

Speed limit compliance on Toronto residential streets is high, but speeding remains prevalent*

Significant and consistent levels of speeding especially outside of the downtown core

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06 February 2022

Abstract

Road safety is a serious issue for high population cities like Toronto, with numerous measures to increase safety having been implemented. We investigate the Mobile Watch Your Speed Program which aims to reduce speeding by reminding drivers of their speed through roadside displays. These displays have collected speed observations, which we have used to analyse overall speed limit compliance within the city and behaviour in individual municipal wards. We find that although generally compliance is high, there is a significant percentage of speeds recorded exceeding the speed limit that has not decreased throughout the program's lifespan so it cannot be said to be effective at reducing speeds.

1 Introduction

Pedestrian safety is a considerable concern for large cities such as Toronto, where population density and high number of vehicles on the road create a greater risk of traffic related fatalities and injuries. The City of Toronto's Vision Zero Plan was created to address these concerns through conducting a number of changes to road and traffic laws within the city (Toronto 2021). One of the most significant factors in causing road fatalities and serious injuries are vehicle speeds. Higher speeds are a major contributor to the risk of pedestrian death with a probability of 50% if a vehicle is travelling at 59 km/h, but falling to 5% when travelling at 30 km/h (Hussain et al. 2019). Due to the mutability of this factor, the city has committed to reducing vehicle speeds through several measures such as reducing speed limits and utilising automated speed enforcement.

As part of the Vision Zero Road Safety Plan, the Mobile Watch Your Speed Program (WYSP) uses speed display signs which contain a radar device to detect the speeds of oncoming vehicles and an LED display to show the speed of the vehicle to the driver. The aim of the device is to “remind [motorists] to check their speeds and to obey speed limits” (“Watch Your Speed Program (WYSP)” 2017). The location of the speed displays is limited to residential roads with no more than two lanes, and as they are temporary installations, require existing infrastructure such as hydro or light poles to be affixed to. This program is distinct from automated speed enforcement; there is no consequence if a vehicle is recorded exceeding the posted speed limit. This is a point of interest as the lack of enforcement means that drivers would not be influenced by wanting to avoid punishment to cause reducing vehicle speed, and so whether publicly displaying their speed is enough of a deterrent to speeding.

This report was produced using `knitr` (Xie 2014) and `bookdown` (Xie 2016).

*Code and data are available at: <https://github.com/chan-roy/VehicleSpeedsToronto>

2 Data

Our primary dataset is the Mobile Watch Your Speed Program - Summary (“Mobile Watch Your Speed Program – Speed Summary” 2022). The data is obtained from the Open Data Toronto portal, retrieved using the `opendatatoronto` package (Gelfand 2020) and saved and retrieved using `readr` (Wickham, Hester, and Bryan 2022) and `here` (Müller 2020) respectively. The dataset is a summary of speeds recorded by these speed display signs over the period when it was installed and operating. It consists of 6517 rows each corresponding to an installation of the display, with columns indicating the location, period of installation, and a summary of speed observations made over the period of time it was installed. All displays are scheduled to be active on weekdays between the hours of 7 AM to 9 PM and only turns on at a minimum detected speed of 20 km/h, but speeds are still recorded by the device. For each row, we have speed distributed by percentiles, as well as the total count of vehicles recorded travelling at a specific speed in bins of 5 km/h increments from 0 km/h to 100 km/h and over. A small subset of our data is shown below, formatted using `kableExtra` (Zhu 2021).

Table 1: Primary dataset preview

_id	location_id	ward_no	location	from_street	to_street	direction	installation_date	removal_date	schedule	min_speed
91811	2074481	13	Lombard St	Victoria St	Jarvis St	WB	2021-06-10	2021-07-01	Weekdays from 7 AM - 9 PM	20
91812	2074482	13	River St	Gerrard St E	Shuter St	NB	2021-06-10	2021-07-01	Weekdays from 7 AM - 9 PM	20
91813	2074484	13	Winchester St	Sumach St	Parliament St	EB	2021-06-10	2021-07-01	Weekdays from 7 AM - 9 PM	20

pct_05	pct_10	pct_15	pct_20	pct_25	pct_30	pct_35	pct_40	pct_45	pct_50	pct_55	pct_60	pct_65	pct_70	pct_75	pct_80	pct_85	pct_90	pct_95
5	6	6	7	8	10	10	12	13	14	15	15	16	18	19	21	22	26	28
6	8	10	13	15	17	19	21	23	24	26	27	29	31	32	34	36	39	43
5	6	6	8	10	12	14	16	17	19	20	21	23	24	25	26	28	30	32

