

Covid-19's effect on crime in Toronto neighbourhoods*

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Abstract

This paper presents an analysis on the effect of Covid-19 on crime rates in Toronto neighborhoods in 2020. The paper uses datasets obtained from opendatatoronto to show how covid-19 had a negative effect on crime rates. The analysis consists of using the statistical programming language R to model the data using regression and constructing various plots and graphs to visually represent the data. The results obtained show us how pandemics like covid-19 can affect a person's mindset, enabling us to better predict their actions during such situations.

Keywords: Covid-19, Crime. Toronto neighborhoods, residents, open data toronto

1 Introduction

After the first reported outbreak of covid-19 in December 2019, the entire world changed. Covid-19 was quickly declared to be a health emergency of global concern by the World health organization in March of 2020. Governments took measures to restrict the spread of the disease such as imposing lockdowns, travel bans, restrictions on public gatherings, closing down businesses and advising people to isolate at home. Citizens of countries were essentially restricted to their homes and rarely left. Covid-19 had a huge impact on the global economy and had restricted people's actions and movements. The question this paper seeks to answer is how the covid pandemic had affected crime in various neighborhoods in Toronto in 2020.

In this paper, we use data on covid cases and crime rates in Toronto for the year 2020 to see how the number of covid cases in a neighborhood had affected crime in Toronto neighborhoods. We construct a model using R in order to see how the number of covid cases can affect the crime rate in a neighborhood. We also use the dataset to construct various histograms, bar plots and summary statistics about the dataset to improve the quality of our analysis. The results obtained seem to imply that the covid pandemic had a negative effect on crime in 2020 as crime rates went down in most Toronto neighborhoods. The results obtained contribute to our understanding of how the presence of a common threat that affects everyone such as a pandemic in this case can discourage people from criminal actions. It will allow us to improve our predictions of a person's behavior during such situations.

The paper first presents an overview of the datasets and the variables we will be using for this study in the data section. The model section presents the regression steps taken to generate the model that shows how covid affects crime. The results section discusses the various conclusions we can draw from the data and the model and finally the discussion section discusses the strenghts and weaknesses of the paper. Any additional details are included in the appendix.

*Code and data are available at: https://github.com/Varun1005473462/final_folder-main.git.

2 Data

2.1 Obtaining the covid_cases dataset

```
## # A tibble: 32,000 x 18
##   '_id' Assigned_ID 'Outbreak Associated' 'Age Group' 'Neighbourhood~' FSA
##   <dbl>      <dbl> <chr>                <chr>        <chr>        <chr>
## 1 53531      55685 Sporadic                20 to 29 Years Dovercourt-Wall~ M6P
## 2 53532      55686 Outbreak Associated    19 and younger Don Valley Vill~ M2J
## 3 53533      55687 Sporadic                60 to 69 Years Brookhaven-Ames~ M6M
## 4 53534      55688 Sporadic                20 to 29 Years Cliffcrest      M1M
## 5 53535      55689 Sporadic                20 to 29 Years Flemington Park M3C
## 6 53536      55690 Outbreak Associated    19 and younger Mount Olive-Sil~ M9V
## 7 53537      55691 Outbreak Associated    50 to 59 Years Roncesvalles     M6R
## 8 53538      55692 Sporadic                30 to 39 Years Willowridge-Mar~ M9R
## 9 53539      55693 Sporadic                60 to 69 Years Keelesdale-Egli~ M6M
## 10 53540      55694 Sporadic                60 to 69 Years Flemington Park M3C
## # ... with 31,990 more rows, and 12 more variables:
## #   'Source of Infection' <chr>, 'Classification' <chr>, 'Episode Date' <date>,
## #   'Reported Date' <date>, 'Client Gender' <chr>, 'Outcome' <chr>,
## #   'Currently Hospitalized' <chr>, 'Currently in ICU' <chr>,
## #   'Currently Intubated' <chr>, 'Ever Hospitalized' <chr>,
## #   'Ever in ICU' <chr>, 'Ever Intubated' <chr>
```

