What factors can affect COVID-19 results?[*]

Statistical Analysis on COVID-19 cases in Toronto

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Abstract

The paper studied the COVID-19 cases in Toronto. By creating some visualizations and applying binomial regression models, we found outbreak-associated, age, gender, infection source, classification type, ever hospitalized, ever in ICU, ever intubated are correlated to the recovery/fatality of the COVID-19 cases. It is necessary for us to conduct such research since it can provide a pathway for the prevention of the pandemic.

Keywords: COVID-19, pandemic, Toronto, Toronto Open Data Portal, Canada

Contents

[*] Code and data are available at: https://github.com/QingyaLi/What-factors-can-affect-COVID-19-results-

1 Introduction

The global death toll attributable to COVID-19 has increased since the outbreak, arousing people's attention. The official data presented over 5.5 million confirmed death cases due to the pandemic, but the actual death tolls were more than the official counts (Adam 2022). In this case, we intended to study whether the COVID-19 fatal/resolved is associated with age, gender, source of infection, outbreak-associated, and other factors. We imported data from the Toronto Open Data Portal website (Health 2022). The data contained information about the Toronto COVID-19 cases between 2020 to 2022.

The paper mainly included four sections : data 2, model 3 , result 4 and discussion5. Data section 2 covered the data cleaning process and removed the unused variables in this paper. We performed some exploratory data analysis (EDA) for the variables with the cleaned dataset. In the model section 3, we conducted a binomial regression model since we considered the results of the COVID-19 cases linearly correlated to the analyzed variables. We applied COVID-19 results as the response variables (either resolved or fatal), other variables were explanatory variables in the models. Then we ended up with the findings in the result section 4. Lastly, we discussed the bias and weakness of the dataset in the discussion section 5.

We can learn more about COVID-19 through research. The findings can study the factors that may increase the probability of pandemic deaths. Additionally, providing a pathway for preventative and treatment initiatives.

2 Data

2.1 Data Source

The dataset was published by Toronto Public Health (TPH). The organization is responsible for the public health issue and well-being of over 2.9 million Toronto residents since 1883 (Toronto 2019). TPH has primarily addressed protecting and enhancing the residents' health. There are three principal objectives of TPH: 1) Preventing the disease spread and promoting the public health; 2) Monitoring the population's health status by applying surveillance, to respond to the ongoing health requirement; 3) Developing and applying public policy to promote the individuals, communities and the whole society' health (Toronto 2019).

2.2 Methodology and Data Collection

The dataset reported the ongoing and emerging COVID-19 pandemic outbreak in Toronto by TPH (Health 2022). The data was collected from the provincial Case & Contact Management System (CCM) (Health 2022). It included information about the demographic, geographic, and other individuals (age, gender, etc) information for the confirmed COVID-19 cases in Toronto from the first case recorded in January 2020 (Health 2022). The population of the data frame was the residents of the entire Toronto city, and the sample was the infected individuals. In addition, TPH mentioned that some limitations existed. The data we used may not be the latest. For the reason that the entire dataset will be refreshed and updated weekly (Health 2022). The data will be overwritten on the given Tuesday at 8:30 AM and released on Wednesday (Health 2022). The data in the provided dataset keeps updating as the TPH continues to report the new confirmed cases and improve the quality of the initiatives (Health 2022). In our paper, we used the dataset was released on April 13th. Another reason is the data may be different from the dataset reported by other organizations since the dataset was collected from different periods and numerous sources (Health 2022). Our report may come up with different conclusions from others as well.

2.3 Data Characteristics

The dataset is available at Toronto Open Data Portal, which can be accessed by using `opendatatoronto` (Gelfand 2020). Our report was written using the `R` statistical language (R Core Team 2020) and the following packages: `dplyr` (Wickham et al. 2021) and `tidyverse` (Wickham et al. 2019). In the visualizations, we plotted the bar charts using `ggplot2` (Wickham 2016). The tables were conducted by `knitr` (Xie 2021) and the tidy function from the package of `tidytext` (Silge and Robinson 2016).

The dataset contains 18 variables and 32,000 observations. The dataset can be directly downloaded in CSV format. We imported the dataset with the provided sample codes: First, we imported the packages with the `show_packages` function. Second, we extracted the resources with `list_package_resources`. Third, we needed to identify the data resource with the `filter` function. Lastly, load the raw dataset with both `filter` and `get_resource`. The dataset was named `raw_df`. During cleaning the dataset, we created a new data frame called `df` which was saved with the `write_csv` function. Then we used the `select` function to keep the variables that we needed, including "Outbreak Associated", "Age Group", "Neighbourhood Name", "Source of Infection", "Classification", "Client Gender", "Outcome", "Ever Hospitalized", "Ever in ICU", "Ever Intubated". Then we used `filter` to exclude the "ACTIVE" cases from "Outcome" because we wanted to focus on the fatal and resolved cases. Also, we used `filter` to exclude the other options in "Client Gender" except males and females. We created a new variable called "result" to distinguish these two cases with `mutate` and `as factor` functions. 1 indicated the COVID-19 cases were resolved and 0 represented fatal cases. Moreover, we `rename` the rest variables into lower letters: "Outbreak Associated" as "outbreak associated", "Age Group" as "age", "neighbourhood" as "Neighbourhood Name", "infection" as "Source of Infection", "Classification" as "classification", "Client Gender" as "gender", "Outcome" as "outcome" "Ever Hospitalized" as "ever hospitalized", "Ever in ICU" as "ever in ICU", and "Ever Intubated" as "ever intubated". The variables are shown in the following.

Variables	Description
result	0 is the fatal cases, 1 is the resolved cases
age	cases's age group by 10
gender	self-reported biological gender
outbreak-associated	outbreak associated with healthcare institutions and other settings
neighbourhood	names of the 140 neighbourhoods
infection	the ways of infection of the COVID-19 cases
outcome	classify the cases into fatal and resolved
classification	classify the cases into confirmed and probable
ever hospitalized	The cases ever hospitalized due to COVID-19
ever in ICU	The cases ever in ICU due to COVID-19
ever intubated	The cases ever intubated due to COVID-19

2.4 Figures

Figures 1-2 illustrate the age at the time of the COVID-19 infection group by 10 and gender, respectively. The age distribution follows a normal distribution and is slightly skewed. We observed the mode is in the column of the age of 20-29 years old, follows by 30-39 years old, 19 and younger. Over 6,000 individuals are between 20 and 29 years infected. As the age gets older, the number of infections falls. The distribution of gender shows the number of infections between male and female groups is most likely the same. The results indicate the cases for both females and males are over 15,000, while the number of COVID-19 cases for males is slightly higher than for females.

Figures 3-7 demonstrate the distribution of COVID-19 cases outcome grouped by outbreak-associated, gender, age, infection, and classification, respectively. The results investigate the factors that may influence the outcome. We noticed that most of the fatal/ resolved cases are sporadic (more than 30,000) instead of the outbreak associated in figure 3. Figure 4 shows there seems no significant difference between the number of females and males in fatal and resolved cases. But we need to consider further investigation. We observed that most of the resolved cases occurred between 19- younger and 50-59 years, similar to the fatal cases. Figure 6 indicates the ways of infection in resolved and fatal cases. We found community as one of the infection sources that most significantly affects the outcome. Figure 7 displays the distribution of COVID-19 by classification. Most of the resolved cases are confirmed when all the fatal cases are confirmed. Moreover, the distribution of the COVID-19 outcome by every hospitalized, ever in ICU, ever intubated, respectively are shown in section appendix 5.2.4.

