Iowa Alcohol Sales and Covid

Tyler Nguyen

6/8/2023

Introduction

The Iowa Department of Commerce requires that every store that sells alcohol in bottled form for off-the-premises consumption must hold a liquor license (an arrangement typical of most of the state alcohol regulatory bodies). All alcoholic sales made by stores registered with the Iowa Department of Commerce are logged in the Commerce department system, which is in turn published as open data by the State of Iowa.

The final data contains information on alcohol sales from 2016, 2018 and 2020. This six year timespan is enough to discern trends in alcohol sales.

Given my training in R, I will analyze the data provided today to help everyone better understand alcohol sales in Iowa before the US national emergency declared on March 13, 2020 and alcohol sales after the emergency declaration. There is much "folklore" surrounding alcohol consumption post-pandemic and Iowa is one of the few places in the US where we can study sales from different sources, on items sold, cost of the items and other related data.

There are many ways to provide an analysis of this data, but first I need to conduct rudimentary analysis of the data, process it, and clean it. Here is some rudimentary analysis:

Firstly, I have to load the data into environment and merge data sets together

```
load("final_data.RData")
load("Store.RData")
data <- merge(yr2016, yr2018, all = TRUE)
data2 <- merge(data, yr2020, all = TRUE)
finalIowa <- merge(data2, store, by.x = "Store Number")
```

Now I will start conducting a preliminary analysis:

```
nrow(finalIowa)
```

```
## [1] 11882
```

```
ncol(finalIowa)
```

```
## [1] 16
```

The data set has 11882 rows and 16 columns. The name of the columns I am interested in are:

- [1] "Invoice/Item Number" - A unique identifier for each sale
- 2 "Date" - Date YYYY-MM-DD of sale

- 3 “Store Number” - The identification (a number) of the store which made the sale
- [4] “Category” - The type of product sold (ignore this)
- [5] “Vendor Number” - The identification (a number) of the vendor which produces the product
- [6] “Item Number” - The identification (a number) of the product sold
- [7] “State Bottle Retail” - The official price of the product
- [8] “Bottles Sold” - The number of units sold
- [9] “Sale (Dollars)” - The total sale price
- [10] “Volume Sold (Liters)” - The volume in liters
- [11] “Volume Sold (Gallons)” - The volume in gallons

Now, I look at the type of variables I am working with.

```
sapply(finalIowa, class) |> table()
```

```
##
## character      Date
##        15         1
```

I know by the names of the variables that I need to convert some of these character type variables to numeric type such that we can quantitatively analyze the data. I look at the first few rows of data to know which ones to convert

```
head(finalIowa)
```

```
##   Store Number Invoice/Item Number       Date Category Vendor Number
## 1         2106     INV-11726900055 2018-04-26  1081600           421
## 2         2106     INV-12519400024 2018-06-07  1031200           434
## 3         2106        S33152600063 2016-06-30  1081200           260
## 4         2106        S32413900065 2016-05-19  1081200           260
## 5         2106     INV-01363700059 2016-11-03  1081300           065
## 6         2106     INV-02026600060 2016-12-08  1081300           434
##   Item Number State Bottle Retail Bottles Sold Sale (Dollars)
## 1       64866              $13.50           24        $324.00
## 2       35179              $10.50           12        $126.00
## 3       68037              $24.75           12        $297.00
## 4       74090              $25.50           12        $306.00
## 5       85526               $7.88           24        $189.12
## 6       79336               $7.50           12         $85.56
##   Volume Sold (Liters) Volume Sold (Gallons)                  Store Name
## 1                   18                 4.76 Hillstreet News and Tobacco
## 2                    9                 2.38 Hillstreet News and Tobacco
## 3                   12                 3.17 Hillstreet News and Tobacco
## 4                    9                 2.38 Hillstreet News and Tobacco
## 5                   18                 4.76 Hillstreet News and Tobacco
## 6                    9                 2.38 Hillstreet News and Tobacco
##        Address        City Zip Code     County
## 1 2217 College Cedar Falls    50613 BLACK HAWK
## 2 2217 College Cedar Falls    50613 BLACK HAWK
## 3 2217 College Cedar Falls    50613 BLACK HAWK
## 4 2217 College Cedar Falls    50613 BLACK HAWK
## 5 2217 College Cedar Falls    50613 BLACK HAWK
## 6 2217 College Cedar Falls    50613 BLACK HAWK
```

