The Impact of Seasonal Changes on Mortality Rates in Toronto*

Death Registry Statistics in Toronto

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This paper analyzes death toll data across four civic centers (Scarborough, North York, Toronto and Etobicoke)) from 2011 to 2023, with the goal of identifying seasonal patterns and regional differences in mortality, which is made available to the public from Open Data Toronto. Utilizing death registry data, we categorized the deaths by season—Winter, Spring, Summer, and Fall—and aggregated the death tolls across the years for each region. The analysis revealed notable variations in mortality trends across both seasons and civic centers. The results show that Winter consistently reported higher death tolls compared to other seasons across most regions. Using visual representations generated through ggplot2, the findings highlight significant regional disparities, which suggest possible influences of environmental or socio-economic factors contributing to seasonal mortality trends.

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*Code and data are available at: https://github.com/Wang20030509/Sta304-Term-Paper-1

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1 Introduction

Seasonal variations in mortality have been a focus of public health research for many years, driven by fluctuations in temperature, disease prevalence, and environmental factors. In colder regions, such as Toronto, winter months often coincide with increased mortality, particularly among vulnerable populations like the elderly or homeless. Numerous studies have linked these seasonal changes to temperature variations, with colder months typically showing elevated mortality rates (Madaniyazi, Chung, et al. 2021) (Madaniyazi, Armstrong, et al. 2021)

This study examines the impact of seasonal changes on death tolls in Toronto between 2011 and 2023, utilizing death registry data from Open Data Toronto. By categorizing deaths by season—Winter, Spring, Summer, and Fall—and analyzing regional variations across the city's four civic centers (Scarborough, North York, Toronto, and Etobicoke), the paper aims to uncover significant trends in mortality rates throughout the year. Previous studies have shown that temperature plays a significant role in seasonal mortality (Martin et al. 2012) (Zhang et al. 2024), with cold winters and heat waves contributing to an increased death toll, but the exact influence of socio-economic and environmental factors at the local level remains under-explored (Madaniyazi, Chung, et al. 2021) (Madaniyazi, Armstrong, et al. 2021).

Past research has focused heavily on the role of extreme weather events and temperature variability in driving mortality rates. Findings suggest that colder months are associated with higher mortality, particularly due to cardiovascular and respiratory issues exacerbated by low temperatures (Madaniyazi, Chung, et al. 2021). This paper builds on those findings by exploring how these seasonal dynamics manifest in a large urban environment like Toronto, where varying environmental and socio-economic conditions across different neighborhoods might influence mortality outcomes (Martin et al. 2012).

The results of this study will offer new insights into seasonal mortality trends within Toronto and inform public health initiatives aimed at mitigating mortality spikes during colder months. Understanding these patterns is crucial for guiding policy decisions and healthcare resource allocation during high-risk periods (Zhang et al. 2024).

The remainder of this paper is structured as follows. Section 2 describes the dataset and cleaning methods used in the analysis. Section 3 presents the results and key findings, and Section 4 offers a discussion of the implications of these results as well as limitations and potential next steps.

2 Data

The datasets used for this report are the latest delay statistics from the 2023 year, `Death Registry Data` (City of Toronto Open Data Team 2024), which was published by the City Clerk's Office from `Open Data Toronto` (Gelfand 2022).

These deaths registry statistics were downloaded, cleaned, parsed, analyzed, and visualized using R (R Core Team 2023), a statistical programming language, with package support from `tidyverse` (Wickham et al. 2019), a collection of libraries which included the following packages that were utilized:

- `ggplot2` (Wickham 2016)
- `dplyr` (Wickham et al. 2023)
- `readr` (Wickham, Hester, and Bryan 2023)
- `tibble` (Müller and Wickham 2023)

For additional assistance with cleaning, the `janitor` (Firke 2023) package was used. For additional assistance with report generation the `knitr` (Xie 2023) package was used.

2.1 Overview Data

Table 1: Sample Data

_id	CIVIC_CENTRE	DEATH_LICENSES	PLACE_OF_DEATH	TIME_PERIOD
27767	ET	69	Outside City Limits	2011-01
27768	ET	341	Toronto	2011-01
27769	NY	141	Outside City Limits	2011-01
27770	NY	540	Toronto	2011-01
27771	SC	129	Outside City Limits	2011-01
27772	SC	545	Toronto	2011-01

The Death Registry Statistics dataset provided by the City of Toronto Open Data team contains key information about death registrations across various civic centers in Toronto. The dataset includes the following columns:

- CIVIC_CENTRE: This column represents the civic center code, corresponding to one of Toronto's four main civic centers: Scarborough (SC), North York (NY), Toronto (TO), and Etobicoke (ET). These civic centers are used to geographically categorize the death registrations.