Therefore, we predicted that the outcome of the COVID-19 cases in Toronto is associated with the outbreak-associated, age, gender, infection, classification, ever hospitalized, ever in ICU, and ever intubated. With a further estimation, we intended to conduct a generalized linear model (binomial regression) that consists of all the explanatory variables mentioned above, and the response variable was the variable called " results".

Before we built the model, we checked whether the assumptions for the binomial regression were held. First, the response variable should be binary the result of COVID-19 is either fatal or resolved. Second, the observations are not correlated and independent of each other. Third, the sample size is not too small with 31,717 observations. Most importantly, the linearity assumption holds.

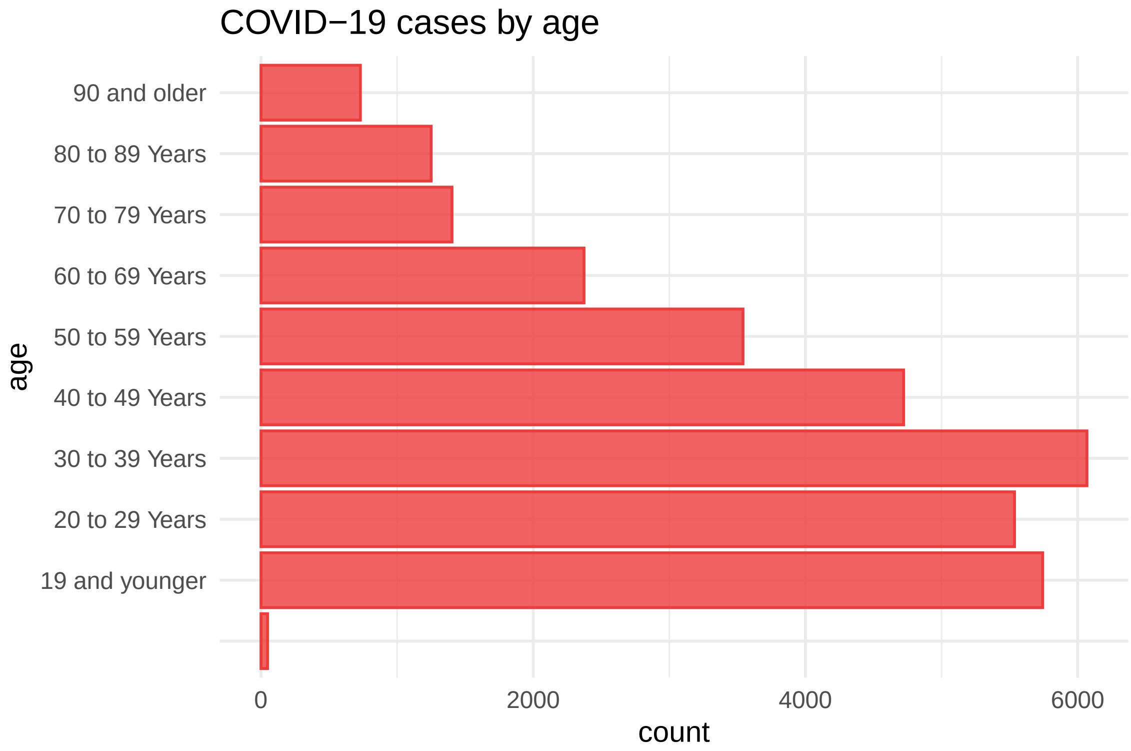

Figure 1: Distribution of COVID-19 cases by age

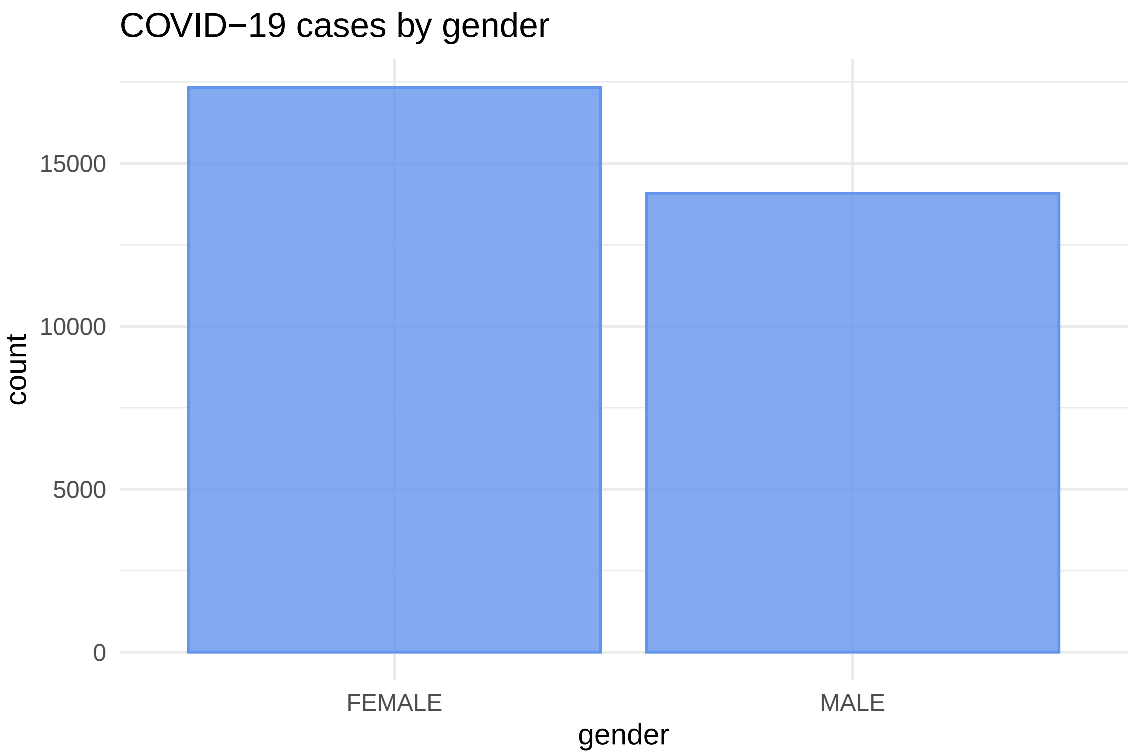

Figure 2: Distribution of COVID-19 cases by gender

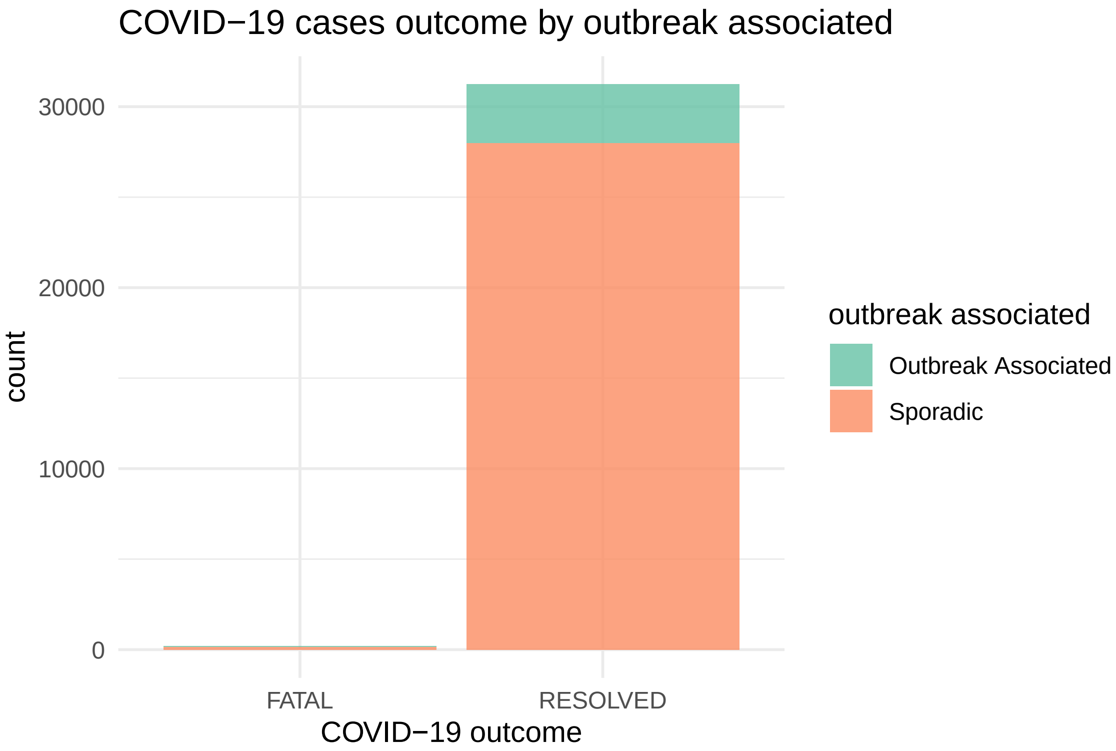

Figure 3: COVID-19 outcome by outbreak associated