From this, I know to convert the columns: “State Bottle Retail”, “Bottles Sold”, “Sale (Dollars)”, “Volume Sold(Liters)”, and “Volume Sold (Gallons)”.

```
finalIowa$`State Bottle Retail` <- gsub("\\$|,", "", finalIowa$`State Bottle Retail`)
finalIowa$`Sale (Dollars)` <- gsub("\\$|,", "", finalIowa$`Sale (Dollars)`)
finalIowa[7:11] <- sapply(finalIowa[7:11], as.numeric)
```

Now we can see what we are working with:

```
numeric <- unlist(lapply(finalIowa, is.numeric), use.names = FALSE)
char <- unlist(lapply(finalIowa, is.character), use.names = FALSE)
summary(finalIowa[numeric])
```

```
##  State Bottle Retail  Bottles Sold     Sale (Dollars)     Volume Sold (Liters)
##  Min.   :  1.34      Min.   :   1.00   Min.   :    0.00   Min.   :   0.050
##  1st Qu.:  8.51      1st Qu.:   2.00   1st Qu.:   32.26   1st Qu.:   1.500
##  Median : 12.39      Median :   6.00   Median :   73.53   Median :   4.800
##  Mean   : 15.69      Mean   :  10.81   Mean   :  144.09   Mean   :   9.393
##  3rd Qu.: 19.49      3rd Qu.:  12.00   3rd Qu.:  148.56   3rd Qu.:  10.500
##  Max.   :375.00      Max.   :1728.00   Max.   :39191.04   Max.   :3024.000
##  Volume Sold (Gallons)
##  Min.   :  0.010
##  1st Qu.:  0.400
##  Median :  1.270
##  Mean   :  2.479
##  3rd Qu.:  2.770
##  Max.   :798.860
```

```
sapply(names(finalIowa)[char], function(x) table(finalIowa[x], useNA = "always", dnn = x) |> sort() |> t
```

```
##      Store Number Invoice/Item Number Category Vendor Number Item Number
## 2512           69                   1      496           593          65
## 2670           69                   1      578           699          69
## 4829           78                   1      617           916          78
## 2572           87                   1      730           940         101
## 2603           88                   1     1159           987         106
## 2633          101                   1     1386          2063         116
##      Store Name Address City Zip Code County
## 2512         69      69  349      206    393
## 2670         69      69  352      225    594
## 4829         78      78  355      230    663
## 2572         87      87  542      267    762
## 2603         88      88  786      317   1017
## 2633        101     136  930      317   2132
```

Time to assess missing values:

```
head(sapply(names(finalIowa), function(ix) round(prop.table(table(is.na(finalIowa[ix]), dnn = ix)), dig
```

```
## $`Store Number`
## Store Number
```

```
## FALSE
##     1
##
## $`Invoice/Item Number`
## Invoice/Item Number
## FALSE
##     1
##
## $Date
## Date
## FALSE
##     1
##
## $Category
## Category
##   FALSE    TRUE
## 0.99815 0.00185
##
## $`Vendor Number`
## Vendor Number
## FALSE
##     1
##
## $`Item Number`
## Item Number
## FALSE
##     1
```

We see that there are barely any missing values so we are good to start analyzing the data.

A

To start, we will construct a table of "Total Sales in Dollars" by year

```
finalIowa$Year <- format(finalIowa$Date, format = "%Y")
finalIowa$Month <- format(finalIowa$Date, format = "%m")
tapply(finalIowa$`Sale (Dollars)`, finalIowa$Year, FUN = sum)
```

```
##     2016     2018     2020
## 565769.8 669415.4 476914.5
```

I created a new variable "Year" to easily analyze the three years we want.

B

Now I will identify from 2016, 2018 and 2020 possible trends in our data for retail price of alcohol.

```
tapply(finalIowa$`State Bottle Retail`, finalIowa$Year, FUN = median)
```

```
##  2016  2018  2020
## 12.38 12.38 13.11
```

```
tapply(finalIowa$`State Bottle Retail`, finalIowa$Year, FUN = mean)
```

```
##     2016     2018     2020
## 15.04960 15.61447 16.56893
```

From the data, it appears that over the years, the price of alcohol has increased. We can see this from the code above when I calculated the mean and median prices by year. The reason for this is probably due to inflation, but also COVID. This is because we see a larger jump from 2018 to 2020 than from 2016 to 2018, meaning that COVID affected the economy. This may because it was harder to export alcohol as a result of COVID 19 restrictions on trade.

