Examining the Role of Race and Gender in Strip Search Patterns

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1. Introduction

Strip Search is an aggressive procedure that entitles law enforcement agencies to search suspected individuals. It is highly controversial and concern raising due to its significant influence on whoever has been searched. Among all the causing factors of the strip search, race and gender are particularly contentious. Conducting strip searches disproportionately based on race and gender will be subject to unjust treatment in the criminal justice system, and utilized force against specific races will further stimulate intensive public discourse. (Fox, 2022)

To explore the association of strip search patterns with regard to races and genders, the focus of the research will fall heavily on defining the frequency of strip searches subject to suspects' race and gender. The research assumes that race and gender shape the strip search pattern in the Toronto criminal justice system. Confirming this assumption involves using statistical measures of t-test, one-way ANOVA, and two-way ANOVA to explore the data submitted by Toronto Police Service. (Toronto Police Service, 2022) By conducting data analysis and statistical analysis, the researcher expects to gain valuable research insights into racial and gender representation in strip searches.

2. Literature Review

Over-representation among communities of color in the criminal justice system is continuously emphasized in public discourse. The data released by Toronto police further confirmed the existence of these racial disparities. Based on the report of "Toronto police's race-based data on use of force, strip searches highlighted" noted by CTV News producer Chris Fox, races including black, indigenous, and Middle East were significantly overrepresented across the majority of offense types and call types. (Fox, 2022) Fox documented that the Black community is 2.3 times more likely to be subjected to having firearms pointed at them, even when no weapons are perceived to be in their possession. (Fox, 2022) This community was also overrepresented in general enforcement actions practiced by Toronto police during 2020; they were 2.2 times more likely to be involved in legal enforcement actions such as strip searches. Similar experiences were shared by indigenous communities and Middle East communities; by the factors of 1.6 times and 1.3 times they were more likely to be exposed to various types of legal enforcement actions. (Fox, 2022)

Upon this irrefutable evidence and public racial accusation, Toronto Police Chief James Ramer attributed the responsibility of racial misconduct to systematic discrimination in

his public apology. (Herhalt, 2022) Based on the report contributed by producer Chris Herhalt, individuals who identified as men of color were more likely to be involved in a police interaction, and the report unleashed particular concern on the ongoing systemic racism within Toronto Police Service. (Herhalt, 2022)

3. Data Description

The research engages in strip search studying in the context of the City of Toronto, using the source of Arrest and Strip Searches (RBDC-ARR-TBL-001) provided by the Toronto Police Service in 2022. (Toronto Police Service, 2022) (The source of data can be approached via the link: Arrests and Strip Searches (RBDC-ARR-TBL-001) | Toronto Police Service Public Safety Data Portal) The sources contain 65,276 arrestees records, notable attributes including arrest location, age of arrestee, arrestee gender, arrestee race, strip search, and booking record within 24 hours. Attributes are provided in the format of binary variables, categorical variables which scale from multiple levels, and numeric integer variables. The attribute of the strip search, which is defined as a search on individuals enforced by law, is explained through binary variables of 1 (Yes Strip Search) and 0 (No Strip Search). The gender attribute is represented by binary variables for female (F) and male (M), while the race attribute is described by categorical variables that encompass eight racial categories.

In exploring the association of strip search patterns with respect to race and gender, the dataset allows the research to develop valuable insight into the criminal justice system in Toronto. The attributes of race and gender, in particular, enable the research to conduct strip search studies based on racial and gender disparities, and the research finding is expected to provide beneficial discovery on the ongoing disparities occurring in the criminal justice system.

4. Research Objective and Questions

The interest of this study falls on potential racial and gender disparities in the Toronto Police service. Supported by the literature pieces "Toronto Police's race-based data on the use of force, strip searches highlighted" and "Review finds people of color faced disproportionate levels of force by Toronto police," the research intends to uncover the disproportionate use of force in conjunction with racial and gender issues. To examine the potential disparities, the research conducts statistical testing and hypothesis on subsequent research questions:

1. Is there a significant difference in the mean number of strip searches with regard to the arrestee's gender?

2. Is there a significant difference in the mean number of strip searches with regard to the arrestee's race?
3. Is there a significant difference in the mean number of strip searches with regards to the arrestee's race and arrestee's gender?

