INF2178 Group 16 Writeup

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2023-03-26

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1. Introduction

1.1 Background Information

The criminal justice system is designed to uphold public safety and maintain social order, but there are growing concerns about possible biases and discrimination in its operations, especially in the treatment of individuals during the arrest process. One area of particular concern is the use of strip searches, which can be an invasive and humiliating experience for those subjected to them.

This data analysis project aims to investigate two research questions related to strip searches during arrests. First, we aim to determine if there are any significant differences in the average number of strip searches conducted based on race. Second, we will explore whether there are any significant differences in the average number of strip searches for individuals of varying genders and age groups. The research questions are stated at the end of the EDA section.

The analysis will use a dataset obtained from the Toronto Police Service Public Safety Data Portal, which contains information on the number of strip searches conducted during arrests, as well as the race, gender, and age group of the individuals searched. The dataset covers multiple years and features a large sample of individuals from diverse backgrounds.

The results of this project will provide critical insights into any possible disparities in the use of strip searches during arrests. These findings could have significant implications for reforming the criminal justice system and promoting fairness and equity in law enforcement practices.

1.2 Literature Review

Literature review is an essential component of any research project as it allows the researcher to identify existing knowledge on a particular topic, evaluate the quality of previous studies, and identify gaps in the literature that the current study can address.

Kirkup (2009) presented a thought-provoking analysis of the intersection of gender identity with strip searches in Canadian criminal law. The author highlights the harm that these searches can cause to transgender individuals and advocates for legal reform to address this issue. However, the analysis could have been more comprehensive if it had explored the experiences of other marginalized groups, such as Indigenous people, who may also face discrimination due to strip searches. Additionally, the author's argument could be strengthened by providing more concrete recommendations for legal reform while critiquing the current legal framework.

Farias (2022) provided a critical analysis of strip-searching practices in Toronto and emphasizes their contribution to systemic discrimination. The article stresses the need for a more equitable

approach to policing. However, the author could have offered specific policy recommendations for change. Furthermore, while the article focuses on the experiences of marginalized communities, it could have delved into the perspectives of law enforcement officials and policymakers for a more comprehensive analysis of the issue.

Hutchison (2020) argued that strip searches in women's prisons constitute state-inflicted sexual assault. The author analyzes the experiences of women who undergo strip searches in prison and emphasizes that these searches often disregard the trauma that women may already face. Strip searches can exacerbate gender-based violence and systemic oppression. However, the author could have provided more empirical evidence to support this claim, such as research establishing a stronger causal link between strip searches and sexual assault.

2. Exploratory Data Analysis

The dataset provides information on the number of strip searches conducted during arrests, as well as the gender, age group, and race of the individuals searched. The goal is to investigate potential disparities in the use of strip searches during arrests. The dataset contains $65,276$ instances of arrests and 25 variables. Below is a sample of the dataset with a selection of variables. It's worth noting that **Stripsearch** takes value 0 if the individual is NOT searched and 1 otherwise.

Table 1: Arrests and Stripsearches

Year	Month	Race	Sex	Age group	Stripsearch
2021	Apr-June	Black	M	Aged 25 to 34 years	1
2021	Oct-Dec	Indigenous	M	Aged 45 to 54 years	0
2020	Apr-June	Black	M	Aged 25 to 34 years	1
2020	Apr-June	Unknown or Legacy	M	Aged 25 to 34 years	0

To clean the data, we first checked for missing values and examined the data for potential confounding variables. By replacing the missing values with the mean and completely omitting unnecessary or confounding variables, we ensured the accuracy and completeness of our analysis. We also grouped the data by the year of the arrest, the perceived race of the individual arrested, and the age group of the individual. For each group, we calculated the total number of arrests and the number of strip searches used. We also calculated the percentage of arrests that involved a strip search in each group.

Data cleaning allowed us to obtain a comprehensive and accurate understanding of the dataset, and ensured that our findings are reliable and valid. The polished dataset is shown below:

Table 2: Post-cleaning dataset

Year	Race	Sex	AgeGroup	StripSearch	Arrest	Prop_SS	High_Prop
2020	Black	F	Aged 17 years and under	11	195	0.056	FALSE
2020	Black	F	Aged 18 to 24 years	78	366	0.213	TRUE
2020	Black	F	Aged 25 to 34 years	79	494	0.160	TRUE

The dataset contains data on the count of individuals who underwent strip searches and were arrested for each combination of **Year**, **Race**, **Sex**, and **Age Group** during the years 2020 and 2021. The dataset encompasses Black, East/Southeast Asian, Indigenous, Latino, Middle-Eastern, South Asian, White, and Unknown or Legacy racial categories. We excluded genders other than male or female and limited the age groups to Aged 17 years and under, Aged 18 to 24 years, Aged 25 to 34 years, Aged 35 to 44 years, Aged 45 to 54 years, Aged 55 to 64 years, and Aged 65 years and older. We utilized the variables **StripSearch** and **Arrest** to compute the **Prop_SS** metric, which represents the proportion of arrests that involved a strip search for each group. Moreover, we designated TRUE to proportions above the average and FALSE to those below the average for the **High_Prop** variable.

