Analyzing the Relationship between Arrests, Strip Searches, and Other Factors: A Study of the Toronto Police Service

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Introduction:

Arrests and strip searches are two common practices within the criminal justice system that have been subject to debate and controversy. When a person is arrested, they are taken into custody by law enforcement officials, and if there is a suspicion that the person may be carrying contraband or weapons, a strip search may be conducted. A strip search involves the removal of all clothing and may include a visual inspection of the person's body cavities. Meanwhile, some people argue that strip searches are a violation of personal privacy and dignity and may be used excessively or unnecessarily in some cases. There have been cases where strip searches have been conducted on individuals who were arrested for minor offences or who posed no threat to themselves or others. Additionally, there have been instances where strip searches have been used to humiliate or intimidate individuals. In recent years, there have been more concerns about strip searches. One concern is about the high strip search rate of the Toronto police service. McNeilly's 2019 report indicates, "Each year, well over 22,000 strip searches are conducted by police officers in Ontario, the majority by the Toronto Police Service." (Wendy, 2020). This raises public doubts about whether Toronto police officers use strip checks rationally and follow the relative rules. Several studies demonstrate the persistence of illegal and brutal strip-searching by Canadian police (Monika, 2022). Thus, understanding the potential relation between strip searches and other factors is essential to improve the current situation and reduce the occurrence of illegal and brutal strip searches.

In this research, we are trying to determine the possible relationships between arrests and strip searches with other factors with the data collected by the Toronto Police Service. We mainly focus on two research questions, which are the occurrence of strip searches in relation to location divisions and the relation of criminals' behaviours at the time of the arrest to crime categories. Through the study of the first question, we can understand whether the strip searches are related to the arrest location. This finding could be further studied to find out which regional factors influence the occurrence of strip searches, which can help police officers better judge whether a strip search is warranted to avoid using it for improper reasons. With the help of a second research question, police officers can better predict the possible actions of criminals during the arrests depending on the criminal category in order to get prepared in advance.

Exploratory Data Analysis:

For the study, we used the arrest and stripped searches dataset gathered from the Toronto Police Service (Toronto Police Service, 2022) to explore the potentially correlated variables and set up the research objective and questions accordingly. In the following sections, we present the process of data cleaning formatting and finding relationships by various data visualization approaches, including bar charts and box plots. Since the dataset is primarily composed of categorical variables, we perform multiple rows and column merging to introduce the continuous variables for further analysis.

a. Data cleaning

The first step in the data-cleaning process is to clarify the dimensions and variables contained by the data frame after reading the CSV file using pandas packages (Figure 1). Using the shape method, we found the dataframe containing 65276 rows of data with 25 variables.

After examining the content, we found there are large amount of null values, and string values such as “XX” appear in columns. The density of null value appeared high for columns under the categories “SearchReson_XX,” while “XX” appears in the “ArrestLocDiv” column representing arrest events that happened outside the Toronto designated divisions. For the “SearchReason” columns, there are three possible values: 0, 1 and NAN, where 0 represents the specific search event happened during the arrest and 0 if there was a search event but not the specific search type. Eventually, “NAN” stands for no search event occurred during the arrest. Since we focused on the accumulated number of strip searches that happened during the year, it is appropriate to set all the “NAN” to 0, representing that the specific event did not occur. For the “Youth_at_arrest_under_18_years” column, we replaced the string variable with integers 1 and 0 for easy determination. Next, when examining each variable, we found unique variables such as “EventID,” “ArrestID,” and “PersonID” not applicable as we were interested in the general pattern relationship over the years rather than a particular event. Therefore we decided to drop these columns.

b. Exploration of relationships

Our general goal at the stage was to explore variables that have relationships with the merged number of searches set as the dependent variable. Before collapsing the search column to create continuous variables, we first made horizontal bar counts plots for the variable we were interested in.

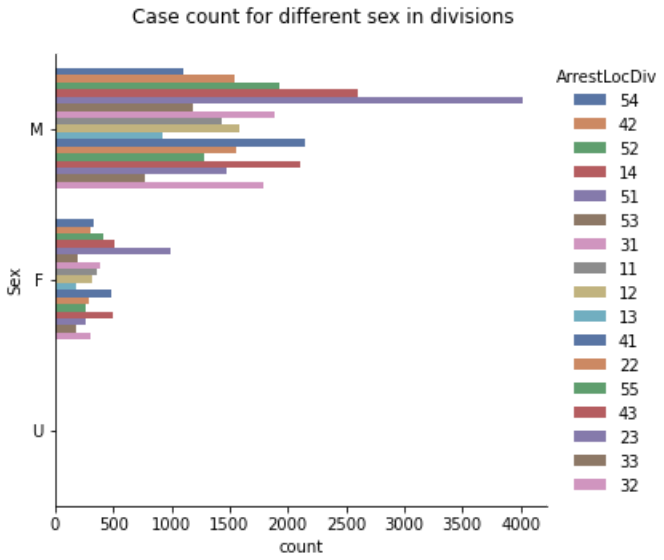

Figure 1: the case count recorded for 2020 and 2021 categories in sex that happened in different divisions labelled in colours.