D

Here, I identify the most influential retailers (e.g., Wal-Mart, Target). I believe that the most influential vendors means the most volume sold. As I result, I will analyze the most amount of alcohol sold in liters by retailer.

```
head(sort(tapply(finalIowa$`Volume Sold (Gallons)`, finalIowa$`Store Name`, FUN = sum), decreasing = TRU
     n= 10)
```

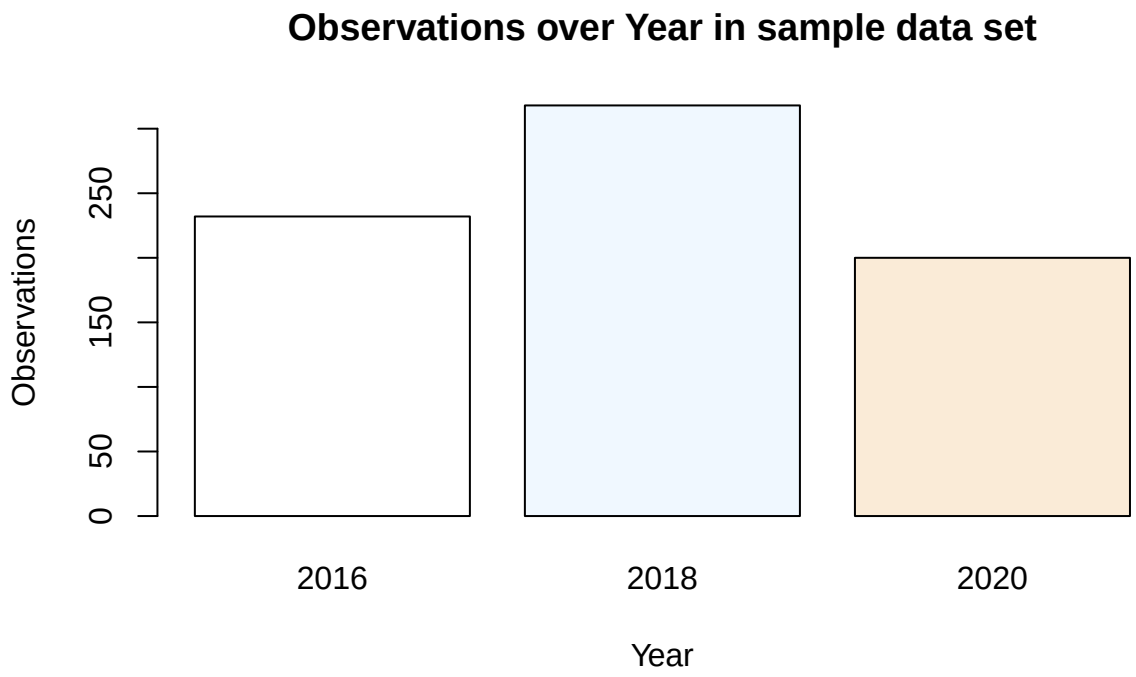
```
##        Hy-Vee #3 / BDI / Des Moines         Costco Wholesale #788 / WDM
##                              957.83                              900.70
##     Hy-Vee Food Store / Cedar Falls                        Wilkie Liquors
##                              626.42                              521.96
## Hy-Vee Wine and Spirits / Iowa City                        Central City 2
##                              513.30                              488.12
##      Sam's Club 8162 / Cedar Rapids         Sam's Club 8238 / Davenport
##                              478.63                              385.35
##        I-80 Liquor / Council Bluffs                     Hy-Vee / Waukee
##                              309.64                              296.95
```

Hy-Vee appears to be the retailer who is most influential as they have the most alcohol sold by volume.

