Factors Related to KSI Traffic Collision and It's Geographical Distribution*

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Abstract

Data were extracted from the City of Toronto open Portal to analyze the causes of KSI accidents and the changes of KSI accidents over time. The data show a decrease in the accident rate between 2006 and 2020. In terms of age, young adults are more likely to be involved in serious traffic accidents. At the same time, dangerous driving, poor vision and poor road conditions may increase the incidence of KSI.

1 Introduction

With the development of cities and the progress of technology, traffic accidents have become one of the main causes of injury or death caused by human beings. According to the World Health Organization, about 1.3million people are injured or even killed in traffic accidents every year (WHO 2021).

Toronto, one of Canada's largest cities, has a high incidence of traffic accidents. To keep Toronto residents safe on the roads, the Toronto Traffic Service has developed a comprehensive traffic safety strategy with emphasis on education, awareness-raising and law enforcement.(Service, n.d.) The objective is to provide an effective and efficient traffic policing service to reduce collisions and incidents of bad driving behaviour, thereby reducing injuries and deaths, and ensuring the orderly flow of traffic on Toronto's city streets.

Meanwhile, the Toronto government has a plan that started on 2017 to keep traffic safe. Called the Vision Zero Road Safety Program,("Vision Zero Plan Overview" 2017) it seeks to reduce the number of traffic-related deaths and serious injuries on Toronto's streets through data-driven and targeted approaches, with a targeted focus on protecting the most vulnerable people in Toronto's transportation system, including. It also focus on aggressive and distracted driving, as well as motorcyclist safety, depending on factors that can lead to serious injuries and fatal accidents.

The adverse impact of traffic accidents is well known, and this article will analyze and discuss the data of serious injury or death in traffic accidents from 2006 to 2020

*Code and data are available at: https://github.com/Ariel-Q/Paper1.git

2 Data

2.1 source

The data used in this report are from the Statistical reports of the Toronto Police Service ("KSI," n.d.). The report covers serious traffic accidents in Toronto from 2006 to 2020. Serious traffic accidents are defined as Motor Vehicle Collisions involving Killed or Seriously Injured Persons (KSI).("KSI," n.d.) KSI data sets have been publicly available to the Toronto Police Service since 2006. The data can be found and downloaded from the Official Toronto Police Service Public Safety Data Portal or the City of Toronto Open Data Portal. The traffic data set analyzed in this report was downloaded in CSV format from the Toronto Open Data Portal. This data was last updated on May 6, 2020.

2.2 Data overview and limitation

The data includes all traffic accidents involving more than one death or serious injury reported to the Toronto Police Service from 2006 to 2020. In the data collected, some accident sites were deliberately moved to safe areas for the sake of privacy and public safety. Therefore, the regional information in this data cannot guarantee accuracy.("Open Data Dataset," n.d.) The raw data included information on 16,860 accidents. This information have 56 categories that includes the time, place, process, weather conditions, vehicle conditions, passenger and driver conditions and so on. Because the raw data was too cumbersome, R (R Core Team 2020) and tidyverse(Wickham et al. 2019) were used to clean up and extract the necessary data. The collated information will be used in the analysis and charting process. The collated dataset contains 10,860 observations and 14 attributes: year, hour, zone, visibility, light, road conditions, accident level, age, injuries, speeding, dangerous driving, red light, and alcohol. The number of accidents is summarized by region, category, year and so on during data processing. An example view of the data set is shown below:

```
## # A tibble: 6 x 14
##    YEAR  HOUR ROAD_CLASS     DISTRICT   VISIBILITY LIGHT RDSFCOND ACCLASS INVAGE
##   <dbl> <dbl> <chr>          <chr>      <chr>      <chr> <chr>    <chr>   <chr>
## 1  2006     8 Major Arterial Toronto a~ Clear      Dayl~ Dry      Fatal   unkno~
## 2  2006     8 Major Arterial Toronto a~ Clear      Dayl~ Dry      Fatal   65 to~
## 3  2006     9 Major Arterial Scarborou~ Clear      Dayl~ Dry      Fatal   45 to~
## 4  2006     9 Major Arterial Scarborou~ Clear      Dayl~ Dry      Fatal   unkno~
## 5  2006     2 Major Arterial Scarborou~ Clear      Dark  Dry      Fatal   25 to~
## 6  2006     2 Major Arterial Scarborou~ Clear      Dark  Dry      Fatal   30 to~
## # ... with 5 more variables: INJURY <chr>, SPEEDING <chr>, AG_DRIV <chr>,
## #   REDLIGHT <chr>, ALCOHOL <chr>
```