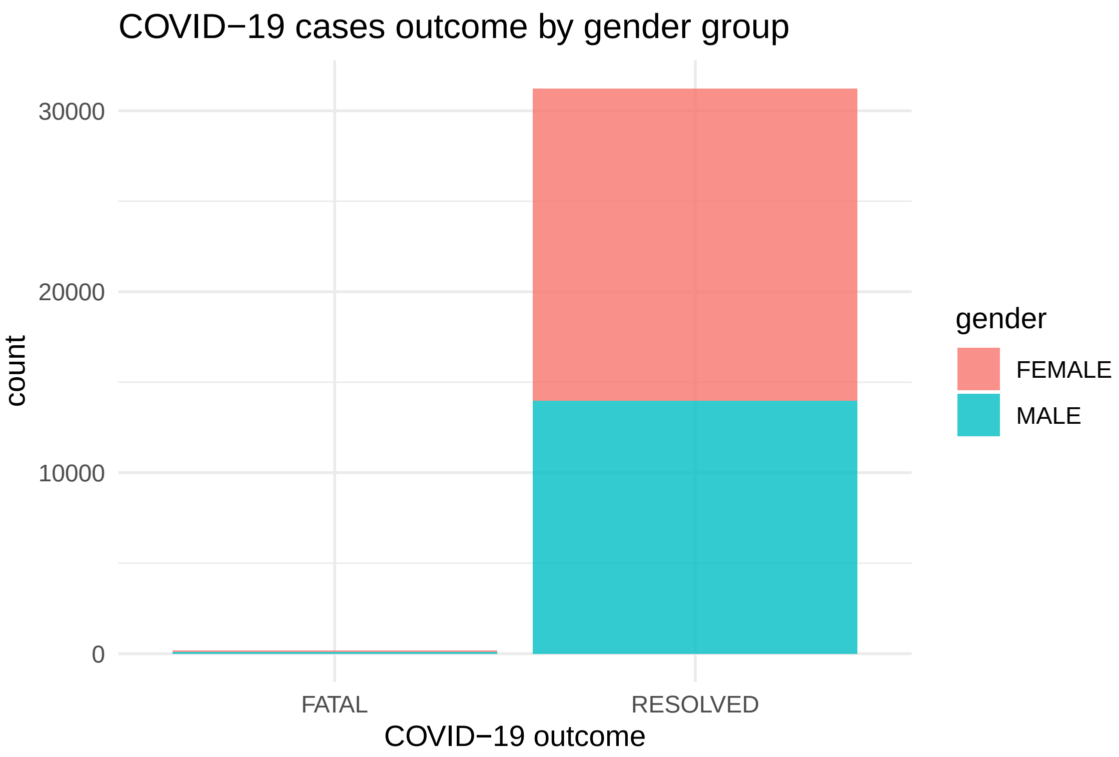

Figure 4: COVID-19 cases outcome by gender

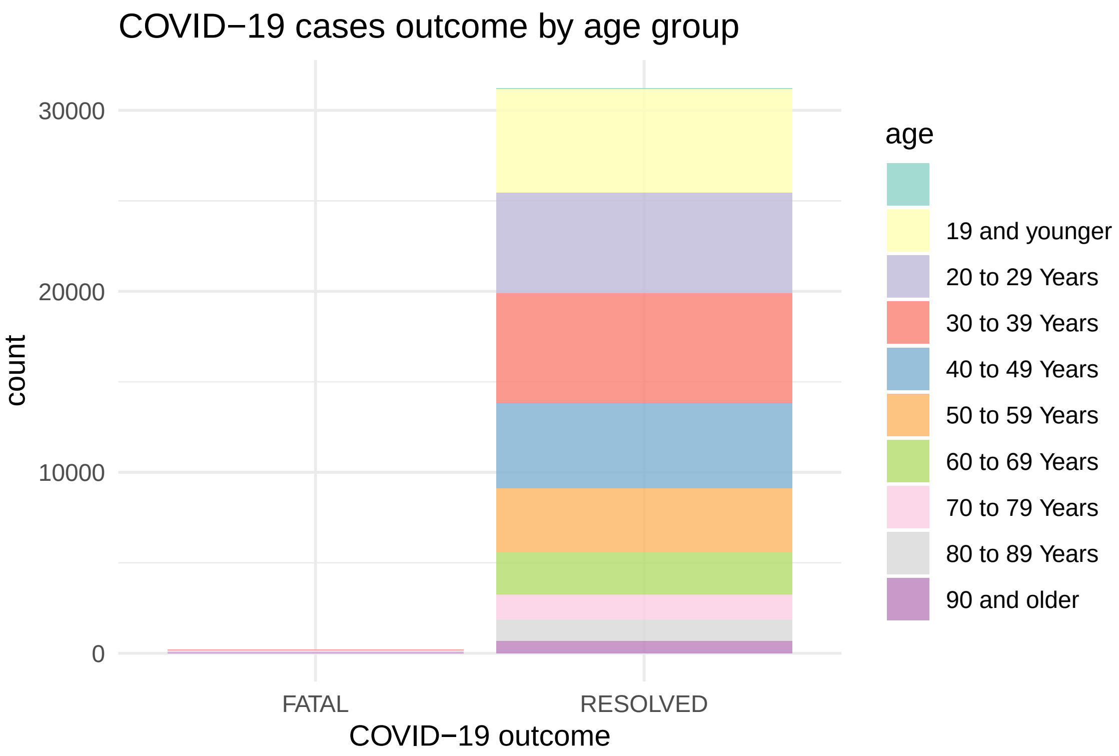

Figure 5: COVID-19 outcome by age

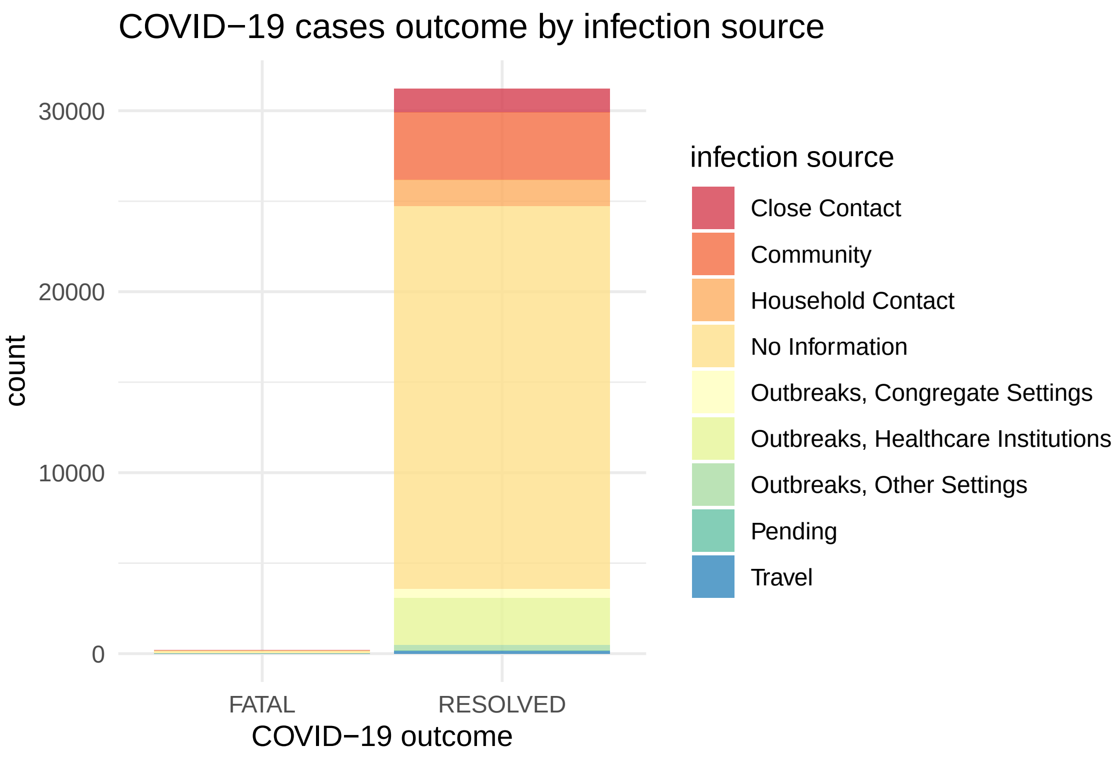

Figure 6: COVID-19 outcome by infection

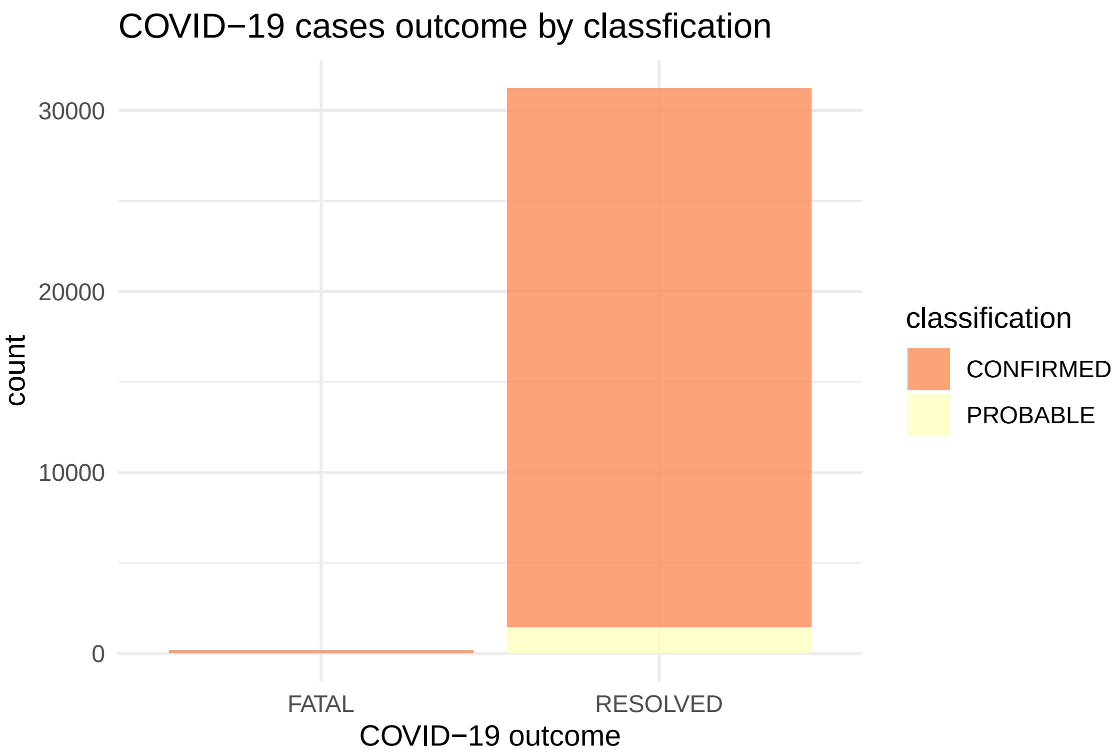

Figure 7: COVID-19 outcome by classification

3 Model

$$Y_i \sim Binomial(N_i, p_i)$$
$$log(\frac{p_i}{1-p_i}) = X_i\beta$$

The function follows the Binomial distribution, where β_0 is the log odds for X = 0, β_1 is the log odds ratio comparing X = 0 and X = 1. We fitted our model as shown.

