NYPD Shooting Assignment

CS

Assignment

Import, tidy and analyze the NYPD Shooting Incident dataset obtained. Be sure your project is reproducible and contains some visualization and analysis. You may use the data to do any analysis that is of interest to you. You should include at least two visualizations and one model. Be sure to identify any bias possible in the data and in your analysis.

```
library(tidyverse)
library(lubridate)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.1     v tibble    3.2.1
v lubridate 1.9.3     v tidyr     1.3.1
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becor
```

```
# import the source data and put it in a df
source_url <- paste0(
  "https://data.cityofnewyork.us/api/views/833y-fsy8/rows.csv?",
  "accessType=DOWNLOAD"
)

incident_df <- read.csv(source_url)
```

Explore

```
# see what columns we have and what data types
glimpse(incident_df)
```

```
Rows: 28,562
Columns: 21
$ INCIDENT_KEY            <int> 244608249, 247542571, 84967535, 202853370, 270~
$ OCCUR_DATE              <chr> "05/05/2022", "07/04/2022", "05/27/2012", "09/~
$ OCCUR_TIME              <chr> "00:10:00", "22:20:00", "19:35:00", "21:00:00"~
$ BORO                    <chr> "MANHATTAN", "BRONX", "QUEENS", "BRONX", "BROO~
$ LOC_OF_OCCUR_DESC       <chr> "INSIDE", "OUTSIDE", "", "", "", "", "", "", "~
$ PRECINCT                <int> 14, 48, 103, 42, 83, 23, 113, 77, 48, 49, 73, ~
$ JURISDICTION_CODE       <int> 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
$ LOC_CLASSFCTN_DESC      <chr> "COMMERCIAL", "STREET", "", "", "", "", "", ""~
$ LOCATION_DESC           <chr> "VIDEO STORE", "(null)", "", "", "", "MULTI DW~
$ STATISTICAL_MURDER_FLAG <chr> "true", "true", "false", "false", "false", "fa~
$ PERP_AGE_GROUP          <chr> "25-44", "(null)", "", "25-44", "25-44", "", "~
$ PERP_SEX                <chr> "M", "(null)", "", "M", "M", "", "", "", "", "~
$ PERP_RACE               <chr> "BLACK", "(null)", "", "UNKNOWN", "BLACK", "",~
$ VIC_AGE_GROUP           <chr> "25-44", "18-24", "18-24", "25-44", "25-44", "~
$ VIC_SEX                 <chr> "M", "M", "M", "M", "M", "M", "M", "M", "M", "~
$ VIC_RACE                <chr> "BLACK", "BLACK", "BLACK", "BLACK", "BLACK", "~
$ X_COORD_CD              <dbl> 986050, 1016802, 1048632, 1014493, 1009149, 99~
$ Y_COORD_CD              <dbl> 214231.0, 250581.0, 198262.0, 242565.0, 190104~
$ Latitude                <dbl> 40.75469, 40.85440, 40.71063, 40.83242, 40.688~
$ Longitude               <dbl> -73.99350, -73.88233, -73.76777, -73.89071, -7~
$ Lon_Lat                 <chr> "POINT (-73.9935 40.754692)", "POINT (-73.8823~
```

I already see lots of nulls, empty strings, missing values, etc. Let's take a closer look at some of the categorical columns to see if there are a limited number of consistently entered values or if they were entered as free text, which might be too difficult to clean.

```
# break out all the unique values and counts
desc_counts <- lapply(incident_df[,
  c(
    "LOC_CLASSFCTN_DESC",
    "LOCATION_DESC",
    "PERP_RACE",
    "VIC_RACE",
    "LOC_OF_OCCUR_DESC",
```

```
    "VIC_SEX",
    "PERP_SEX"
  )
], table)

print(desc_counts)
```

```
$LOC_CLASSFCTN_DESC

                (null)  COMMERCIAL    DWELLING     HOUSING       OTHER
      25596          2         208         243         460          59
PARKING LOT  PLAYGROUND      STREET     TRANSIT     VEHICLE
         15          41        1886          23          29

$LOCATION_DESC

                                      (null)                         ATM
                 14977                  1711                           1
                  BANK           BAR/NIGHT CLUB         BEAUTY/NAIL SALON
                     3                   668                         119
          CANDY STORE             CHAIN STORE                CHECK CASH
                     7                     7                           1
     CLOTHING BOUTIQUE          COMMERCIAL BLDG                DEPT STORE
                    14                   304                           9
        DOCTOR/DENTIST               DRUG STORE       DRY CLEANER/LAUNDRY
                     1                    14                          32
     FACTORY/WAREHOUSE               FAST FOOD               GAS STATION
                     8                   130                          74
        GROCERY/BODEGA     GYM/FITNESS FACILITY                 HOSPITAL
                   750                     4                          77
           HOTEL/MOTEL            JEWELRY STORE              LIQUOR STORE
                    35                    14                          42
         LOAN COMPANY  MULTI DWELL - APT BUILD MULTI DWELL - PUBLIC HOUS
                     1                  2964                        5007
                  NONE         PHOTO/COPY STORE                 PVT HOUSE
                   175                     1                         983
       RESTAURANT/DINER                SCHOOL                SHOE STORE
                   212                     1                          10
        SMALL MERCHANT SOCIAL CLUB/POLICY LOCATI          STORAGE FACILITY
                    44                    73                           1
    STORE UNCLASSIFIED           SUPERMARKET           TELECOMM. STORE
                    37                    21                          11
```

```
            VARIETY STORE                VIDEO STORE
                       11                          8

$PERP_RACE

                                                (null)
                         9310                     1141
AMERICAN INDIAN/ALASKAN NATIVE    ASIAN / PACIFIC ISLANDER
                            2                      169
                        BLACK              BLACK HISPANIC
                        11903                     1392
                      UNKNOWN                    WHITE
                         1837                      298
                WHITE HISPANIC
                         2510

$VIC_RACE

AMERICAN INDIAN/ALASKAN NATIVE    ASIAN / PACIFIC ISLANDER
                           11                      440
                        BLACK              BLACK HISPANIC
                        20235                     2795
                      UNKNOWN                    WHITE
                           70                      728
                WHITE HISPANIC
                         4283

$LOC_OF_OCCUR_DESC

         INSIDE OUTSIDE
  25596     460    2506

$VIC_SEX

    F     M     U
 2760 25790    12

$PERP_SEX

       (null)      F      M      U
  9310   1141    444  16168   1499
```

Everything seems to be consistently entered (no misspellings or variations.) But there is a

weird mix of “unknown”, “U”, and “null”. It will probably be best to recode empty values as “Unknown for consistency. There is something weird in a few columns too.

```
unique(incident_df$PERP_RACE)
table(incident_df$PERP_RACE)
```

1. ‘BLACK’
2. ‘(null)’
3. ’ ’
4. ‘UNKNOWN’
5. ‘WHITE HISPANIC’
6. ‘BLACK HISPANIC’
7. ‘ASIAN / PACIFIC ISLANDER’
8. ‘WHITE’
9. ‘AMERICAN INDIAN/ALASKAN NATIVE’

```
                                                (null)
                            9310                  1141
AMERICAN INDIAN/ALASKAN NATIVE       ASIAN / PACIFIC ISLANDER
                               2                   169
                           BLACK               BLACK HISPANIC
                           11903                  1392
                         UNKNOWN                 WHITE
                            1837                   298
                  WHITE HISPANIC
                            2510
```

Oh, that’s annoying - there is an empty string `''` as one of the largest groups, I guess the best option will be to categorize that as `"UNKNOWN"` as well. While I’m at it I’m going to make the date time columns a little more usable by separating out the date and time and converting them to the right type.