2.3 Discussion

2.3.1 Road Impact

Table 1: Table1: Number of Collision by Road

Road Class	Surface Condition	Number of Collision
Collector	Dry	759
Collector	Loose Sand or Gravel	3
Collector	Other	6
Collector	Packed Snow	1
Collector	Slush	13
Collector	Wet	147
Expressway	Dry	33
Expressway	Wet	19
Expressway Ramp	Dry	4
Laneway	Dry	10
Local	Dry	622
Local	Ice	8
Local	Loose Snow	5
Local	Other	3
Local	Packed Snow	1
Local	Wet	122
Major Arterial	Dry	9507
Major Arterial	Ice	48
Major Arterial	Loose Sand or Gravel	2
Major Arterial	Loose Snow	122
Major Arterial	Other	106
Major Arterial	Packed Snow	37
Major Arterial	Slush	76
Major Arterial	Spilled liquid	1
Major Arterial	Wet	2061
Major Arterial Ramp	Dry	1
Minor Arterial	Dry	2061
Minor Arterial	Ice	17
Minor Arterial	Loose Sand or Gravel	2
Minor Arterial	Loose Snow	18
Minor Arterial	Other	24
Minor Arterial	Packed Snow	2
Minor Arterial	Slush	7
Minor Arterial	Wet	460
Other	Dry	23
Other	Loose Snow	2

Based on the information provided by the data, all accidents were summarized according to the road conditions on which they occurred. Road conditions will be affected by two factors, one is the grade of the road, the other is the state of the road caused by the weather conditions at that time. Different road grades to a certain extent determine the width and quality of the road. Weather conditions can affect a vehicle's grip on the road.(Jägerbrand and Sjöbergh 2016) For example, cars are more likely to skid in snow and wet surface. In this set of data, Table 1 shows that under the same road grade, most traffic accidents occur on dry roads, while other weather conditions also have a relatively small number of traffic accidents. However, due to the lack of complete weather statistics, this data cannot be used to show the impact of weather conditions on

the likelihood of severe traffic. However, given the same weather conditions, most accidents occur in Major and Minor Arterial systems. This may be due to the greater number of roads under these two classifications. ("About the Road Classification System" 2017)

