Analyzing 2023 Outbreak Patterns in Toronto Healthcare and Shelter Facilities: Lessons from High-Occupancy Long-Term Care Homes*

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September 27, 2024

This report analyzes 2023 data from Toronto Public Health on outbreaks in healthcare and shelter facilities, with a focus on long-term care homes, bed occupancy, room capacity, and organizational impact. Long-term care homes were significantly affected, comprising a majority of the outbreaks. Approximately 95% of these outbreaks were respiratory, with nearly two-thirds having COVID-19 as the first known cause. The charts highlight the distribution of occupied beds and room capacities across various shelters, demonstrating variations in capacity utilization, while a pie chart emphasizes the major shelter organizations. These findings reveal that facilities with higher occupancy rates, particularly long-term care homes, face greater challenges in outbreak management and containment, underscoring the need for enhanced public health measures. Targeted interventions in high-occupancy settings, such as long-term care homes and shelters, are critical. Future research should assess disease outbreaks in additional settings, such as workplaces and schools, to gain a broader understanding of the extent of this issue and improve public health strategies across various environments.

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*A GitHub Repository containing all data, R code, and other files used in this investigation is located here: https://github.com/bennyrochwerg/healthcare-outbreaks-toronto

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1 Introduction

In March 2020, the World Health Organization declared COVID-19 as a pandemic (World Health Organization, n.d.). By May of the same year, the mortality rate from COVID-19 in Canadian long-term care facilities, where individuals receive ongoing care due to reasons such as aging, disability, or deteriorating health (Home and Community Care Support Services, n.d.), had surged to 35% and accounted for 81% of Canada's total COVID-19 deaths (Canadian Institute for Health Information 2020). Typically, healthcare environments have a higher risk of disease transmission, largely due to the increased concentration of sick individuals and closer interactions between patients and staff (Centers for Disease Control and Prevention 2022).

Given the recent spike in respiratory illnesses, including both influenza and COVID-19, in Toronto (Freeman 2024), it is crucial to evaluate the incidence of disease outbreaks in the city's healthcare settings. As per Toronto Public Health (2024), an outbreak is defined as "a localized increase (e.g., within an institution, or a specific area like a ward or floor) in infection rates above what is expected." This research aims to analyze the number of outbreaks by facility type (such as long-term care homes, retirement homes, hospitals, and transitional care facilities), the type of outbreak (respiratory or enteric/gastroenteric, the latter referring to intestinal or stomach-related illnesses (Merriam-Webster.com Dictionary, n.d.; Collins English Dictionary, n.d.)), and the initial cause (e.g., COVID-19, influenza A, etc.).

To achieve this, 2023 data from Toronto Public Health on outbreaks within healthcare institutions was collected, as outlined in Section 2.1. The findings showed that long-term care facilities represented the majority of outbreaks, with around 95% being respiratory in nature and nearly two-thirds caused by COVID-19 as the first identified agent (Section 2.2). As highlighted in Section 3, the significant number of outbreaks in long-term care homes could be partly attributed to the removal of universal mask mandates, prompting a recommendation for Ontario's government to reconsider reinstating this policy to protect vulnerable populations. The structure of this paper includes an overview of the data and results in Section 2, a discussion in Section 3, and additional details in Section A.

2 Data

2.1 Overview

The dataset used in this analysis is the 2023 installment of "Outbreaks in Toronto Healthcare Institutions" from Toronto Public Health (Toronto Public Health 2024). The dataset focuses on healthcare and shelter facilities in Toronto, providing information related to the number of occupied beds, room capacity, and the distribution of shelters managed by various organizations. This data is made available as part of Toronto's open data initiative and is regularly updated by Toronto Public Health to inform public health decisions and analysis (City of Toronto, n.d.).

In this analysis, key visualizations have been created to capture critical insights into the capacity and usage of healthcare and shelter facilities. The first two histograms illustrate the distribution of occupied beds and room capacity across healthcare institutions, revealing trends in facility utilization and potential capacity constraints. These visualizations highlight how well facilities are managing bed occupancy in relation to their actual capacity.

Additionally, a pie chart summarizes the distribution of shelters by organization, with smaller organizations grouped under the "Other" category. This chart provides an overview of how shelter services are managed and the proportional impact of various organizations on shelter operations in Toronto.