$$\begin{aligned} log(\frac{p\_resolved}{1-p\_resolved}) = \beta_0 + \beta_1 age19andyounger + \beta_2 age20to29Years + \beta_3 age30to39Years \\ +\beta_4 age40to49Years + \beta_5 age50to59Years + \beta_6 age60to69Years \\ +\beta_7 age70to79Years + \beta_8 age80to89Years + \beta_9 age90andolder \\ +\beta_1 0genderMALE + \beta_1 1outbreakassociatedSporadic + \beta_1 2infectionCommunity \\ +\beta_1 3infectionHouseholdContact + \beta_1 4infectionNoInformation + \beta_1 5infectionOutbreaks, CongregateSettings \\ +\beta_1 6infectionOutbreaks, HealthcareInstitutions + \beta_1 7infectionOutbreaks, OtherSettings \\ +\beta_1 8infectionPending + \beta_1 9infectionTravel + \beta_2 0classificationPROBABLE \\ +\beta_2 1everhospitalizedYes + \beta_2 2everinICUYes + \beta_2 3everintubatedYes \end{aligned}$$

The intercept β_0 represents the log odds of the COVID-19 cases being resolved. β_2 to β_9 represent the log odds of the resolved COVID-19 cases when age is getting older and keeping the other variables constant. $\beta_1 0$ represents the log odds being the resolved cases when the gender is changed from female to male. $\beta_1 1$ is the log off being the resolved cases when outbreak associated changes to sporadic. $\beta_1 2$, $\beta_1 3$, $\beta_1 4$, $\beta_1 5$, $\beta_1 6$, $\beta_1 7$, $\beta_1 8$, $\beta_1 9$ represents the log odds being the resolved cases when the source of infection changes from close contact to the community, household contact, no information, congregate settings, healthcare institutions, other settings, pending, travel, respectively. $\beta_2 0$ is the log odds of resolved cases when the case is changed from confirmed to probable. Similarly, $beta_2 1$, $beta_2 2$, $beta_2 3$ means log odds being the resolved cases when they are ever hospitalized, ever in ICU, ever intubated changed from no to yes.

4 Results

$$\begin{aligned} log(\frac{p\_resolved}{1-p\_resolved}) = 23.07 - 0.55age19andyounger - 0.42age20to29Years - 15.43age30to39Years \\ -16.16age40to49Years - 16.94age50to59Years - 17.40age60to69Years \\ -18.40age70to79Years - 19.47age80to89Years - 20.26age90andolder \\ -0.34genderMALE + 0.22outbreakassociatedSporadic + 0.19infectionCommunity \\ +0.40infectionHouseholdContact + 0.24infectionNoInformation + 1.26infectionOutbreaks, CongregateSettings \\ -0.30infectionOutbreaks, HealthcareInstitutions + 0.07infectionOutbreaks, OtherSettings \\ +18.73infectionPending + 1.77infectionTravel - 1.12classificationPROBABLE \\ -2.31everhospitalizedYes - 1.70everinICUYes - 2.07everintubatedYes \end{aligned}$$

Overall, we observed that the log odds for the recovery of COVID-19 cases is 23.07. The log odds of the resolved cases are negatively correlated to the age groups, which are -0.55, -0.42, -15.43, -16.16, -16.94, -17.40, -18.40, -19.47, and -20.26, respectively. The recovery decreases and the fatality rate increases as the age gets older. When the gender switches from female to male, we found the log odds being resolved

Table 2: Summary table of cofficients of COVID-19 cases's result model

term	estimate	std.error	statistic	p.value
(Intercept)	37.25	6.7e+03	0.01	1.00
age19 and younger	1.23	6.0e+03	0.00	1.00
age20 to 29 Years	1.14	6.0e+03	0.00	1.00
age30 to 39 Years	-13.23	6.0e+03	0.00	1.00
age40 to 49 Years	-13.81	6.0e+03	0.00	1.00
age50 to 59 Years	-14.24	6.0e+03	0.00	1.00
age60 to 69 Years	-15.72	6.0e+03	0.00	1.00
age70 to 79 Years	-16.75	6.0e+03	0.00	1.00
age80 to 89 Years	-17.22	6.0e+03	0.00	1.00
age90 and older	-18.03	6.0e+03	0.00	1.00
genderMALE	-0.28	1.7e-01	-1.62	0.10
‘outbreak associated‘Sporadic	-15.45	3.0e+03	-0.01	1.00
infectionCommunity	-0.21	6.7e-01	-0.31	0.76
infectionHousehold Contact	-0.20	9.3e-01	-0.22	0.83
infectionNo Information	-0.27	6.3e-01	-0.44	0.66
infectionOutbreaks, Congregate Settings	-14.89	3.0e+03	-0.01	1.00
infectionOutbreaks, Healthcare Institutions	-15.98	3.0e+03	-0.01	1.00
infectionOutbreaks, Other Settings	17.13	2.2e+03	0.01	0.99
infectionPending	16.95	1.4e+04	0.00	1.00
infectionTravel	-1.43	1.4e+00	-1.06	0.29
classificationPROBABLE	0.18	6.0e-01	0.30	0.76
‘ever hospitalized‘Yes	-2.50	2.0e-01	-12.70	0.00
‘ever in ICU‘Yes	-2.20	3.6e-01	-6.09	0.00
‘ever intubated‘Yes	-0.70	4.7e-01	-1.50	0.13

decreases. Meaning male patients may have a higher fatality. Additionally, as outbreak-associated changes to sporadic, the log odds being resolved raised by 0.22. The log odds being recovery changes from close contact to the community, household contact, no information, congregate settings, other settings, pending, travel is positive. Meaning the log odds being resolved increases. However, we also noticed that the log odds being recovery drops when close contact with healthcare institutions. Last but not least, the log odds being recovery declined as classification changes to probable, ever hospitalized, ever in ICU, ever intubated changed from no to yes, respectively. The reason is obvious: the patients who ever hospitalized, ever stayed in ICU, or ever intubated, his case is more serious than others, which leads to a higher fatality.

5 Discussion

5.1 Findings

To answer our research question what are the factors that may affect the recovery of COVID-19 cases, we visualized the fatal and resolved cases grouped by various explanatory variables. Besides, we conducted the binomial regression model which is the part of generalized regression model, and came up with the following conclusion. Older people are less likely to be resolved from COVID-19. Males patients are less resolved compared to females. Sporadic cases tends to be resolved. In addition, the sources of infection are positively related to the resolved cases excepts for healthcare institutions. Probable cases are more likely to be resolved. The cases of ever hospitalized/ever in ICU/ever intubated are less likely to be resolved.

5.2 Limitations and Weaknesses

5.2.1 Only including Females and Male in Gender

The original dataset included several gender options based on the self-reported from patients: female, male, non-binary, transgender, and unknown. However, our analysis only considered the cases of both females and males. For the reason that females and males are associated with the most cases. However, non-binary, transgender, and unknown patients cases excluded from the model may cause bias in our results.

5.2.2 The P-values of the Age Groups

In the summary table of coefficients of the model of the COVID-19 case, we saw the p-values of different age groups are approximately 1. The p-values close to 1 represent no difference between the age groups other than due to chance. Nevertheless, some people argued that the p-value maybe not be that important because it does not provide a good measure in a model. We still recommend we need a further investigation to explain why the p-values are small or exclude the variable of age in our model.

5.2.3 Dataset Consisted of Different Sources

As TPH mentioned, they extracted the data from different time periods and different sources (Health 2022). Thus, our analysis conclusions may be entirely different from other research papers. For instance, we estimated that males cases are less likely to be resolved compared to females. But other research proved that the COVID-19 cases fatality is higher in females than males (Dehingia and Ra 2021).

