My title*

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First sentence. Second sentence. Third sentence. Fourth sentence.

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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

1 Introduction

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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). In Ontario, the law mandates that respiratory and gastroenteric infections in healthcare facilities are followed and that any outbreaks, regardless of verification, are reported to public health entities such as Toronto Public Health (Toronto Public Health 2024). Based on this information (or these measurements), Toronto Public Health updates this dataset on a weekly basis (Toronto Public Health 2024). Moreover, this dataset is considered to be "open data" (Toronto Public Health 2024) and can be utilized for a variety of purposes as long as an attribution statement is attached (Section A.2) and the link to the City of Toronto's Open Data License is added (City of Toronto, n.d.b).

The variables or measurements included in this analysis are "Type of Location" (named "Outbreak Setting" in the original dataset), which refers to the nature of the healthcare offered at each facility; "Type of Outbreak", which indicates whether each outbreak is respiratory, enteric, or other in nature; and "Outbreak First Known Cause" (named "Causative Agent-1" in the original dataset), which denotes the first discovered pathogen based on at least one of the outbreak's cases (Toronto Public Health 2024).

Only two other datasets involving outbreaks, titled "COVID-19 Cases in Toronto" and "Daily Shelter & Overnight Service Occupancy & Capacity", could be identified following a search of the City of Toronto's Open Data Catalogue (City of Toronto, n.d.a). However, none of these datasets pertain specifically to healthcare settings in Toronto and were thus not used in this analysis.

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) and `knitr` (Xie 2023)

packages were used to generate tables and graphs. In doing so, R code was adapted from Alexander (2023).

Table 1: Outbreaks by type of healthcare location in Toronto in 2023

Type of location	Number of outbreaks	Proportion of total outbreaks
Long-Term Care Home	601	0.56
Retirement Home	195	0.18
Hospital (Chronic Care)	131	0.12
Hospital (Acute Care)	107	0.10
Hospital (Psychiatric)	19	0.02
Transitional Care	13	0.01

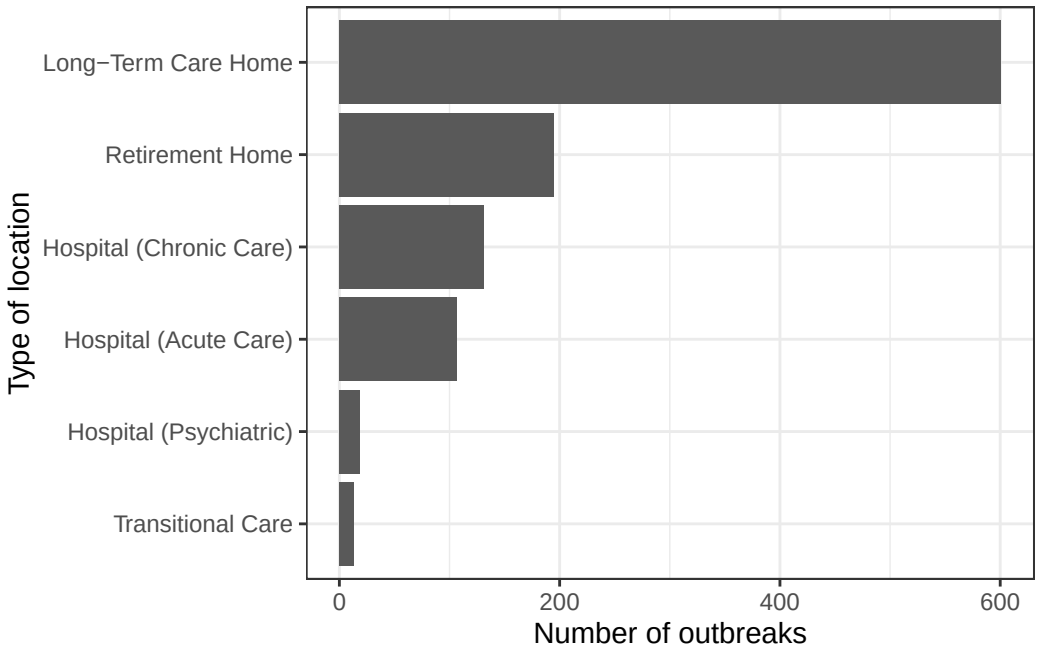

Figure 1: Number of outbreaks by type of healthcare location in Toronto in 2023

Table 1 and Figure 1 illustrate that long-term care homes comprise a majority (approximately 56%) of the total number of healthcare outbreaks in Toronto. This is followed by retirement homes (approximately 18%), chronic care settings in hospitals (approximately 12%), acute care settings in hospitals (approximately 10%), psychiatric care settings in hospitals (approximately 2%), and transitional care locations (approximately 1%). Note that these percentages do not add up to 100% as the proportions in Table 1 were rounded to two decimal places.