2.3.2 Vision Impact

Table 2: Table2: Number of Collision by View Condition

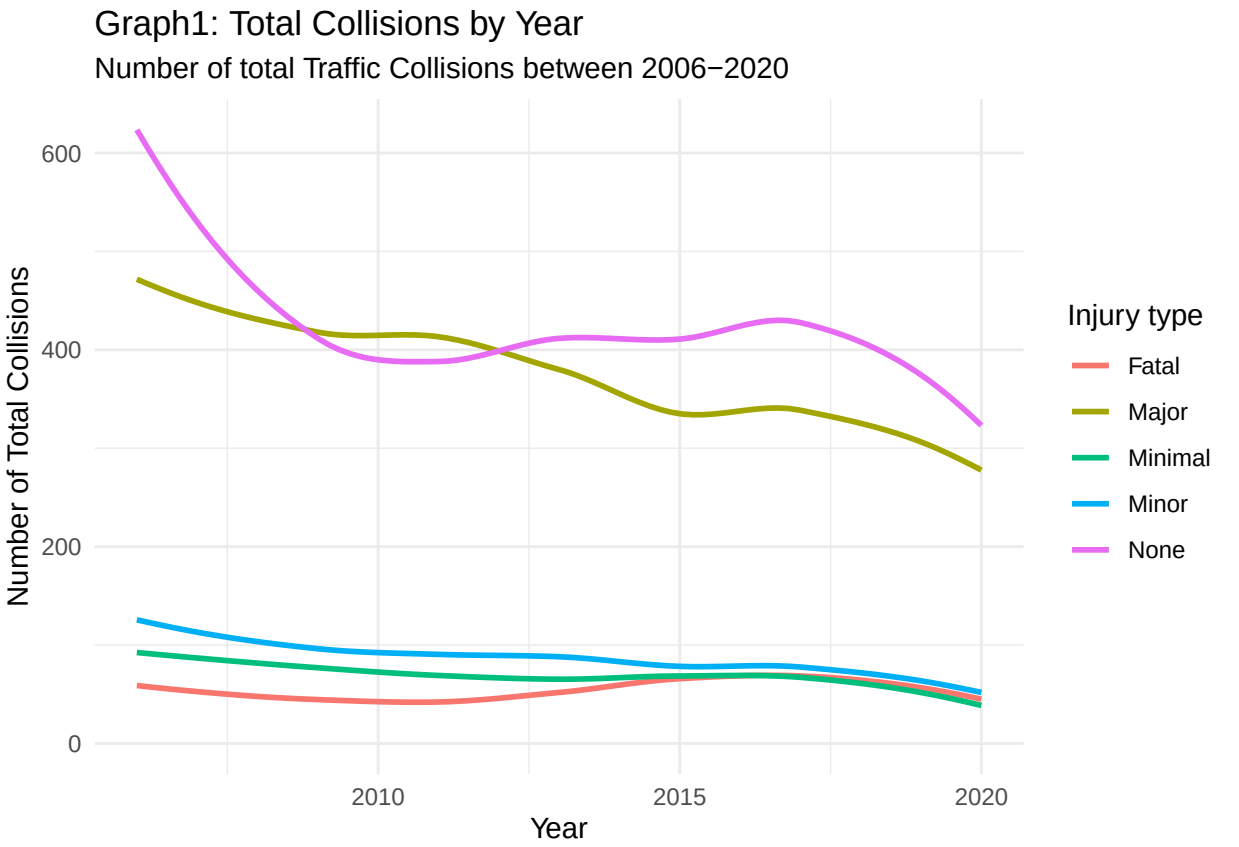
Visibility	Light Condition	Number of Collision
Clear	Dark	2765
Clear	Dark, artificial	2263
Clear	Dawn	78
Clear	Dawn, artificial	70
Clear	Daylight	8845
Clear	Daylight, artificial	108
Clear	Dusk	190
Clear	Dusk, artificial	157
Drifting Snow	Dark	2
Drifting Snow	Dark, artificial	7
Drifting Snow	Daylight	8
Drifting Snow	Dusk, artificial	2
Fog, Mist, Smoke, Dust	Dark	18
Fog, Mist, Smoke, Dust	Dark, artificial	13
Fog, Mist, Smoke, Dust	Daylight	15
Freezing Rain	Dark	21
Freezing Rain	Dark, artificial	11
Freezing Rain	Daylight	11
Other	Dark	39
Other	Dark, artificial	4
Other	Daylight	49
Other	Dusk	1
Other	Other	6
Rain	Dark	579
Rain	Dark, artificial	506
Rain	Dawn	26
Rain	Dawn, artificial	23
Rain	Daylight	609
Rain	Daylight, artificial	20
Rain	Dusk	35
Rain	Dusk, artificial	21
Snow	Dark	146
Snow	Dark, artificial	50
Snow	Daylight	132
Snow	Dusk, artificial	4
Strong wind	Dark	2
Strong wind	Daylight	6
NA	Dark	10
NA	Daylight	8

When driving a motor vehicle, the driver's vision can also affect the driving condition. In Table 22, traffic accidents are classified and summarized according to the visual field conditions at that time. The data records two factors that can affect visibility: visibility due to weather and light conditions at the time of the

accident. The data showed that KSI occurred in greater numbers in dark conditions (38.17%), both natural and artificial. In dark conditions, the driver's response speed to emergencies and the visible distance of obstacles will decrease, which may lead to one of the reasons for traffic accidents. (Jägerbrand and Sjöbergh 2016) As with table 1**??**, weather cannot be relied on as a statistical factor due to the lack of complete statistics on weather conditions.