5.2.4 Model Fitting

Applying more complicated models may crush the R studio due to the large dataset and also many variables were included in our model. So we fitted the binomial regression model without the interaction terms. Consequently, we cannot consider all the possible situations.

Appendix

.1 Datasheet

Motivation

1. *For what purpose was the dataset created? Was there a specific task in mind? Was there a specific gap that needed to be filled? Please provide a description.*
   - The dataset was created to estimate the COVID-19 cases in Toronto between 2020 to 2022. It contained the demographic, geographic, and severity information for the cases.
2. *Who created the dataset (for example, which team, research group) and on behalf of which entity (for example, company, institution, organization)?*
   - The dataset was created by Toronto Public Health
3. *Who funded the creation of the dataset? If there is an associated grant, please provide the name of the grantor and the grant name and number.*
   - The creation was funded by the Government of Canada
4. *Any other comments?*
   - The dataset was extracted from the provincial Case & Contact Management System (CCM).

Composition

1. *What do the instances that comprise the dataset represent (for example, documents, photos, people, countries)? Are there multiple types of instances (for example, movies, users, and ratings; people and interactions between them; nodes and edges)? Please provide a description.*
   - The instances that comprise the dataset represent the neighbourhoods in Toronto. The city of Toronto is geographically divided into distinct neighborhoods including Islington-City Centre West, Pelmo Park-Humberlea, New Toronto and so on.
2. *How many instances are there in total (of each type, if appropriate)?*
   - There are 140 instances in total.
3. *Does the dataset contain all possible instances or is it a sample (not necessarily random) of instances from a larger set? If the dataset is a sample, then what is the larger set? Is the sample representative of the larger set (for example, geographic coverage)? If so, please describe how this representativeness was validated/verified. If it is not representative of the larger set, please describe why not (for example, to cover a more diverse range of instances, because instances were withheld or unavailable).*
   - The dataset contains all COVID-19 cases in Toronto.
4. *What data does each instance consist of? "Raw" data (for example, unprocessed text or images) or features? In either case, please provide a description.*
   - Each instance consists of 18 variables that describe the information about the cases.
5. *Is there a label or target associated with each instance? If so, please provide a description.*
   - Each of the instance has an ID assigned by Toronto Public Health .
6. *Is any information missing from individual instances? If so, please provide a description, explaining why this information is missing (for example, because it was unavailable). This does not include intentionally removed information, but might include, for example, redacted text.*
   - No, there is no missing values.

7. *Are relationships between individual instances made explicit (for example, users' movie ratings, social network links)? If so, please describe how these relationships are made explicit.*

    - There is no relationship between individual instances.

8. *Are there recommended data splits (for example, training, development/validation, testing)? If so, please provide a description of these splits, explaining the rationale behind them.*

    - There is no recommended data splits.

9. *Are there any errors, sources of noise, or redundancies in the dataset? If so, please provide a description.*

    - There is no errors, no sources of noise or redundancies in the dataset.

10. *Is the dataset self-contained, or does it link to or otherwise rely on external resources (for example, websites, tweets, other datasets)? If it links to or relies on external resources, a) are there guarantees that they will exist, and remain constant, over time; b) are there official archival versions of the complete dataset (that is, including the external resources as they existed at the time the dataset was created); c) are there any restrictions (for example, licenses, fees) associated with any of the external resources that might apply to a dataset consumer? Please provide descriptions of all external resources and any restrictions associated with them, as well as links or other access points, as appropriate.*

    - The dataset is self-contained.

11. *Does the dataset contain data that might be considered confidential (for example, data that is protected by legal privilege or by doctor-patient confidentiality, data that includes the content of individuals' non-public communications)? If so, please provide a description.*

    - There is no considered confidential data.

12. *Does the dataset contain data that, if viewed directly, might be offensive, insulting, threatening, or might otherwise cause anxiety? If so, please describe why.*

    - There is no offensive, insulting, threatening or might otherwise cause anxiety data.

13. *Does the dataset identify any sub-populations (for example, by age, gender)? If so, please describe how these subpopulations are identified and provide a description of their respective distributions within the dataset.*

    - Outbreak-associated variable is divided into outbreak associated and sporadic. Age group is grouped by 10, source of infection is determined including household contact, close contact, outbreaks, travel, community and no information. Classification is categorized as either confirmed or probable. Client gender is categorized as female, male, non-binary, transgender and unknown. Outcome is either fatal or resolved.

14. *Is it possible to identify individuals (that is, one or more natural persons), either directly or indirectly (that is, in combination with other data) from the dataset? If so, please describe how.*

    - No, it is not possible to identify individuals

15. *Does the dataset contain data that might be considered sensitive in any way (for example, data that reveals race or ethnic origins, sexual orientations, religious beliefs, political opinions or union memberships, or locations; financial or health data; biometric or genetic data; forms of government identification, such as social security numbers; criminal history)? If so, please provide a description.*

    - Client Gender may be considered sensitive since it included the following options: female, male, non-binary, transgender and unknown.

16. *Any other comments?*

    - No

Collection process

1. *How was the data associated with each instance acquired? Was the data directly observable (for example, raw text, movie ratings), reported by subjects (for example, survey responses), or indirectly inferred/derived from other data (for example, part-of-speech tags, model-based guesses for age or language)? If the data was reported by subjects or indirectly inferred/derived from other data, was the data validated/verified? If so, please describe how.*
    - The data are extracted from the the provincial Case & Contact Management System (CCM) and refreshed weekly.
2. *What mechanisms or procedures were used to collect the data (for example, hardware apparatuses or sensors, manual human curation, software programs, software APIs)? How were these mechanisms or procedures validated?*
    - The data collected by the report from Toronto Public Health.
3. *If the dataset is a sample from a larger set, what was the sampling strategy (for example, deterministic, probabilistic with specific sampling probabilities)?*
    - The dataset is not a sample from a large set.
4. *Who was involved in the data collection process (for example, students, crowdworkers, contractors) and how were they compensated (for example, how much were crowdworkers paid)?*
    - Toronto Public Health was involved. No compensation.
5. *Over what timeframe was the data collected? Does this timeframe match the creation timeframe of the data associated with the instances (for example, recent crawl of old news articles)? If not, please describe the timeframe in which the data associated with the instances was created.*
    - The dataset is collected between 2020-2022 and refreshed weekly. The data are extracted at 8:30 AM on the Tuesday and released on Wednesday.
6. *Were any ethical review processes conducted (for example, by an institutional review board)? If so, please provide a description of these review processes, including the outcomes, as well as a link or other access point to any supporting documentation.*
    - No, there was no ethical review process.
7. *Did you collect the data from the individuals in question directly, or obtain it via third parties or other sources (for example, websites)?*
    - I obtained the dataset from Toronto Open Data Portal website.
8. *Were the individuals in question notified about the data collection? If so, please describe (or show with screenshots or other information) how notice was provided, and provide a link or other access point to, or otherwise reproduce, the exact language of the notification itself.*
    - The noticed was not provided.
9. *Did the individuals in question consent to the collection and use of their data? If so, please describe (or show with screenshots or other information) how consent was requested and provided, and provide a link or other access point to, or otherwise reproduce, the exact language to which the individuals consented.*
    - Yes, the individuals were consent. The consents were not available.
10. *If consent was obtained, were the consenting individuals provided with a mechanism to revoke their consent in the future or for certain uses? If so, please provide a description, as well as a link or other access point to the mechanism (if appropriate).*
    - A mechanism to revoke their consent in the future or for certain uses was not provided.
11. *Has an analysis of the potential impact of the dataset and its use on data subjects (for example, a data protection impact analysis) been conducted? If so, please provide a description of this analysis, including the outcomes, as well as a link or other access point to any supporting documentation.*

- No, it has not been conducted.

