My title*

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Toronto's shelter system and homeless population has experienced a significant increase over recent years. Using Toronto's shelter system data and deaths of people experiencing homelessness data from the City of Toronto's Open Data Portal, this paper analyzes when deaths most frequently occur in Toronto's homeless population and the trends of different demographics that utilized shelters from 2018 to 2023. This paper studies the month of death of unhoused individuals, the age group that visits shelters the most, the trend of the average number of individuals who are actively homeless using shelters, the average number of people who return to shelters after acquiring housing, and the gap separating the average number of male and female shelter users from 2018 to 2023. This paper finds that deaths of unhoused individuals occur most frequently in January. Additionally, males and individuals aged 25 to 44 account for a significantly larger portion of shelter users. This study may be employed to inform policy makers of the demographic most at risk of homelessness and of where to target solutions for tackling the underlying issue of homelessness in Toronto.

1 Introduction

Toronto's shelter system provides a temporary home to those who are in need of one. The system is essential for Toronto's homeless population and refugees as the shelters uphold standards that support meals and laundry accommodations, mental health and harm reduction services, and a host of counselors to direct and aid individuals acquire permanent housing. Although the shelters provide a multitude of services and aid to secure permanent housing for the unhoused, there are still many who return to shelters after securing housing (Toronto, n.d.).

The affordable housing crisis is directly contributing to Toronto's shelter availability crisis. As Toronto's housing market has skyrocketed in the past few years, it is no wonder why

*Code and data are available at: LINK.

Toronto's shelters are receiving significantly more visitors. The City of Toronto states that, "One in three of Toronto's homeowner and renter households (373,965 households or 32 per cent) experienced affordability issues," (Toronto 2023). According to CBC News, an estimated average of at least 273 individuals were turned away from shelters in June 2023, which was a record high for Toronto shelters (Draaisma 2023). The amount of families seeking warm beds has been unmatched and as Toronto's winters can be extremely frigid, shelter availability is becoming increasingly more critical. Moreover, as temperatures continue to reach record highs as a consequence of climate change, Toronto's summers become increasingly more hazardous for unhoused individuals.

Analyzing and studying Toronto's shelter system data can reveal those within society that are struggling the most with securing housing. This paper analyzes the demographics that utilize Toronto's shelter system and the month of deaths of unhoused individuals. Analyzing different age groups that utilize shelters are of particular interest to produce a predictive model that determines whether specific months impact the likelihood of death in Toronto's homeless population. In addition, this paper is also concerned with the actively homeless population and different demographics, such as refugees and single adults, that stay in shelters. The main estimand of this study is the effect of months on deaths in individuals experiencing homelessness in Toronto. This paper finds that the largest demographic of shelter users are males and individuals aged 25 to 44, and the death of people experiencing homelessness occurs most frequently in January.

The remainder of this paper is structured as follows: the Data section details the collection and processing of Toronto shelter system and deaths of unhoused individuals data. Additionally, the section includes discussion on the measurement of the original dataset and the variables examined in this study. The following Models section discusses the regression model used and the Results section displays the tables and figures that model the data. The Discussion section draws conclusions from those tables and figures and details the importance of my findings and weaknesses of the paper.

2 Data

2.1 Sources

The data utilized in this paper was retrieved from the City of Toronto's Open Data Portal (*Opendatatoronto: An r Package for Accessing Open Data from Toronto*, n.d.). The statistical programming language R was used to retrieve, clean, and process the data (R Core Team 2022). In particular, the following R packages were used: `opendatatoronto` (*Opendatatoronto: An r Package for Accessing Open Data from Toronto*, n.d.), `tidyverse` (Wickham et al. 2021), and `dplyr` (Wickham et al. 2023) for data acquisition; `janitor` (Firke 2023) and `arrow` (Richardson et al. 2024) for data cleaning and processing; `rstanarm` (Goodrich et al. 2024)

and `marginaleffects` (Arel-Bundock 2024) for modeling; and `ggplot2` (Wickham 2016) for creating figures.