Cleanup

```
# make a nicer datetime column
clean_incident_df <- incident_df %>%
  mutate(
```

```
    Date = as.POSIXct(
      paste(OCCUR_DATE, OCCUR_TIME),
      format = "%m/%d/%Y %H:%M:%S"
    )
  ) %>%
  rename(
    # rename some of the hardest to read columns
    In_Out = LOC_OF_OCCUR_DESC,
    Location_Category = LOC_CLASSFCTN_DESC,
    Location_details = LOCATION_DESC
  ) %>%
  select(
    Date, BORO, Location_Category, Location_details,
    In_Out, OCCUR_DATE, OCCUR_TIME,
    -JURISDICTION_CODE, -X_COORD_CD, -Y_COORD_CD,
    -Latitude, -Longitude, -Lon_Lat, -PRECINCT,
    everything()
  ) %>%
  mutate(
    # Replace specific values in PERP_RACE and VIC_RACE using recode
    PERP_RACE = recode(PERP_RACE,
                       "ASIAN / PACIFIC ISLANDER" = "ASIAN_PAC_ISLAND",
                       "AMERICAN INDIAN/ALASKAN NATIVE" = "AM_INDIAN/ALASKAN"
    ),
    VIC_RACE = recode(VIC_RACE,
                      "ASIAN / PACIFIC ISLANDER" = "ASIAN_PAC_ISLAND",
                      "AMERICAN INDIAN/ALASKAN NATIVE" = "AM_INDIAN/ALASKAN"
    ),
    # recode some of the empty value to the corresponding unknown option
    # I'm going to handle the nulls later
    PERP_RACE = ifelse(PERP_RACE == "", "UNKNOWN", PERP_RACE
    ),
    PERP_SEX = ifelse(PERP_SEX == "", "U", PERP_SEX)
  )

# check that I have the columns and order that I wanted
glimpse(clean_incident_df)

# check that we fixed the empty string values
unique(clean_incident_df$PERP_RACE)

# printing a df is a little uglier in some ways but prevents text
```

```r
# overlap when there are lots of columns or long column names
print(tail(clean_incident_df))
```

```
Rows: 28,562
Columns: 22
$ Date                    <dttm> 2022-05-05 00:10:00, 2022-07-04 22:20:00, 201~
$ BORO                    <chr> "MANHATTAN", "BRONX", "QUEENS", "BRONX", "BROO~
$ Location_Category       <chr> "COMMERCIAL", "STREET", "", "", "", "", "", ""~
$ Location_details        <chr> "VIDEO STORE", "(null)", "", "", "", "MULTI DW~
$ In_Out                  <chr> "INSIDE", "OUTSIDE", "", "", "", "", "", "", "~
$ OCCUR_DATE              <chr> "05/05/2022", "07/04/2022", "05/27/2012", "09/~
$ OCCUR_TIME              <chr> "00:10:00", "22:20:00", "19:35:00", "21:00:00"~
$ INCIDENT_KEY            <int> 244608249, 247542571, 84967535, 202853370, 270~
$ PRECINCT                <int> 14, 48, 103, 42, 83, 23, 113, 77, 48, 49, 73, ~
$ JURISDICTION_CODE       <int> 0, 0, 0, 0, 0, 2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0~
$ STATISTICAL_MURDER_FLAG <chr> "true", "true", "false", "false", "false", "fa~
$ PERP_AGE_GROUP          <chr> "25-44", "(null)", "", "25-44", "25-44", "", "~
$ PERP_SEX                <chr> "M", "(null)", "U", "M", "M", "U", "U", "U", "~
$ PERP_RACE               <chr> "BLACK", "(null)", "UNKNOWN", "UNKNOWN", "BLAC~
$ VIC_AGE_GROUP           <chr> "25-44", "18-24", "18-24", "25-44", "25-44", "~
$ VIC_SEX                 <chr> "M", "M", "M", "M", "M", "M", "M", "M", "M", "~
$ VIC_RACE                <chr> "BLACK", "BLACK", "BLACK", "BLACK", "BLACK", "~
$ X_COORD_CD              <dbl> 986050, 1016802, 1048632, 1014493, 1009149, 99~
$ Y_COORD_CD              <dbl> 214231.0, 250581.0, 198262.0, 242565.0, 190104~
$ Latitude                <dbl> 40.75469, 40.85440, 40.71063, 40.83242, 40.688~
$ Longitude               <dbl> -73.99350, -73.88233, -73.76777, -73.89071, -7~
$ Lon_Lat                 <chr> "POINT (-73.9935 40.754692)", "POINT (-73.8823~
```