12. *Any other comments?*
    - No

Preprocessing/cleaning/labeling

1. *Was any preprocessing/cleaning/labeling of the data done (for example, discretization or bucketing, tokenization, part-of-speech tagging, SIFT feature extraction, removal of instances, processing of missing values)? If so, please provide a description. If not, you may skip the remaining questions in this section.*
    - We used the `select` function to keep the variables that we needed, including "Outbreak Associated", "Age Group", "Neighbourhood Name", "Source of Infection", "Classification", "Client Gender", "Outcome", "Ever Hospitalized", "Ever in ICU", "Ever Intubated". Then we used `filter` to exclude the "ACTIVE" cases from "Outcome" because we wanted to focus on the fatal and resolved cases. Also, we used `filter` to exclude the other options in "Client Gender" except males and females. We created a new variable called "result" to distinguish these two cases with `mutate` and `as factor` functions. 1 indicated the COVID-19 cases were resolved and 0 represented fatal cases. Moreover, we `rename` the rest variables into lower letters: "Outbreak Associated" as "outbreak associated", "Age Group" as "age", "neighbourhood" as "Neighbourhood Name", "infection" as "Source of Infection", "Classification" as "classification", "Client Gender" as "gender", "Outcome" as "outcome" "Ever Hospitalized" as "ever hospitalized", "Ever in ICU" as "ever in ICU", and "Ever Intubated" as "ever intubated".
2. *Was the "raw" data saved in addition to the preprocessed/cleaned/labeled data (for example, to support unanticipated future uses)? If so, please provide a link or other access point to the "raw" data.*
    - The raw data saved in inputs/data/COVID-19 cases.csv
3. *Is the software that was used to preprocess/clean/label the data available? If so, please provide a link or other access point.*
    - The R Software is avalaible at https://www.R-project.org/
4. *Any other comments?*
    - No

Uses

1. *Has the dataset been used for any tasks already? If so, please provide a description.*
    - No
2. *Is there a repository that links to any or all papers or systems that use the dataset? If so, please provide a link or other access point.*
    - No
3. *What (other) tasks could the dataset be used for?*
    - The dataset could be used for predicting the number of confirmed COVID-19 cases in Toronto.
4. *Is there anything about the composition of the dataset or the way it was collected and preprocessed/cleaned/labeled that might impact future uses? For example, is there anything that a dataset consumer might need to know to avoid uses that could result in unfair treatment of individuals or groups (for example, stereotyping, quality of service issues) or other risks or harms (for example, legal risks, financial harms)? If so, please provide a description. Is there anything a dataset consumer could do to mitigate these risks or harms?*

- NO

5. *Are there tasks for which the dataset should not be used? If so, please provide a description.*
   - The dataset is not appropriately used for estimating the COVID-19 cases outside of Toronto.
6. *Any other comments?*
   - No

Distribution

1. *Will the dataset be distributed to third parties outside of the entity (for example, company, institution, organization) on behalf of which the dataset was created? If so, please provide a description.*
   - No
2. *How will the dataset be distributed (for example, tarball on website, API, GitHub)? Does the dataset have a digital object identifier (DOI)?*
   - The dataset will be distributed by Github.
3. *When will the dataset be distributed?*
   - The dataset will be distributed on April 26, 2022.
4. *Will the dataset be distributed under a copyright or other intellectual property (IP) license, and/or under applicable terms of use (ToU)? If so, please describe this license and/ or ToU, and provide a link or other access point to, or otherwise reproduce, any relevant licensing terms or ToU, as well as any fees associated with these restrictions.*
   - MIT license.
5. *Have any third parties imposed IP-based or other restrictions on the data associated with the instances? If so, please describe these restrictions, and provide a link or other access point to, or otherwise reproduce, any relevant licensing terms, as well as any fees associated with these restrictions.*
   - None
6. *Do any export controls or other regulatory restrictions apply to the dataset or to individual instances? If so, please describe these restrictions, and provide a link or other access point to, or otherwise reproduce, any supporting documentation.*
   - No
7. *Any other comments?*
   - No

Maintenance

1. *Who will be supporting/hosting/maintaining the dataset?*
   - Qingya Li
2. *How can the owner/curator/manager of the dataset be contacted (for example, email address)?*
   - Github: https://github.com/QingyaLi?tab=repositories, email: qingya.li@mail.utoronto.ca
3. *Is there an erratum? If so, please provide a link or other access point.*
   - No erratum.
4. *Will the dataset be updated (for example, to correct labeling errors, add new instances, delete instances)? If so, please describe how often, by whom, and how updates will be communicated to dataset consumers (for example, mailing list, GitHub)?*

- No

5. *If the dataset relates to people, are there applicable limits on the retention of the data associated with the instances (for example, were the individuals in question told that their data would be retained for a fixed period of time and then deleted)? If so, please describe these limits and explain how they will be enforced.*

   - No limitations so far.

6. *Will older versions of the dataset continue to be supported/hosted/maintained? If so, please describe how. If not, please describe how its obsolescence will be communicated to dataset consumers.*

   - No

7. *If others want to extend/augment/build on/contribute to the dataset, is there a mechanism for them to do so? If so, please provide a description. Will these contributions be validated/verified? If so, please describe how. If not, why not? Is there a process for communicating/distributing these contributions to dataset consumers? If so, please provide a description.*