5. Descriptive Statistic

The descriptive statistic incorporates data cleaning, univariate analysis, bivariate analysis, and small multiple figures creation based on the source of Arrest and Strip Searches (RBDC-ARR-TBL-001). The adoption of descriptive tools enables the researcher to obtain a professional understanding of the underlying patterns and distribution of the dataset, all of which will serve as a foundation for subsequent statistical testing and hypothesis analysis.

5.1 Data Cleanning

The dataset of Arrest and Strip Searches, which has been made available through the Toronto police portal, contains 24 attributes in total. To filter out the required attributes for testing and hypothesis, the research collects arrest year, person ID, sex, perceived race, strip search, booked, and age as independent variables. The filtering process involves using '*groupby'*, which allowing python to select and package the required attributes. During the attributes filtering, the research notices that the value of strip search is explained by the binary variables of 1 and 0. To convert the strip search as a continuous variable that counts the frequency of searching per individual, the research sums up the number of strip searches based on PersonID.

Figure 1

Grouping the required attributes

```
df3 = df_new.groupby(['Arrest_Year', 'PersonID', 'Sex', 'Perceived_Race']).agg({'StripSearch':'sum', 'Booked':'sum', 'Age':'max'})
df3.head(25)
```

Arrest_Year	PersonID	Sex	Perceived_Race	StripSearch	Booked	Age
2020	300000	M	East/Southeast Asian	0	0	40.0
2020	300001	F	White	0	1	17.0
2020	300002	M	White	0	0	40.0
2020	300003	M	White	1	3	30.0
2020	300004	M	Black	0	1	30.0
2020	300005	M	South Asian	0	0	50.0
2020	300006	M	Middle-Eastern	0	1	60.0
2020	300007	M	South Asian	1	3	30.0
2020	300008	M	Black	0	1	30.0
2020	300009	M	White	0	0	40.0
2020	300012	M	White	0	1	50.0
2020	300014	M	East/Southeast Asian	0	0	60.0
2020	300015	F	Unknown or Legacy	1	1	30.0

The study further develops research concern on the age of arrestees. To enhance the calculability of the age attribute, the research converts the age group (e.g. Aged 25 to 34 years) into the average age of the group (30) using python tools of *replace()*. After completing all the processes, the dataset is qualified for data visualization.

Figure 2

Replacing age strings into age values

```
#Convert Age into categorical numbers
df2['Age_group__at_arrest_'] = df2['Age_group__at_arrest_'].replace({'Aged 25 to 34 years': 30,
                                                                     'Aged 35 to 44 years': 40,
                                                                     'Aged 18 to 24 years': 21,
                                                                     'Aged 45 to 54 years': 50,
                                                                     'Aged 55 to 64 years': 60,
                                                                     'Aged 65 and older': 65,
                                                                     'Aged 65 years and older': 65,
                                                                     'Aged 17 years and younger': 17,
                                                                     'Aged 17 years and under': 17,})
df2
```

None

Like what you see? Visit the data table notebook to learn more about interactive tables.

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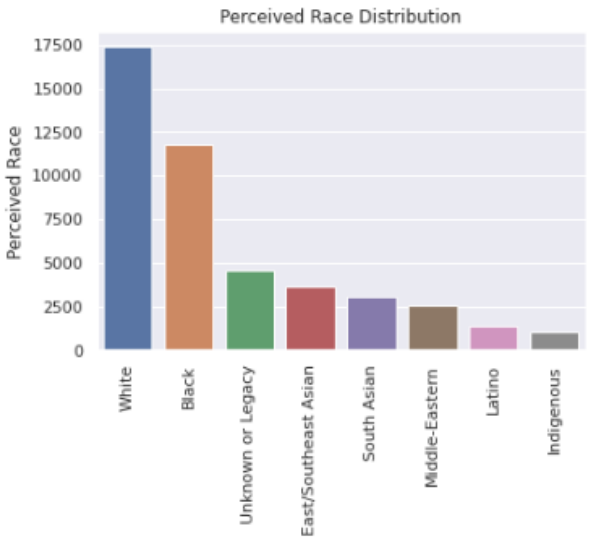
index	Arrest_Year	Arrest_Month	EventID	ArrestID	PersonID	Perceived_Race	Sex	Age_group__at_arrest_	Youth_at_arrest__under_18_years
0	2020	July-Sept	1005907	6017884.0	326622.0	White	M	40.0	Not a youth
1	2020	July-Sept	1014562	6056669.0	326622.0	White	M	40.0	Not a youth
2	2020	Oct-Dec	1029922	6057065.0	326622.0	Unknown or Legacy	M	40.0	Not a youth