2.2 Toronto Shelter System Data

The shelter system data acquired from the City of Toronto's Open Data Portal provided monthly statistics of Toronto's shelters from January 2018 to December 2023. For each month, the data set included information for the entire population, chronic visitors, refugees, families, youth, single adults, and non-refugees. The information of interest for each of those demographics are the number of individuals that returned to shelters after previously acquiring housing, those that are new to the shelter system, those that are actively homeless, those that identify as male and female, and the number of individuals in each age group in that demographic. The age groups consist of visitors under 16, 16 to 24, 25 to 44, 45 to 64, and 65 years of age or older.

2.3 Deaths of People Experiencing Homelessness Data

The death count for individuals experiencing homelessness data acquired from the City of Toronto's Open Data Portal provided monthly statistics of deaths from January 2017 to June 2023.

2.4 Measurement

The City of Toronto's Open Data Portal is Toronto's official source for city data relating to each of its divisions and agencies. Thus, the quality of the data used in this study is reliable; however, the Portal does state that there were limitations to the data sets. For the Toronto shelter system data, a limitation or possible avenue for measurement error for the data is that the data excludes individuals who do not sleep in shelters or who use other resources for shelter, such as public infrastructure and buildings open all hours (Portal, n.d.b). Additionally, for the deaths of people experiencing homelessness data, the data only includes reported deaths (Portal, n.d.a). Therefore, the number of deaths could be much higher as unreported deaths were excluded from the dataset.

3 Model

The goal of my modelling strategy is to utilize the Poisson distribution to build a Poisson regression model as the data is concerned with count data and λ distributes probabilities over non-negative integers.

3.1 Model set-up

Define y_i as the number of deaths and the explanatory variable as the month. I am interested in how the number of deaths differs by month.

$$y_i|\lambda_i \sim \text{Poisson}(\lambda_i) \tag{1}$$
$$\log(\lambda_i) = \beta_0 + \beta_1 \times \text{Month}_i \tag{2}$$
$$\beta_0 \sim \text{Normal}(0, 2.5) \tag{3}$$
$$\beta_1 \sim \text{Normal}(0, 2.5) \tag{4}$$
$$\tag{5}$$

I run the model in R (R Core Team 2022) using the `rstanarm` package of Goodrich et al. (2024). I use the default priors from `rstanarm`.

4 Results

4.1 Relationship Between Deaths of Homeless Individuals and Months

Table 1: Examining the number of deaths of homeless individuals occuring in each month

	First model
(Intercept)	2.33
	(0.11)
month_of_deathAug	0.24
	(0.16)
month_of_deathDec	0.15
	(0.16)
month_of_deathFeb	0.11
	(0.16)
month_of_deathJan	0.38
	(0.15)
month_of_deathJul	0.34
	(0.16)
month_of_deathJun	−0.02
	(0.16)
month_of_deathMar	−0.12
	(0.16)
month_of_deathMay	0.34
	(0.15)
month_of_deathNov	0.31
	(0.16)
month_of_deathOct	0.15
	(0.16)
month_of_deathSep	0.04
	(0.17)
Num.Obs.	78
Log.Lik.	−238.249
ELPD	−257.3
ELPD s.e.	13.5
LOOIC	514.6
LOOIC s.e.	27.1
WAIC	513.7
RMSE	4.76

4.2 Relationship Between Deaths of Homeless Individuals and Months

Table 2 helps with interpreting the model results in Table 1. Table 2 suggests that in our dataset, compared to April, August tends to have around three additional deaths, December tends to have around two additional deaths, February tends to have one additional death, and so on. Most notably, compared to April, January tends to have five additional deaths–the most additional deaths out of all the months; July tends to have around four additional deaths–the second most additional deaths out of all the months; and March tends to have one less death–the least amount of additional deaths out of all the months.

