No evidence of Homicide Patterns: A Comprehensive Analysis of Homicide Cases and Characteristics in Toronto (2004-2020)*

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One crucial factor in measuring a city's well-being is its homicide rates and its associating characteristics. Using data from OpenDataToronto, this paper aims to investigate all recorded homicide cases in Toronto from 2004-2020. By exploring data encompassing all Toronto neighbourhoods and focusing on those with the highest incidence of homicide cases, I found that shooting is the predominant form of homicide. This paper reveals that homicide occurrences in Toronto, in general, do not follow a noticeable temporal pattern, as there is no correlation between the frequency of homicides and temporal variables.

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*Code and data are available at: https://github.com/hannahyu07/Toronto-Homicide-Analysis

1 Introduction

The homicide rate plays a pivotal role in assessing the state of violence in society. In 2022, Canadian police services documented 874 cases of homicide, with 2.25 homicides per 100,000 people (Canada 2024). With an 8% increase in the national homicide rate, this increase signifies the fourth consecutive annual rise in the national homicide rate (Canada 2024). As one of Canada's most vibrant and diverse cities, Toronto is the home of 2.93 million people. Toronto's safety and stability are extremely important for all the residents of the city. Understanding the patterns, factors, and implications of homicide cases is important in ensuring Toronto's public safety and establishing targeted interventions.

This research seeks to analyze the spatial and temporal distribution of Toronto's homicide cases. By investigating whether specific times or certain areas are prone to be associated with homicide incidents, we want to shed light on the dynamics of homicide occurrences and think about addressing and preventing future prevention for homicide cases. My findings showed that homicide occurrences do not adhere to any specific pattern, and therefore are inherently unpredictable. However, the likelihood of homicide resulting from shooting is significantly higher compared to other methods. This underscores the need for policymakers and law enforcement agencies to take more effective and preventative measures into aspects in firearms.

The Police Annual Statistical Report - Homicides (Services 2024) from (Gelfand 2022) provides a record of all homicide cases in Toronto from 2004-2020 including details such as the time of occurrence, location, and type of homicide. I could draw information about homicide cases and their related features from this extensive dataset and investigate Toronto's homicide patterns across time. In Section 2, I introduce the dataset along with general information. In its subsection, I navigate the change in homicide case numbers over time considering various characteristics and analyzing the relationship between homicide cases and temporal variables. And I refine most of the analysis specifically on the top five neighbourhoods with the highest number of homicide cases. Lastly, I delve into the implications and further discussions on these results in Section 3.

2 Data

To investigate the homicide cases in Toronto, I obtained the dataset " Police Annual Statistical Report - Homicides (Services 2024) from the Toronto Open Data Portal (Gelfand 2022). Data was cleaned and analyzed using the open source statistical programming language R (R Core Team 2023), with additional support from 'tidyverse' (Wickham et al. 2019), 'dplyr' (Wickham et al. 2023), 'janitor'(Firke 2023), 'readr' (Wickham, Hester, and Bryan 2024), 'stringr' (Wickham 2023), 'lubridate' (Grolemund and Wickham 2011), 'ggplot2' (Wickham 2016), 'knitr' (Xie 2014), 'gt'(Iannone et al. 2024). Further details about data extraction and analysis processes will be discussed in the following sections below.

This dataset includes a thorough list of every homicide case in Toronto from the year 2004 to 2020 summing up to 1167 cases. I cleaned the dataset and selected variables that are relevant to my analysis of homicide cases. My variables of interest include the year the offence occurred, type of homicide (shooting, stabbing, other), date of offence, and identifier of neighbourhood using Toronto's 140 neighbourhood structure. In addition to these variables, I also constructed three more variables: the day of the week when the offence occurred (Monday-Sunday), the season when the offence occurred (fall, winter, spring, summer), and the count of homicide cases by year to further aid our data analysis Table 1. This dataset was last refreshed on January 11, 2024.

Table 1: Sample of Cleaned Homicide Data

Year	Homicide Type	Date	Hood ID	Day of the Week	Season	Homicide Count
2004	Other	2004-01-03	97	Saturday	Winter	64
2004	Shooting	2004-01-08	137	Thursday	Winter	64
2004	Shooting	2004-01-08	132	Thursday	Winter	64
2004	Shooting	2004-01-25	93	Sunday	Winter	64
2004	Shooting	2004-01-25	131	Sunday	Winter	64

2.1 General Homicide Analysis

I listed out the number of homicide cases each year in Table 2 and created the summary statistics table detailing the homicide count per year. I found the year 2011 has the lowest number of cases of homicide, totalling only 51, while 2018 with a total of 97 has the most number of homicide cases.