5.2 Univariate Analysis

The initial stage of data visualization involves adopting a histogram based on the perceived race of the arrestee. According to the histogram of perceived race distribution, white arrestees and black arrestees perform outstandingly in comparison with other races. This performance reveals that legal involvement is commonly observed among white community and the black community, whereas all the other race communities have relatively low involvement in legal action.

Figure 3

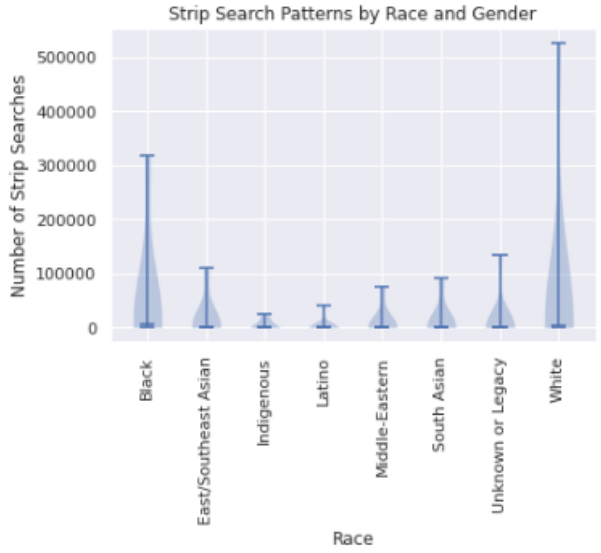
Histogram of race distribution in all strip search events



The analysis of the histogram proves against some assumptions raised in the previous research. Indigenous communities and Middle-Eastern communities are expected to have higher rates of legal involvement in the literature study. Yet, the histogram disapproves of this statement and argues that white communities and black communities have the highest involvement in legal enforcement. In particular, white communities are assumed to enjoy more tolerance in legal enforcement, where the histogram suggests that white communities have the highest legal issue among all races.

Figure 4

Histogram of races distribution in all strip search events



The violin plot conducted on strip searches and races expresses a similar argument to the histogram above. White communities and black communities were actively performing in strip searches, and a significant number of white and black arrestees had at least 1 or 2 times strip search experiences. Other than that, the majority of arrestees have no strip search experience regardless of race; the mean number of strip searches for all races lies at 0.

Considering that white communities account for the largest demographic population (43.5%) in Toronto (*Demographics of Toronto*, 2022), the research remains neutral on the strip search activities white communities participated. Black communities have only a 9.6% demographic distribution in Toronto, but the outstanding performance of Black communities uncovers potential racial disparities occurring in Toronto's legal enforcement activities.

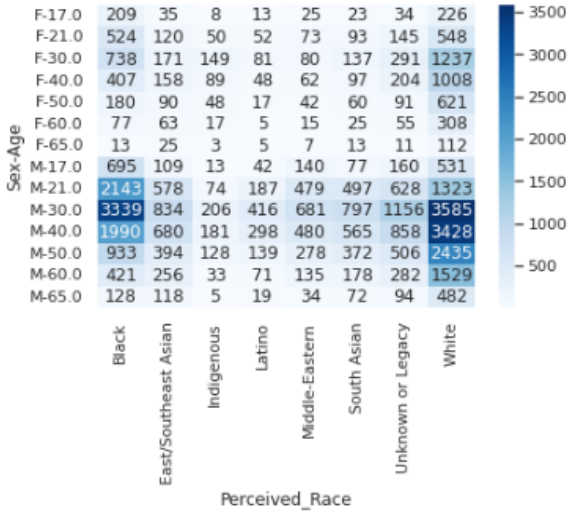
5.3 Small Multiple Figure

The second stage of data visualization involves conducting a heatmap based on the perceived race of arrestees, gender of arrestees, and age of arrestees. According to the heatmap below, white male arrestees and black male arrestees perform actively in strip