2.2 Obtaining the neighborhood crime cases dataset

```
## # A tibble: 140 x 104
##   '_id' OBJECTID Neighbourhood      Hood_ID F2020_Population~ Assault_2014
##   <dbl>      <dbl> <chr>                <chr>        <dbl>        <dbl>
## 1      1         1 Yonge-St.Clair        097          14083         16
## 2      2         2 York University Heights 027          30277        273
## 3      3         3 Lansing-Westgate      038          18146         42
## 4      4         4 Yorkdale-Glen Park    031          17560        106
## 5      5         5 Stonegate-Queensway   016          27410         91
## 6      6         6 Tam O'Shanter-Sullivan 118          29970        103
## 7      7         7 The Beaches           063          23364         88
## 8      8         8 Thistletown-Beaumont He~ 003          10948         61
## 9      9         9 Thorncliffe Park       055          23518         86
## 10     10        10 Danforth East York    059          18427         68
## # ... with 130 more rows, and 98 more variables: Assault_2015 <dbl>,
## #   Assault_2016 <dbl>, Assault_2017 <dbl>, Assault_2018 <dbl>,
## #   Assault_2019 <dbl>, Assault_2020 <dbl>, Assault_Rate2014 <dbl>,
## #   Assault_Rate2015 <dbl>, Assault_Rate2016 <dbl>, Assault_Rate2017 <dbl>,
## #   Assault_Rate2018 <dbl>, Assault_Rate2019 <dbl>, Assault_Rate2020 <dbl>,
## #   AutoTheft_2014 <dbl>, AutoTheft_2015 <dbl>, AutoTheft_2016 <dbl>,
## #   AutoTheft_2017 <dbl>, AutoTheft_2018 <dbl>, AutoTheft_2019 <dbl>, ...
```

2.3 Finding the number of covid cases for each neighborhood for the year 2020

```
covid_cases<-
  covid_cases |>
```

```

mutate(year=format(covid_cases$`Episode Date`, "%Y"))
covid_cases2020<-
  covid_cases |>
  filter(year == 2020)
covid_cases_neighbourhood<-data.frame(table(covid_cases2020['Neighbourhood Name']))
colnames(covid_cases_neighbourhood)[1]<-"Neighbourhood"
colnames(covid_cases_neighbourhood)[2]<-"Number of Covid cases"
covid_cases_neighbourhood

```

##	Neighbourhood	Number of Covid cases
## 1	Agincourt North	136
## 2	Agincourt South-Malvern West	115
## 3	Alderwood	38
## 4	Annex	152
## 5	Banbury-Don Mills	98
## 6	Bathurst Manor	124
## 7	Bay Street Corridor	52
## 8	Bayview Village	52
## 9	Bayview Woods-Steeles	43
## 10	Bedford Park-Nortown	126
## 11	Beechborough-Greenbrook	51
## 12	Bendale	121
## 13	Birchcliffe-Cliffside	73
## 14	Black Creek	204
## 15	Blake-Jones	23
## 16	Briar Hill - Belgravia	87
## 17	Bridle Path-Sunnybrook-York Mills	16
## 18	Broadview North	32
## 19	Brookhaven-Amesbury	116
## 20	Cabbagetown-South St. James Town	9
## 21	Caledonia-Fairbank	75
## 22	Casa Loma	19
## 23	Centennial Scarborough	57
## 24	Church-Yonge Corridor	82
## 25	Clairlea-Birchmount	140
## 26	Clanton Park	97
## 27	Cliffcrest	73
## 28	Corso Italia-Davenport	86
## 29	Danforth	18
## 30	Danforth-East York	42
## 31	Don Valley Village	144
## 32	Dorset Park	174
## 33	Dovercourt-Wallace Emerson-Junction	138
## 34	Downsview-Roding-CFB	339
## 35	Dufferin Grove	26
## 36	East End-Danforth	42
## 37	Edenbridge-Humber Valley	80
## 38	Eglinton East	152
## 39	Elms-Old Rexdale	81
## 40	Englemount-Lawrence	230
## 41	Eringate-Centennial-West Deane	57
## 42	Etobicoke West Mall	63
## 43	Flemingdon Park	122