###Changing Over Year

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```



With the progress of medical treatment and the development of cities, the number of KSI incidents is gradually decreasing. Chart 1 shows the curve of the number of KSI injuries over time. Although all types of KSI increased slightly in 2017, the overall slope of the line is still negative. This data only includes KSI information in traffic accidents. We cannot infer the overall change in the number of traffic accidents from this table, but it at least shows that the number of traffic accidents resulting in serious injury or death in Toronto is decreasing year by year. In this regard, Toronto's road safety level is gradually improving.

###Unsafe Driving The data included records for four conditions that could lead to dangerous driving, including alcohol, red light running, aggressive driving and speeding. These four factors were classified as dangerous driving factors and the occurrence of dangerous driving situations and whether accidents resulted in deaths were statistically analyzed. The results are as follows:

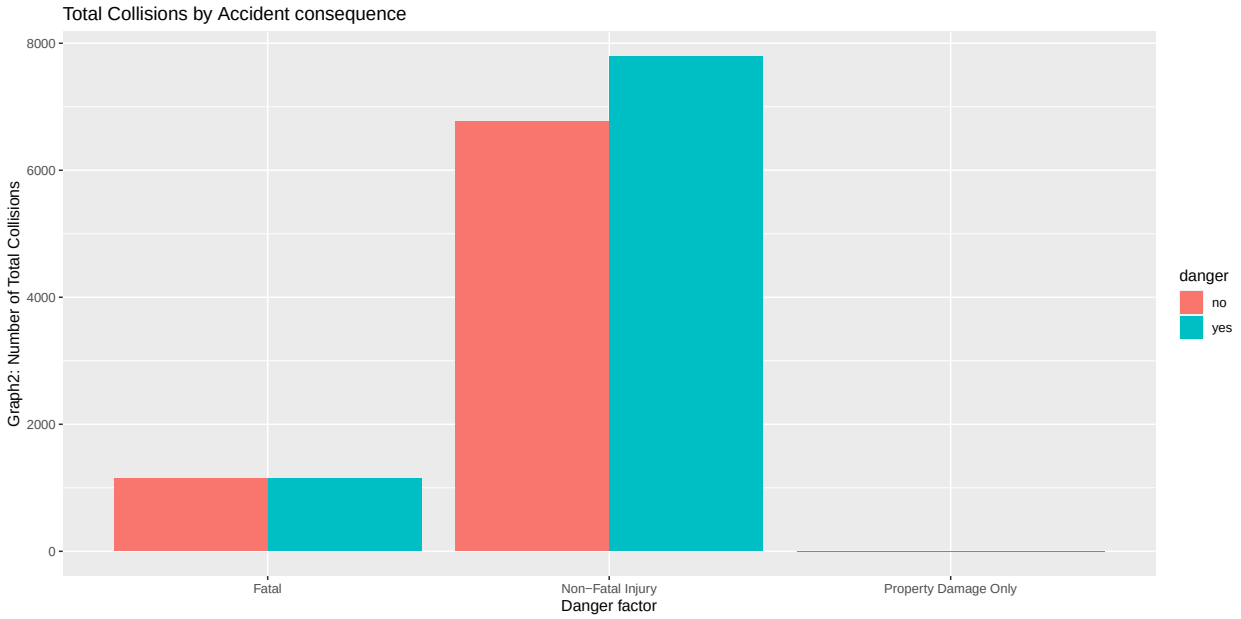
2.3.3 Age Range

In Table 3, the number of KSI accidents is divided by age group. Among them, the number of people aged 20-39 participating in KSI accidents is significantly higher than that of other age groups, accounting for 32.7% of all KSI accidents. The proportion of other age groups is as follows: The proportion of people aged

40-59 is 27.0%, those aged 60-79 13.6%, those over 80 18.6% and those under 20 8.0%. Other studies have also shown that drivers between the ages of 18 and 30 are more likely to be involved in accidents, which may have to do with driving habits and frequency(Hu et al. 2020).