Table 2: The estimated difference in the number of deaths of homeless indivuals in each month

	Compare month	Estimate
1	Aug - Apr	2.85
79	Dec - Apr	1.65
157	Feb - Apr	1.14
235	Jan - Apr	4.74
313	Jul - Apr	4.17
391	Jun - Apr	-0.20
469	Mar - Apr	-1.19
547	May - Apr	4.19
625	Nov - Apr	3.78
703	Oct - Apr	1.67
781	Sep - Apr	0.39

4.3 Average Number of Indivduals for each Age Group

Figure 1 demonstrates that individuals age 25 to 44 enter shelters the most on average, followed by individuals age 45 to 64, then those under 16 and those age 16 to 24. Additionally, individuals 65 and over enter shelters the least on average. This result is expected as the cost of living in Toronto has risen significantly in recent years and individuals age 25 to 44 must have a large percentage of their income allotted to rent (Heaven 2023). This quota may be difficult to reach every month as the price of other necessities have also risen, such as grocery bills. Individuals over 65 may not choose to stay in shelters as they have other options, including retirement homes and elder care centres.

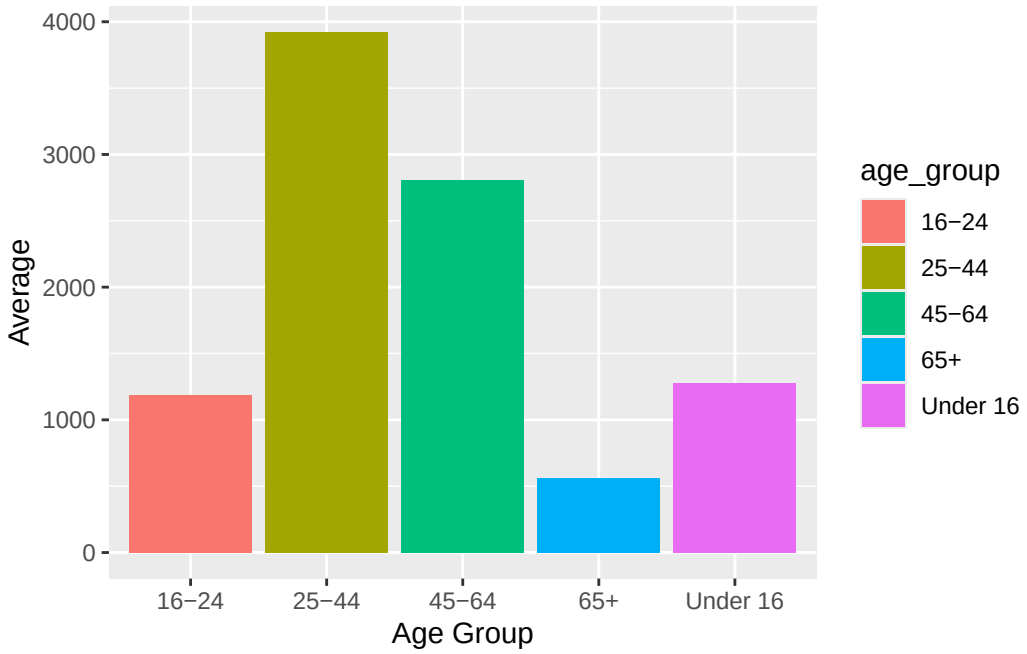

Figure 1: The average of all shelter visitors in each age group over 6 years from 2018 to 2023

4.4 Average Number of Actively Homeless Indivduals

Figure 2 demonstrates that the average number of actively homeless individuals increased from 2018 to 2019, significantly decreased from 2019 to 2020, remained almost unchanged from 2020 to 2021, experienced a sharp increase from 2021 to 2022, and increased more from 2022 to 2023. Additionally, the average in 2023 reached a high of almost 10500 actively homeless individuals. The housing crisis and spike in the cost of living since the COVID-19 pandemic is a notable contributing factor to the increase in homelessness and shelter usage after 2021. The significant decrease in the average number of actively homeless individuals using shelters from 2019 to 2021 can also be attributed to the pandemic: many public areas were restricted or fully closed for physical distancing purposes.