2.1 Descriptive Statistics

Descriptive analysis is a statistical technique utilized to present and describe the key features of a dataset. For this study, the dependent variable of interest **Prop_SS**. Descriptive statistics were applied to this variable to gain a better comprehension. As shown in Table 3, the variable have a relatively modest mean compared to the extensive range and elevated standard deviation. This observation implies the likelihood of the existence of outliers within the dataset.

Table 3: Descriptive Statistics of Prop_SS

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.	Sd
0	0	0.029	0.078	0.144	0.556	0.098

2.2 Data Visualization

Among the various types of diagrams available, barplots were chosen as the most appropriate visualization technique for the categorical data being analyzed. Barplots are a widely-used type of graph that can effectively represent the frequency or proportion of different categories in a clear and concise manner. By utilizing barplots, we were able to quickly identify any notable patterns or trends in the data, leading to informed and data-driven conclusions. Overall, the use of barplots proved to be a valuable tool in analyzing and presenting the categorical data in our statistical report.

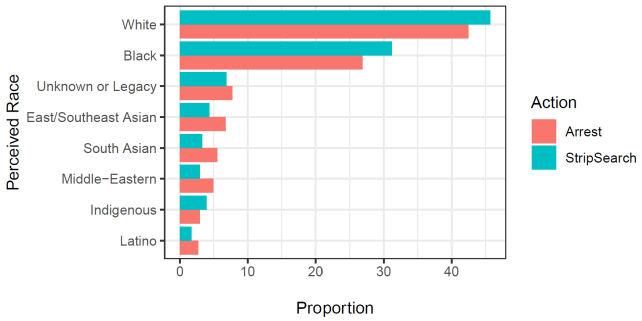

Figure 1: Barplot of number of stripsearches in each race

In Figure 1, we compare the proportion of arrests to the proportion of strip searches in each perceived race. Ideally, we would expect these proportions to be equal, as the number of strip searches should be proportional to the number of arrests. However, our analysis reveals a notable difference in these proportions within the black population. Although black people account for only 27% of the total number of arrests, approximately 32% of all strip searches were conducted on black individuals. This discrepancy is particularly significant and suggests the possibility of racial discrimination in the use of strip searches.

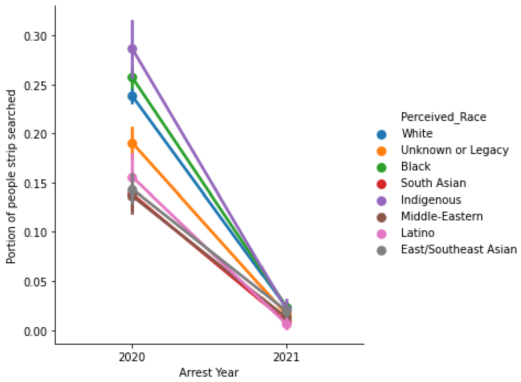

Figure 2: Pointplot of proportion of stripsearches in each race by year

Figure 2 displays the proportion of individuals who were strip searched for each perceived race by year. The results show that the use of strip searches has significantly decreased from 2020 to 2021. Moreover, there are notable differences in the proportion of individuals who were searched across both year and race. An ANCOVA analysis will be conducted to gain further insights.

2.3 Hypothesis Test

A t-test is a statistical test used to determine if there is a significant difference between the means of two groups of data. It is a parametric test that assumes the data is normally distributed and the variances of the two groups are equal. In this data analysis, a t-test was employed to investigate whether the number of strip searches and arrests differed significantly by race, gender, year, and whether they were youth (aged 17 or below). The statistical significance level, also known as alpha, was set to 0.05. The results of the t-test provide a p-value, which indicates the probability of obtaining the observed difference between the two groups by chance alone. If the p-value is less than the significance level, typically set at 0.05, then we can conclude that there is a significant difference between the means of the two groups.

