

Trends in Mortality Rates*

Analyzing Deaths Among Shelter Residents from 2007 to 2024

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Poverty and homelessness remain pressing issues in today's society, particularly evident in downtown Toronto, where many individuals still sleep on the streets or in subway stations. Due to these harsh living conditions, these individuals often face severe health issues, leading to an increased risk of mortality. Luckily, there are services in the city that provide place for some of these people to live. This paper analyzes the trends in mortality rates among shelter residents in the City of Toronto from 2007 to 2024, highlighting patterns over time and exploring the factors contributing to these rates.

1 Introduction

Homelessness is a well-known issue worldwide, particularly in impoverished cities and countries. It was reported approximately 15 million homeless individuals globally by the World Economic Forum in 2021 (Homeless World Cup Foundation (2024)). Although homelessness is more severe in developing countries, it does not mean that developed places are free from this problem. In downtown Toronto, a city that hosts numerous corporate headquarters and some of the Canada's top educational institutions, homelessness remains a significant issue. Homeless individuals can be seen on the streets and even in subway stations, showing the persistent challenges faced by the city and those without stable housing.

Homeless individuals often live and sleep in harsh and unsanitary conditions, which severely compromises their health. They are more likely to get diseases and suffer from various health problems due to limited access to proper healthcare and nutrition. Consequently, this significantly increases their risk of mortality. The City of Toronto is also deeply concerned about this issue and has implemented numerous aid programs and support services to assist homeless individuals. Despite these efforts, many homeless individuals continue to face significant

*Code and data are available at: <https://open.toronto.ca/dataset/deaths-of-shelter-residents/>

challenges, and there are still a considerable number of deaths occurring at relatively young ages

In this paper we will look at the data Toronto (2024), which explore the trends in mortality rates among shelter residents in the City of Toronto from 2007 to 2024, highlighting patterns over time and exploring the factors contributing to these rates. The data indicates that mortality rates were relatively low, with fewer than five deaths per month in the prior 2019. However, after 2019, there was a sharp increase in the number of deaths, peaking in 2021 and 2022. This surge can be attributed to the onset of the COVID-19 pandemic in 2019, which significantly impacted public health and resulted in many fatalities.

The data was examined more in depth by analyzing the mortality rate and average mortality rate between male and female homeless individuals in shelter residences. There are a lot more male death compare to female death every single year. Additionally, the average age at death is around 50 to 60 years old, which is relatively young compared to Canada's life expectancy. Future details about the findings will be discussed in the discussion section.

The remainder of this paper is structured as follows. Section 2 will discuss the data used in the study, highlighting key aspects and limitations. Section 3 will focus on generating graphs using the data presented in Section 2. Section 4 will elaborate on the graphs from Section 3, providing interpretations and possible explanations for the findings.

2 Data

2.1 Raw Data

The data used in this paper is access in from Open Data Toronto and the particular data set used was the Deaths of Shelter Residents (Toronto (2024)). To analysis the data and creating graphs using the data, following package that was build in the (R program R Core Team (2023)) was used: tidyverse (Wickham et al. (2019)), dplyr (Wickham et al. (2023)), knitr (Xie (2023)), and ggplot2 (Wickham (2023)).

The data used in this paper was collected by the Toronto Shelter and Support Services Division since 2007. Shelters are required to notify the City of Toronto within 24 hours of a death and submit a written report within 30 days. Consequently, the data is updated monthly on the Open Data Toronto website. The raw data set includes 10 variables and 18 observations, covering the period from 2007 to 2024, as shown in Table 1 ((**Tab-Table1?**)). The key variables used in this paper include: year, total decedents, average age at death for all decedents, male decedents, average age at death for male decedents, female decedents, and average age at death for female decedents. Additionally, the monthly death counts from 2007 to 2024 will be used for graphing, comprising 212 observations.