## 44	Forest Hill North	65
## 45	Forest Hill South	8
## 46	Glenfield-Jane Heights	263
## 47	Greenwood-Coxwell	31
## 48	Guildwood	28
## 49	Henry Farm	59
## 50	High Park-Swansea	96
## 51	High Park North	42
## 52	Highland Creek	72
## 53	Hillcrest Village	31
## 54	Humber Heights-Westmount	48
## 55	Humber Summit	157
## 56	Humbermede	173
## 57	Humewood-Cedarvale	53
## 58	Ionview	45
## 59	Islington-City Centre West	199
## 60	Junction Area	38
## 61	Keelesdale-Eglinton West	55
## 62	Kennedy Park	100
## 63	Kensington-Chinatown	41
## 64	Kingsview Village-The Westway	119
## 65	Kingsway South	18
## 66	L'Amoreaux	198
## 67	Lambton Baby Point	21
## 68	Lansing-Westgate	45
## 69	Lawrence Park North	24
## 70	Lawrence Park South	37
## 71	Leaside-Bennington	36
## 72	Little Portugal	47
## 73	Long Branch	26
## 74	Malvern	291
## 75	Maple Leaf	89
## 76	Markland Wood	25
## 77	Milliken	151
## 78	Mimico (includes Humber Bay Shores)	128
## 79	Morningside	81
## 80	Moss Park	61
## 81	Mount Dennis	84
## 82	Mount Olive-Silverstone-Jamestown	305
## 83	Mount Pleasant East	32
## 84	Mount Pleasant West	85
## 85	New Toronto	39
## 86	Newtonbrook East	31
## 87	Newtonbrook West	171
## 88	Niagara	60
## 89	North Riverdale	19
## 90	North St. James Town	66
## 91	O'Connor-Parkview	47
## 92	Oakridge	57
## 93	Oakwood Village	94
## 94	Old East York	21
## 95	Palmerston-Little Italy	22
## 96	Parkwoods-Donalda	115
## 97	Pelmo Park-Humberlea	89

## 98	Playter Estates-Danforth	17
## 99	Pleasant View	55
## 100	Princess-Rosethorn	29
## 101	Regent Park	19
## 102	Rexdale-Kipling	57
## 103	Rockcliffe-Smythe	143
## 104	Roncesvalles	42
## 105	Rosedale-Moore Park	24
## 106	Rouge	307
## 107	Runnymede-Bloor West Village	8
## 108	Rustic	41
## 109	Scarborough Village	130
## 110	South Parkdale	77
## 111	South Riverdale	75
## 112	St.Andrew-Windfields	35
## 113	Steeles	215
## 114	Stonegate-Queensway	67
## 115	Tam O'Shanter-Sullivan	94
## 116	Taylor-Massey	73
## 117	The Beaches	23
## 118	Thistletown-Beaumont Heights	94
## 119	Thorncliffe Park	102
## 120	Trinity-Bellwoods	41
## 121	University	32
## 122	Victoria Village	125
## 123	Waterfront Communities-The Island	134
## 124	West Hill	104
## 125	West Humber-Clairville	297
## 126	Westminster-Branson	290
## 127	Weston	122
## 128	Weston-Pellam Park	96
## 129	Wexford/Maryvale	142
## 130	Willowdale East	101
## 131	Willowdale West	37
## 132	Willowridge-Martingrove-Richview	106
## 133	Woburn	327
## 134	Woodbine-Lumsden	11
## 135	Woodbine Corridor	15
## 136	Wychwood	37
## 137	Yonge-Eglinton	26
## 138	Yonge-St.Clair	23
## 139	York University Heights	181
## 140	Yorkdale-Glen Park	167