1. 'BLACK'
2. '(null)'
3. 'UNKNOWN'
4. 'WHITE HISPANIC'
5. 'BLACK HISPANIC'
6. 'ASIAN_PAC_ISLAND'
7. 'WHITE'
8. 'AM_INDIAN/ALASKAN'

```
                     Date      BORO Location_Category          Location_details
28557 2023-07-02 21:40:00     BRONX            STREET                    (null)
28558 2023-03-19 23:48:00     BRONX        COMMERCIAL            GROCERY/BODEGA
28559 2023-08-16 02:46:00     BRONX            STREET                    (null)
28560 2023-06-27 12:27:00     BRONX          DWELLING   MULTI DWELL - APT BUILD
```

```
28561 2023-07-08 11:27:00    QUEENS            STREET         BEAUTY/NAIL SALON
28562 2023-07-24 23:38:00 MANHATTAN          HOUSING MULTI DWELL - PUBLIC HOUS
       In_Out OCCUR_DATE OCCUR_TIME INCIDENT_KEY PRECINCT JURISDICTION_CODE
28557 OUTSIDE 07/02/2023   21:40:00    270719378       46                 0
28558  INSIDE 03/19/2023   23:48:00    265354835       47                 0
28559 OUTSIDE 08/16/2023   02:46:00    272968931       41                 0
28560  INSIDE 06/27/2023   12:27:00    270489846       41                 0
28561 OUTSIDE 07/08/2023   11:27:00    271021661      102                 0
28562 OUTSIDE 07/24/2023   23:38:00    271818283       28                 2
      STATISTICAL_MURDER_FLAG PERP_AGE_GROUP PERP_SEX      PERP_RACE
28557                   false         (null)   (null)         (null)
28558                    true          18-24        M          BLACK
28559                   false          25-44        F          BLACK
28560                    true          25-44        M          BLACK
28561                   false          25-44        M WHITE HISPANIC
28562                   false         (null)   (null)         (null)
      VIC_AGE_GROUP VIC_SEX         VIC_RACE X_COORD_CD Y_COORD_CD Latitude
28557         18-24       M   BLACK HISPANIC    1009601     247515 40.84601
28558         18-24       M            BLACK    1025687     268586 40.90378
28559         45-64       M            BLACK    1014639     240066 40.82555
28560         25-44       M            BLACK    1012221     238552 40.82140
28561           65+       M ASIAN_PAC_ISLAND    1028856     192785 40.69572
28562         25-44       M            BLACK     997853     230889 40.80040
      Longitude                     Lon_Lat
28557 -73.90837 POINT (-73.908369 40.846012)
28558 -73.85010 POINT (-73.850098 40.903785)
28559 -73.89020 POINT (-73.890195 40.825549)
28560 -73.89894 POINT (-73.898938 40.821404)
28561 -73.83914 POINT (-73.839138 40.695717)
28562 -73.95086 POINT (-73.950864 40.800405)
```

I'm going to make a few different dataframes with different groups for eventual analysis and plotting. Things I'm going to start with

- Daily incidents over time to look for general trends
- Incidents by month and year
- Incidents by borough
- Incidents by month (not over time, so total incidents that occured in each month summed over all years)
- Time and year data broken down by borough

```r
# for plotting incidents over time
time_series_df <- clean_incident_df %>%
  mutate(simple_date = as.Date(OCCUR_DATE, format = "%m/%d/%Y")) %>%
  group_by(simple_date) %>%
# Add a new column that represents only the month and year
# This step may be unnecessary since I have a good date column
# but it's easier for me to understand
  summarise(total_by_day = n()) %>%
  mutate(month_year = floor_date(simple_date, "month"))

# for plotting overtime by month and year
df_aggregated <- time_series_df %>%
  mutate(year = format(simple_date, "%Y"),
         month = format(simple_date, "%m")) %>%
  group_by(year, month) %>%
  summarise(total_by_day = sum(total_by_day)) %>%
  ungroup()

# borough totals
total_by_borough <- clean_incident_df %>%
  group_by(BORO) %>%
  summarize(total_incidents = n())

# monthly borough totals
monthly_totals_by_borough <- clean_incident_df %>%
  mutate(month = floor_date(Date, "month")) %>%
  mutate(month = as.Date(month)) %>%
  group_by(BORO, month) %>%
  summarize(monthly_incidents = n()) %>%
  ungroup()

tail(time_series_df)
tail(df_aggregated)
tail(total_by_borough)
tail(monthly_totals_by_borough)
```

```
`summarise()` has grouped output by 'year'. You can override using the
`.groups` argument.
`summarise()` has grouped output by 'BORO'. You can override using the
`.groups` argument.
```

A tibble: 6 x 3

simple_date <date>	total_by_day <int>	month_year <date>
2023-12-22	8	2023-12-01
2023-12-23	4	2023-12-01
2023-12-24	5	2023-12-01
2023-12-26	6	2023-12-01
2023-12-27	1	2023-12-01
2023-12-29	3	2023-12-01

A tibble: 6 x 3

year <chr>	month <chr>	total_by_day <int>
2023	07	152
2023	08	108
2023	09	105
2023	10	99
2023	11	71
2023	12	83

A tibble: 5 x 2

BORO <chr>	total_incidents <int>
BRONX	8376
BROOKLYN	11346
MANHATTAN	3762
QUEENS	4271
STATEN ISLAND	807

A tibble: 6 x 3

BORO <chr>	month <date>	monthly_incidents <int>
STATEN ISLAND	2023-05-01	3
STATEN ISLAND	2023-06-01	8
STATEN ISLAND	2023-07-01	6
STATEN ISLAND	2023-08-01	3
STATEN ISLAND	2023-10-01	3
STATEN ISLAND	2023-11-01	2

That's looks pretty good. I'm going to make all my plots at once, so it will get a little messy looking, but that will be the easiest way to set some universal configurations (theme, size, etc.) Then we can use these to decide on further plotting or analysis or modeling to do.

Visualization

```
options(repr.plot.width = 10, repr.plot.height = 7)
theme_set(theme_minimal())

# plot daily incidents
ggplot(time_series_df, aes(x = simple_date, y = total_by_day)) +
  geom_line(color = "skyblue") +
  labs(
    title = "Fig.1 - Daily Incidents",
    x = "Date",
    y = "Incident Count"
  )


# plot monthly incidents over time
ggplot(time_series_df, aes(x = month_year, y = total_by_day)) +
  geom_bar(stat = "identity", fill = "skyblue") +
  labs(
       title = "Fig. 2 - Total Occurrences by Month",
       x = "Year",
       y = "Total Occurrences") +
  scale_x_date(date_labels = "%Y", date_breaks = "1 year")

# plot yearly incidents
ggplot(time_series_df, aes(
  x = year(simple_date),
  y = total_by_day)) +
  geom_bar(stat = "identity", fill = "skyblue") +
  labs(
       title = "Fig. 3 - Total Occurrences by Year",
       x = "Year",
       y = "Total Occurrences")
```

```r
# Plot occurrences by month (across all years)
ggplot(time_series_df, aes(
  x = month(simple_date, label = TRUE),
  y = total_by_day
  )) +
  geom_bar(
    stat = "identity",
    fill = "skyblue"
  ) +
  labs(
    title = "Fig. 4 - Total Occurrences by Month",
    x = "Month",
    y = "Total Occurrences"
  )


# Plot total by borough
ggplot(total_by_borough, aes(
  x = BORO,
  y = total_incidents
)) +
  geom_bar(
    stat = "identity",
    fill = "skyblue"
  ) +
  labs(
    title = "Fig. 5 - Total by Borough",
    x = "Borough",
    y = "Total"
  )

# Assuming you already have the 'monthly_totals' dataframe
ggplot(monthly_totals_by_borough, aes(
  x = month,
  y = monthly_incidents,
  color = BORO)
  ) +
  # I wanted to try a line instead of a bar
  geom_line(linewidth = 1.2) +
  geom_point(size = 2) +
  labs(
    title = "Fig. 6 - Monthly Incidents by Borough",
```

```
    x = "Month",
    y = "Total Incidents"
  ) +
  scale_x_date(date_labels = "%b %Y", date_breaks = "6 month") +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))

# Plot incidents by year for each borough with side-by-side bars
ggplot(monthly_totals_by_borough, aes(
  x = year(month),
  y = monthly_incidents,
  fill = BORO)
  ) +
  # Use dodge for side-by-side bars
  geom_bar(stat = "identity", position = "dodge") +
  labs(
    title = "Fig. 7 - Yearly Incidents by Borough",
    x = "Year",
    y = "Total Incidents")
```