As shown in Figure 2, the male was observed to have more cases reported than the female for all divisions, and the number of cases also varied among divisions. Division 51 seems to have a significantly higher case number than other divisions. In Figure 3, we then switch the y-axis to whether a strip search occurred and whether the target is underage. We see a similar distribution for case count comparing among all variables we set for the y-axis, implying that the distribution of divisions target got arrest is likely independent of selected control variables. On the other hand, we observed a case count variation when a strip search was conducted among different divisions. Moreover, suspects that are not underage have significantly higher case counts than those who are. This observation can result from a lack of attention to youth crime, or the youth group itself has a lower chance to commit crimes, yet the topic is out of the scope of this study. Therefore we would not explore further.

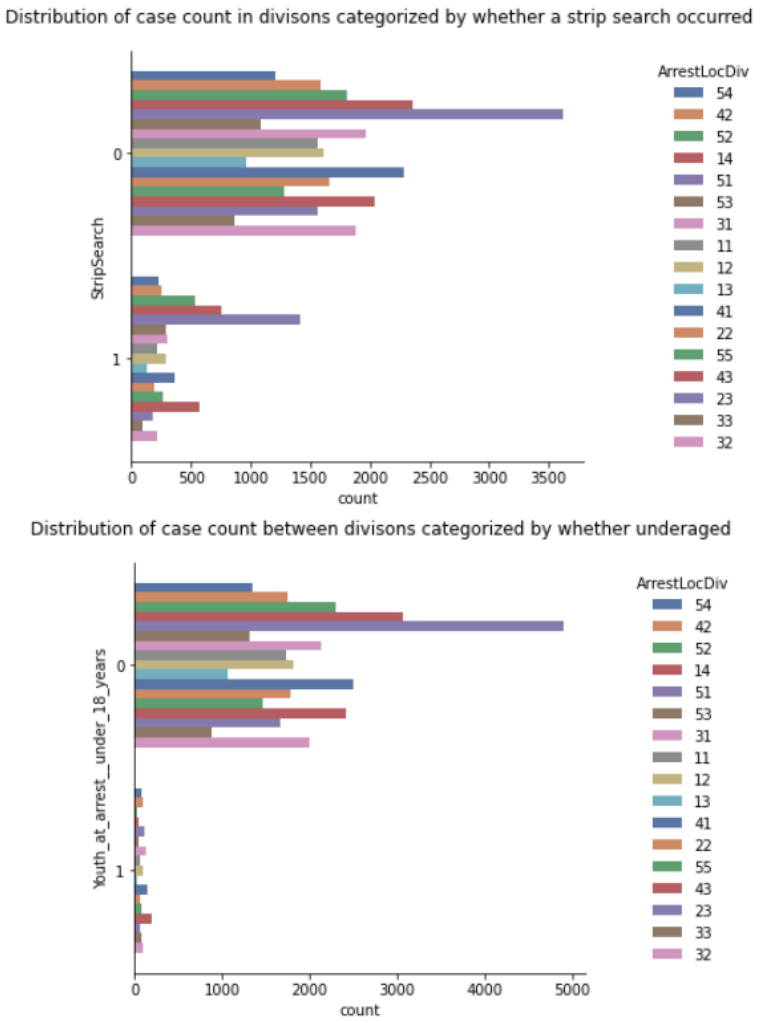

Figure 2: Comparing the distribution of case numbers in divisions by strip search (top) and youth (bottom), respectively

Further, arrest count and strip search numbers categorized by race and year were as well examined. The graph shows that white and black race groups have considerably higher case counts than others, and fewer strip search events occurred in 2021 than in 2020. There was not sufficient support to relate race with the high strip search number, for we also observed a high proportion of cases with no search conducted for the two races and in fact, according to the demographic composition of Toronto in 2016, white accounted for 50.2 percent of the total population. However, it is a surprise that East Asian and South Asian race group has extremely low crime rate compared to other race groups, as they together took 23 percent of the population (East Asian 12.7%, South Asian 12.3%) and only account for 5.33 percent of the cases reported,

and 3.46 percent of the cases reported with a search conducted. In comparison, the black race group seems to have a relatively high case number reported (31.44%), considering its population proportion. Although we do need to account for factors like the officer selecting the target being searched, which in this case, is out of the scope of our study, we would not dive deeper into the topic. Also, we want to expand on how the year change and sex differences affect the number of searches conducted.

	StripNum_20_M	StripNum_21_M	StripNum_20_F	StripNum_21_F
count	17.000000	17.000000	17.000000	15.000000
mean	282.764706	27.117647	55.352941	5.666667
std	231.272710	33.421330	55.128193	6.521028
min	69.000000	4.000000	11.000000	1.000000
25%	167.000000	6.000000	25.000000	2.000000
50%	220.000000	11.000000	38.000000	3.000000
75%	274.000000	31.000000	69.000000	6.000000
max	1049.000000	108.000000	241.000000	23.000000

Table 1: Statistical description of a table categorized the number of strip searches into two columns according to variable sex and year.