2.4 Arranging the neighborhoods in the neighborhodd_crime_rates and covid_cases_neighborhood dataset alphabetically.

```
neighbourhood_crime_rates |>
  arrange(Neighbourhood)
```

```
## # A tibble: 140 x 104
##   '_id' OBJECTID Neighbourhood Hood_ID F2020_Population~ Assault_2014
```

```
##      <dbl>      <dbl> <chr>                <chr>                <dbl>      <dbl>
## 1      80        80 Agincourt North          129          31618        67
## 2      81        81 Agincourt South-Malvern~ 128          27406        104
## 3      87        87 Alderwood                020          13242         45
## 4      57        57 Annex                    095          34680        242
## 5      85        85 Banbury-Don Mills          042          31186         60
## 6      86        86 Bathurst Manor            034          17628         47
## 7      94        94 Bay Street Corridor          076          32790        522
## 8     114       114 Bayview Village            052          24799         83
## 9      46        46 Bayview Woods-Steeles          049          14020         36
## 10     115       115 Bedford Park-Nortown          039          26015         59
## # ... with 130 more rows, and 98 more variables: Assault_2015 <dbl>,
## #   Assault_2016 <dbl>, Assault_2017 <dbl>, Assault_2018 <dbl>,
## #   Assault_2019 <dbl>, Assault_2020 <dbl>, Assault_Rate2014 <dbl>,
## #   Assault_Rate2015 <dbl>, Assault_Rate2016 <dbl>, Assault_Rate2017 <dbl>,
## #   Assault_Rate2018 <dbl>, Assault_Rate2019 <dbl>, Assault_Rate2020 <dbl>,
## #   AutoTheft_2014 <dbl>, AutoTheft_2015 <dbl>, AutoTheft_2016 <dbl>,
## #   AutoTheft_2017 <dbl>, AutoTheft_2018 <dbl>, AutoTheft_2019 <dbl>, ...
```

```
covid_cases_neighbourhood |>
  arrange(Neighbourhood)
```

```
##      Neighbourhood Number of Covid cases
## 1      Agincourt North          136
## 2      Agincourt South-Malvern West 115
## 3      Alderwood                38
## 4      Annex                    152
## 5      Banbury-Don Mills          98
## 6      Bathurst Manor            124
## 7      Bay Street Corridor          52
## 8      Bayview Village            52
## 9      Bayview Woods-Steeles          43
## 10     Bedford Park-Nortown          126
## 11     Beechborough-Greenbrook          51
## 12     Bendale                    121
## 13     Birchcliffe-Cliffside          73
## 14     Black Creek                204
## 15     Blake-Jones                 23
## 16     Briar Hill - Belgravia          87
## 17     Bridle Path-Sunnybrook-York Mills 16
## 18     Broadview North              32
## 19     Brookhaven-Amesbury          116
## 20     Cabbagetown-South St. James Town 9
## 21     Caledonia-Fairbank           75
## 22     Casa Loma                   19
## 23     Centennial Scarborough          57
## 24     Church-Yonge Corridor          82
## 25     Clairlea-Birchmount          140
## 26     Clanton Park                97
## 27     Cliffcrest                  73
## 28     Corso Italia-Davenport          86
## 29     Danforth                    18
## 30     Danforth-East York           42
## 31     Don Valley Village          144
```