2.3.1 T-test of StripSearch between sex

In this section, a t-test was performed to compare the mean number of strip searches between male and female sex groups. To achieve this, we formulated the following null and alternative hypotheses:

H_0 : The number of StripSearch upon arrest is the same for Men and Women

H_1 : The number of StripSearch upon arrest is NOT the same for Men and Women

Table 4: T-test of StripSearch between sex

	t	df	p-value
StripSearch	3.292	223	0.001

The t-test results indicate that there is a statistically significant difference in the mean number of strip searches between male and female sex groups. The t statistic of 3.292 and the p-value of 0.001 suggest that the observed difference in means is unlikely to have occurred by chance. Since the p-value (0.001) is smaller than the significance level (0.05), we can reject the null hypothesis and conclude that the strip search differs significantly between men and women.

2.3.2 T-test of Arrest between sex

Similarly, for comparing the mean number of arrests between male and female sex groups, the following null and alternative hypotheses were formulated:

H_0 : The number of Arrest is the same for Men and Women

H_1 : The number of Arrest is NOT the same for Men and Women

Table 5: T-test of Arrest between sex

	t	df	p-value
Arrest	5.134	223	< 0.001

The t-test results indicate that there is a statistically significant difference in the mean number of strip searches between male and female sex groups. The t statistic of 5.134 and the p-value of less than 0.05 suggest that we can reject the null hypothesis and conclude that the number of arrests differs significantly between men and women.

2.3.3 T-test of StripSearch between year

For comparing the mean number of strip searches between year 2020 and 2021, the following null and alternative hypotheses were formulated:

H_0 : The number of StripSearch upon arrest is the same for 2020 and 2021

H_1 : The number of StripSearch upon arrest is NOT the same for 2020 and 2021

Table 6: T-test of StripSearch between year

	t	df	p-value
Arrest	4.094	223	< 0.001

The t-test results indicate that there is a statistically significant difference in the mean number of strip searches between years. The p-value of less than 0.001 suggest that we can reject the null hypothesis and conclude that the strip search differs significantly between 2020 and 2021.

2.3.4 T-test of Arrest between year

For comparing the mean number of arrests between year 2020 and 2021, the following null and alternative hypotheses were formulated:

H_0 : The number of Arrest is the same for 2020 and 2021

H_1 : The number of Arrest is NOT the same for 2020 and 2021

Table 7: T-test of Arrest between year

	t	df	p-value
StripSearch	-0.16	223	0.873

The t-test results indicate that there is no statistically significant difference in the mean number of arrests between years. The p-value of 0.873 suggest that we do not have enough evidence to reject the null hypothesis.

2.3.5 T-test of StripSearch between youth and adult

For comparing the mean number of strip searches between youth and adult, the following null and alternative hypotheses were formulated:

H_0 : The number of StripSearch upon arrest is the same for youth and adult

H_1 : The number of StripSearch upon arrest is NOT the same for youth and adult

Table 8: T-test of StripSearch between youth and adult

	t	df	p-value
StripSearch	-1.471	223	0.143

The t-test results indicate that there is no statistically significant difference in the mean number of strip searches between youth and adult. The p-value of 0.143 suggest that we do not have enough evidence to reject the null hypothesis.

2.3.6 T-test of Arrest between youth and adult

For comparing the mean number of arrests between youth and adult, the following null and alternative hypotheses were formulated:

H_0 : The number of Arrest is the same for youth and adult

H_1 : The number of Arrest is NOT the same for youth and adult

Table 9: T-test of Arrest between youth and adult

	t	df	p-value
Arrest	-2.199	223	0.029

The t-test results indicate that there is a statistically significant difference in the mean number of arrests between youth and adult. The p-value of less than 0.029 suggest that we can reject the null hypothesis and conclude that the arrest differs significantly between youth and adult.

2.3.7 T-test of SrtripSearch among black and non-black

To investigate whether there is a significant difference in the mean number of strip searches between black and non-black populations, the following null and alternative hypotheses were formulated:

H_0 : The number of StripSearch is the same for black and non-black

H_1 : The number of StripSearch is NOT the same for black and non-black

Table 10: T-test of StripSearch between black and non-black

	t	df	p-value
StripSearch	1.453	223	0.148

The t-test results indicate that there is no statistically significant difference in the mean number of strip searches between youth and adult. The p-value of 0.148 suggest that we do not have enough evidence to reject the null hypothesis.