We then rearrange the original table — select and categorize columns in the number of strip searches conducted by the sex of the suspect and the year the case was raised in all divisions. From table 1, examining evidence from the mean, minimum and maximum, we see that mean search cases raised for males were considerably higher than for females and males were also shown to have a higher standard derivative of 231.3 and 33.4 compared to females [55,1, 5.7]. We also observed a dramatic drop in strip search numbers across the year for both sexes. Figure 3 illustrates the density distribution across divisions for different sex and years. For both years, males and females share a similar drop in group mean. Especially for females, because of the low base search value in 2020, the drop illustrated as shape nail-shaped rise near the zero. Except for the female curve for 2021, the other three categories seem to show a standard bell-shaped curve, meaning that while the mean is high in density, there are few extreme cases. There are some

outliers that indicate the unusually high number of cases in some divisions. However, we decided not to treat these divisions as outliers considering the population density distribution in Toronto (the population tends to be concentrated in the downtown area.)

Interested in the relations between divisions and the number of strip searches conducted, we dive deeper into how each specific reason for search varies by divisions chosen. We first constructed a bar plot for the distribution of strip search count for specific reasons across all divisions (Figure 4.) We see the quantity relationship between search types stay consistent across divisions, and strip search caused by "Cause injury" is significantly higher than others. Moreover, the relative number of search patterns for each reason across divisions follows the pattern we found for the total search counts across divisions, implying that the pattern might not be correlated to the specific search type conducted. The box plot gave a direct image of the spread and skewness of each category. We first notice a higher IQR of 136 and a range of 851 for "CauseInjury" compare to the other third reasons. The spread for "AssistEscape," "PossessWeapons," and "PossessEvidence" are similar, except "AssistEscape" is shown to be more normally distributed, "PossessWeapons" skews more to the left and "PossessEvidence" seems more right-skewed. Overall, there seems to be a strong relationship between sex, divisions, and the number of strip searches conducted during the year. Therefore, we decide to conduct T-test to validate these potential relationships further.

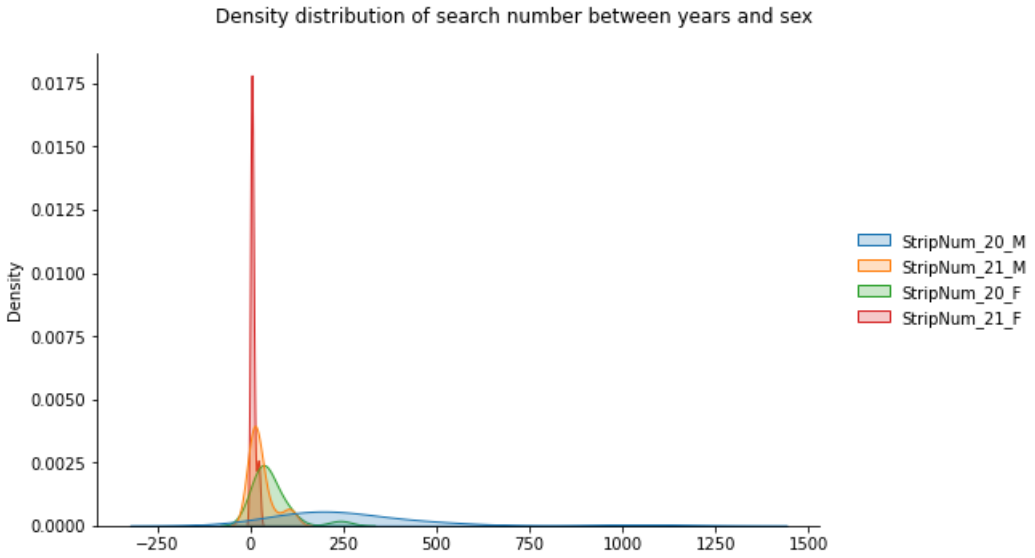

Figure 3: Density distribution of search number between years and sex

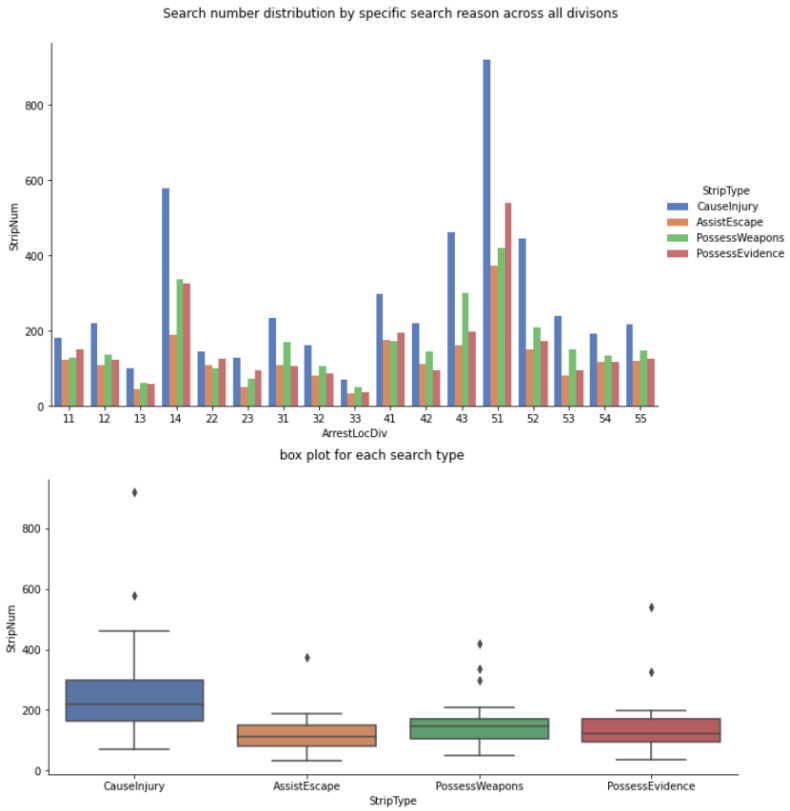

Figure 4: The distribution of strip search count for specific reasons across all divisions (Top) and the box plot for each strip search type where data points gathered from all divisions (Bottom)