Table 1: Trends in Mortality Rates Among Shelter Residents (2007-2024)

Year	Total Dece- dents	Avg Age of Death (All)	Male Dece- dents	Avg Age of Death (Male)	Female Dece- dents	Avg Age of Death (Female)	Trans/NB/2SAvg Age of Dece- dents	Death (Trans/NB/2S)
2007	24	52	22	53	2	50	0	0
2008	26	50	19	47	7	58	0	0
2009	16	56	14	59	2	37	0	0
2010	21	54	11	53	10	56	0	0
2011	21	54	15	53	6	56	0	0
2012	18	53	18	53	0	0	0	0
2013	16	52	13	51	3	59	0	0
2014	30	57	26	57	4	58	0	0
2015	45	58	41	58	4	64	0	0
2016	33	57	27	58	6	47	0	0
2017	35	56	23	54	12	58	0	0
2018	26	57	23	58	3	45	0	0
2019	48	54	38	57	10	43	0	0
2020	74	51	54	51	19	50	1	0
2021	132	47	96	48	31	48	5	33
2022	110	51	81	52	29	49	0	0
2023	91	51	78	52	12	45	1	0
2024	47	50	35	49	7	52	5	50

Yearly Mortality rate from 2007-2024

2.2 Limitation of Data

The Deaths of Shelter Residents data is part of a larger database shared by Toronto Public Health (TPH), which also includes deaths of homeless individuals living in shelters and outdoors (City of Toronto (2024a)). Therefore, the findings in this paper focus solely on homeless individuals residing in shelters, which may limit the data set and lead to potential biases that do not fully represent the mortality of all homeless individuals.

Other limitations include the absence of certain data points, such as the cause of death and additional information that could identify the deceased, due to confidentiality concerns. This lack of information may impact the reasoning behind the findings, as possible explanations will need to be drawn from other research and sources.