Table 2: Outbreaks by type of outbreak for Toronto healthcare locations in 2023

Type of outbreak	Number of outbreaks	Proportion of total outbreaks
Respiratory	1016	0.95
Enteric	47	0.04
Other	3	0.00

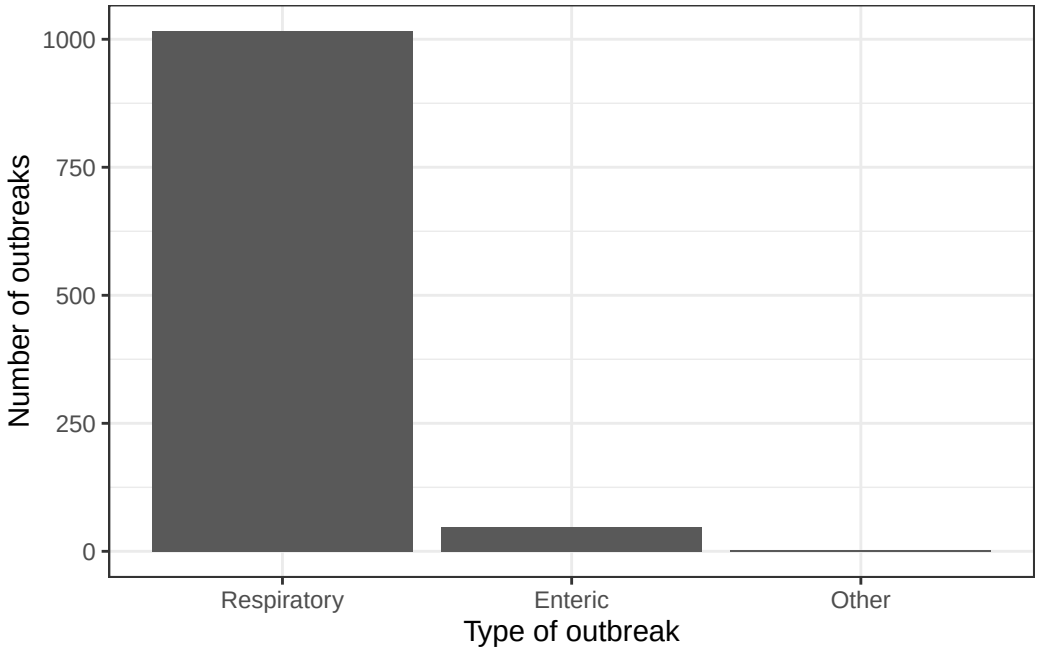

Figure 2: Number of outbreaks by type of outbreak for Toronto healthcare locations in 2023

Table 2 and Figure 2 show that the vast majority of healthcare outbreaks in Toronto are respiratory in nature (approximately 95%). This is followed by enteric outbreaks (approximately 4%) and other types of outbreaks (less than 1%). Note that these percentages do not add up to 100% as the proportions in Table 2 were rounded to two decimal places.

Table 3: Outbreaks by first known cause for Toronto healthcare locations in 2023

Outbreak first known cause	Number of outbreaks	Proportion of total outbreaks
COVID-19	700	0.66
Rhinovirus	77	0.07
Pending/Unknown	73	0.07
Respiratory syncytial virus	50	0.05

Outbreak first known cause	Number of outbreaks	Proportion of total outbreaks
Parainfluenza	34	0.03
Influenza A	33	0.03
Seasonal coronavirus	32	0.03
Metapneumovirus	25	0.02
Norovirus	17	0.02
Enterovirus/Rhinovirus	15	0.01
Enterovirus	6	0.01
CPE	2	0.00
Group B Streptococcal disease (neonatal)	1	0.00
Streptococcus pyogenes	1	0.00

Table 3 and Figure 3 illustrate that the majority of Toronto healthcare outbreaks have COVID-19 as their first known cause (approximately 66%). This is followed by rhinovirus (approximately 7%), respiratory syncytial virus (approximately 5%), parainfluenza (approximately 3%), influenza A (approximately 3%), seasonal coronavirus (approximately 3%), metapneumovirus (approximately 2%), norovirus (approximately 2%), enterovirus/rhinovirus (approximately 1%), enterovirus (approximately 1%), CPE (less than 1%), neonatal Group B streptococcal disease (less than 1%), and streptococcus pyogenes (less than 1%). Approximately 7% of outbreaks had a pending or unknown first known cause. Note that these percentages do not add up to 100% as the proportions in Table 3 were rounded to two decimal places.

3 Acknowledgements

Some of the R code used to create this work was adapted from Alexander (2023).

4 Introduction

You can and should cross-reference sections and sub-sections.

The remainder of this paper is structured as follows. Section 2….