Besides the study about strip searches, we are interested in the relations between actions at arrest and other factors. Initially, we count the number of all recorded criminals' actions at arrest in 2020 and 2021.

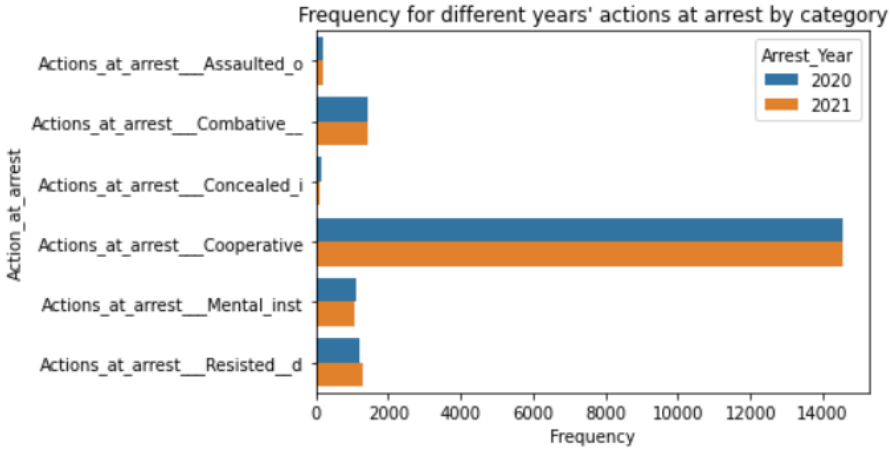

Figure 5: The frequency of different actions at arrest in 2020 and 2021.

The above figure shows the frequency of different actions at arrest in 2020 and 2021. We can find that cooperative action is the most common action of criminals at arrest, which was recorded over 14000 times in each of the last two years. The remaining actions are much lower than the number of cooperative actions, with assaulting officers and concealing items happening the least. By comparing the frequency of each action in 2020 and 2021, it was evident that there is no significant disparity in the number. As a result, we can conclude that the arrest year does not have a relationship with the occurrence of the criminals' actions at arrest. Because of the vast number of cooperative action cases, we decide to focus on discovering the possible relationship between this specific action at arrest and other factors. Then, we split the amount of cooperative action at arrest by quarter and occurrence category.