searches at the age of 30. White male arrestees express continuous active performance throughout the ages of 40 and 50, whereas black males have a significant decline in legal involvement until they reach the age of 40. Female performance in strip search remains relatively low in comparison with the male. Frequent involvements among females take place at the age of 30, where white female arrestees and black female arrestees exhibit high involvement in strip search. Based on the pattern, white communities and black communities are actively involved in strip search at the age of 30, while males are more likely to experience strip search in comparison with females. The heatmap exhibits valuable insight into the pattern of strip search with regard to race, gender, and age.

Figure 5

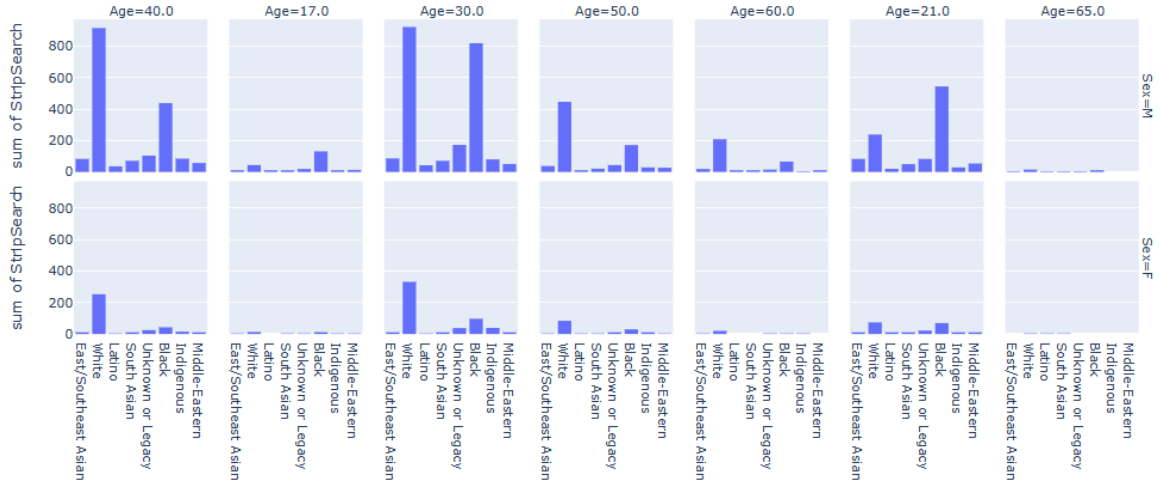
Heatmap of pattern of strip search with regard to race, gender, and age



The small multiple histogram conducted on gender, age, and race shares similar discoveries with the heatmap. The small multiple histograms observe that white males and black males are involved in considerable numbers of strip searches during the age of 30 and age 40. At the age of 21, they also revealed a frequent involvement in strip search. Females had less strip search experience compared with males. Yet, it is noteworthy to observe that white females exhibit the highest level of performance in strip searches, whereas black and other females have minimal to no experience with strip searches. This observation is captured specifically by the small multiple histogram.