spd_00	spd_05	spd_10	spd_15	spd_20	spd_25	spd_30	spd_35	spd_40	spd_45	spd_50	spd_55	spd_60	spd_65	spd_70	spd_75	spd_80	spd_85	spd_90	spd_95	spd_100_and_above	volume
0	41	33	28	15	8	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	129
0	22191	17481	20069	24508	29865	24868	15453	7798	2674	690	157	50	14	3	1	0	0	0	0	0	165822
0	4442	2063	2583	3032	2698	1090	301	97	27	14	1	2	1	0	0	0	0	0	0	0	16351

We recognise that it would be very difficult to individually operate on all 6517 observations, so we should devise an appropriate method of summarisation. Since the data spans over the years of 2018-2021, one way is to focus on investigating trends in vehicle speeds over the time the program is operational. Additionally, it is stated the city rotates displays throughout each ward; thus we can also organise the data further by ward. For our data analysis, we will be using `R` (R Core Team 2020) and the `tidyverse` package; specifically, `dplyr` (Wickham et al. 2021) to perform our data manipulations and `ggplot2` (Wickham 2016) to generate plots and figures. Since we are aggregating our data into wards, we did not utilise any of the individual data values such as information about the location or percentiles.

A few issues that were discovered with the data are were an inconsistent operating period: City site specifies 2-3 weeks, but some cameras have operated for multiple months if not years. The criteria of how locations where displays are deployed are unknown- there exists an online form for requesting the program on a specific street, but it is not made clear whether the suggestions are directly implemented or vetted further. We would think that the locations would possess some level of speed limit non-compliance if it is necessary for a speed display to be installed. Importantly for our discussion of speeding habits, the speed limit of roads where displays are located is not specified. The WYSP operates on residential/local streets, and as stated by the city of Toronto (“Minimum Speed Limit on Streets” 2020) the speed limit on such roads is 40km/h. However, in 2015 speed limits on Toronto (downtown) and East York residential streets were further reduced to 30km/h (King 2015). This change occurred before the 25 ward system was introduced in 2018 so wards 4, 9, and 19 which are now considered part of this area were not previously subjected to this change (Toronto 2019). Thus we will only consider wards 10 to 14 to have the lowered speed limit of 30km/h.

WYSP displays are located on roads which are more busy than others, so to account for this we will use relative counts. The first exploratory plot we generate is the distribution of vehicle speeds in the entire city, grouped by year. No vehicles were recorded travelling at 0 km/h, so it has been omitted.