Fig.1 - Daily Incidents

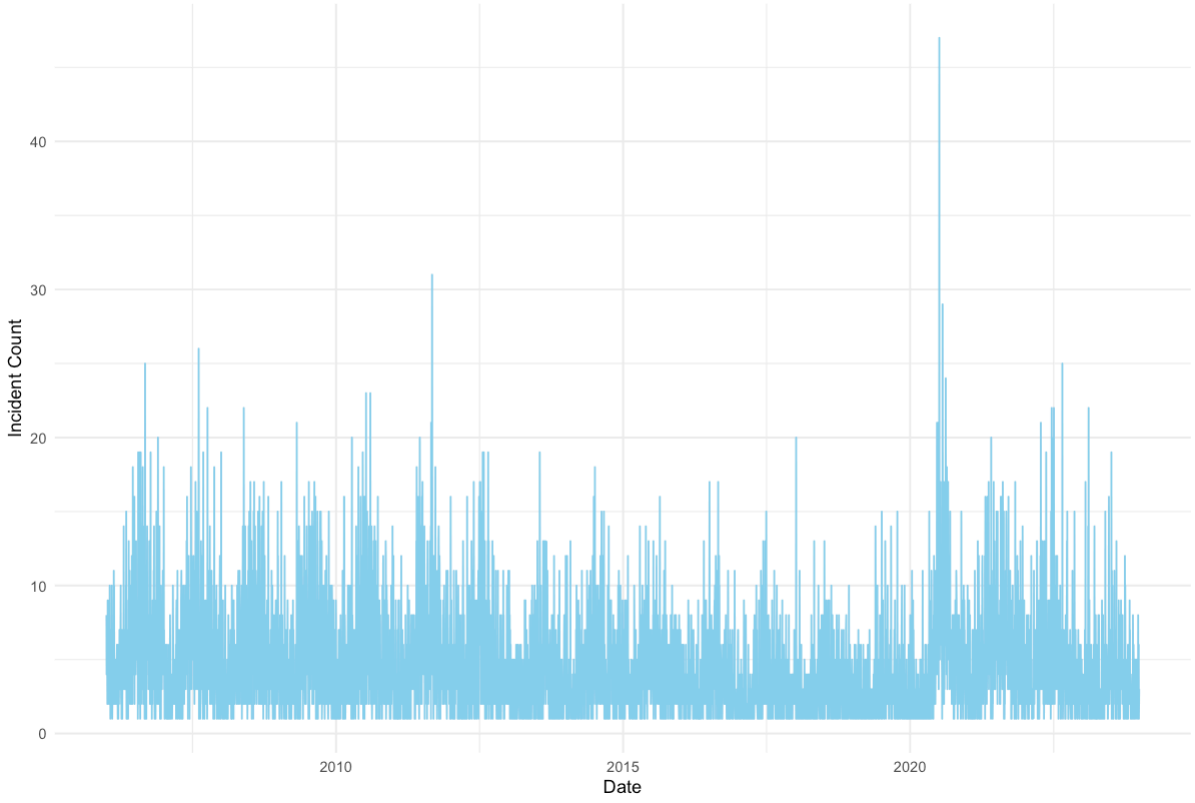


Fig. 2 - Total Occurrences by Month

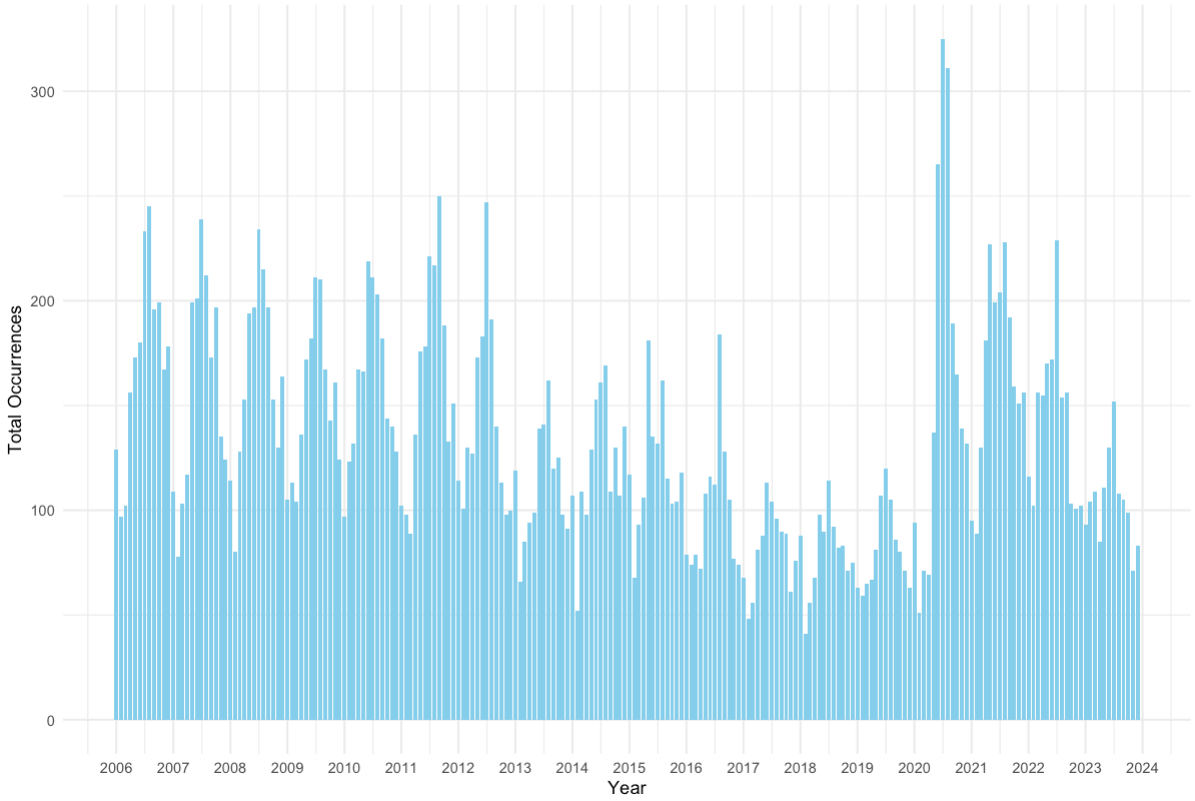


Fig. 3 - Total Occurrences by Year