Figure 6

Small Multiple Histogram of strip search pattern with regard to race and gender

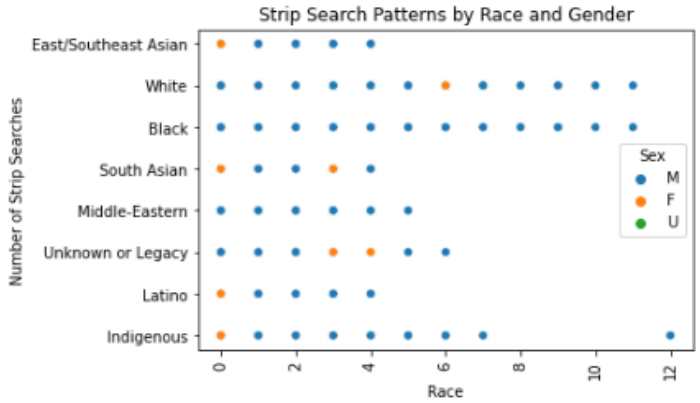


5.4 Bivariate Analysis - Scatter plot

To exhibit the empirical association of strip search with regard to race and gender, the research conducts a scatter plot to obtain the pattern of strip search. The examination of the scatter plot indicates that strip searches are frequently conducted in both white and black communities, with a maximum number of searches reaching 12 times for both races. In contrast, other races generally experience a maximum number of strip searches at five times.

Figure 7

Scatter Plot of strip search distribution expressed by race and gender



The scatter plot also captures unique findings that were not observed by previous visualizations. While the small multiple histogram expresses that white female arrestees have relatively high involvement in strip search, the scatter plot reveals that females from South Asian and unknown races also uncover active participation in strip search. Females from South Asia and unknown races had strip search experience three times higher than other races, and the majority of the females in other races have no strip search experience at all.

5.5 T-test

T-test is used to test the null hypothesis and determine whether the observed difference between the means is statistically significant. The null hypothesis for the independent t-test is that there is no significant difference between the means of two samples (H0: $\mu = \mu 0$), while the alternative hypothesis means there is a statically significant difference (H1: $\mu \neq \mu 0$) (Mashra et al., 2019). In this case, our null hypotheses are 1) there is no difference in the mean frequency of strip searches between male and female. 2) there is no difference in the mean frequency of strip searches between perceived races: specifically test between White & Black, White & Indigenous, and Black & South Asian. Using the ‘‘stats.ttest_ind’ function in the Scipy package and ‘rp.ttest’ in Researchpy package in Python, we got the same t-test results for each test group.

From the two-sample t-test for the comparison of strip searches by gender, the results showed that the mean frequency of strip searches for males (*M*=0.17, *SD*=0.58) was significantly higher than for females (*M*=0.14, *SD*=0.51), $t(45270)= 5.65$, $p < 0.05$, which suggest there is significant difference between the male and female on strip searches (Table 1).

Table 1

t-test Comparison of strip searches by gender

	N	*Mean*	*SD*	*t-value*	*p-value*
Male	36226	0.17	0.58	5.65	1.53e-08
Female	9046	0.14	0.51		

From the two-sample t-test for the comparison of strip searches by perceived race (White & Black), the results showed no significant difference in the mean frequency of strip searches between White (*M*=0.21, *SD*=0.65) and Black (*M*=0.21, *SD*=0.62) arrestees, the p-value of t-test ($p = 0.88$) is greater than the significance level alpha = 0.05.

Table 2

t-test Comparison of strip searches by perceived race: White & Black

	N	*Mean*	*SD*	*t-value*	*p-value*
White	17386	0.21	0.65	-0.14	0.88
Black	11805	0.21	0.62		

According to the results of the t-test analysis, there was a significant difference in the mean frequency of strip searches between Indigenous and White arrestees. Specifically, Indigenous arrestees had a higher mean frequency of strip searches (*M*=0.30, *SD*=0.85) compared to White arrestees (*M*=0.21, *SD*=0.65), $t(18390)=-4.58$, $p<0.05$ (Table **3**).

Table 3

t-test Comparison of strip searches by perceived race: White & Indigenous

	N	*Mean*	*SD*	*t-value*	*p-value*
White	17386	0.21	0.65	-4.58	4.47e-06
Indigenous	1006	0.30	0.85		

Table 4 presents the results of the t-test comparison of strip searches by perceived race for Black and South Asian groups. The mean frequency of strip searches for Black arrestees (M=0.21, SD=0.62) was significantly higher than for South Asian arrestees (M=0.08, SD=0.33), $t(13809)=10.25$, $p<0.05$, which suggest there is a significant difference in the mean frequency of strip searches between the Black and South Asian.