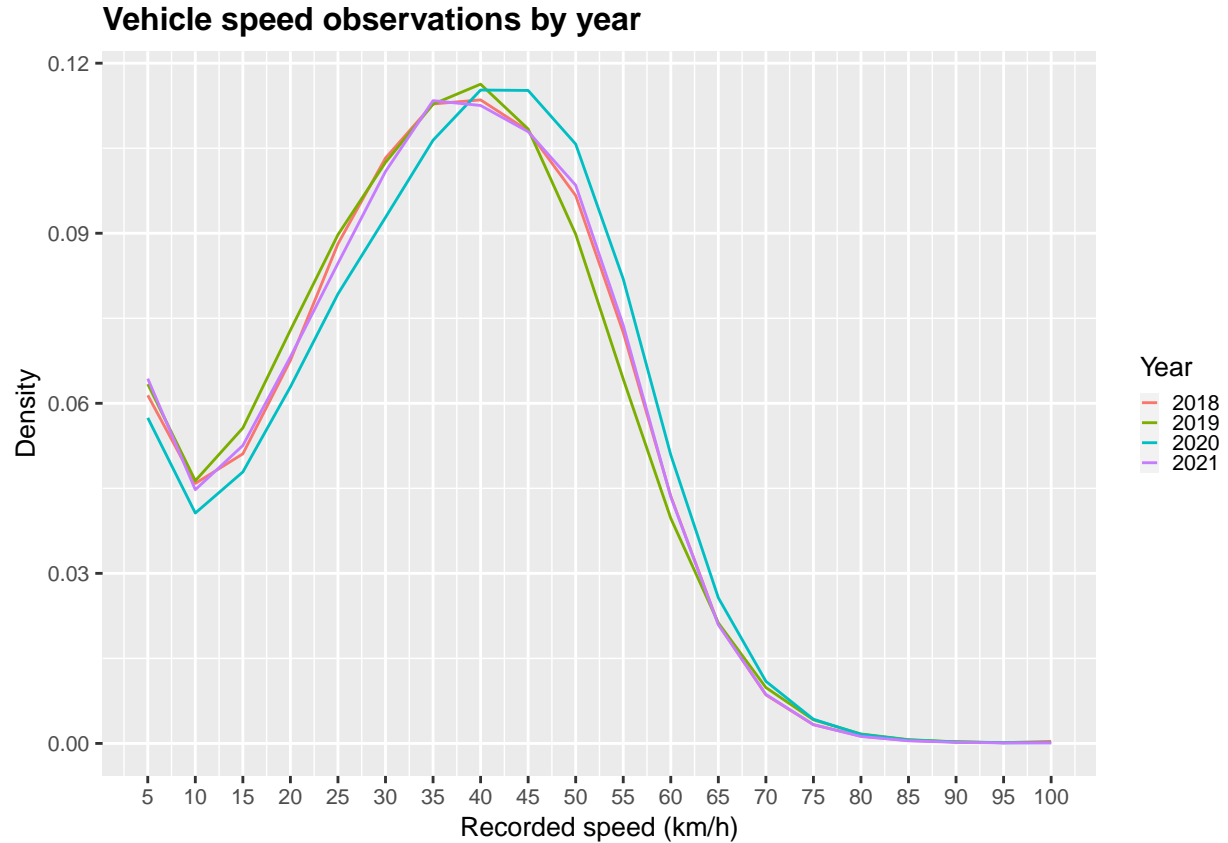
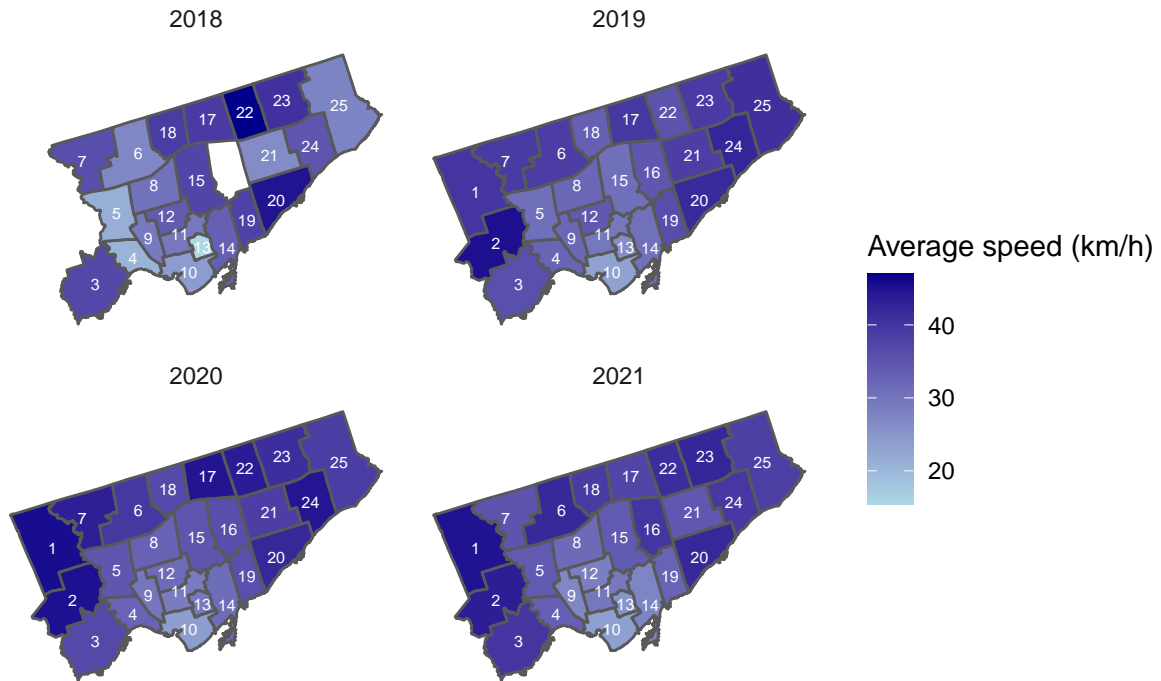


Figure 1: Histogram of vehicle speed distributions

Some immediate observations that we can make from this histogram are that it is right-skewed, which indicates a trend of speed limit compliance with our assumption that the speed limit is 40 km/h. It is also very consistent from year to year, so there does not appear to be any significant changes in driving behaviour. One limitation as mentioned earlier is the disparity of speed limits within Downtown Toronto and East York, being 10 km/h lower it is possible that speeding behaviour in those wards are not properly represented. For more detailed analysis, we want to see if we can make any observations about speed behaviours in specific wards. The city of Toronto so is divided into 25 wards, which would be difficult to display on a single graph. As such, we will create a map plot using `ggplot2` and `sf` (Pebesma 2018), generated from the City Wards dataset also retrieved from `opendatatoronto` (“City Wards” 2022) so that we can also take advantage of being able to see larger trends in neighbouring wards.

