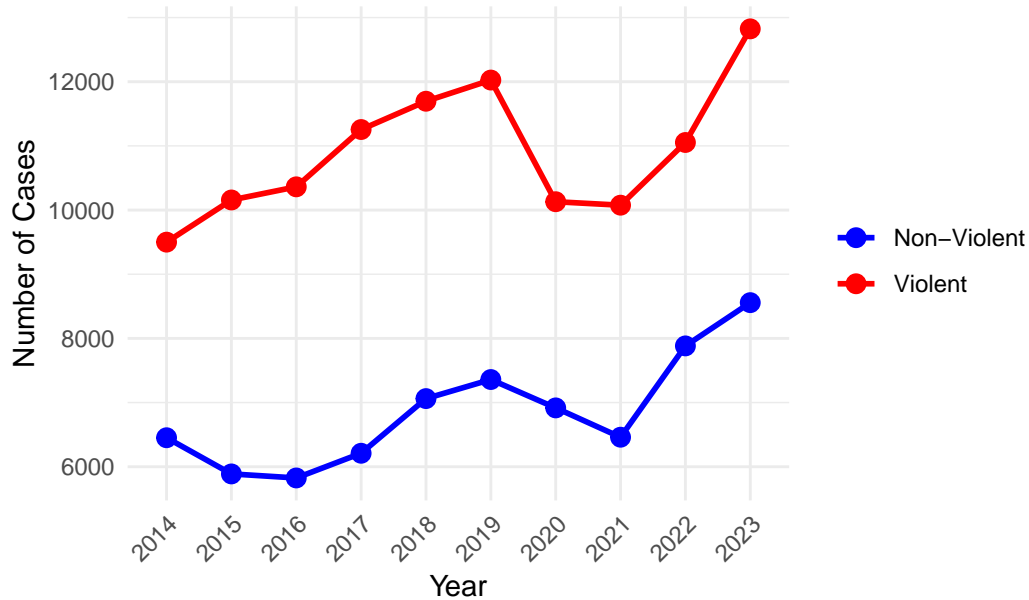


Figure 2: Comparative Trend Analysis of Violent and Non-Violent Crime Cases from 2014 to 2023

Overall, the graph indicates that while both violent and non-violent crimes have seen rises and falls, the increase in violent crimes towards the later years is more pronounced. This could reflect changes in societal conditions, law enforcement practices, or reporting mechanisms.

4 Discussion

Based on the analysis of the provided dataset and the visual representation of crime trends in Toronto over the years, several key results can be summarized:

4.1 Variation in Crime Trends:

The dataset reveals distinct trends for different types of crimes in Toronto. Some crime categories exhibit an upward trend, indicating an increase in incidents over the years, while others show a downward trend, suggesting a decrease in occurrences. This variation highlights the complexity of crime dynamics in an urban setting.

4.2 Potential Factors Influencing Trends:

The observed trends in crime rates could be influenced by a multitude of factors. These include socio-economic changes, urban development, law enforcement strategies, policy reforms, and technological advancements in crime reporting. For example, an increase in certain types of crimes might be linked to economic downturns, demographic shifts, or changes in urban density, while a decrease could reflect effective policing strategies or community intervention programs.

The findings of this analysis are particularly relevant for policymakers and law enforcement agencies. Understanding these trends is crucial for developing targeted strategies to address and prevent crime effectively, thereby enhancing public safety and community well-being in Toronto.

4.3 Weaknesses and next steps

While the visual analysis provides a high-level overview of crime trends in Toronto, it's essential to conduct more detailed investigations to understand the underlying causes of these trends. This includes examining subcategories of crimes, focusing on specific geographic areas within the city, and considering other relevant data sources.

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