Table 4

t-test Comparison of strip searches by perceived race: Black & South Asian

	N	*Mean*	*SD*	*t-value*	*p-value*
Black	11805	0.21	0.62	10.25	1.31e-24
South Asian	2006	0.08	0.33		

Before we ran the t-test, we conducted the Shapiro-Wilk test to check whether the data were normally distributed. However, due to the sample size, N > 5000, the p-value may not be accurate, which indicated $p = 0$, so we decided to keep conducting the t-tests (Appendix A).

6. Methods

We identified several data patterns relevant to our research question based on Exploratory Data Analysis (EDA) findings. Descriptive statistics were used to summarise the data, including means, standard deviations, and frequency distributions. In addition, t-tests were conducted to determine if there are significant differences between the two groups we are interested in exploring in the research and further driven us to use One-way ANOVA and Two-way ANOVA to explore our research question.

The t-test results indicated a statistically significant difference in the mean frequency of strip searches between certain racial groups and gender. To further investigate our research question, we will conduct one-way and two-way ANOVA to explore the relationship between strip searches and arrestee race, gender, and the interaction effect between them. A significance level of $p<0.05$ was used to determine statistical significance in all analyses.

7. Findings

7.1 *One-way ANOVA*

One-way ANOVA is a powerful statistical technique used compare the means of two or more groups to determine if there is a significant difference between them (Mishra et al., 2019). In this case, Perceived Race with seven subgroups is the independent variable being analyzed, and the dependent variable is the frequency of strip searches on arrested individuals. A one-way ANOVA was conducted by using the '.ols().fit()' and 'stats.anova_lm()' of the Startsmodels package to test the null hypothesis that there was no significant difference in the mean frequency of strip searches between races of arrested people. The result yields there was a significant effect (at the $p < 0.05$ level) of perceived race on the strip searches performed on arrested individuals, (F (7, 45273) = 58.63, $p < 0.05$).

Table 5

Results of One-way ANOVA

	Sum of Squares	*df*	*F*	*p*
Perceived_Race	133.31	7	58.63	3.47e-84
Residual	14707.07	45273		

However, one-way ANOVA was not able to identify which specific pairs of groups differed significantly from each other. Therefore, in addition to ANOVA, a post-hot test was conducted for pairwise comparisons. A Tukey HSD test was used to examine the differences between groups, revealing which pairs of groups had statistically significant differences in means, and minimizing the chance for Type I error in hypothesis testing and yielding a more accurate estimation of significance (S. Lee & D. Lee, 2018). The result of Tukey HSD test (Table 6) shows that there were seventeen group pairs have their mean strip searches statistically different from each other (all $p < 0.5$). In addition to that, total eleven group paris indicates that there were no significant differences from each other (all $p > 0.5$).

Table 6

Results of Tukey HSD for One-way ANOVA

Group 1	Group 2	meandiff	p-adj	Lower	Upper
1	2	-0.11	0.001	-0.14	-0.07
	3	0.09	0.001	0.04	0.15
	4	-0.11	0.001	-0.16	-0.06
	5	-0.11	0.001	-0.15	-0.07
	6	-0.12	0.001	-0.15	-0.08

	7	-0.08	0.001	-0.11	-0.05
2	3	0.21	0.001	0.14	0.27
	8	0.11	0.001	0.07	0.14
3	4	-0.2	0.001	-0.28	-0.13
	5	-0.21	0.001	-0.27	-0.14
	6	-0.21	0.001	-0.28	-0.15
	7	-0.18	0.001	-0.24	-0.12
	8	-0.09	0.001	-0.15	-0.04
4	8	0.11	0.001	0.06	0.15
5	8	0.11	0.001	0.07	0.15
6	8	0.11	0.001	0.08	0.15

**1-Black, 2-East/South East Asian, 3-Indigenous, 4-Latino, 5-Middle-Eastern, 6-South Adian, 7-Unknown or Legacy, 8-White*