Average speeds in Toronto are compliant with the speed limit*



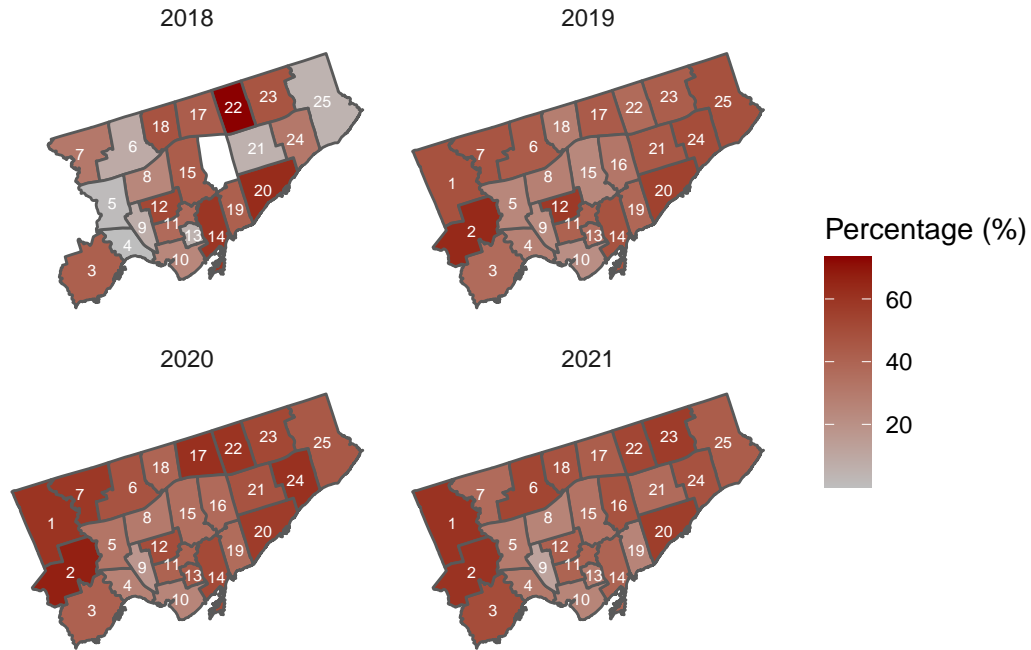
*No speed displays were used in wards 1, 2, and 16 in 2018

Figure 2: Map plots of average recorded speeds in each word separated by year

Ward 10, Spadina-Fort York, stands out for its significantly low average recorded speed, falling below the posted speed of 30 km/h and consistently throughout all years. While speed limit compliance is generally high, there is a number of wards with an average exceeding the limit, with a maximum average speed of 46.96 km/h recorded in 2018 in ward 22, Scarborough-Agincourt. For more elaborated analysis on the behaviour of speeding in Toronto, we will plot the percentage of speeds recorded exceeding the speed limit, adjusting for the lower speed limit in certain wards.

Significant number of vehicles in Toronto recorded exceeding the sp

Percentages remain consistently high each year



*No speed displays were used in wards 1, 2, and 16 in 2018

Figure 3: Percentage of recorded speeds exceeding the speed limit in each ward

As visualised in this plot, the number of speed observations made that exceed the corresponding speed limit of residential streets in their ward represents a significant proportion of all observations made. With the exception of 9 observations recorded in 2018, the minimum percentage of speeds recorded as exceeding the speed limit was 11.9%, with the majority falling between the 30% to 50% range. This demonstrates that although as seen on Figure 2 average speeds are compliant, it is not an exact representation of driving behaviour as it masks a considerable number of speeding occurrences. Owing to the number of overlapping road safety measures, it would be difficult to attribute the lack of reduction to the ineffectiveness of the speed displays, but it could be said that the current set of measures as a whole is not sufficient for preventing speeding.

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