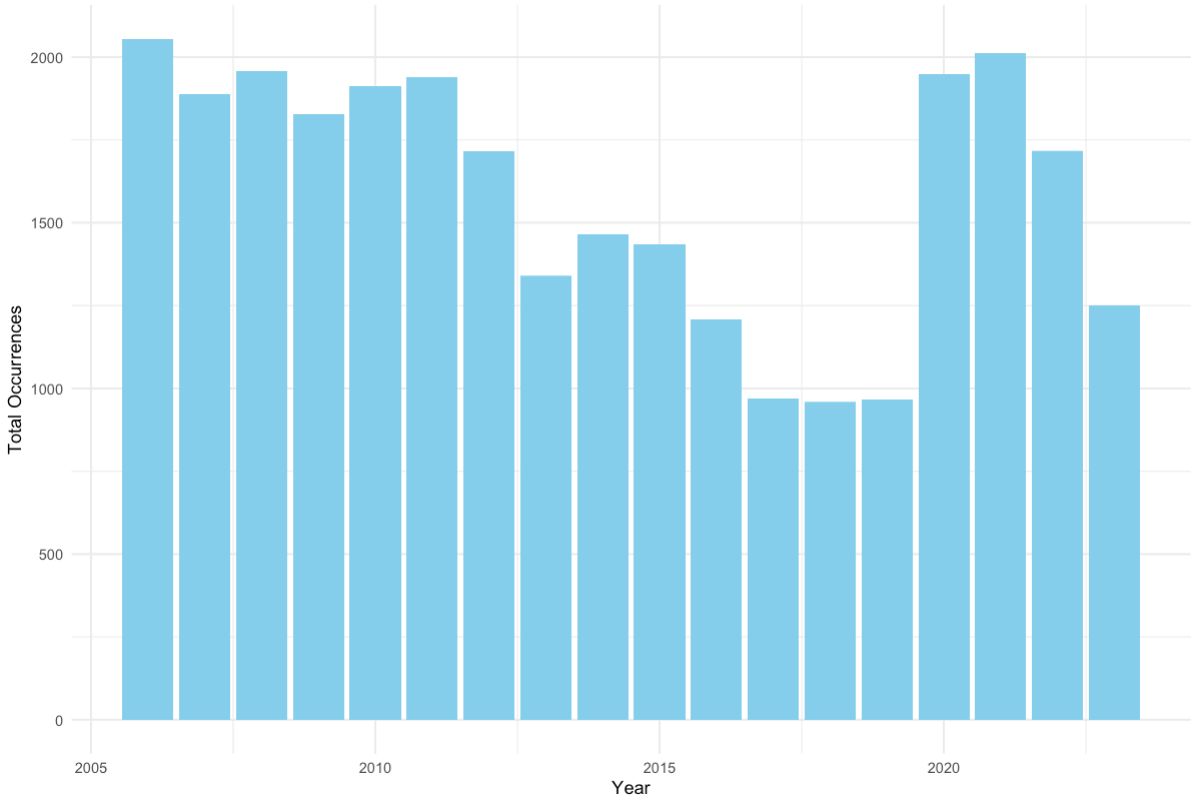


Fig. 4 - Total Occurrences by Month

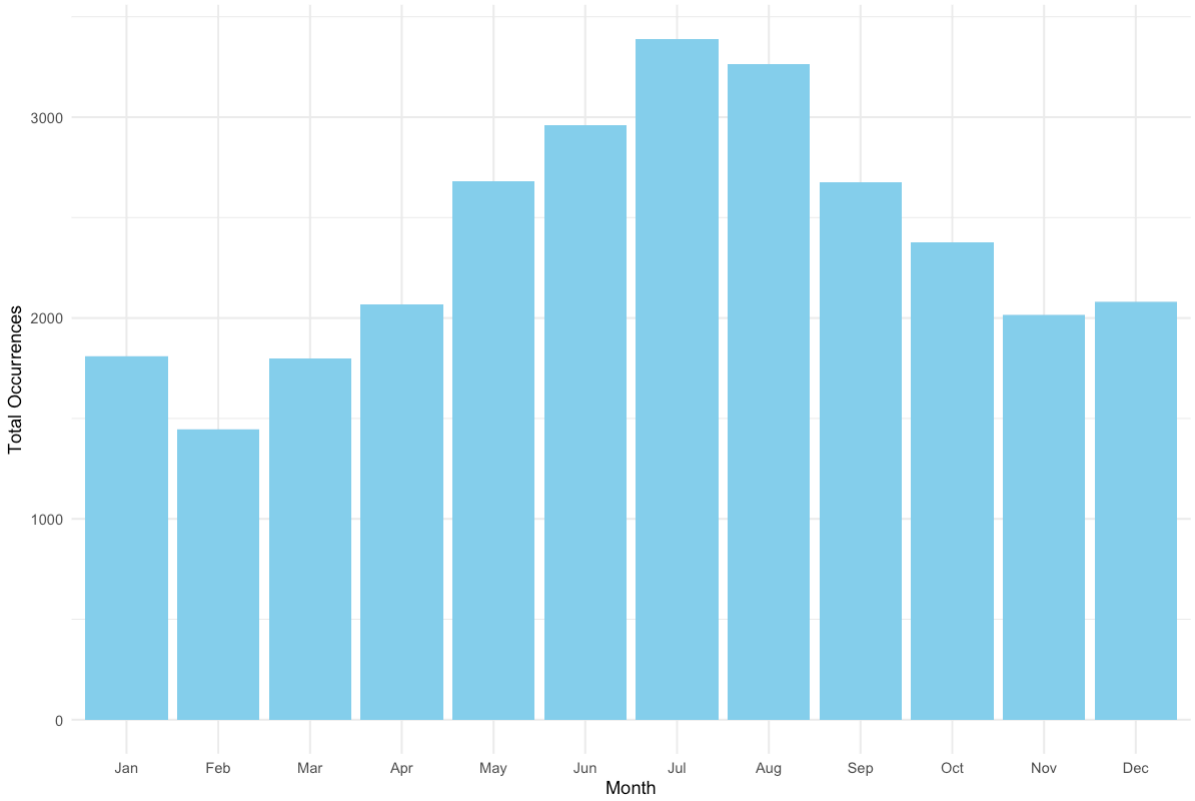


Fig. 5 - Total by Borough