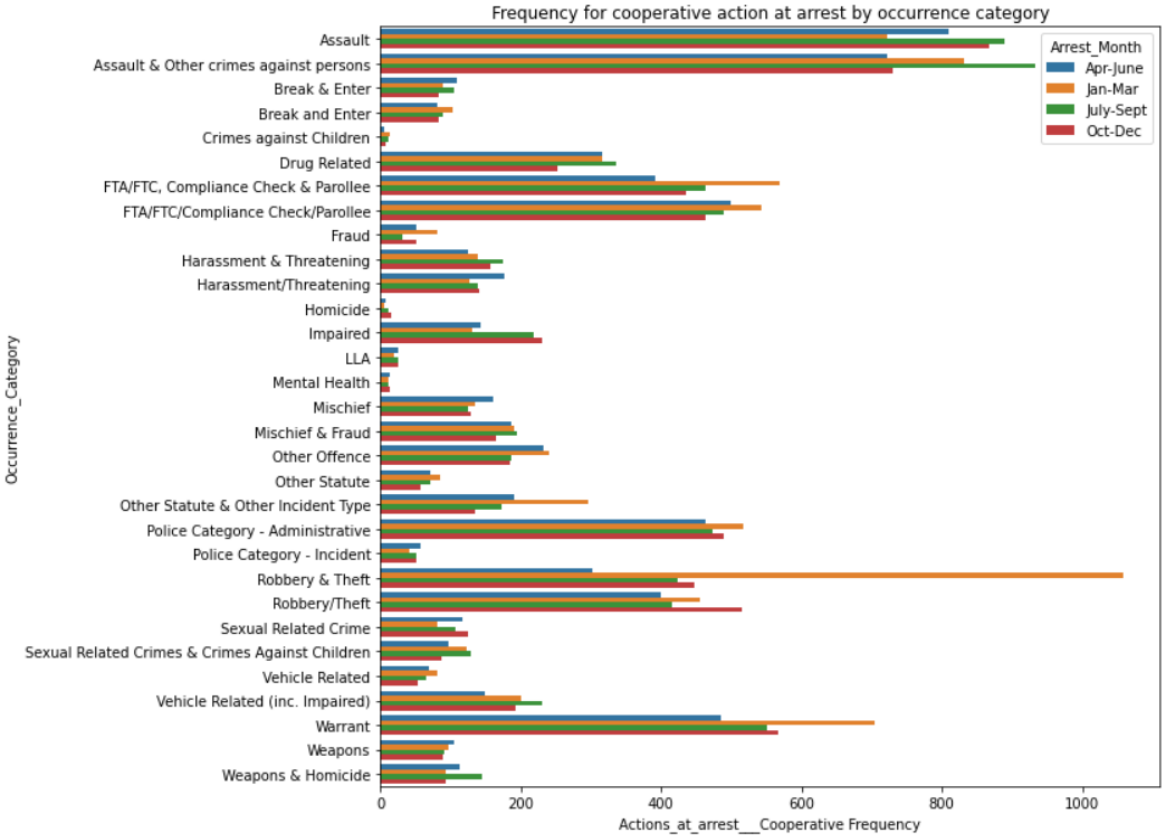

Figure 6: The frequency of cooperative action at arrest by occurrence category and quarter.

Arrest_Month	Apr-June	Jan-Mar	July-Sept	Oct-Dec
count	31.000000	31.000000	31.000000	31.000000
mean	214.967742	261.064516	237.387097	223.548387
std	205.410075	275.604540	239.584735	225.181236
min	6.000000	5.000000	11.000000	8.000000
25%	76.000000	82.500000	79.000000	70.500000
50%	143.000000	130.000000	145.000000	135.000000
75%	308.000000	385.000000	375.500000	343.500000
max	810.000000	1058.000000	933.000000	867.000000

Table 2: Statistical description of a table categorized the number of cooperative actions at arrest by quarter.

Figure 6 shows the frequency of cooperative action at arrest across 31 criminal categories. We can find that assault and assault & other crimes against persons have the most records of cooperative action at arrest, while crimes against children and homicide are the opposite. It is obvious that the number of cooperative actions for robbery & theft from January to March significantly differs from other quarters. However, there is not enough evidence to prove the existence of a relationship between quarters and the frequency of cooperative action at arrest. This situation could just be a special case. From table 2, the mean for the number of cooperative actions in each quarter is almost closed. January to March has the largest mean variable, and April to June has the lowest, which are 261 and 214, respectively. Meanwhile, we can find that the standard deviation is relatively high for all four periods, indicating a significant amount of variability in the number of cooperative actions taken from one criminal category to another. As a result, we convert the time period with the occurrence category and create a new statistical description.

Occurrence_Category	Assault	Assault & Other crimes against persons	Break & Enter	Break and Enter	Crimes against Children	Drug Related	FTA/FTC, Compliance Check & Parollee	FTA/FTC/Compliance Check/Parollee	Fraud	Harassment & Threatening	...
count	4.00000	4.000000	4.000000	4.000000	4.000000	4.000000	4.000000	4.000000	4.000000	4.000000	...
mean	822.00000	804.000000	96.250000	88.750000	9.500000	304.500000	464.500000	498.750000	54.000000	148.750000	...
std	75.26398	99.622621	12.148388	9.945686	3.109126	36.373067	75.244047	33.230257	20.215506	21.608255	...
min	721.00000	722.000000	83.000000	81.000000	6.000000	252.000000	391.000000	463.000000	32.000000	125.000000	...
25%	787.75000	727.250000	87.500000	82.500000	7.500000	299.250000	424.000000	483.250000	46.250000	135.500000	...
50%	838.50000	780.500000	97.000000	85.500000	9.500000	315.000000	449.500000	494.500000	51.500000	147.500000	...
75%	872.75000	857.250000	105.750000	91.750000	11.500000	320.250000	490.000000	510.000000	59.250000	160.750000	...
max	890.00000	933.000000	108.000000	103.000000	13.000000	336.000000	568.000000	543.000000	81.000000	175.000000	...

Table 3: Statistical description of a table categorized the number of cooperative actions at arrest by occurrence category.

In Table 3, it lists all the mean and standard deviation for each occurrence category. We can find that the frequency of cooperative action at arrest for different categories varies in mean, and the same is true for standard deviation. The assault has the largest mean, which is 822, with a 75.3 standard deviation. The mean of Crimes against children is only 9.5, and its standard deviation is 3.1. The difference is huge between different categories, and we think there could be a relationship between the occurrence category and the cooperative action at arrest. As a result, we decide to conduct a T-test for two categories to prove the relationship, which are assault and FTA/FTC, Compliance Check & Parollee.

c. Tests and hypotheses

Since we are interested in if division, change in years and differences in sex affect the counts of the strip searches, we performed T-test for each of these topics. The first hypothesis is stated as:

H0: The number of people being searched is identical between males and females.

H1: There is a difference between the number of people being searched for male and female

For the change in years, the results indicate that the mean search count in 2020 (M=338.1, SD=285.8) is higher than the mean search count in 2021 (M= 32.1, SD=39.5). With alpha established at 0.05, this is a statistically significant difference as the p-value (4.35e-4) is less than 0.05, 95% CI [158.1, 453.9], and the Welch test gives a degree of freedom of 16.6. Therefore, we

can reject the null hypothesis that there is no difference in the mean search count in 2020 and in 2021.

For the relationship between sex and search count, we proposed the following hypothesis:

H0: The number of people being searched is identical between males and females.