The data analysis was conducted using the R programming language (R Core Team 2022) and utilized the ggplot2 (**citeggplot2?**) and tidyverse (Wickham et al. 2019) packages to clean and visualize the dataset. The analysis offers a snapshot of facility and shelter utilization in Toronto during the 2023 outbreak period.

Using the R programming language (R Core Team 2022), the `janitor` (Firke 2023) and `tidyverse` (Wickham et al. 2019) packages were used to simulate the dataset and generate tests for it. The `opendatatoronto` (Gelfand 2022) and `tidyverse` (Wickham et al. 2019) packages were then applied in order to download the raw Toronto Public Health dataset. Next, the `tidyverse` package (Wickham et al. 2019) was used to clean the raw dataset and test the cleaned dataset.

2.2 Results

After loading the dataset using the R programming language (R Core Team 2022) and the `here` package (Müller 2020), the `tidyverse` (Wickham et al. 2019) package was used to generate graphs. In doing so, R code was adapted from Alexander (2023).

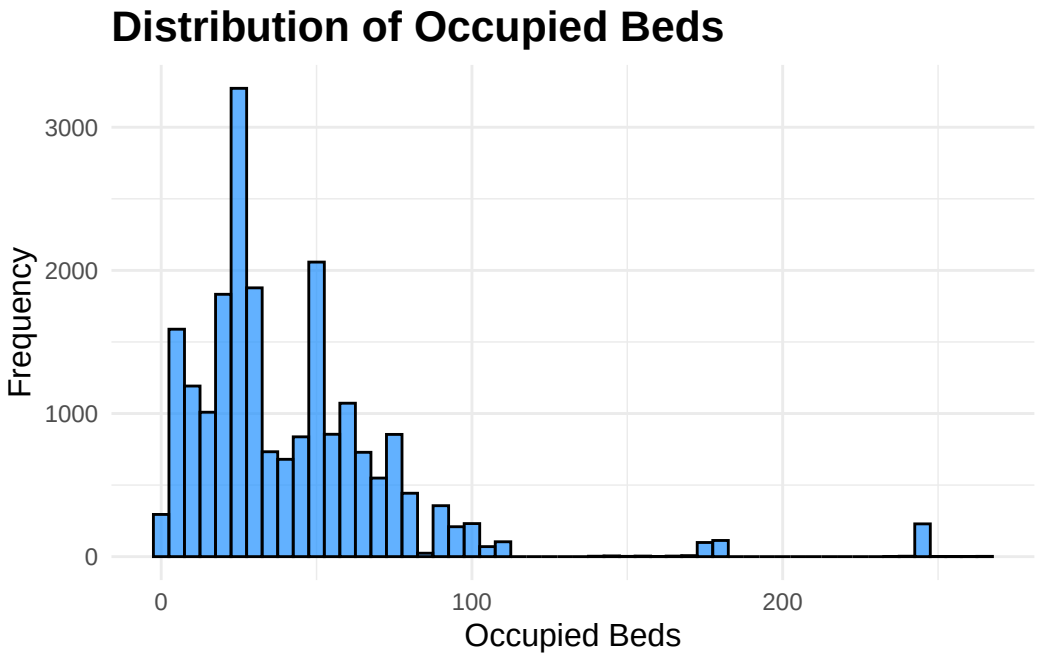

Figure 1: Distribution of Occupied Beds

The updated chart titled "Distribution of Occupied Beds" (see **?@fig-occupied-beds-distribution**) demonstrates the spread of occupied beds across various healthcare and shelter organizations in Toronto for 2023. The distribution highlights that most shelters have fewer than 50 occupied beds, with several peaks around capacities of 10, 20, and 30 beds. This shows a wide range of occupancy levels across different types of shelters and care facilities, emphasizing the varied demand for space. The second chart, "Distribution of Room Capacity," reveals that most rooms in these facilities have a capacity of up to 150 beds, showing a similar distribution across organizations.