7.2 *Two-way ANOVA*

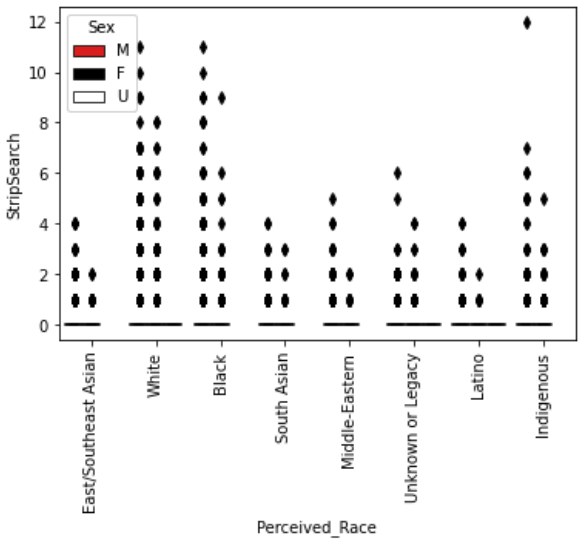
Moving beyond examining the effect of race on strip search, two-way ANOVA was used to explore the differences in the mean frequency of strip searches between race and gender, as well as the potential interaction effect. Because the two-way ANOVA consider the effect of two categorical variables, and the effect of the categorical variable on each other, there are three pair of null hypotheses has been tested at the same time.

a. H0: There is no difference in the means strip searches across gender group
b. H0: There is no difference in the means strip searches across race group
c. H0: There is no interaction between the gender and race

Boxplot was created to visually examine the distribution of the frequency of strip searches across different groups of race and gender and identify outliers (Figure 8). However, the results indicated a high number of outliers, suggesting that there are some arrestees who have been subject to an unusually high number of strip searches, while the majority have either not been strip searched or have only been searched once. In this case, we have decided to ignore outliers in our analysis of the frequency of strip searches.

Figure 8

Boxplot for Two-way ANOVA



According to Table 7, it rejects the null hypothesis that there is a significant difference in the mean frequency of strip searches of gender group ($F(2) = 23.23$, $p < 0.05$) and perceived race group ($F(7) = 48.12$, $p < 0.05$). Additionally, the result revealed that there was a statistically significant interaction between the effect of gender and perceived race ($F(14) = 4.21$, $p < 0.05$). Furthermore, to visually interpret the results of two-way ANOVA, drawing an interaction plot helps to show the effect of the interaction between gender and race on the strip searches. The Figure 9 proves there is interaction effect, since the lines on the graph are not parallel and have intercepts.

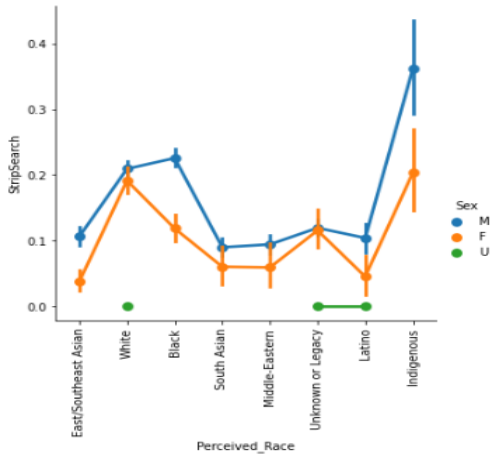
Table 7

Results of Two-way ANOVA

	Sum of Squares	***df***	***F***	***p***
Sex	15.06	2	23.23	8.18e-11
Perceived_Race	109.22	7	48.12	1.89e-40
Sex : Perceived_Race	19.13	14	4.21	7.05e-06
Residual	14675.93	45262		

Figure 9

Interaction Plot of Mean Strip Searches by Race and Gender



As two-way ANOVA results revealed a significant difference between means, the Tukey HSD was conducted to determine which groups differ significantly from one another. The post hoc test contains three sections: the main effect of race, the main effect of gender, and the interaction of race and gender. Since the results contain a large number of groups, table 8 will only include the representative pairs that show statistically significant (p<0.05).