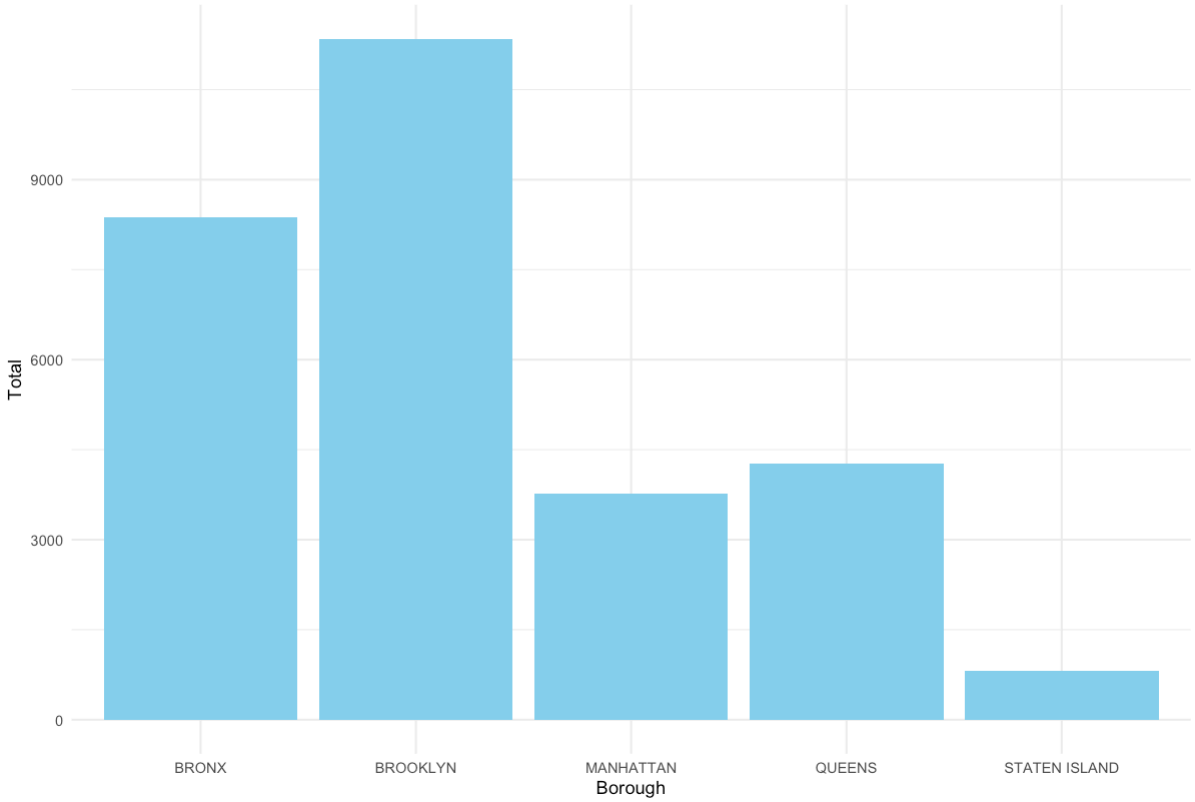


Fig. 6 - Monthly Incidents by Borough

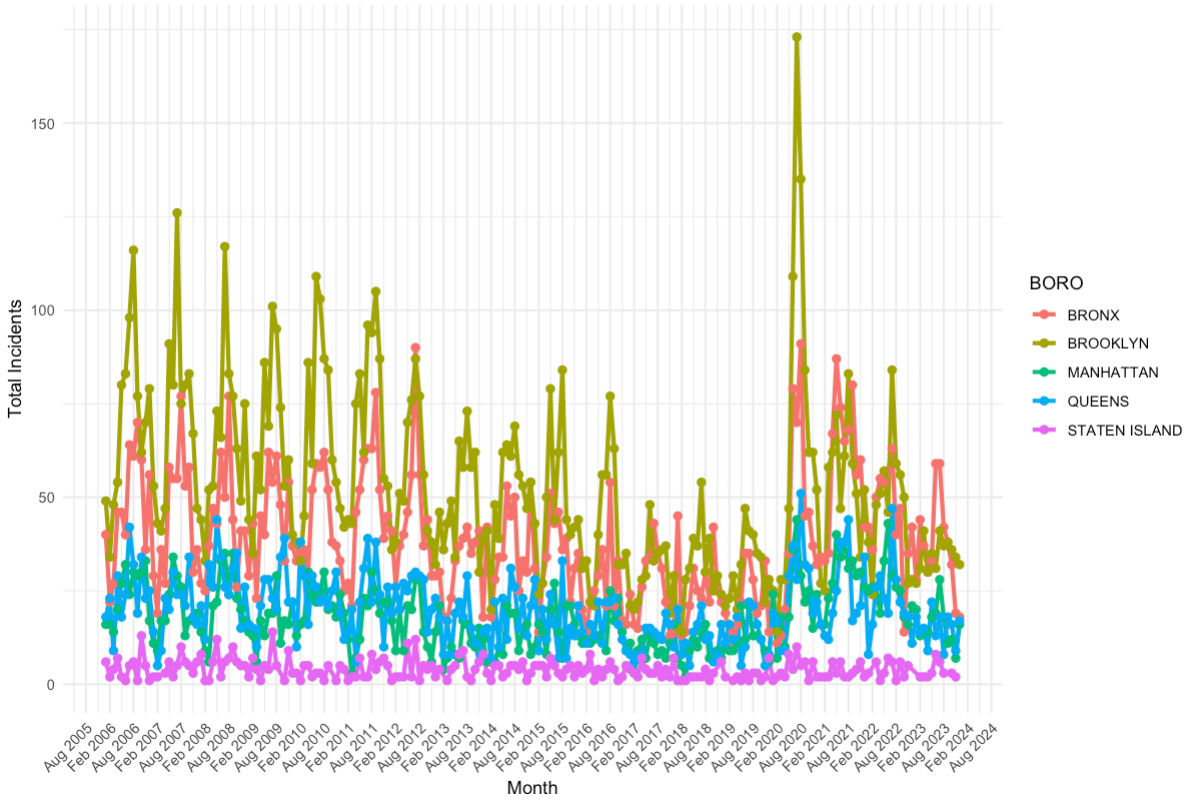
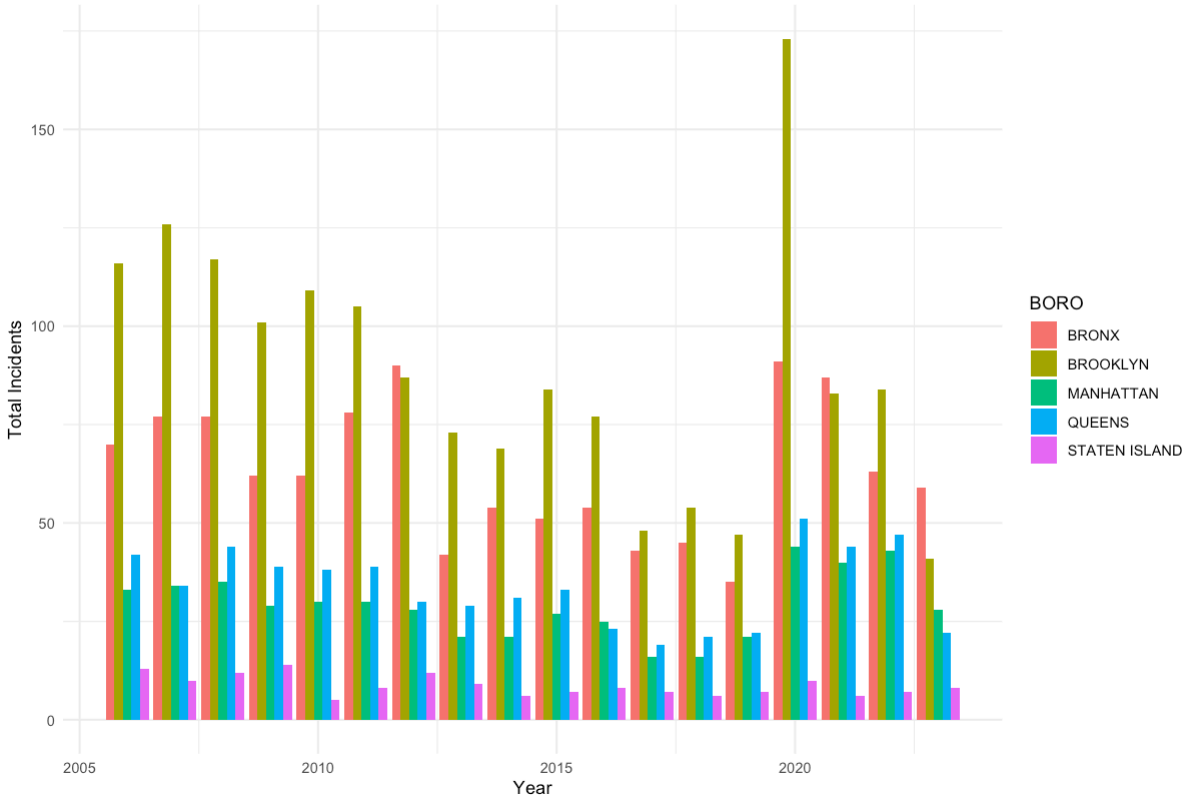