2.4 Research Questions

Based on the investigations, we have identified several explanatory variables that may have an impact on the dependent variables, specifically the strip search and the proportion of its use upon arrests. Specifically, we have found that sex and arrest year are potentially important factors, as well as perceived race. In light of these findings, we have formulated the following research questions:

- Does the perceived race of an individual significantly affect his/her likelihood of being strip searched when arrested?
- Does the perceived race of an individual and the year of arrest significantly affect his/her likelihood of being strip searched when arrested?
- Does the sex of an individual and the year of arrest significantly affect his/her likelihood of being strip searched when arrested?

By exploring these research questions, we hope to gain a deeper understanding of how strip search is influenced by various demographic factors, and to identify any potential disparities or inequalities that may exist within the criminal justice system.

3. Method

3.1 Power Analysis

Power analysis is a statistical method used to determine the probability of detecting a true effect in a research study given a specific sample size and statistical test.

Power analysis involves several key components, including the significance level (α), the effect size (ES), the sample size (n), and the statistical test used. The significance level is the probability of rejecting the null hypothesis when it is actually true, which is typically set at 0.05. The effect size is a measure of the strength of the true effect in the population and is typically expressed as Cohen's d or a similar metric. The sample size is the number of participants or observations included in the study, and the statistical test used is the method used to analyze the data.

The power of a study is typically expressed as a percentage, which represents the likelihood of detecting a true effect if it exists. After careful consideration, we have determined that a high power of 0.8 is necessary to achieve adequate statistical power.

The objective of this method is to investigate the impact of StripSearch (an independent variable) on the perceived races (a two-level categorical variable) and determine the effect size. This analysis is aimed at enhancing our understanding of racial discrimination.

3.2 ANCOVA

ANCOVA (Analysis of Covariance) is a statistical technique used to analyze the relationship between a continuous dependent variable and one or more independent variables while controlling for the effect of one or more covariates (continuous variables that are not of primary interest).

The statistical analysis of ANCOVA involves estimating the slope and intercept of the regression line between the dependent variable and the independent variable(s), while controlling for the effect of the covariate(s). The F-test is used to determine whether the relationship between the dependent variable and the independent variable(s) is statistically significant after controlling for the covariate(s).

3.3 Logistic regression

Logistic regression is a statistical technique used to model the probability of a binary outcome, given that the assumptions of linearity of the logit, independence of observations, absence of multicolinearity, and normality of residuals are met. The model estimates the probability of the dependent variable (Y) being a certain category or level, given a set of independent variables (X). The dependent variable is modeled as a function of the independent variables using the logit function as shown below, which maps any real-valued input to a value between 0 and 1

$$\text{logit}(p) = \log(\frac{p}{1-p}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \epsilon$$

The model estimates the coefficients of the independent variables, which represent the change in the logarithm of the odds ratio for a one-unit change in the independent variable, holding all other variables constant.

4. Results

4.1 Power Analysis

Table 11: Effect size (Cohen's D) for StripSearch

	Effect size
StripSearch	0.0816

Effect size is the quantified magnitude of a result present in the population and is calculated using Cohen's d for the difference between groups. As Table 11, we calculated an effect size of 0.08 for **StripSearch** which is considered small. This means that there is a small or weak relationship between the variables being studied.

Table 12: Sample size and actual size between groups

	Sample size	Actual size
black	1609.8	17526
other	4384.8	47737

After obtaining the effect size, the required sample size was computed using the obtained effect size and establishing the statistical power at 80%. The results indicated that a sample size of 1610 was required for black people, while a sample size of 4385 was required for all other races combined. This study has more power than what was originally calculated because the sample size provided in the dataset are 17526 and 47737 respectively.

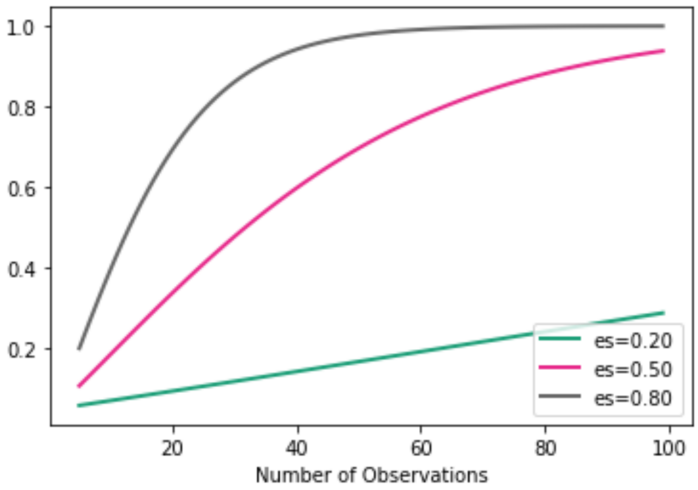

Figure 3: Power of test

A power graph is a visual representation of the statistical power of a hypothesis test as a function of sample size, effect size, and significance level. The power of a test refers to the probability of rejecting the null hypothesis when the alternative hypothesis is true. We found that as the effect size increases, the statistical power of the test increases at a faster rate. This implies that larger effect sizes are associated with a greater likelihood of detecting a significant effect in the study.