Table 8

Results of Tukey HSD for Two-way ANOVA

	Group 1	Group 2	meandiff	p-adj	Lower	Upper
Main effect of race	8	6	0.11	0.001	0.08	0.15
		5	0.11	0.001	0.07	0.15
		7	0.08	0.001	0.05	0.11
		4	0.11	0.001	0.06	0.15
		3	0.09	0.001	0.04	0.15
		2	0.11	0.001	0.07	0.14
Main effect of gender	M	F	0.03	0.001	0.02	0.05
Interaction between race & gender	(M,8)	(M,6)	0.11	0.001	0.07	0.16
	(M,6)	(F,8)	0.09	0.001	0.04	0.15
	(F,2)	(F,8)	0.15	0.001	0.06	0.24
	(M,1)	(M,4)	0.12	0.001	0.05	0.18
	(F,8)	(F,5)	0.13	0.019	0.01	0.25

**1-Black, 2-East/South East Asian, 3-Indigenous, 4-Latino, 5-Middle-Eastern, 6-South Adian, 7-Unknown or Legacy, 8-White*

8. Discussion

The findings from Exploratory Discovery Analysis (EDA) and hypothesis testing proved that gender and race are significant factors that shape the strip searches at the arrest. In this section, we will dive deeper into the discussion of the limitation of the study, the implications of the findings, and discuss the opportunity for future research.

In this study, we aimed to explore how gender and perceived race shape the strip searches of arrestees in Toronto. However, due to the lack of a continuous variable in the dataset, we merged the sample with the same arrest IDs and added up their strip searches number in a year to create a continuous variable. This approach allows us to merge data from several arrests of the same person. However, it is essential to note that this method also has limitations. By aggregating the strip search numbers across multiple arrests, we assumed that the frequency of strip searches is consistent across all individual arrests, which may not always be accurate in all the cases and could have affected our results. Future research should aim to collect more accurate data on the frequency of strip searches along with arrestees' demographic information to better explore the impact on different groups.

While the study provides valuable insights into the frequency of strip searches among individuals arrested in Toronto, the findings may not be generalizable to other regions. As the data was collected in Toronto, it may not accurately reflect the practices and policies of enforcement in other jurisdictions. It is necessary to determine and collect data in the region with similar patterns of strip search if further research is needed.

Furthermore, this study has significant implications for addressing bias and discrimination in law enforcement. The fact that there are significant differences in the means of strip searches for different racial and gender groups, as well as the interaction effect between them, suggests that police officials may be influenced by unconscious biases or stereotypes when deciding whether to conduct a strip search on the arrestees. In addition, it highlighted the need for conducting more research in this area to investigate further potential factors contributing to bias and discrimination in law enforcement to promote fairness and equality in law enforcement practices.

9. Conclusion

Drawing research insight from this study, compelling evidence approves that strip search patterns are shaped by the factors of race and gender. The research also discovered unique patterns with respect to age, arrestees at their age of 30 to 40 exhibited higher involvement in strip search activity. Via rich statistical analysis adopted through one-way ANOVA and two-way ANOVA, seventeen pairs of races are found to display statistical significance in the average number of strip search experiences. The t-test further confirms that indigenous arrestees and black arrestees performed actively in strip search activities, whereas white arrestees and South Asian arrestees have more tolerance in the legal action. Male arrestees are more likely to experience strip searches in comparison with females, which approves the assumption of disproportionate use of force conducted by law enforcement agencies in Toronto legal service.

The establishment of these valuable findings confirms the unjust treatment and racial disparities raised by previous public discourse. A pressing need for impartial treatment of all races should be promoted in law enforcement activities. The research thus calls for equal and just treatment of all races, thereby enhancing accountability and fairness of the criminal justice system of Toronto.

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11. Appendix A

```
stats.shapiro(df3.StripSearch)
```

```
/usr/local/lib/python3.8/dist-packages/scipy/stats/morestats.py:1760: UserWarning: p-value may not be accurate for N > 5000.
  warnings.warn("p-value may not be accurate for N > 5000.")
ShapiroResult(statistic=0.32957732677459717, pvalue=0.0)
```