3 Results

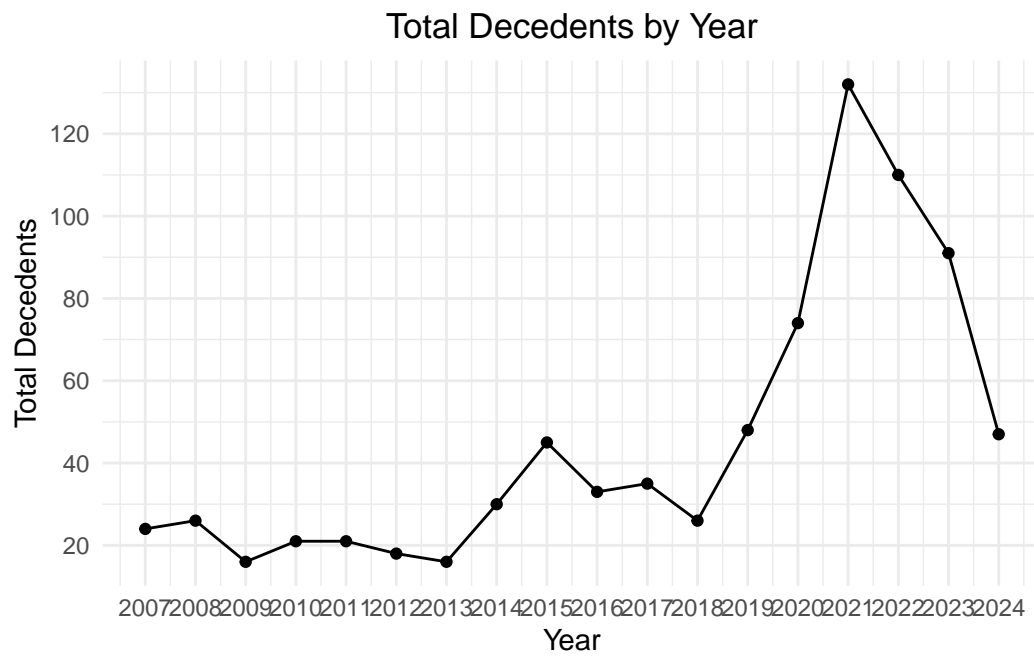


Figure 1: Yearly Mortality rate from 2007-2024

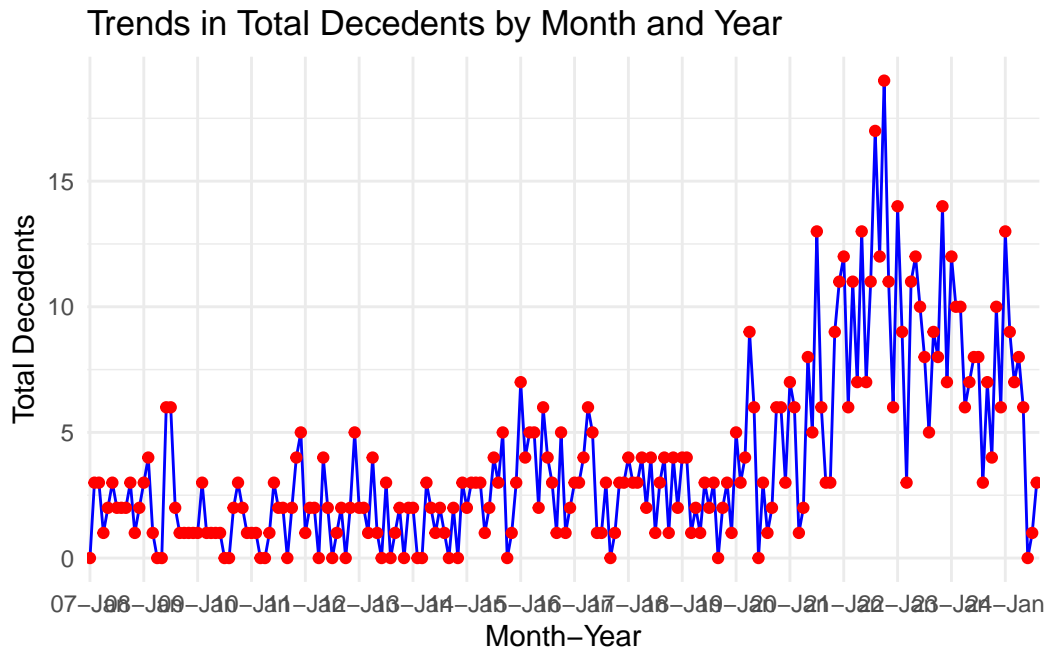


Figure 2: Yearly Mortality rate from 2007-2024

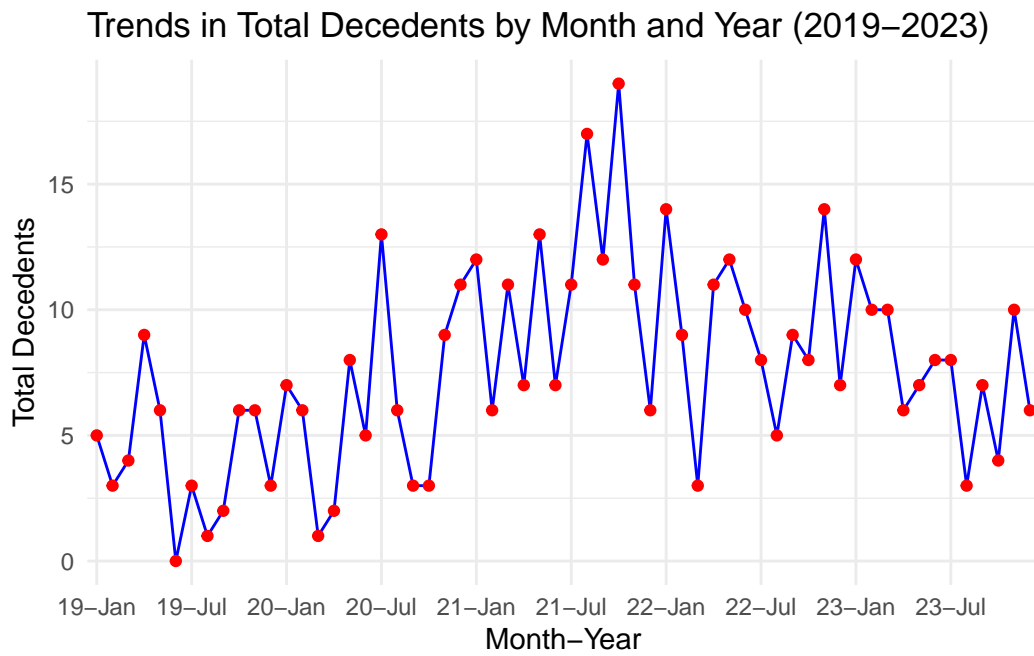


Figure 3: Yearly Mortality rate from 2019-2023

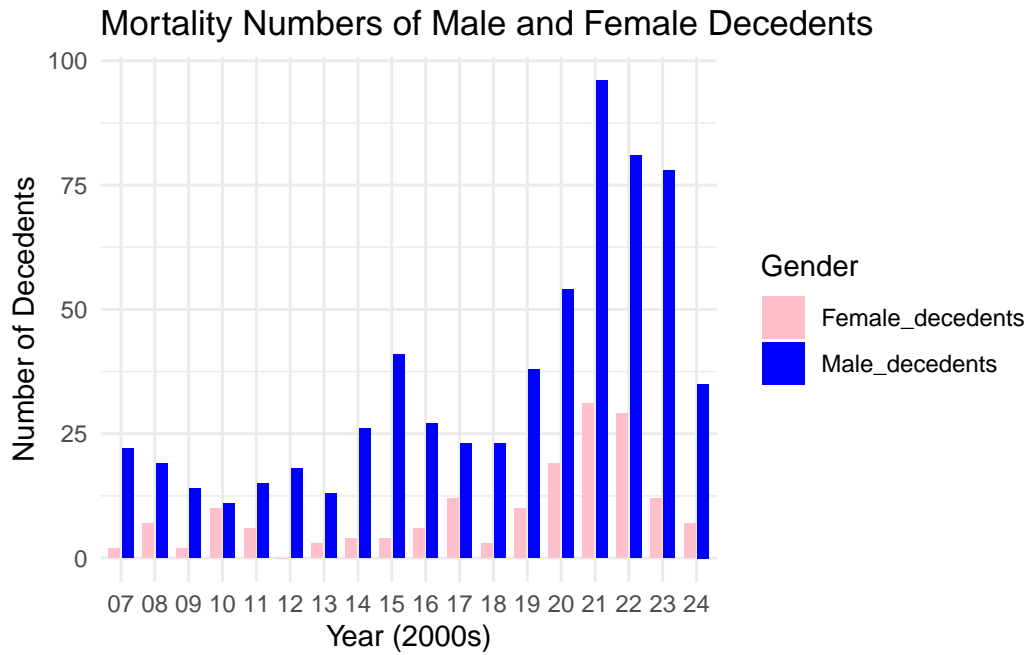


Figure 4: Total Decedents Female VS Male

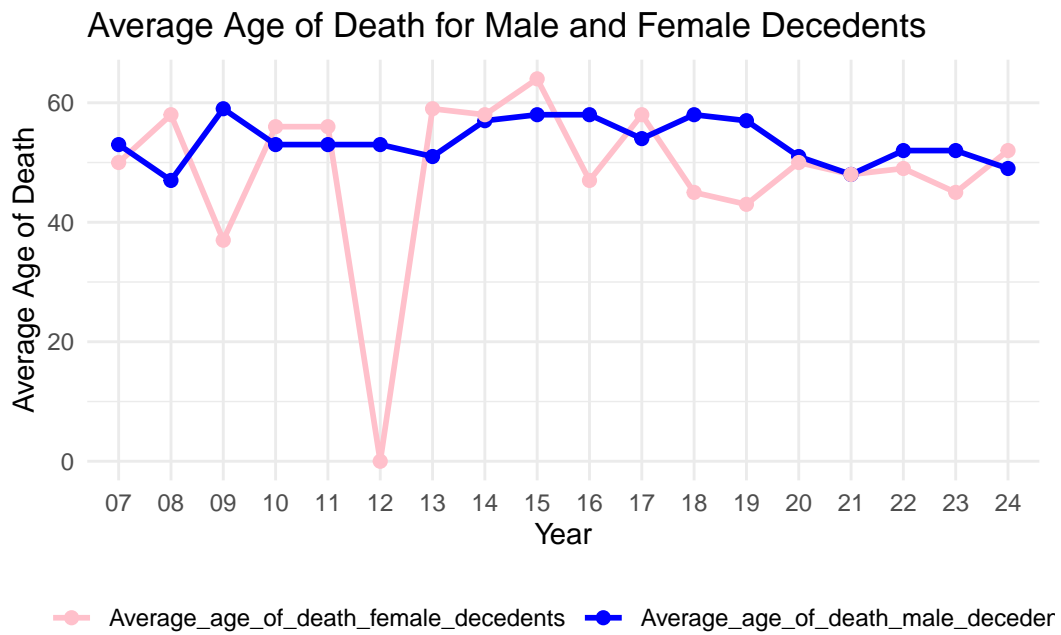


Figure 5: Total Decedents Female VS Male

4 Discussion

4.1 First discussion point

Figure 1 shows the total number of decedents among homeless individuals living in shelters. The graph visualizes two notable increases in 2013 and 2019. According to making connection with other sources, the primary causes of these increases are linked to macro health conditions occurring during those times.