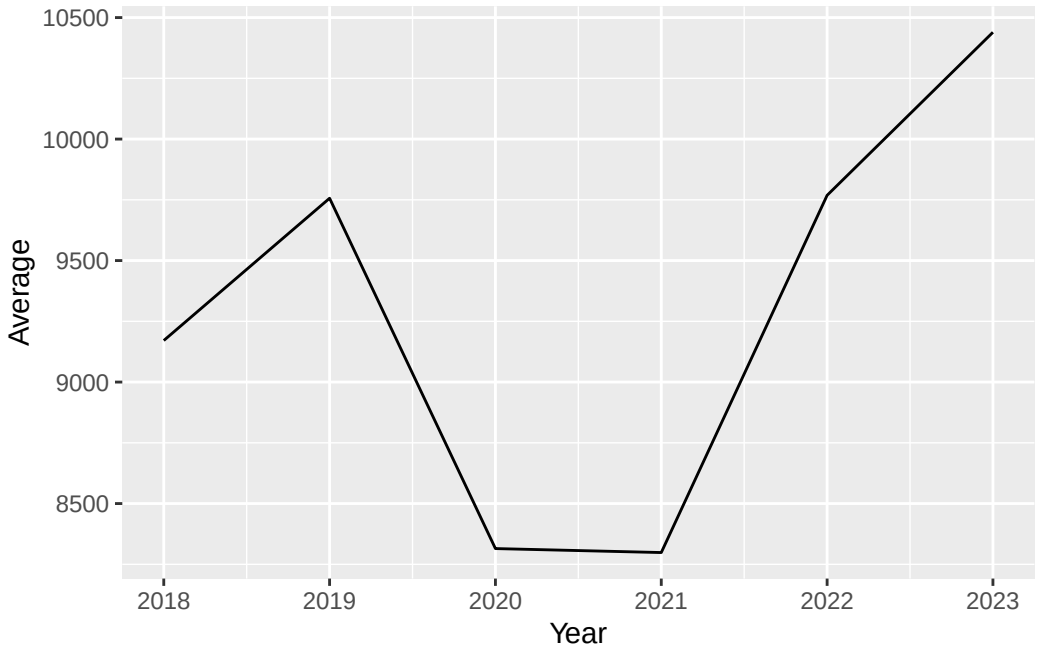

Figure 2: The average number of actively homeless people from 2018 to 2023

4.5 Average Number of Shelter Returners

Figure 3 illustrates that the average number of individuals who return to shelters each year increased each year from 2018 to 2021, then the average began to decrease from 2021 to 2022 and significantly declined from 2022 to 2023. In addition, less than 60 individuals returned to a shelter in 2023. This outcome is surprising as it was expected to find that after acquiring housing, many would return to shelters due to the rise of rental prices and the overall housing and cost of living crisis in recent years. Additionally, Figure 2 demonstrates the significant increase in homeless individuals. A reason that can explain why many homeless people who acquire housing and become homeless again but do not return to shelters is that more individuals are experiencing homelessness; thus, shelter capacity is quickly filling up and many returning visitors are being turned away (Draaisma 2023).