## 32	Dorset Park	174
## 33	Dovercourt-Wallace Emerson-Junction	138
## 34	Downsview-Roding-CFB	339
## 35	Dufferin Grove	26
## 36	East End-Danforth	42
## 37	Edenbridge-Humber Valley	80
## 38	Eglinton East	152
## 39	Elms-Old Rexdale	81
## 40	Englemount-Lawrence	230
## 41	Eringate-Centennial-West Deane	57
## 42	Etobicoke West Mall	63
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## 47	Greenwood-Coxwell	31
## 48	Guildwood	28
## 49	Henry Farm	59
## 50	High Park-Swansea	96
## 51	High Park North	42
## 52	Highland Creek	72
## 53	Hillcrest Village	31
## 54	Humber Heights-Westmount	48
## 55	Humber Summit	157
## 56	Humbermede	173
## 57	Humewood-Cedarvale	53
## 58	Ionview	45
## 59	Islington-City Centre West	199
## 60	Junction Area	38
## 61	Keelesdale-Eglinton West	55
## 62	Kennedy Park	100
## 63	Kensington-Chinatown	41
## 64	Kingsview Village-The Westway	119
## 65	Kingsway South	18
## 66	L'Amoreaux	198
## 67	Lambton Baby Point	21
## 68	Lansing-Westgate	45
## 69	Lawrence Park North	24
## 70	Lawrence Park South	37
## 71	Leaside-Bennington	36
## 72	Little Portugal	47
## 73	Long Branch	26
## 74	Malvern	291
## 75	Maple Leaf	89
## 76	Markland Wood	25
## 77	Milliken	151
## 78	Mimico (includes Humber Bay Shores)	128
## 79	Morningside	81
## 80	Moss Park	61
## 81	Mount Dennis	84
## 82	Mount Olive-Silverstone-Jamestown	305
## 83	Mount Pleasant East	32
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## 86	Newtonbrook East	31
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## 88	Niagara	60
## 89	North Riverdale	19
## 90	North St. James Town	66
## 91	O'Connor-Parkview	47
## 92	Oakridge	57
## 93	Oakwood Village	94
## 94	Old East York	21
## 95	Palmerston-Little Italy	22
## 96	Parkwoods-Donalda	115
## 97	Pelmo Park-Humberlea	89
## 98	Playter Estates-Danforth	17
## 99	Pleasant View	55
## 100	Princess-Rosethorn	29
## 101	Regent Park	19
## 102	Rexdale-Kipling	57
## 103	Rockcliffe-Smythe	143
## 104	Roncesvalles	42
## 105	Rosedale-Moore Park	24
## 106	Rouge	307
## 107	Runnymede-Bloor West Village	8
## 108	Rustic	41
## 109	Scarborough Village	130
## 110	South Parkdale	77
## 111	South Riverdale	75
## 112	St. Andrew-Windfields	35
## 113	Steeles	215
## 114	Stonegate-Queensway	67
## 115	Tam O'Shanter-Sullivan	94
## 116	Taylor-Massey	73
## 117	The Beaches	23
## 118	Thistletown-Beaumond Heights	94
## 119	Thorncliffe Park	102
## 120	Trinity-Bellwoods	41
## 121	University	32
## 122	Victoria Village	125
## 123	Waterfront Communities-The Island	134
## 124	West Hill	104
## 125	West Humber-Clairville	297
## 126	Westminster-Branson	290
## 127	Weston	122
## 128	Weston-Pellam Park	96
## 129	Wexford/Maryvale	142
## 130	Willowdale East	101
## 131	Willowdale West	37
## 132	Willowridge-Martingrove-Richview	106
## 133	Woburn	327
## 134	Woodbine-Lumsden	11
## 135	Woodbine Corridor	15
## 136	Wychwood	37
## 137	Yonge-Eglinton	26
## 138	Yonge-St. Clair	23
## 139	York University Heights	181

3 Model

$$Pr(\theta|y) = \frac{Pr(y|\theta)Pr(\theta)}{Pr(y)} \quad (1)$$

Equation (1) seems useful, eh?

Here's a dumb example of how to use some references: In paper we run our analysis in `R` (R Core Team 2020). We also use the `tidyverse` which was written by Wickham et al. (2019) If we were interested in baseball data then Friendly et al. (2020) could be useful.

We can use maths by including latex between dollar signs, for instance θ .

4 Results

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

A Additional details

References

- Friendly, Michael, Chris Dalzell, Martin Monkman, and Dennis Murphy. 2020. *Lahman: Sean ‘Lahman’ Baseball Database*. <https://CRAN.R-project.org/package=Lahman>.
- R Core Team. 2020. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. <https://www.R-project.org/>.
- Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D’Agostino McGowan, Romain François, Garrett Golemund, et al. 2019. “Welcome to the tidyverse.” *Journal of Open Source Software* 4 (43): 1686. <https://doi.org/10.21105/joss.01686>.