In 2013, there was an influenza outbreak across Ontario that lasted from 2013 to 2016. Influenza is a viral infection that affects the nose, throat, and sometimes the lungs, leading to respiratory illness. Symptoms can range from mild to severe, and in some cases, the flu can result in death. The best way to prevent infection is to get vaccinated each year (Centers for Disease Control and Prevention (2023)). There is a clear trend of increasing deaths up until 2015, followed by a drop in 2016. This pattern closely resembles the total number of influenza outbreaks reported in the article “Influenza Outbreaks in Ontario Hospitals” (Cameron et al. (2019)). According to Table 1 in the article, the number of outbreaks increased from 38 in 2013-2014 to 117 in 2014-2015, then decreased to 36 in 2015-2016. This rise and fall in outbreaks corresponds with the trends observed in Figure 1, where the number of deaths peaked in 2015 and then significantly declined in 2016, coinciding with the flu being brought under control.

One notable point is that in the article, the fatality rate for the 2014-2015 outbreak was only 2.4%, despite the hundreds of flu outbreaks that occurred that year. However, Figure 1 shows that the number of deaths in 2015 was around 45. This discrepancy can be explained by the fact that the data in the article pertains to hospital outbreaks, where individuals have access to better medical care. In contrast, homeless individuals may lack the resources to seek treatment, leading to a higher number of deaths in this population.

4.2 Second discussion point

Another clear increasing trend in the mortality rate is evident in 2019, as shown in Figure 1. This is not surprising, given that people around the world were experiencing and still recovering from the COVID-19 pandemic, which began in 2019 and continued until the end of 2023. To better understand the impact, the Government of Canada (Government of Canada (2024)) continuously updates the numbers of cases and deaths related to the pandemic, showing a significant rise in fatalities from 2021 to 2022, followed by a decline after 2023.

Additionally, the challenging living conditions faced by homeless individuals, compared to those of wealthier individuals who also experienced hardships during this time, suggest that the mortality rates among shelter residents are likely to remain elevated. COVID-19 was also a primary driver behind the large number of deaths, as evidenced by the immediate decrease in the number of deaths following the post-pandemic period shown in Figure 3.

4.3 Third discussion point

From Figure 4, it is evident that the mortality rate for males is significantly higher than that for females. One reason for this observation is that the proportion of male residents in shelters is greater than that of female residents, with 60% male and only 40% female (City of Toronto (2024b)). Nonetheless, research has shown that females tend to live longer than males at all stages of life, from infancy to young adulthood and into retirement (Our World in Data (2024)). The overall reason for the higher male mortality rate compared to females can be attributed to genetic factors as well as differences in health awareness and behaviors between the two genders.

Figure 5 indicates that the average age at death for homeless individuals living in shelters ranges from 50 to 60 years. According to data from the World Bank, the life expectancy in Canada is approximately 81 years, which suggests that the average age at death for homeless individuals is relatively young (Data Commons (2024)). Despite the increasing life expectancy in today's society, as health and technology continue to evolve, homeless individuals still die at a younger age due to financial constraints and limited access to resources.

4.4 Weaknesses and next steps

The findings in this paper represent a small aspect of what is happening in the world, focusing specifically on the homeless population. While these results cannot be used to draw definitive conclusions about broader trends, they do provide insights into patterns that may be occurring on a larger scale.

The connections discussed in this section are not statistically proven, as no models were run to demonstrate the correlation between the deaths of homeless individuals residing in shelters and the various possible explanations mentioned. In addition, the actual causes of death may remain unknown due to confidentiality restrictions and are inferred based on global events that could have contributed to these fatalities.

Other data will have to be gathered and analyzed using appropriate models to establish a solid scientific connection. For instance, to establish a connection between the increase in death numbers in 2013 and 2019 and the flu outbreak and pandemic, data on flu-related deaths and pandemic-related deaths should be gathered and analyzed. A model should be run to test the relationship between these variables.

Appendix

A Additional data details

B Model details

B.1 Posterior predictive check

In `?@fig-ppcheckandposteriorvsprior-1` we implement a posterior predictive check. This shows...

In `?@fig-ppcheckandposteriorvsprior-2` we compare the posterior with the prior. This shows...

B.2 Diagnostics

`?@fig-stanareyouokay-1` is a trace plot. It shows... This suggests...

`?@fig-stanareyouokay-2` is a Rhat plot. It shows... This suggests...

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