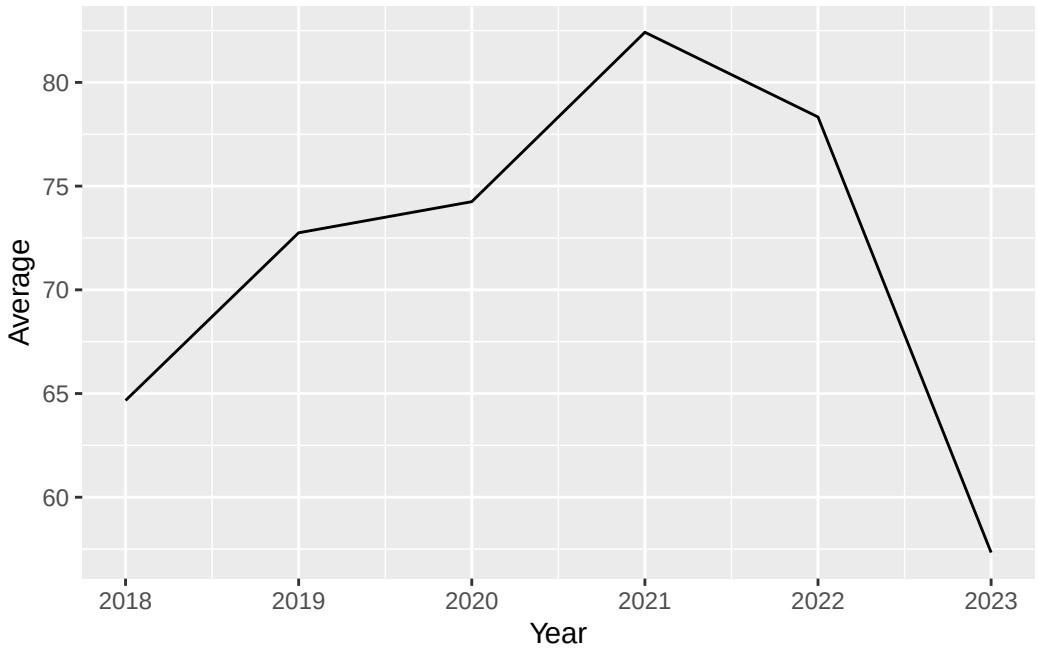

Figure 3: The average of number of visitors who returned to shelters from 2018 to 2023

4.6 Average Number of Males and Females

There is an average of over 5000 male individuals in shelters each year (blue); whereas for female individuals (red), there is an average of less than 4000. Figure 4 illustrates how every year, the average number of male shelter users is significantly higher than that of female users. Additionally, from 2020 to 2021, the average number of male shelter users increased while the average number of female shelter users decreased. In regards to other annual intervals, the average for males and females both increase from 2018 to 2019, decrease from 2019 to 2020, and increase from 2021 to 2023.

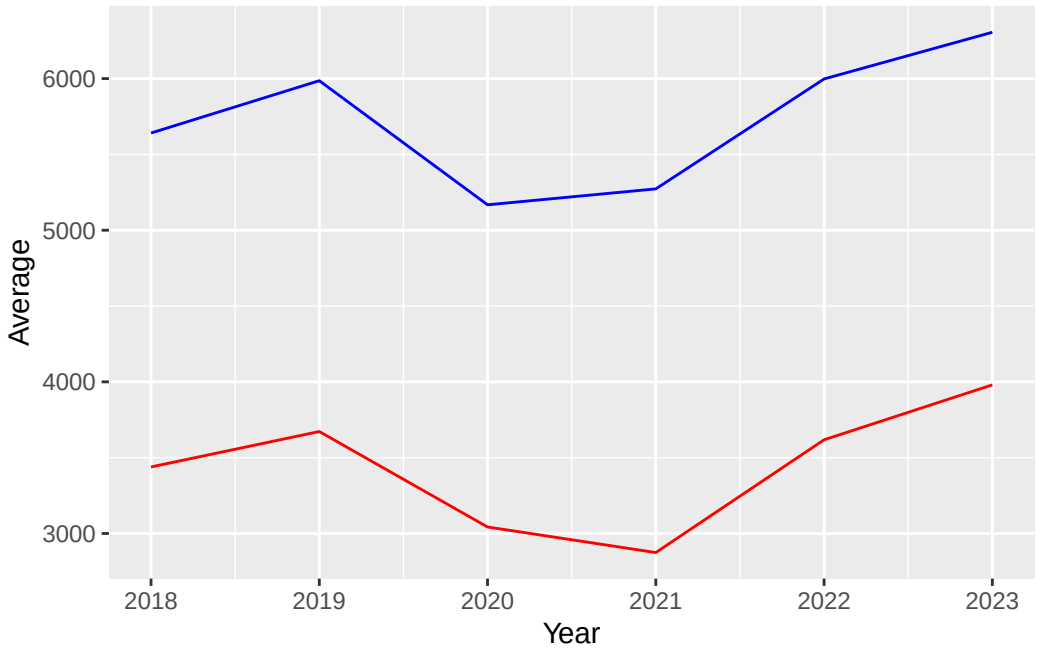

Figure 4: The average of male and female shelter visitors from 2018 to 2023

5 Discussion

5.1 First discussion point

5.2 Weaknesses and next steps

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