Table 2: Total Homicide Cases Each Year

Total Homicide Cases Each Year

occurrence_year	total_cases
2004	64
2005	80
2006	70
2007	86
2008	70
2009	62
2010	65
2011	51
2012	57
2013	57

2014	58
2015	59
2016	75
2017	65
2018	97
2019	79
2020	71

Of all the homicide cases analyzed, the cases related to shooting are significantly higher than other types of homicides. Over the years under examination, shooting incidents accounted for more than 608 cases of homicides, surpassing stabbing, which accounted for 260 cases, and all other types combined which took up around 298 cases (Table 3).

Table 3: Distribution of Homicide Types

homicide_type	total_cases
Other	298
Shooting	608
Stabbing	260

We then redirect our attention to the temporal trend of homicide cases. Figure 1 portrays the trend of homicide cases throughout the span of nearly 2 decades. With no obvious trend evident, I do not observe a consistent increase or decrease in cases over time. However, it is noteworthy that the number of homicide cases has decreased after it peaked in 2018.

Following our examination over time, Figure 2 breaks down the homicide cases over time into further details based on the type of homicide. The trends of the three distinct types of homicide cases broadly follow the overall pattern in Figure 1. Shooting cases always prevail over other types of homicide cases even during their lowest year. We conclude that there is no evidence of a clear increase or decrease in homicides across time.

We want to identify whether there are specific times in the year when homicides are more likely to occur. To explore this topic, we generated Figure 3 that displays the homicide counts by each day of the week. Sunday with a total count of 200 cases is the day with the most cases followed by Saturday and Friday with 197 and 175 respectively. On the other hand, Thursday has the lowest count, with only 124 cases. This analysis suggests that homicides are slightly more likely to occur on weekends.

We performed a parallel analysis on the count of homicide cases by season and found a relatively even distribution with fall exhibiting slightly more cases than other seasons, but the difference is marginal Figure 4.