- DEATH_LICENSES: This column records the number of deaths registered within a given month at each respective civic center. It represents the official count of death licenses issued, reflecting the mortality data across the city over different time periods.
- PLACE_OF_DEATH: This column provides information on where the death occurred. It indicates whether the death took place inside the City of Toronto or outside its city limits. This information can help to identify trends in deaths occurring within the jurisdiction of the city as opposed to those occurring elsewhere.
- TIME_PERIOD: This column captures the specific month and year during which the death licenses were registered. The time period is formatted as "YYYY-MM", allowing for temporal analysis of death registrations over time. The combination of month and year in this column enables the dataset to be used for tracking changes in death registration patterns on a monthly and yearly basis.

The death registry that Table 1 samples contains 947 entries in total. The dataset provides valuable insights into the geographic and temporal distribution of death registrations across Toronto, which is the main dataset used to analyze seasonal mortality patterns and potential regional disparities from 2011 to 2023.

2.2 Cleaned Data

Table 2: Sample Cleaned Data

ID	Civic Centre	Death Toll	Place of Death	Year	Month	Season
27767	ET	69	Outside City Limits	2011	Jan	Winter
27768	ET	341	Toronto	2011	Jan	Winter
27769	NY	141	Outside City Limits	2011	Jan	Winter
27770	NY	540	Toronto	2011	Jan	Winter
27771	SC	129	Outside City Limits	2011	Jan	Winter

2.3 Summarized Data

3 Results

Our results are summarized in Figure 3 Something Something Something

Table 3: Summarized Data

(a) Total Death toll by Season (2011-2023)

Season	Civic Centre	Death Toll
Fall	ET	21827
Spring	ET	26261
Summer	ET	19696
Winter	ET	25173
Fall	NY	19565
Spring	NY	23605
Summer	NY	21262
Winter	NY	18923
Fall	SC	15428
Spring	SC	17055
Summer	SC	13422
Winter	SC	16744
Fall	TO	2666
Spring	TO	1900
Summer	TO	1866
Winter	TO	2074

(b) Average Deaths by Month (2011-2023)

Month	Mean of the Death Toll
Apr	280.0658
Aug	238.8049
Dec	215.2222
Feb	248.9630
Jan	336.4444
Jul	221.5570
Jun	233.6707
Mar	285.1000
May	297.9277
Nov	266.1299
Oct	252.1039
Sep	254.3117

(c) Death Toll by Place of Death Across 12 Months

Month	Place of Death	Death Toll
Apr	Outside City Limits	4424
Aug	Outside City Limits	4420
Dec	Outside City Limits	3128
Feb	Outside City Limits	4391
Jan	Outside City Limits	5713
Jul	Outside City Limits	3594

(d) Death Toll by Civic Centre Across 12 Months

Month	Civic Centre	Death Toll
Apr	ET	7378
Aug	ET	5906
Dec	ET	5624
Feb	ET	8806
Jan	ET	10743
Jul	ET	6676

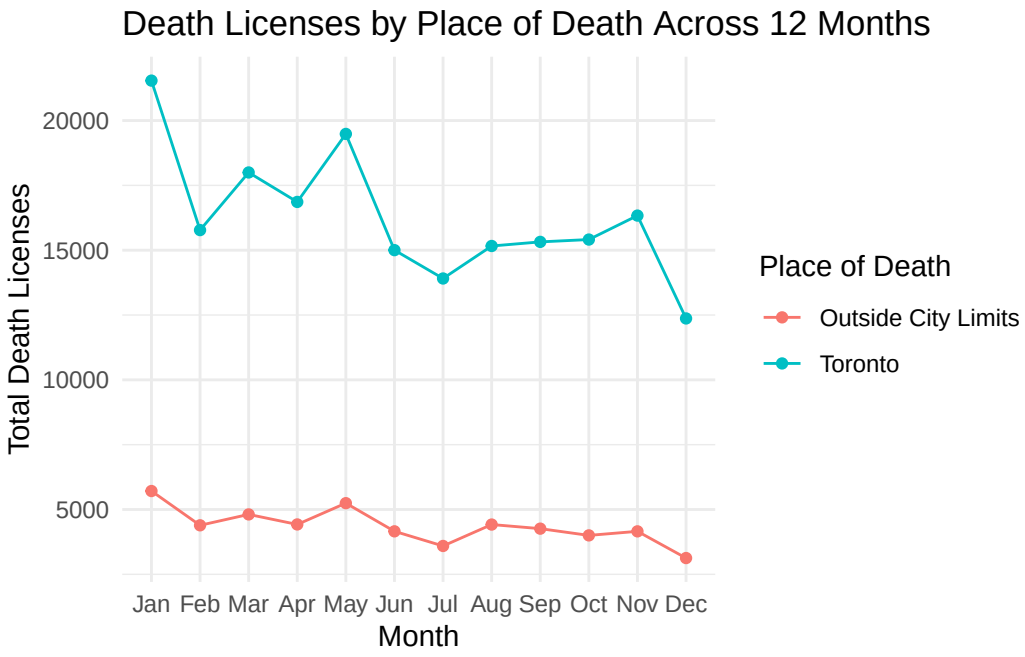

Figure 1: Death Toll by Civic Centre Across 12 Months (2011-2023)