4.2 ANCOVA

The purpose of our study is to examine the influence of perceived race on the likelihood of being strip searched, while also accounting for the year of the arrest as a covariate using ANCOVA. Based on this, we have formulated the following hypotheses:

H_0 : There is no significant difference in the probability of being strip searched between perceived races, after controlling for the year of the arrest.

H_1 : There is a significant difference in the probability of being strip searched between perceived races, after controlling for the year of the arrest.

Table 13: ANCOVA results of perceived race while controlling arrest year

Source	SS	DF	F	p-unc	np2
Race	0.1404	7	4.4897	1.09e-04	0.128
Year	1.0351	1	231.69	6.08e-36	0.5198
Residual	0.9561	214	NaN	NaN	NaN

Based on our analysis, we observed that the uncorrected p-value for race is less than 0.05, indicating that there is a statistically significant relationship between perceived race and the probability of being strip searched, even after controlling for the year of the arrest. Therefore, we reject the null hypothesis that each race results in the same probability of being strip searched. This supports our hypothesis that perceived race is a significant predictor of the likelihood of being strip searched during arrests.

4.3 Logistic Regression

In our study, we conducted t-tests to compare the proportion of strip searches in each group with the mean proportion. We then created a new dependent variable, **High_Prop**, which takes the value `TRUE` if the proportion of arrests that were strip searched is above the average and `FALSE` otherwise. Based on the findings from the t-tests, we decided to investigate the effect of year and sex on the likelihood of an individual being strip searched upon arrest. By exploring the influence of year and sex on strip searches, we can gain a better understanding of the factors that contribute to these practices and identify potential areas for improvement.

Table 14: Summary of logistic regression

	Coef.	Std.Err.	z	P>|z|	[0.025	0.975]
Year	-0.0004	0.0001	-3.7638	0.0002	-0.0007	-0.0002
Sex_M	0.6815	0.3139	2.1714	0.0299	0.0664	1.2967

Table 14 shows the results of a logistic regression model with two predictor variables: **Year** and **Sex_M** (a binary variable representing male sex, coded as 1 for male and 0 for female).

The coefficient for Year is -0.0004, which means that for every one unit increase in Year, the odds of being strip searched decrease by a factor of $\exp(-0.0004) = 0.9996$. The associated p-value for Year is 0.0002, which indicates that the effect of Year on the odds of being strip searched is statistically significant at the 0.05 level.

The coefficient for Sex_M is 0.6815, which means that the odds of being strip searched are $\exp(0.6815) = 1.98$ times higher for males compared to females after controlling for Year. The associated p-value for Sex_M is 0.0299, which indicates that the effect of Sex_M on the odds of being strip searched is statistically significant at the 0.05 level.

Overall, these results suggest that both **Year** and **Sex_M** are significant predictors of the odds of being strip searched, with **Year** having a negative effect and **Sex_M** having a positive effect. After conducting tests on the testing dataset, which comprises 20% of the total dataset, the model's accuracy score was determined to be 73%. Although this score falls towards the lower end, it still demonstrates the model's ability to accurately predict outcomes. The confusion matrix is provided below:

Table 15: Confusion matrix for logistic regression

	Observed Positive	Observed Negative
Predicted Positive	33	0
Predicted Negative	12	0

The precision of our model ($\frac{TP}{TP+FP}$) was calculated as 1 there were no false positive. In contrast, the recall ($\frac{TP}{TP+FN}$) was 0.73 because some of the observed positive were incorrectly predicted as negative. These findings suggest that efforts to reduce the proportion of strip searches during arrests could take into account the effect of year and sex on these practices.

5. Discussion

The results section presents the findings of a study investigating the influence of perceived race, year, and sex on the probability of being strip searched during arrests. The section is divided into three subsections, discussing the power analysis, ANCOVA, and logistic regression results.