Table 3: Table3: Number of Collision by View Age Range

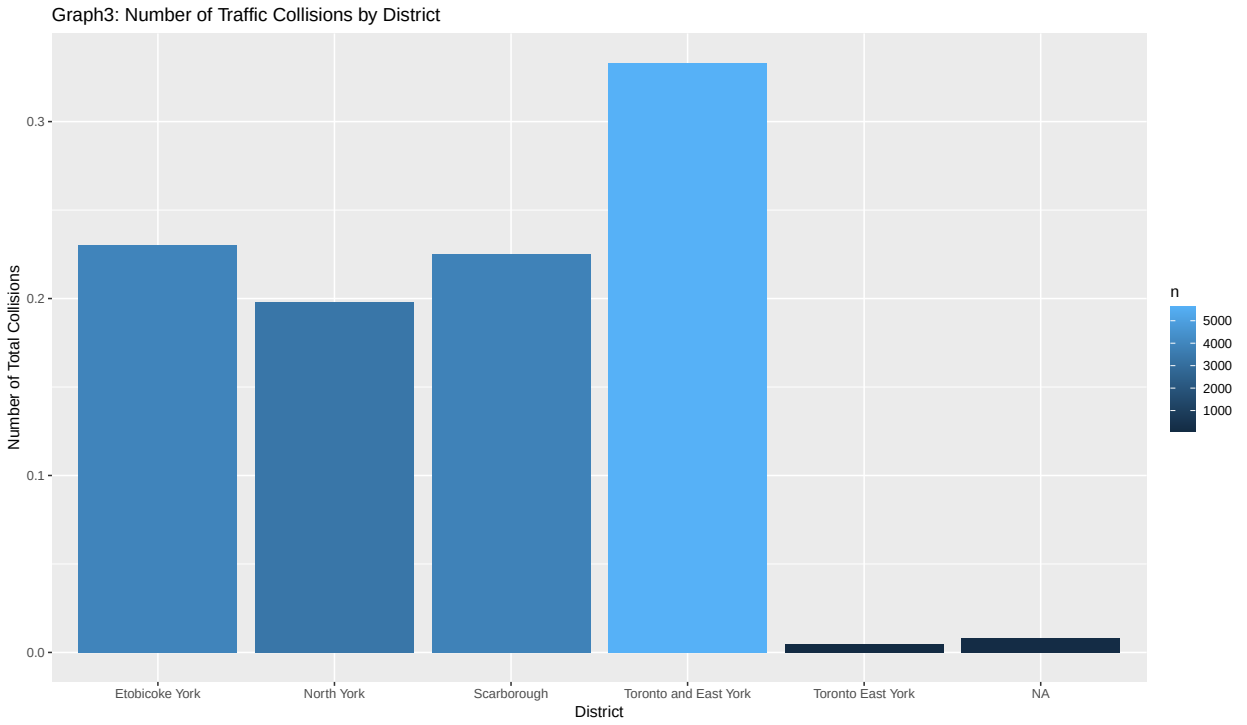
Age Range	Number of Collision
20-39	5518
40-59	4549
60-79	2300
over 80	3146
under 20	1347



Graph 2 shows that there is no significant difference in the presence or absence of dangerous driving factors in traffic accidents without death, while in the number of fatal traffic accidents, the number of accidents with dangerous driving factors is higher than the number of accidents without dangerous driving factors. Overall, 53 per cent of accidents involved drivers in one or more dangerous driving situations. This suggests that dangerous driving factors do have an impact on the likelihood of an accident, and that dangerous driving is more likely to result in death.

2.3.4 Collision Consequences by Division

Different districts in Toronto have different traffic conditions. In order to better understand the regional distribution of KSI, all KSI accidents are classified according to the region and the number of casualties. The statistical results are as follows:



Taken as whole, the number of KSI in Toronto and East York is much higher than that in other boroughs, which are more evenly distributed. Toronto and East York's KSI report number accounted for 33.3%, Etobicoke York's KSI report number account for 23.0% and North York's KSI report number account for 19.8%, respectively. Scarborough had a KSI ratio of 22.5%. Since The area of Toronto East York is too small compared with other regions, and the data of Toronto East York is included in the data of Toronto and East York, it is not discussed here as the main content. The reason behind this figure may be that downtown Toronto is located in old Toronto, which is more prosperous and has more people and cars than other areas. At the same time, a greater police presence in downtown may be one reason why the number of KSI reported in Toronto and East York is higher than in other districts.

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