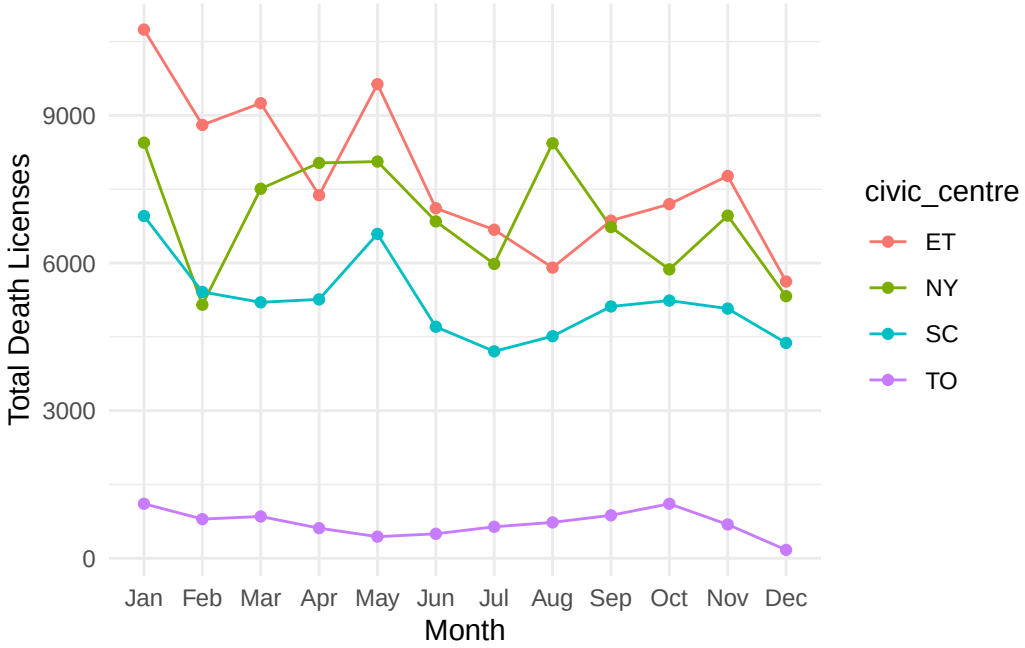

Figure 2: Death Toll by Civic Centre Across 12 Months (2011-2023)

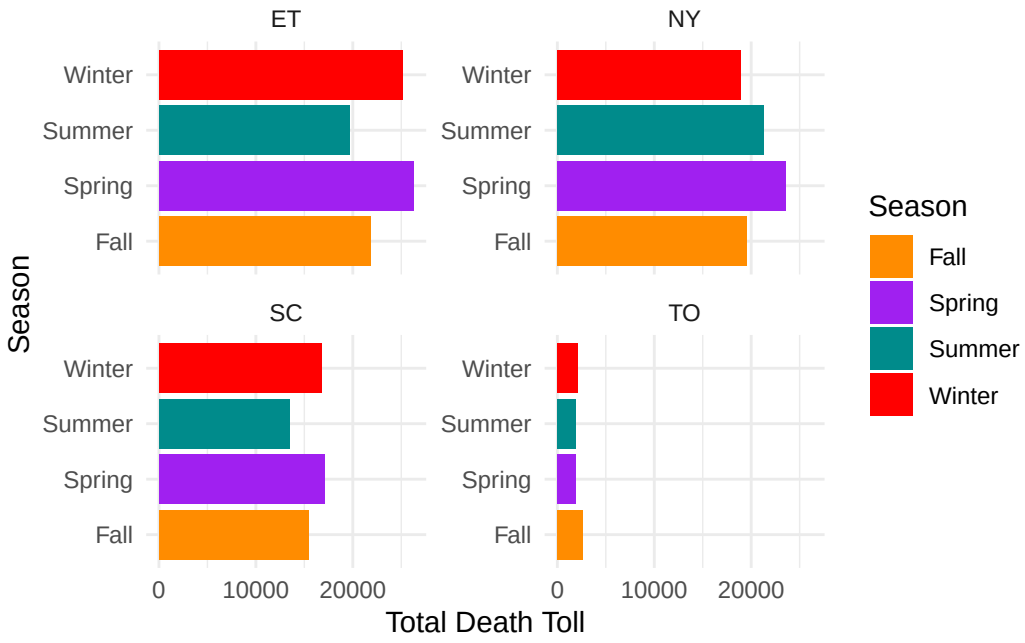

Figure 3: Total Death Toll by Season and Region (2011-2023)