In the power analysis subsection, the effect size for strip search was calculated using Cohen's d, and it was found to be 0.08, indicating a weak relationship between the variables. The required sample size for each race group was also calculated, and it was determined that the study had more power than originally calculated due to the large sample sizes provided in the dataset. The power graph revealed that as the effect size increased, the statistical power of the test increased at a faster rate, suggesting that larger effect sizes are associated with a greater likelihood of detecting a significant effect in the study.

In the ANCOVA subsection, the results revealed that there was a statistically significant relationship between perceived race and the probability of being strip searched, even after controlling for the year of the arrest. This finding supports the hypothesis that perceived race is a significant predictor of the likelihood of being strip searched during arrests. Our findings raise important insights regarding the potential influence of a person's perceived race on the likelihood of being strip searched during arrests. By controlling for the year of the arrest, we were able to demonstrate that perceived race has an independent effect on the likelihood of being strip searched. This has important implications for understanding the potential role of racial bias in policing and law enforcement practices.

In the logistic regression subsection, the study investigated the effect of year and sex on the likelihood of being strip searched. The results revealed that both year and sex were significant predictors of the odds of being strip searched, with year having a negative effect and sex having a positive effect. Specifically, for every one unit increase in year, the odds of being strip searched decreased by a factor of 0.9996, and the odds of being strip searched were 1.98 times higher for males compared to females after controlling for year.

Overall, the results of this study suggest that perceived race, year, and sex are all significant predictors of the probability of being strip searched during arrests. These findings have important implications for understanding the factors that contribute to these practices and identifying potential areas for improvement in law enforcement policies and practices. The study's strengths include the large sample size and the use of statistical techniques like ANCOVA and logistic regression to explore the relationships between the variables. However, the study's limitations include the use of self-reported race and potential confounding factors that were not accounted for, such as socioeconomic status and location of the arrest. Further research is needed to address these limitations and better understand the complex relationships between these variables.

6. Conclusion

In conclusion, this study aimed to investigate the influence of perceived race, year, and sex on the probability of being strip searched during arrests, as a means of understanding potential disparities and inequalities within the criminal justice system. Through the use of power analysis, ANCOVA, and logistic regression, this investigation provided essential insights into the relationships between these variables and their impact on the likelihood of being strip searched.

The power analysis revealed a weak relationship between the variables, with a calculated effect size of 0.08. Despite the small effect size, the large sample sizes in the dataset provided the study with more power than originally calculated. This observation highlights the importance of having a large sample size to increase the likelihood of detecting a significant effect in the study.

The ANCOVA results demonstrated a statistically significant relationship between perceived race and the probability of being strip searched, even after controlling for the year of arrest. This finding supports the hypothesis that perceived race is a significant predictor of the likelihood of being strip searched during arrests. The results indicate that racial bias may play a role in policing and law enforcement practices, which has serious implications for fairness and equity within the criminal justice system.

The logistic regression analysis revealed that both year and sex were significant predictors of the odds of being strip searched. The odds of being strip searched decreased with each passing year, and males were more likely to be strip searched compared to females after controlling for year. These findings highlight the importance of considering multiple factors, such as temporal trends and gender, when examining the use of strip searches in law enforcement practices.

This study has several strengths, including the large sample size and the use of advanced statistical techniques like ANCOVA and logistic regression to explore the relationships between the variables. The large sample size allowed the researchers to obtain more accurate and reliable results, while the advanced statistical techniques facilitated the investigation of complex relationships between the variables.

However, there were some limitations to this study, such as the use of self-reported race and potential confounding factors not accounted for, including socioeconomic status and location of the arrest. These limitations may have influenced the results and could be addressed in future research to better understand the complex relationships between these variables.

To build on this research, future studies could explore additional factors that may influence the likelihood of being strip searched during arrests, such as the type of offense and the arresting officer's characteristics. Researchers could also investigate the impact of policy changes on the use of strip searches and examine whether changes in law enforcement practices have led to a

reduction in racial disparities. Furthermore, qualitative research methods could be employed to gain a deeper understanding of the lived experiences of individuals subjected to strip searches and the potential psychological and emotional consequences of these invasive procedures.

In summary, this study has provided valuable insights into the significant predictors of the probability of being strip searched during arrests, including perceived race, year, and sex. The findings have important implications for understanding the factors that contribute to these practices and identifying potential areas for improvement in law enforcement policies and practices. By recognizing the role of racial bias, temporal trends, and gender differences in the use of strip searches, policymakers and law enforcement agencies can work towards promoting fairness and equity within the criminal justice system, ensuring that all individuals are treated with dignity and respect.

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