Fig. 7 - Yearly Incidents by Borough



- Fig 1 - Daily incidents - hard to see many trends since the data is so noisy, but it does look like it's generally periodic and there is a big spike around the first covid summer.
- Fig 2 - Total occurences by month over time - clearer seasonality and a little easier to see the pre- and post-covid trends
- Fig 3 - Total occurences by year - now we can see trends. Decreasing incidents starting in the early 20-teens and flattening out, before a big covid spike and almost back down to pre-covid levels.
- Fig 4 - Total occurences by month - pretty strong visual trend towards higher incidents in the hottest months, which is a well studied phenomenon.
- Fig 5 - Total by borough - generaly interesting, but would be more useful with the context of per capita and per area data for the boroughs.
- Fig 6/7 - Boroughs over time (final 2 plots) - interesting to see that not all boroughs follow the same trends over time, and that the first covid spike was driven heavily by increased in Brooklyn.

We could keep going with similar visuals (breakdown by race, gender, age group, etc. or relationships between group like victime age relative to perpetrator age) but I'll stop there. I'm going to focus on victim sex for the analysis and modeling component. I want to see how predictive of a victime being female some of the other attributes (perpetrator race and sex,

victime race). I'll start with a simple model of victim sex as predicted by perpetrator sex. To start will have to exclude the "unknowns" from victim sex and clean up some of the other factors.

Modeling

```
# Recode "U" as NA for victim
clean_incident_df$VIC_SEX[clean_incident_df$VIC_SEX == "U"] <- NA

# create new df for modeling
#replace null/na in some of the factors with "unknown" for consistency
model_df <- clean_incident_df %>%
  mutate(
    PERP_SEX = ifelse(PERP_SEX == "(null)", "U", PERP_SEX),
    PERP_RACE = ifelse(PERP_RACE == "(null)", "UNKNOWN", PERP_RACE)
  )

# Convert all categorical variables to factors
model_df$VIC_SEX <- factor(model_df$VIC_SEX)
model_df$BORO <- factor(model_df$BORO)
model_df$VIC_RACE <- factor(model_df$VIC_RACE)
model_df$PERP_RACE <- factor(model_df$PERP_RACE)
model_df$PERP_SEX <- factor(model_df$PERP_SEX)

# Apply droplevels to all factor columns (to remove unused levels)
model_df <- model_df %>%
  mutate_if(is.factor, droplevels)

# Set "M" as the victim reference so that we model the odds of being "Female"
# Set the reference race for victims and perps as "white"
model_df$VIC_SEX <- relevel(model_df$VIC_SEX, ref = "M")
model_df$VIC_RACE <- relevel(model_df$VIC_RACE, ref = "WHITE")
model_df$PERP_RACE <- relevel(model_df$PERP_RACE, ref = "WHITE")

# Check the levels of the factor to confirm they are correct
levels(model_df$VIC_SEX)
levels(model_df$PERP_SEX)
levels(model_df$PERP_RACE)
```

1. 'M'
2. 'F'

1. 'F'
2. 'M'
3. 'U'

1. 'WHITE'
2. 'AM_INDIAN/ALASKAN'
3. 'ASIAN_PAC_ISLAND'
4. 'BLACK'
5. 'BLACK HISPANIC'
6. 'UNKNOWN'
7. 'WHITE HISPANIC'

```
# create a simple generalize linear model to predict odds of female victim
# based on perp sex
simple_model_vic_sex <- glm(VIC_SEX ~  PERP_SEX,
  family=binomial,
  data=model_df,
  na.action = na.exclude)

summary(simple_model_vic_sex)
```

```
Call:
glm(formula = VIC_SEX ~ PERP_SEX, family = binomial, data = model_df,
    na.action = na.exclude)

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -1.5588     0.1254 -12.433  < 2e-16 ***
PERP_SEXM    -0.5463     0.1279  -4.272 1.94e-05 ***
PERP_SEXU    -0.9154     0.1300  -7.044 1.86e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 18141  on 28549  degrees of freedom
Residual deviance: 18038  on 28547  degrees of freedom
  (12 observations deleted due to missingness)
AIC: 18044
```

```
Number of Fisher Scoring iterations: 5
```