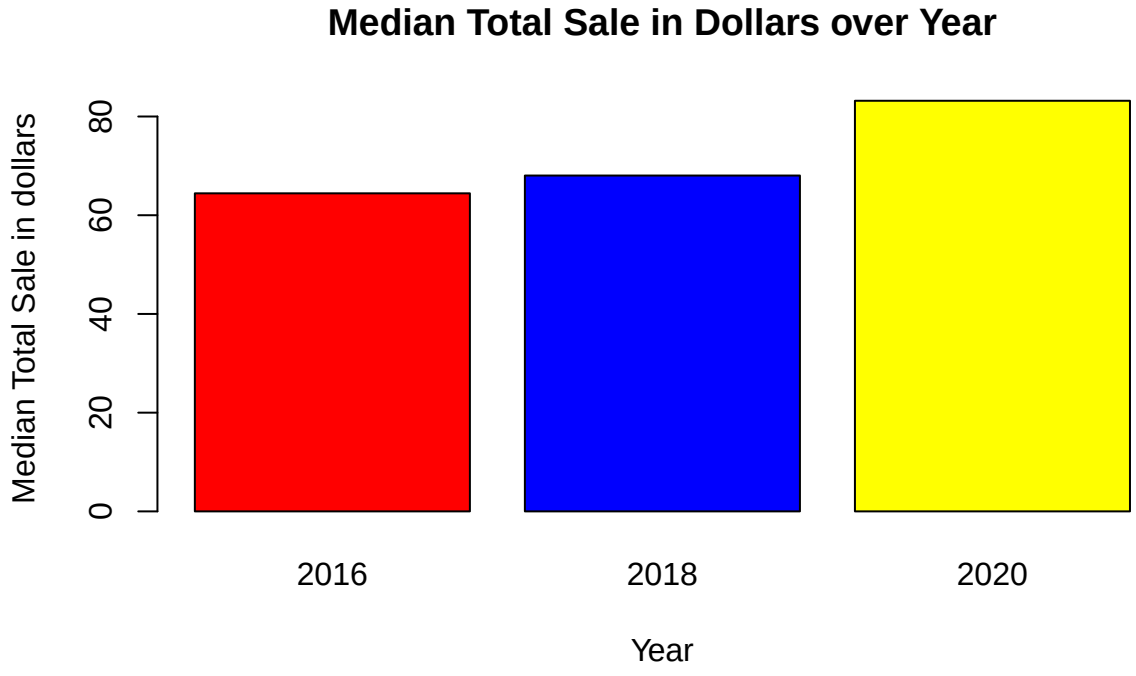
2

In this portion of my paper, I will construct a data visualization via a sample in our data to easily illustrate my findings. The reason I take a sample is to show that this data is randomized.

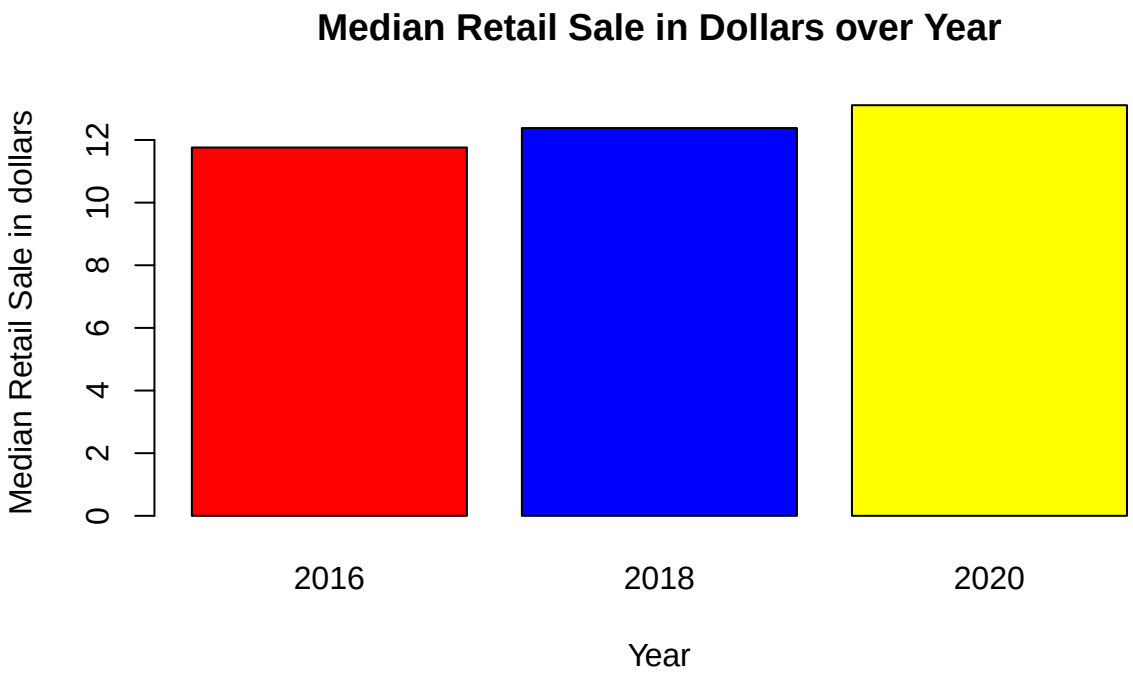
```
set.seed(105764460)

index <- sample(nrow(finalIowa), 750)

sampleData <- finalIowa[index,]

sampleVolumebyYear <- tapply(sampleData$`Volume Sold (Liters)`, sampleData$Year, median)
sampleBottlesbyYear <- tapply(sampleData$`Bottles Sold`, sampleData$Year, median)
samplePricebyYear <- tapply(sampleData$`Sale (Dollars)`, sampleData$Year, median)
sampleRetailbyYear <- tapply(sampleData$`State Bottle Retail`, sampleData$Year, median)

barplot(table(sampleData$Year), col = colors(), xlab = "Year", ylab = "Observations", main = "Observati
```




```
barplot(samplePricebyYear, xlab = "Year", ylab = "Median Total Sale in dollars", col = c("red", "blue",
```



```
barplot(sampleRetailbyYear, xlab = "Year", ylab = "Median Retail Sale in dollars", col = c("red", "blue
```