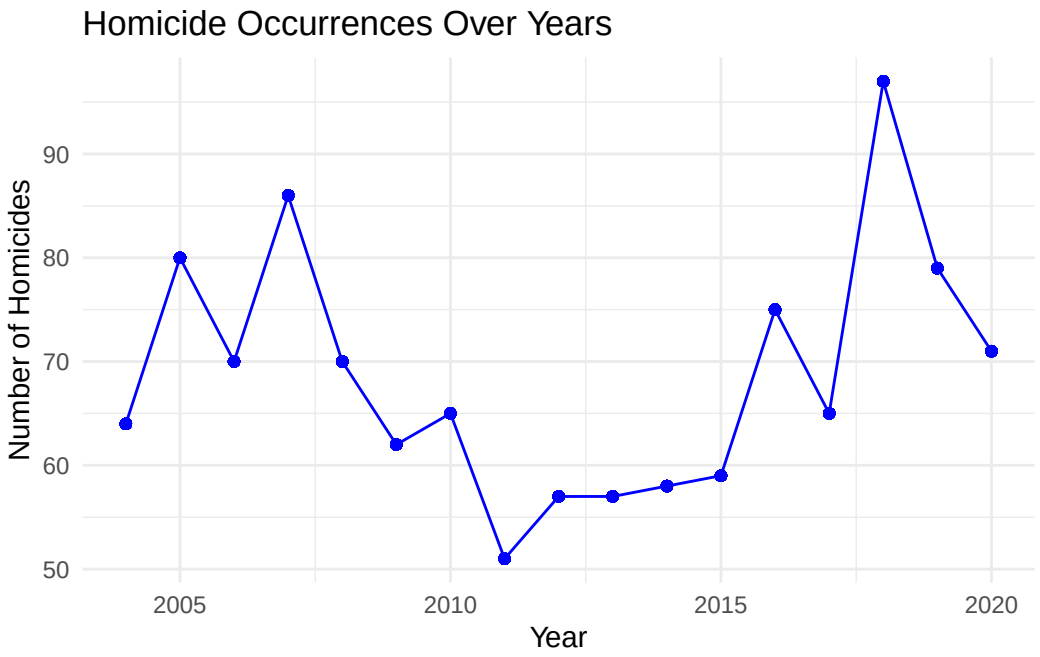

Figure 1: Homicide Occurrences Over Years

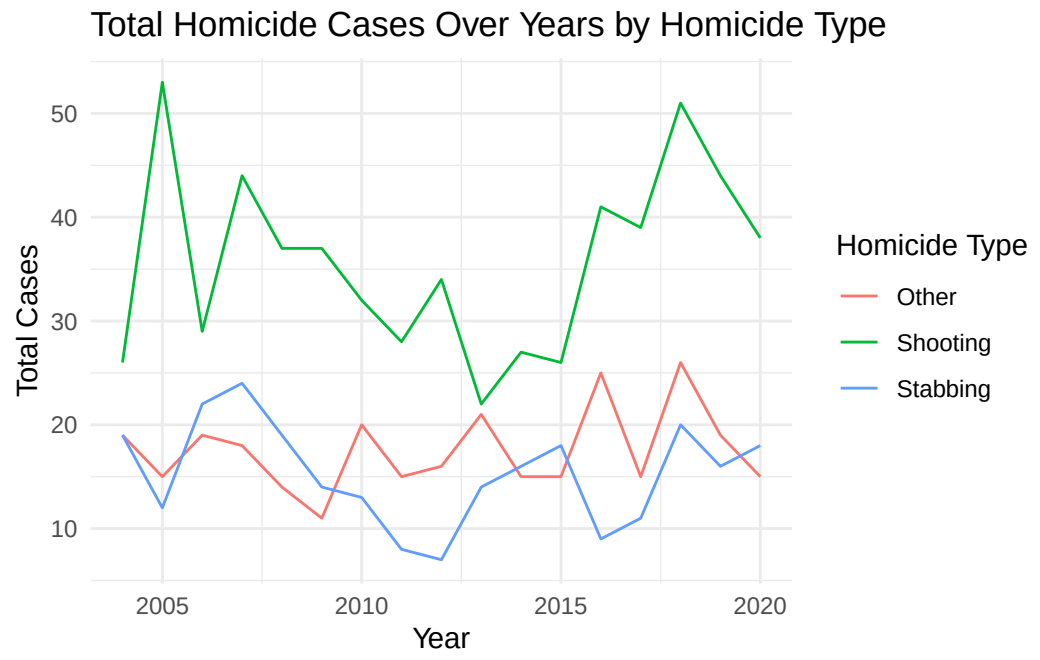

Figure 2: Total Homicide Cases Over Years by Homicide Type

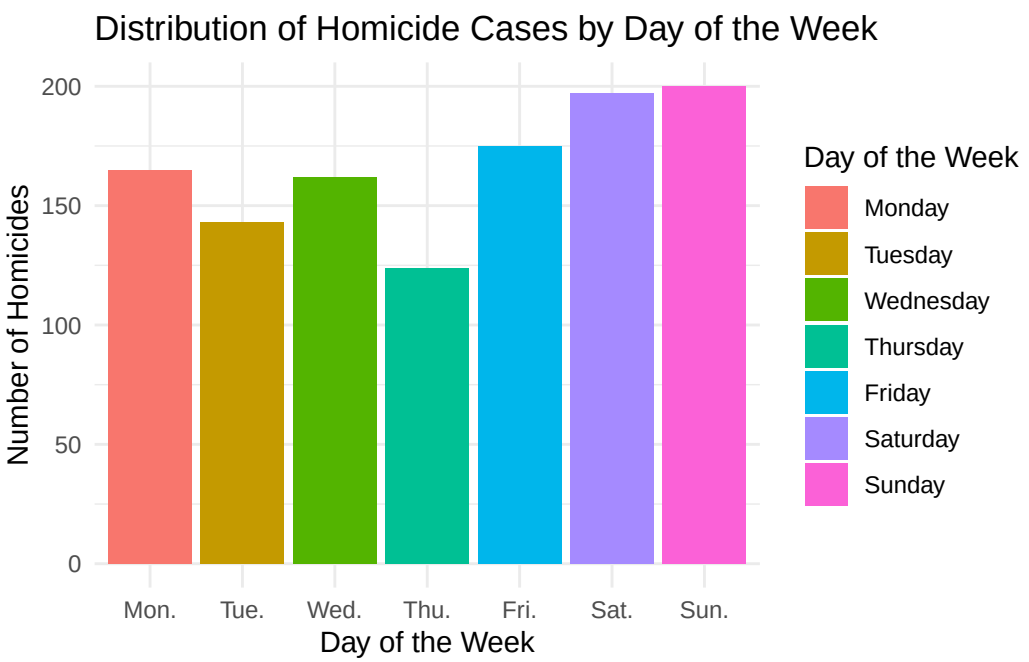

Figure 3: Distribution of Homicide Cases by Day of the Week

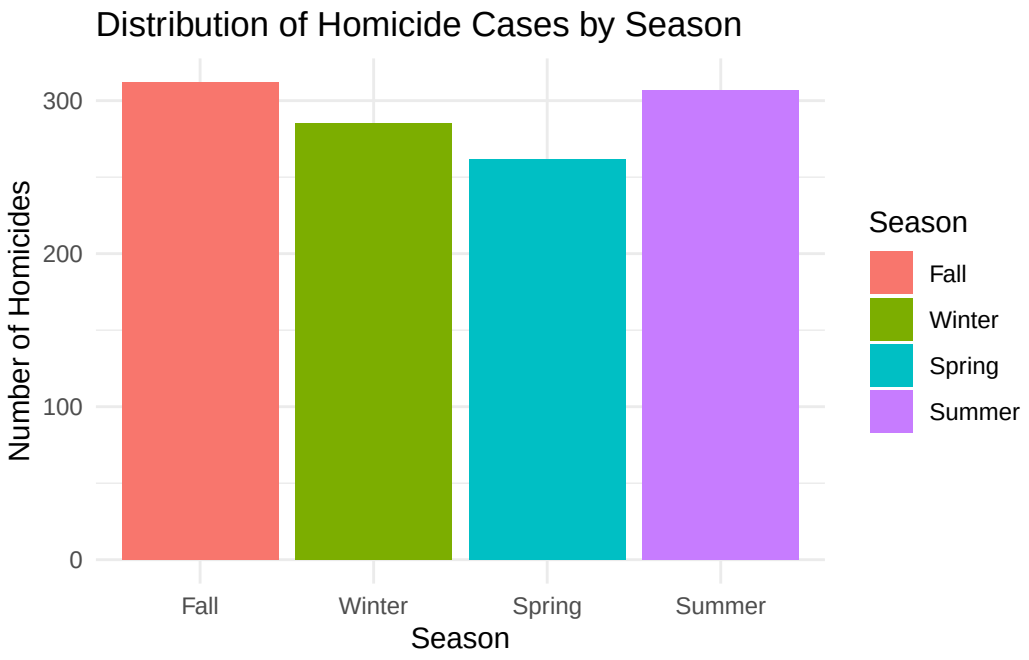

Figure 4: Distribution of Homicide Cases by Season

To investigate the relationship between geographical location and homicide cases, we constructed Figure 5. This bar plot illustrates the distribution of homicide cases in Toronto's 140 neighbourhoods. This visualization enables the identification of patterns or areas of concern in the city. The spectrum of homicide cases in different neighbourhoods spans from 0 to as many as 31 cases. While most neighbourhoods report fewer than 10 cases, it is noteworthy that several neighbourhoods stand out with significantly higher homicide incidences compared to the rest.