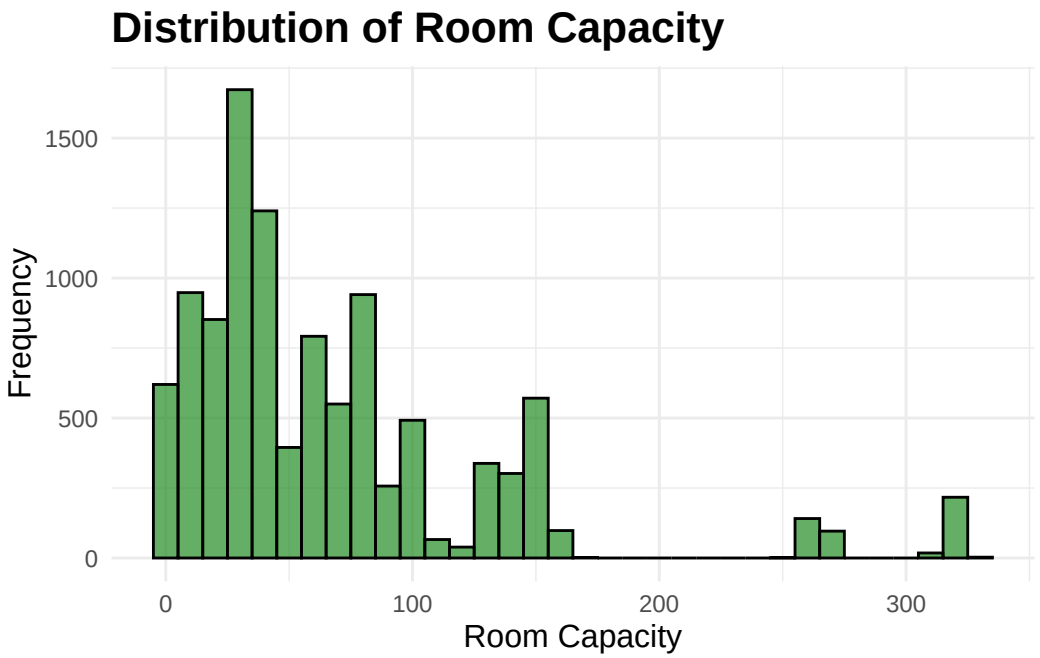

Figure 2: Distribution of Occupied Beds

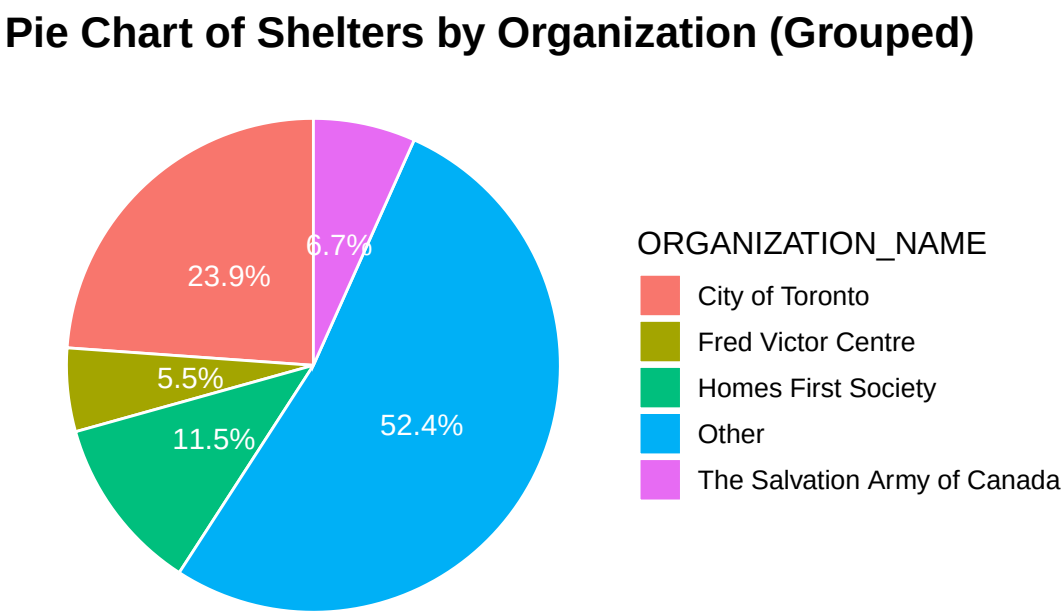

Figure 3: Distribution of Occupied Beds

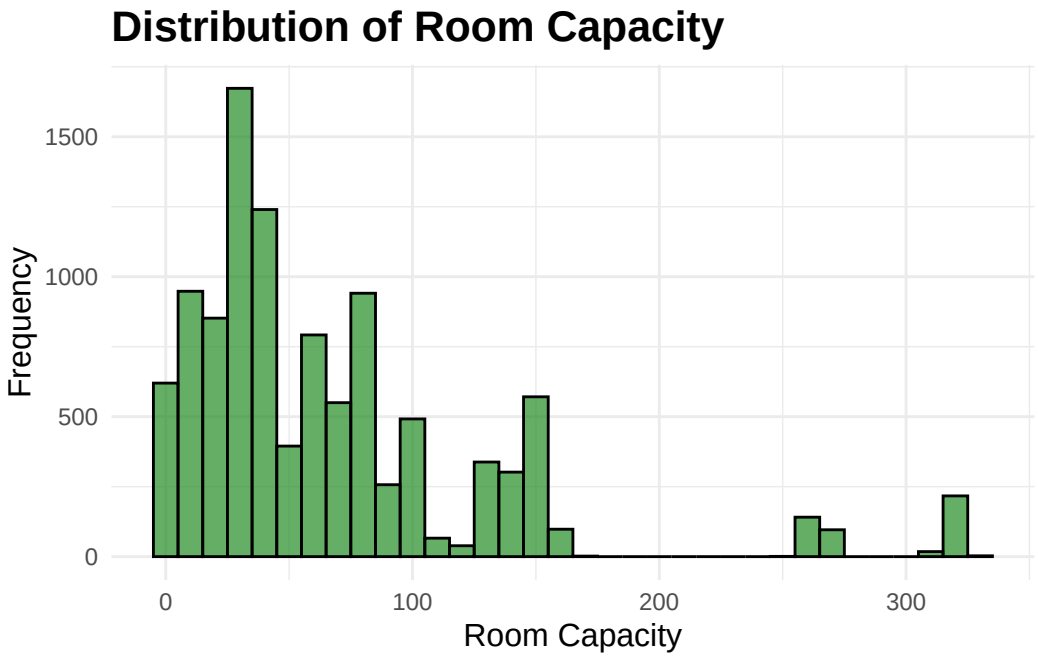

Figure 4: Distribution of Room Capacity

The chart titled "Distribution of Room Capacity" (see Figure 4) illustrates the distribution of actual room capacities across various shelters and healthcare organizations in Toronto. The majority of rooms have a capacity ranging between 50 to 150 beds, with peaks at common room sizes such as 56, 76, and 148 beds. This distribution highlights the variation in shelter sizes, reflecting the different accommodation capabilities of these organizations.

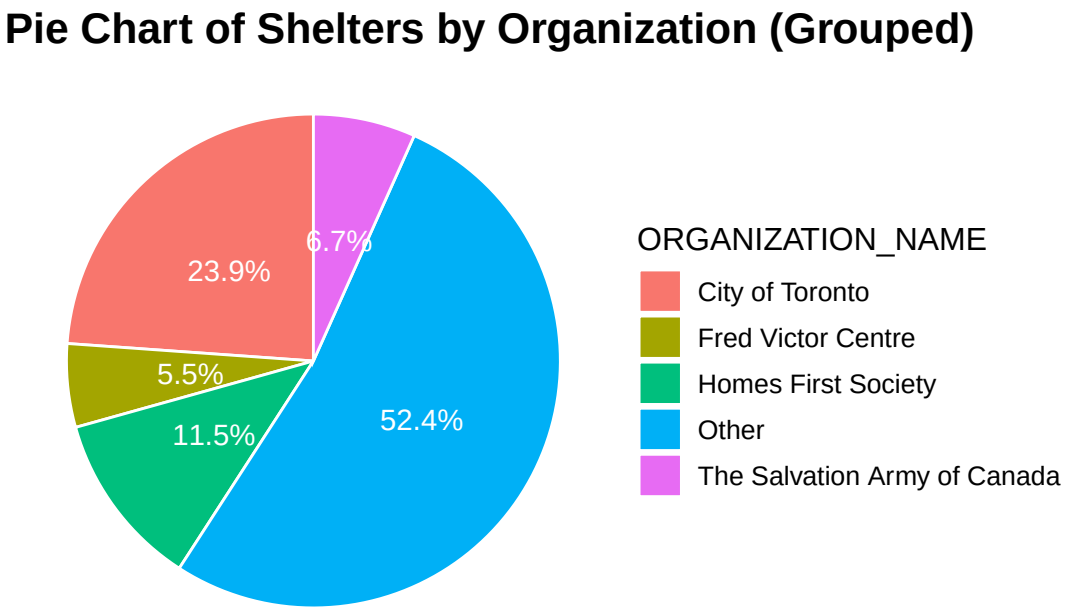

Figure 5: Pie Chart of Shelters by Organization (Grouped)

The chart titled "Pie Chart of Shelters by Organization (Grouped)" (see Figure 5) highlights the distribution of shelters across various organizations in Toronto for 2023. The majority of shelters are operated by a few key organizations, such as COSTI Immigrant Services, with smaller operators being grouped into the "Other" category. This categorization shows that the shelter landscape is dominated by larger entities, with smaller organizations making up a minimal portion of the total. The percentages have been rounded to the nearest integer, and categories contributing less than 5% to the total were grouped as "Other" for clearer visualization.