H1: There is a difference between the number of people being searched for male and female

In this trial, the results suggest the mean search count for males (M=309.9, SD=257.8) is higher than the mean search count for females (M= 60.3, SD=59.9). The result of the T-test suggests that there is a statistically significant difference, given the p-value of 0.01, which is less than 0.05 (alpha), 95% [114.5, 384.5]. In addition, the Welch test gives a degree of freedom of 17.7. The low value of DoF suggests the limited information available to estimate the variance of the population. With these outcomes can conclude that we can reject the null hypothesis that there is no difference in the mean search count for males and females.

For the relationship between two different occurrence categories and cooperative action at arrest, we proposed the following hypothesis:

H0: The number of people having cooperative actions at arrest is identical between assault and FTA/FTC,Compliance Check & Paeollee.

H1: There is a difference between the number of people having cooperative actions at arrest for assault and FTA/FTC,Compliance Check & Paeollee.

In this test, the result suggests that the mean of assault (M=822.0, SD=75.3) is higher than the mean of FTA/FTC, Compliance Check & Parollee (M=464.5, SD=75.2). The T-Statistic of 6.718 and a p-value of 0.0005, which is less than Alpha = 0.05, indicates that the difference in means between the two occurrence categories is statistically significant. Therefore, we can reject the null hypothesis and conclude that there is a significant difference between the number of cooperative actions at arrest in assault and FTA/FTC, Compliance Check & Parollee. Therefore, we can further analyze the relationship between cooperative action and the occurrence category.

Method:

a. Dataset Description

In this study, we analyze the dataset, which includes information on all arrests made by the Toronto Police Service between January 2020 and December 2021. It includes data on the location and time of the arrest, the nature of the crime, the age, gender and race of the person being arrested, and other relevant information about arrest and strip search. This dataset totally has 65276 records of the arrest with 24 attributes. One of the key features of this dataset is that it includes information on strip searches conducted by police officers during the arrest process. The information is basically divided into four search reasons and if there are items found. Another key feature is a wide range of offences, which contains 31 categories, from relatively minor offences to serious crimes. It also involves indicators of whether a person was booked at a police station within 24 hours following a particular arrest event and the six possible actions at arrest.

b. T-test, one-way ANOVA & two-way ANOVA

As for our study, the dataset is composed of primarily categorical variables, and we aimed to analyze the relationship between these categorical variables and the continuous variable we created for the counts of strip searches and suspects' actions. We chose T-test to examine the relationship between variables during the exploratory data analysis process. A t-test is a statistical method used to compare the means of two groups and determine whether they are statistically different. The method aligns with our research goals, for it typically suits a small sample size and unknown population standard deviation. In addition, Welch's t-test was used to examine the sample's degree of freedom (DoF). After the research questions were set, we applied one-way ANOVA, a statistical method used to compare the means of three or more groups and determine whether they are statistically different from each other, to obtain the F-statistic and p-value to validate the relationship between our target variables. Depending on the value of the F-statistic and p-value, we can make a conclusion of whether there is a significant difference between the two testing groups examined according to the variable we wish to study. To further examine the relationship and the interaction of variables, A two-way ANOVA has the suited characteristics of analyzing the relationship between two categorical variables and one

continuous variable. It provides insights into any existing interaction between two categorical variable as well as their individual effects on the continuous variable. An interaction plot was utilized to visualize the interaction of the categorical variables.

Results:

Lastly, we want to examine the relationship between the search count and divisions by conducting a one-way ANOVA test with the following hypothesis:

H0: The means for people being searched are identical for all divisions.

H1: The means for people being searched are different for all divisions.

The outcome gives a p-value of 3.68e-08 and an F-statistic of 7.06. A p-value less than alpha (0.05) combined with the large F-statistic suggest a significant difference between at least two of the population means. Based on this, we then performed the Tukey's HSD test to locate the specific group. Checking through the list, we see the comparison group that gives a "True" statement for the "reject" column dominantly relates to division "51" and some relates to division "14". To sum up, we can reject the null hypothesis of the group means of people get searched for the years 2020 and 2021 are identical, based on divisions. Next, the relationship between sex, divisions and search count can be further investigated with a two-way ANOVA test to see how sex and divisions act together to affect the search count.

For two-way ANOVA, we investigate how divisions add to the sex of the suspect affect the searched number and how divisions and sex interact with each other. The hypotheses were set up into two groups:

Hypothesis A:

H0: Group means of people get searched based on divisions are identical, for males and females.

H1: Group means of people get searched based on divisions are different, for males and females.

Hypothesis B:

H0: Group means of people got searched for males and females are identical, based on divisions.

H1: Group means of people got searched for males and females are different, based on divisions.

The outcome gave a surprising p-value of 0.62 and an F-statistic of 0.86 for the divisions related to the strip search number. The value is less than the set significant level alpha (0.05), which means we can not reject the null hypothesis of there is no difference between group means of people get searched based on divisions that are identical for males and females. This result contradicts the result we obtained earlier for one-way ANOVA. For sex, we observed an expected low p-value of 0.0055, F of 8.89 and a high p-value (0.99) for the interaction term. According to the outcome, we can reject the null hypothesis and conclude there is a difference in the group mean of got searched for males and females, based on divisions. Further, the interaction term implies that there is no significant interaction between the division suspect who got searched and the sex of the suspect.