It looks like each perpetrator sex option has a statistically significant effect on the change in log-odds of the victim being female, so I'll pull out each of them and convert them to odds, so I'll pull them each out and convert them to odds.

```
print("Log-odds are")
print(coef(simple_model_vic_sex)[c("PERP_SEXM","PERP_SEXU")])

#convert log-odds to odds and print
print("The odds relative to the female victim/female perpetrator baseline are")
print((exp(coef(simple_model_vic_sex)[c("PERP_SEXM","PERP_SEXU")])))

# Print odds for when the perpetrator is female
paste(
  "The odds of a victim being female when the perpetrator is female are",
  round(exp(coef(simple_model_vic_sex)["(Intercept)"]), 2)
)

# Print odds for when the perpetrator is male
paste0(
  "The odds of a victim being female when the perpetrator is male are ",
  round(exp(coef(simple_model_vic_sex)["PERP_SEXM"]), 2) * 100,
  "% of baseline"
)

# Print odds for when the perpetrator is unknown
paste0(
  "The odds of a victim being female when the perpetrator is unknown are ",
  round(exp(coef(simple_model_vic_sex)["PERP_SEXU"]), 2) * 100,
  "% of baseline"
)
```

```
[1] "Log-odds are"
 PERP_SEXM  PERP_SEXU
-0.5463480 -0.9154259
[1] "The odds relative to the female victim/female perpetrator baseline are"
PERP_SEXM PERP_SEXU
0.5790607 0.4003461
```

'The odds of a victim being female when the perpetrator is female are 0.21'

'The odds of a victim being female when the perpetrator is male are 58% of baseline'

'The odds of a victim being female when the perpetrator is unknown are 40% of baseline'

That's the end of the analysis I'm comfortable with. Below I wanted to see what it would look like to do similar modeling with multiple predictor variables (perp sex, race, borough.) It looks like it worked, but it gets out of hand to interpret it pretty quickly so I just stopped and left it here as an interesting example.

```
model_vic_sex <- glm(VIC_SEX ~ BORO + VIC_RACE +
  PERP_SEX + PERP_RACE,
  family=binomial,
  data=model_df,
  na.action = na.exclude)

print(levels(model_df$VIC_RACE))
print(levels(model_df$PERP_RACE))
print(levels(model_df$BORO))
print(summary(model_vic_sex))
```

```
[1] "WHITE"             "AM_INDIAN/ALASKAN" "ASIAN_PAC_ISLAND"
[4] "BLACK"             "BLACK HISPANIC"    "UNKNOWN"
[7] "WHITE HISPANIC"
[1] "WHITE"             "AM_INDIAN/ALASKAN" "ASIAN_PAC_ISLAND"
[4] "BLACK"             "BLACK HISPANIC"    "UNKNOWN"
[7] "WHITE HISPANIC"
[1] "BRONX"         "BROOKLYN"      "MANHATTAN"     "QUEENS"
[5] "STATEN ISLAND"

Call:
glm(formula = VIC_SEX ~ BORO + VIC_RACE + PERP_SEX + PERP_RACE,
    family = binomial, data = model_df, na.action = na.exclude)

Coefficients:
                           Estimate Std. Error z value Pr(>|z|)
(Intercept)               -1.078413   0.206495  -5.222 1.77e-07 ***
BOROBROOKLYN               0.157686   0.052155   3.023 0.002499 **
BOROMANHATTAN              0.108796   0.067349   1.615 0.106220
BOROQUEENS                 0.182218   0.064675   2.817 0.004841 **
BOROSTATEN ISLAND          0.227746   0.117056   1.946 0.051700 .
VIC_RACEAM_INDIAN/ALASKAN -0.583073   1.057088  -0.552 0.581233
VIC_RACEASIAN_PAC_ISLAND  -0.706628   0.199946  -3.534 0.000409 ***
VIC_RACEBLACK             -0.628932   0.112511  -5.590 2.27e-08 ***
```

```
VIC_RACEBLACK HISPANIC     -0.566739   0.128208  -4.420 9.85e-06 ***
VIC_RACEUNKNOWN            -2.394956   1.014271  -2.361 0.018213 *
VIC_RACEWHITE HISPANIC     -0.300278   0.119115  -2.521 0.011705 *
PERP_SEXM                  -0.533656   0.128639  -4.148 3.35e-05 ***
PERP_SEXU                  -0.406559   0.236166  -1.722 0.085160 .
PERP_RACEAM_INDIAN/ALASKAN -8.691789  84.201452  -0.103 0.917784
PERP_RACEASIAN_PAC_ISLAND   0.200856   0.282430   0.711 0.476980
PERP_RACEBLACK              0.007634   0.174752   0.044 0.965155
PERP_RACEBLACK HISPANIC    -0.317345   0.196338  -1.616 0.106025
PERP_RACEUNKNOWN           -0.536431   0.261226  -2.054 0.040023 *
PERP_RACEWHITE HISPANIC    -0.253171   0.183560  -1.379 0.167824
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 18141  on 28549  degrees of freedom
Residual deviance: 17939  on 28531  degrees of freedom
  (12 observations deleted due to missingness)
AIC: 17977

Number of Fisher Scoring iterations: 9
```

```
sessionInfo()
```

```
R version 4.4.1 (2024-06-14)
Platform: aarch64-apple-darwin20
Running under: macOS Sonoma 14.6.1

Matrix products: default
BLAS:   /Library/Frameworks/R.framework/Versions/4.4-arm64/Resources/lib/libRblas.0.dylib
LAPACK: /Library/Frameworks/R.framework/Versions/4.4-arm64/Resources/lib/libRlapack.dylib;

locale:
[1] C

time zone: America/Denver
tzcode source: internal

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods   base
```

```
other attached packages:
 [1] broom_1.0.6     lubridate_1.9.3 forcats_1.0.0   stringr_1.5.1
 [5] dplyr_1.1.4     purrr_1.0.2     readr_2.1.5     tidyr_1.3.1
 [9] tibble_3.2.1    ggplot2_3.5.1   tidyverse_2.0.0

loaded via a namespace (and not attached):
 [1] gtable_0.3.5      jsonlite_1.8.8    compiler_4.4.1    crayon_1.5.3
 [5] tidyselect_1.2.1  IRdisplay_1.1     scales_1.3.0      uuid_1.2-0
 [9] fastmap_1.2.0     IRkernel_1.3.2    R6_2.5.1          labeling_0.4.3
[13] generics_0.1.3    backports_1.5.0   munsell_0.5.1     pillar_1.9.0
[17] tzdb_0.4.0        rlang_1.1.4       utf8_1.2.4        stringi_1.8.4
[21] repr_1.1.7        timechange_0.3.0  cli_3.6.3         withr_3.0.1
[25] magrittr_2.0.3    digest_0.6.36     grid_4.4.1        base64enc_0.1-3
[29] hms_1.1.3         pbdZMQ_0.3-11     lifecycle_1.0.4   vctrs_0.6.5
[33] evaluate_0.24.0   glue_1.7.0        farver_2.1.2      fansi_1.0.6
[37] colorspace_2.1-1  tools_4.4.1       pkgconfig_2.0.3   htmltools_0.5.8.1
```