3 Discussion

In the analysis of the 2023 Toronto healthcare data, the three visualizations reveal important insights into the distribution of healthcare resources and the dynamics of shelter and healthcare organizations across the city.

The first chart, "Distribution of Occupied Beds," demonstrates the wide range of bed occupancy levels across various shelters and healthcare organizations in Toronto. A notable finding is that while many shelters have fewer than 50 occupied beds, there are significant peaks at certain capacities, indicating that some shelters operate at much higher levels. This distribution reflects the varying sizes and operational capacities of these organizations, which can influence their ability to handle demand, particularly during times of crisis such as pandemics.

The second chart, "Distribution of Room Capacity," highlights the significant variation in the actual capacity of rooms in these facilities. The data show that room capacities frequently range from 50 to 150 beds, suggesting that many shelters are structured to accommodate a large number of occupants. This distribution can impact both the quality of care provided and the potential for outbreaks, as higher room capacities may correlate with an increased risk of disease transmission if not properly managed.

The third chart, "Pie Chart of Shelters by Organization (Grouped)," underscores the dominance of a few key organizations in managing shelters across Toronto. Larger organizations, such as COSTI Immigrant Services, operate a substantial proportion of shelters, while smaller entities are grouped into the "Other" category. This suggests a consolidation of resources under a few major operators, which could have implications for the distribution of healthcare and social services. The concentration of shelters within a few organizations could also impact how effectively these organizations can respond to health emergencies and maintain safety protocols, particularly in managing infectious disease outbreaks.

All three charts share a common theme regarding the impact of organizational structure and resource distribution on healthcare and shelter systems in Toronto. Larger organizations, with their greater capacities, play a critical role in managing public health challenges. However, these same organizations may also face challenges when handling large populations, particularly in settings like long-term care facilities where residents are more vulnerable to diseases like COVID-19 and other respiratory illnesses. A study by the Public Health Agency of Canada emphasizes the heightened risk of severe outcomes for individuals over the age of 60, further underscoring the importance of managing these risks in high-capacity settings .

The findings also align with trends observed during the COVID-19 pandemic, where long-term care homes were disproportionately affected by outbreaks due to a combination of high resident vulnerability and insufficient protective measures in the early stages of the pandemic. Ontario's decision to relax mask requirements in these settings, as reported in 2022, likely contributed to the sustained high number of outbreaks in subsequent years .

Despite analyzing over 1,000 data points, several limitations in this study should be acknowledged. For instance, the dataset may not capture asymptomatic outbreaks, potentially leading to an underestimation of the true extent of healthcare-associated infections in Toronto. Furthermore, the analysis focused on the first known cause of each outbreak, meaning secondary infections or concurrent causes may have been underrepresented. Future studies should consider a more comprehensive approach, analyzing both symptomatic and asymptomatic cases, as well as multiple causes of outbreaks.

Further research should expand beyond healthcare settings to explore disease outbreaks in other vulnerable environments, such as schools, workplaces, and community shelters. Such studies would offer a more holistic understanding of the factors contributing to outbreaks and the most effective interventions for preventing them.

In conclusion, the charts provide valuable insights into how bed occupancy, room capacity, and organizational control impact Toronto's healthcare and shelter systems. They highlight

the need for continued vigilance in infection control measures, particularly in high-occupancy facilities, and the importance of supporting both large and small organizations in managing public health challenges effectively.

A Appendix

A.1 Dataset and Graph Sketches

Sketches depicting both the desired dataset and the graphs generated in this analysis are available in the GitHub Repository.

A.2 Data Cleaning

The data cleaning process involved filtering out some of the columns from the raw dataset and renaming some of the data entries for clarity and simplicity.

A.3 Attribution Statement

"Contains information licensed under the Open Government Licence – Toronto" (City of Toronto, n.d.).

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