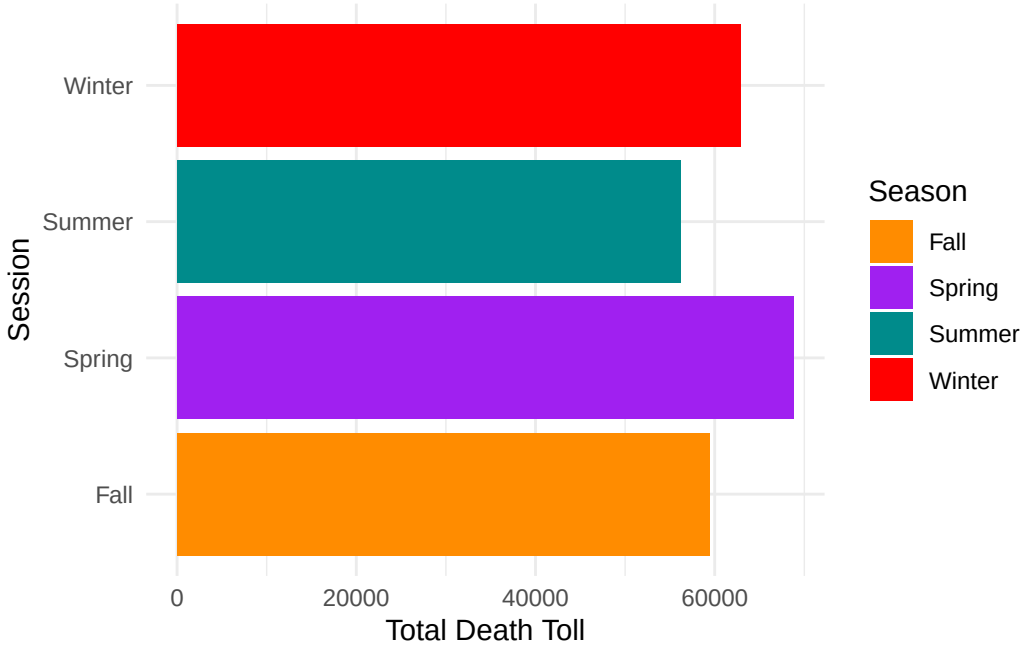

Figure 4: Total Death toll by Season (2011-2023)

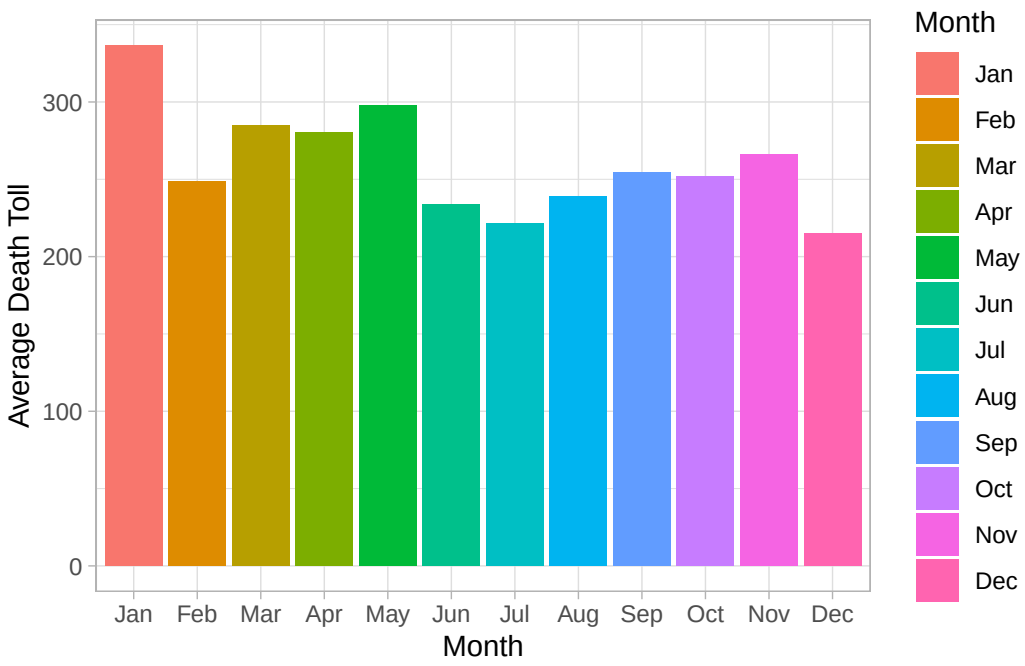

Figure 5: Average Death Toll by Month (2011-2023)

4 Discussion

4.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

4.2 Second discussion point

4.3 Third discussion point

4.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

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