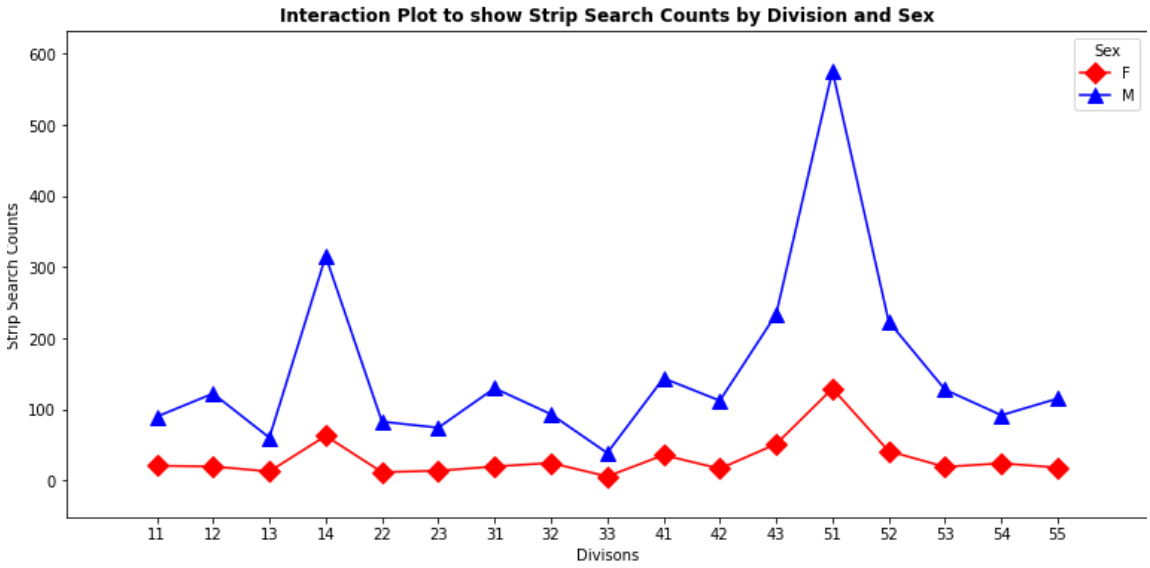

Figure 7: Interaction Plot to show Strip Search Counts by Division and Sex

From the interaction plot, we can see that the effect of the divisions is greater for males than females. This is because the solid line (male searched number) is steeper than the dashed line

(female searched number) for divisions 14 and 51. On the other hand, the effect of the other divisions is similar for males and females, as the two lines are roughly parallel.

For actions at arrest, we want to examine the relationship between the cooperative actions and occurrence category by conducting a one-way ANOVA test with the following hypothesis:

H0: All means for the number of people having cooperative action at arrest are identical for all occurrence categories.

H1: At least one means for the number of people having cooperative action at arrest is different from other occurrence categories.

The result of one-way ANOVA shows that the p-value is 5.335e-41 and F-statistic is 39.94. Because the p-value is smaller than the alpha level of 0.05, we can reject the null hypothesis and conclude that there is a significant difference between the means of at least two categories' cooperative action frequency. Based on this result, we use Tukey's HSD test to verify each pair of categories. In Tukey's HSD test result, it totally shows p-values for 465 combinations of two different categories. The result indicates that we can reject the null hypothesis for 205 pairs of categories, and it is the opposite for the rest of the 260 pairs.