   - there is no mechanism

8. *Any other comments?*

   - No

.2 Additional details

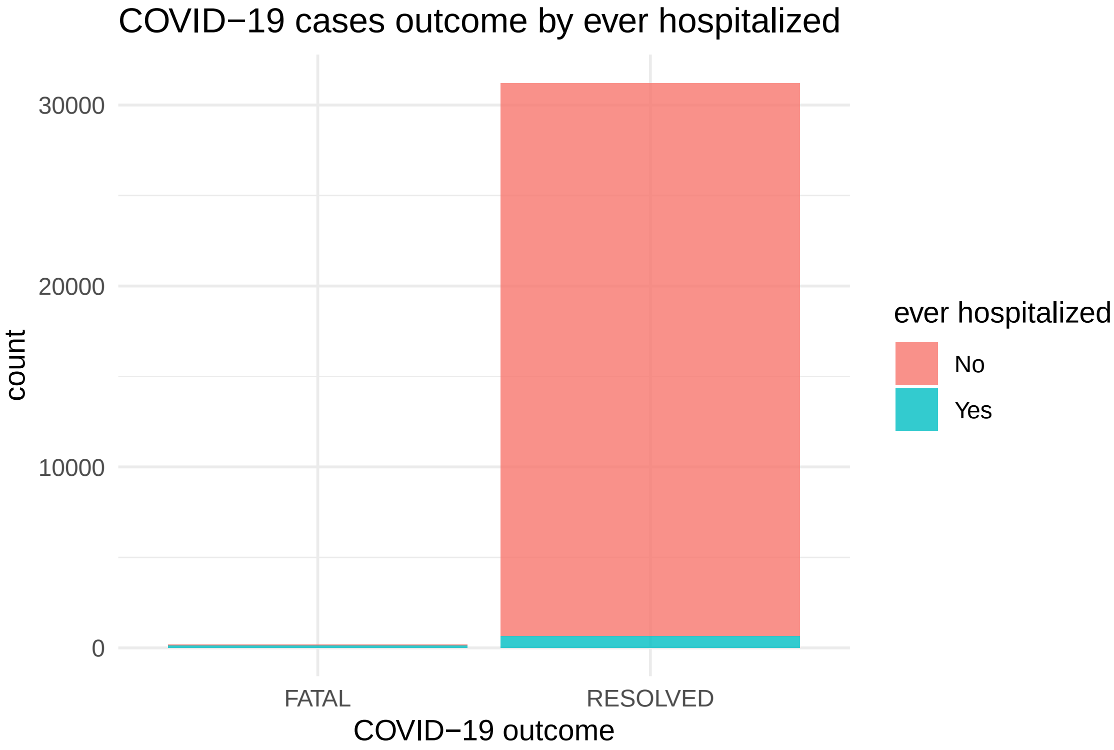

Figure 8: COVID-19 outcome by ever hospitalized

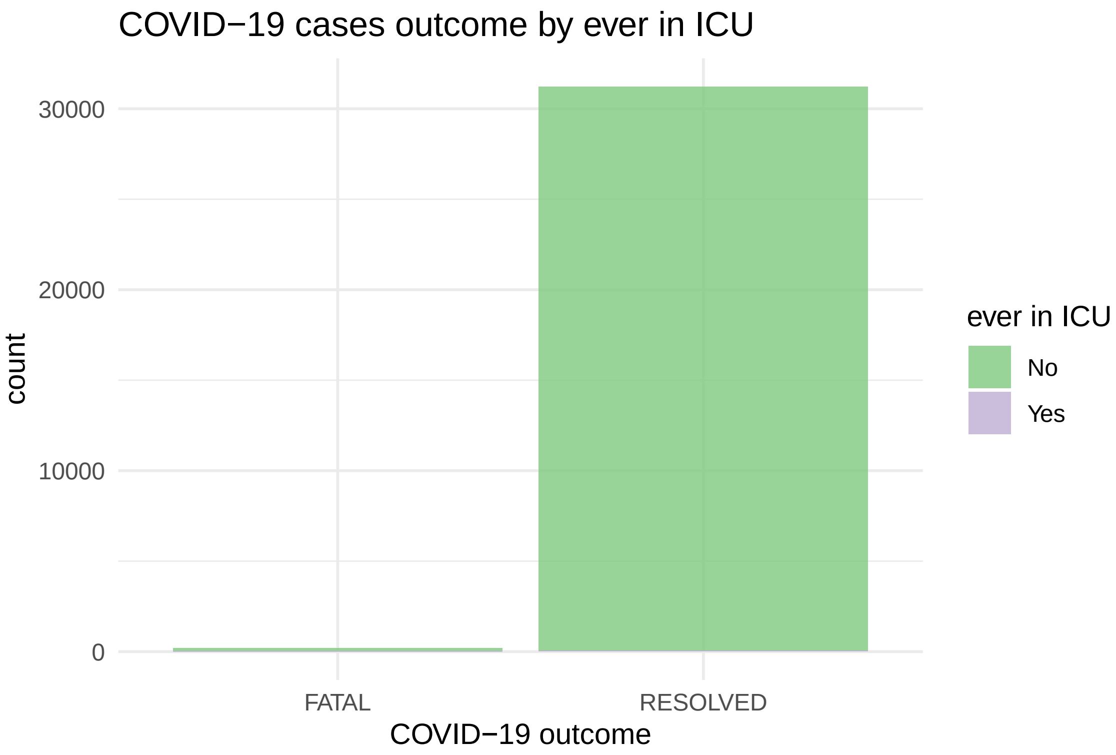

Figure 9: COVID-19 outcome by ever in ICU

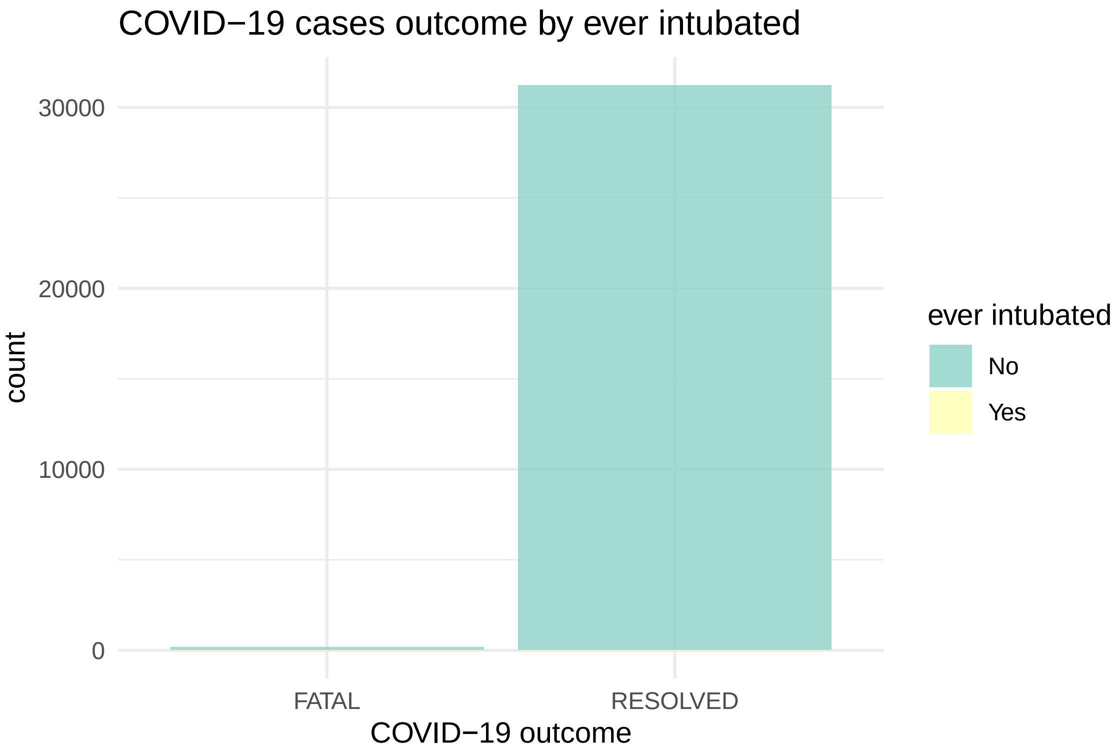

Figure 10: COVID-19 outcome by ever intubated

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