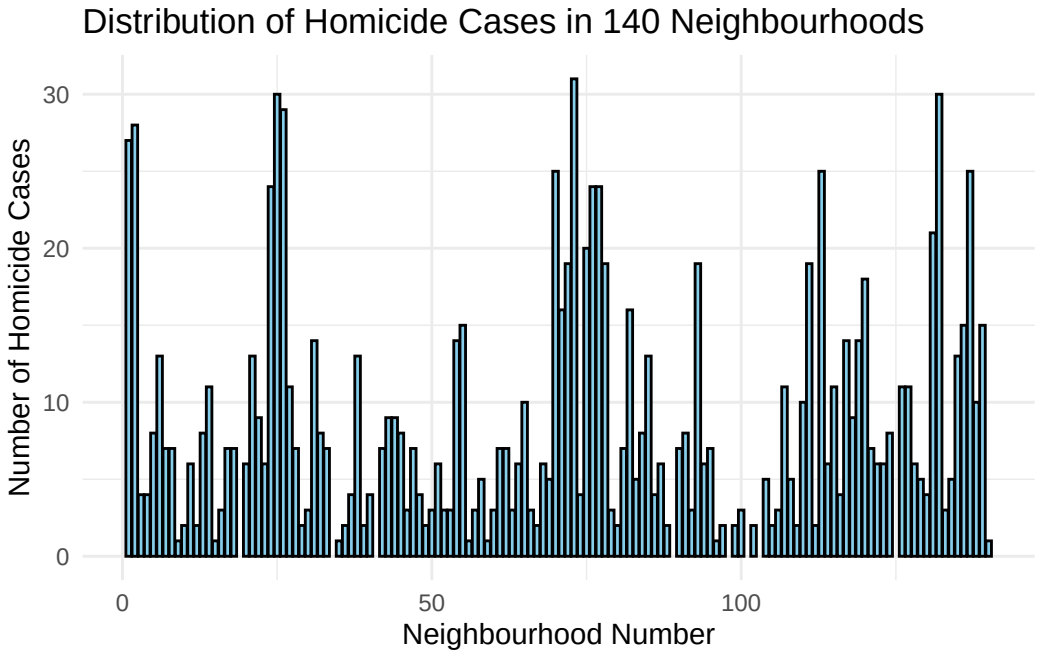

Figure 5: Distribution of Homicide in neighbourhoods

2.2 Homicide Analysis in Top Five Neighbourhood

Having observed the significantly higher cases of homicide in specific neighbourhoods, I selected the five neighbourhoods with the highest number of homicide cases-neighbourhoods 73, 25, 132, 26, and 2 with neighbourhood 73 having the highest number of cases of 31 and neighbourhood 2 with 28 cases. Through targeted analysis, we can discern if there are specific patterns or trends in the occurrence of homicide incidences in these neighbourhoods and generalize the conclusion in broader contexts.

In order to observe the relationship between various related factors and homicide cases, I examined the correlation of the occurrence of each case with each day of the week, season, and type of homicide (Table 5, Table 4, Table 6). Interestingly, we do not observe a specific trend in the relation between homicide cases and the day of the week. Similar to our earlier analysis on Figure 4, the correlation between the number of homicide cases and a specific day

of the week or the weekends is also not noticeable. We could attribute this result to a limited sample size, given the relatively small number of homicide cases in the city compared to other crimes. However, we do notice that just like our earlier results, the amount of homicide caused by shooting is consistently higher than any other method. This reaffirms that shooting is the predominant type of homicide in Toronto.

Table 4: Homicide Cases in Most Frequent neighbourhoods by Season

Homicide Cases in Most Frequent Neighbourhoods by Season

	Top 5 Neighbourhoods				
season	73	25	132	26	2
Fall	4	9	5	9	10
Winter	7	5	15	9	9
Spring	5	6	4	4	5
Summer	15	10	6	7	4

Table 5: Homicide Cases in Most Frequent Neighbourhoods by Day of the Week

Homicide Cases in Most Frequent Neighbourhoods by Day of the Week

	Top 5 Neighbourhoods				
day_of_week	73	25	132	26	2
Monday	8	7	3	2	4
Tuesday	3	7	6	2	5
Wednesday	5	1	2	6	2
Thursday	4	3	4	6	3
Friday	4	6	6	5	1
Saturday	3	1	3	6	7
Sunday	4	5	6	2	6

Table 6: Homicide Cases in Most Frequent Neighbourhoods by Type

Homicide Types in Most Frequent Neighbourhoods

	Top 5 Neighbourhoods				
homicide_type	73	25	132	26	2
Other	10	2	10	3	3
Shooting	13	21	20	17	21

Stabbing	8	7	0	9	4

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3 Discussion

The outcome of our overall analysis of homicide cases by season and by each day of the week throughout Toronto generally aligns with our specific focus on the top five neighbourhoods with the highest homicide cases. We discern no significant correlation between homicide occurrences and particular timings. Homicides may have a slightly higher likelihood of occurring on weekends compared to weekdays but there is no distinct pattern of homicide cases in a certain season.

However, one characteristic that stands out throughout the entirety of our analysis is the prominence of shooting as the major type of homicide. This trend has prevailed from 2004 to 2020. We could conclude that shooting is the predominant cause of homicide over time. This finding emphasizes the need for potential targeted interventions specifically addressing challenges associated with gun violence in Toronto.

We do not observe an apparent increase or decrease in homicide cases throughout time. However, after the number of homicide cases peaked in 2018, the cases are experiencing a decline. Cases caused by shootings are also in decline during the same period. This decline may be associated with how Toronto gun violence has dropped by 30% over the past five years (Balintec (2023)).

Our analysis would be more comprehensive if there were more detailed data on relevant characteristics and a larger sample of homicide cases. However, due to the scope of our dataset and the rarity of homicide occurrences, it is very difficult to offer a firm statement regarding a specific factor causing more homicide incidences or predicting homicide incidences are more likely to happen on certain dates. Despite these limitations, our analysis provides a valuable foundation for future research targeted in addressing homicide dynamics in Toronto.

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