4.1 Discussion

In Section 2.2, it was observed that long-term care homes had the greatest proportion of total outbreaks among healthcare facilities in Toronto in 2023 (Table 1 and Figure 1), that

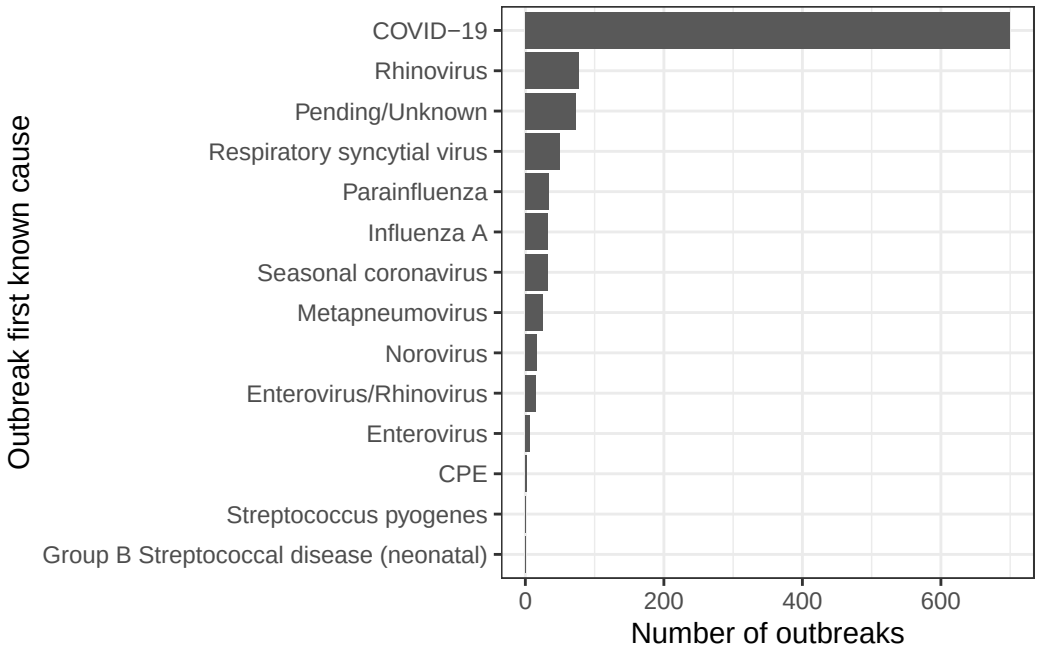

Figure 3: Number of outbreaks by first known cause for Toronto healthcare locations in 2023

approximately 95% of outbreaks were respiratory in nature (Table 2 and Figure 2), and that COVID-19 was the first known cause of a majority of outbreaks (Table 3 and Figure 3).

All three of these results share common origins. For instance, in October 2022, the Government of Ontario removed a masking requirement for caregivers and visitors in long-term care homes (The Canadian Press 2022), whose residents are primarily at or above 65 years of age as reported in 2018 (Ontario Centres for Learning, Research and Innovation in Long-Term Care 2018). Since individuals aged 60 years or older are more likely to experience worse health effects after contracting COVID-19, the Public Health Agency of Canada recommends that they wear a respirator or mask to limit the transmission of this pathogen (Public Health Agency of Canada 2022). As a result, it seems that the Government of Ontario did not heed this advice, possibly contributing to the large proportion of disease outbreaks (which include COVID-19) in Toronto long-term care homes in 2023. This appears to follow a long-standing trend in Ontario long-term care homes. For example, at the start of the COVID-19 pandemic, long-term care homes in Ontario experienced a sizable increase in COVID-19 cases (Casey 2020). This was potentially made worse by the fact that not all of these facilities enforced mask-wearing and that long-term care homes were passed over for personal protective equipment in favour of hospitals (Casey 2020). Moreover, the fact that several hospitals in Toronto curtailed their mask requirements in June and July of 2023 (Fox 2023) likely contributed to the large volume of respiratory disease outbreaks observed in Table 2 and Figure 2.

Although over 1,000 data points pertaining to healthcare outbreaks in Toronto in 2023 were examined in this analysis, several limitations were present. For instance, asymptomatic disease

outbreaks were likely not included in the studied dataset as they may not have been noticeable enough to be reported, contributing to an underestimate of the total number of outbreaks. In addition, only the first known cause of each outbreak was examined for clarity purposes. This also likely led to an underestimate of the number of outbreaks associated with each disease.

Future research should be conducted to assess the state of disease outbreaks in long-term care homes in particular, both in Toronto and across Canada, in order to gain deeper insight into this critical issue. The prevalence of disease outbreaks in other settings, such as schools and workplaces, should also be investigated to expand on this analysis.

A Appendix

A.1 Dataset and Graph Sketches

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

A.2 Attribution Statement

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

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