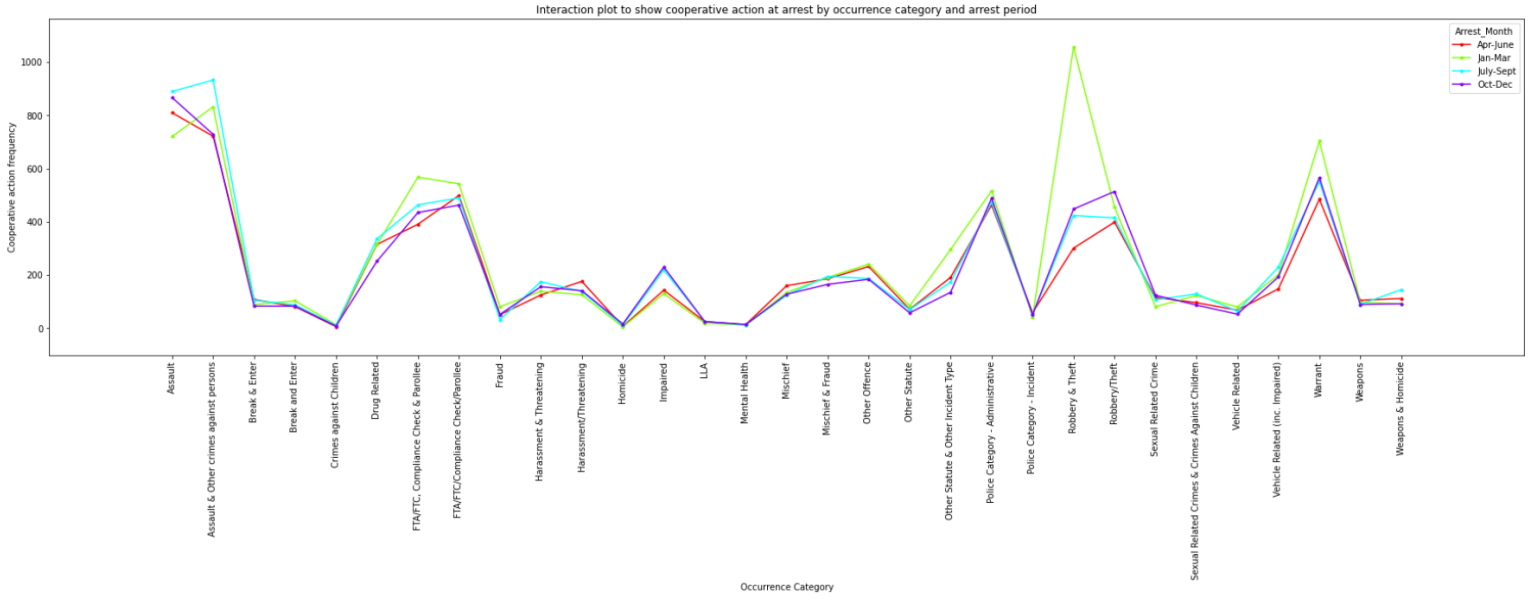

Figure 8: Interaction plot to show cooperative action frequency at arrest by occurrence category and quarter.

From the above interaction plot, we can more directly understand the differences between the cooperative action's frequency for each occurrence category. Sharply sloping lines prove strong evidence for the existence of relationships between the frequency of cooperative action at arrest and the occurrence category. In general, the time period does not have a significant impact on the frequency of cooperative actions for all categories. However, we can find that the frequency of robbery & theft is significantly higher from January to March than in other periods.

Discussion:

For the first research question, we are interested in how the division of search events occurs related to the number of search cases and how factors like sex and year act as influence factors. From the one-way ANOVA test, we conclude the effective influence of divisions on the search number. However, the p-value for divisions is shown to be unexpectedly high for the two-way ANOVA test, which contradicts the result we obtained earlier for the one-way ANOVA. The divergence could be a result of the different counting logics for the search number total we applied for the two tests. For the one-way ANOVA test, we defined the search number as the sum of the search number from each specific reason. When the suspect has multiple reasons for the search, it adds to the total strip search number and eventually results in a higher value compared to the count from the "StripSearch" columns. By analyzing the practical reasons, this result reflects that suspects tend to have more than one reason for the search. Tukey's HSD test, as a supplement to the one-way ANOVA test, reveals that the effective division influences the result mainly related to divisions 51 and 14, which are two divisions located in the downtown area. This could be evidence of the higher crime rate in the area. Nevertheless, division 52, as another division located in the downtown area, did not appear to have a similar high search count pattern. The divergence can be further investigated with extensive consideration of an increase in police power might result in a climbing arrest rate. From the interaction plot, we observe a strong interaction between sex and divisions on the strip search number for divisions 51 and 14, while it seems roughly parallel for the other divisions. The steep curve for males indicates that males have a much more significant effect on strip search numbers for divisions 51 and 14 than females. It is mentioned that we have found a significant impact. Moreover, lacking information about population density distribution alters our interpretations of the subjects and results in potential biases, especially when trying to analyze the effect of divisions of the search number.

Without information on population density, the balancing effect of each division becomes difficult.

In the second research question, we focus on how criminal categories affect individuals' actions at arrest. Through the study, we find that cooperative action is the most common action at arrest, and the time period does not have an obvious influence on the frequency of cooperative action in general. Only in the robbery & theft category does the frequency of cooperative action present a significant difference between January - March and the rest quarters. According to the result of the one-way ANOVA and the Tukey HSD test, we find that there are strong relationships in the frequency of cooperative action among many pairs of categories. However, there are many limitations of one-way ANOVA, and that could cause the result to be inaccurate. For example, the small sample size may not provide enough statistical power to detect the correct result. Meanwhile, the actual analyzed data does not match the assumptions of one-way ANOVA, which could cause inaccurate results. For further study, we can convert the frequency of cooperative action data into the rate of cooperative action at arrest by occurrence categories. In this case, we can eliminate the effects of different sample sizes in order to improve the accuracy of this study.

Conclusion:

The investigations and tests suggest an evidenced relationship between the divisions and the strip search number, while the results emphasize a high search rate in the downtown Toronto area, especially for divisions 51 and 14. This could include a sequence of other external influential factors, such as the police office regional distribution. The research also illustrates a strong influence of sex on the number of searches conducted: males have a significantly higher connection to the increase in search number, potentially suggesting an unequal searching pattern regarding the sex of suspects. In terms of the actions, one-way ANOVA suggests a unique relationship for the quarter of January - March for the robbery $ theft category, yet there is no other significant connection evidenced from the test. Considering the singularity of the time factor, we can make a direction about whether season affects suspects' willingness to cooperate. There was evidence suggesting the relationship between the actions at arrest and the actual occurrence category. However, due to the size of categories in both variables, locating the strongest influential pairs would not be practical without further analysis. Further analysis can be

conducted on identifying and isolating strong pairs to form constructive advice in preparing officers for suspects' possible actions.

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