The barplot illustrates that there is a drastic increase in median total sale in dollars per year from 2018 to 2020 but a more reserved increase from 2016 to 2018. A reason for this could be that during the declaration of a national emergency, buyers flocked to the markets to stock up on their alcohol. However, although median retail price increased, the increase from 2016-2018 was about the same as the increase from 2018-2020, demonstrating that there may not be a relationship between COVID and the increase in alcohol prices.

3

I would outline the effect of COVID-19 on alcohol sales by computing the median price of sales by Year. The reason I would do this is to see the effect which COVID-19 had on the alcohol prices. And as we could see from question 2 and its bar plots, it is safe to say that COVID 19 did affect the price of alcohol as we can see a sharp increase in the median total sales and the median retail price of alcohol. For instance, the median total price increased from 68.04 dollars to 83.19 dollars, a drastic increase when compared to the increase of 64.44 dollars to 68.04 dollars from 2016-2018.

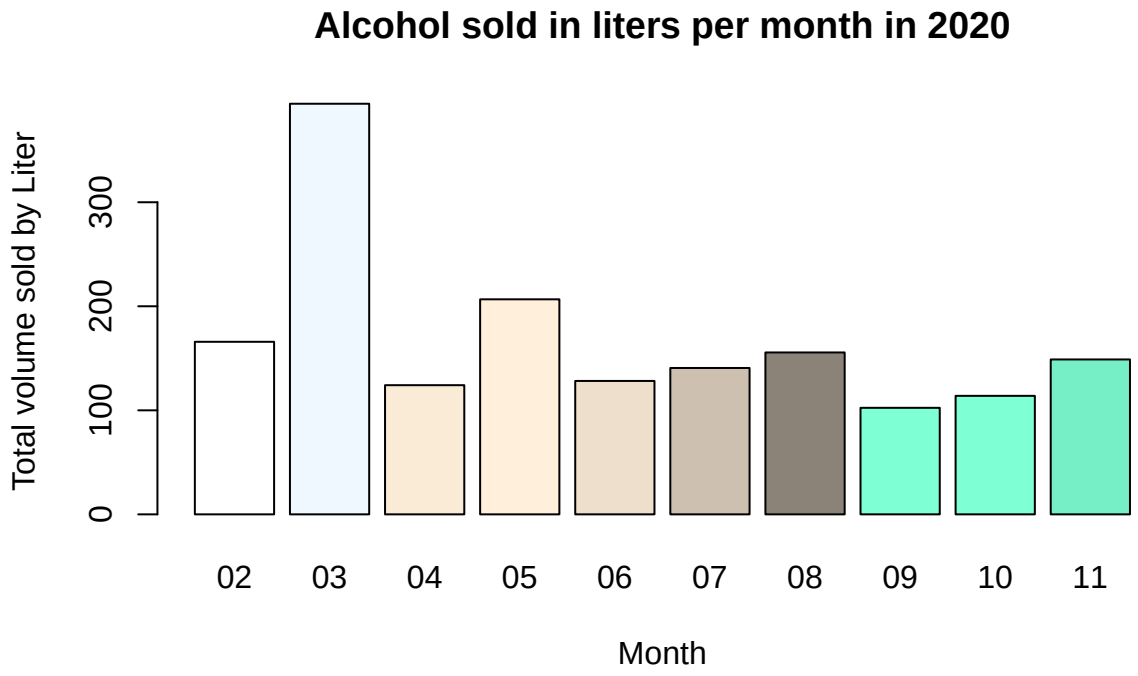
```
samplePricebyYear <- tapply(sampleData$`Sale (Dollars)`, sampleData$Year, median)
samplePricebyYear
```

```
##  2016  2018  2020
## 64.44 68.04 83.19
```

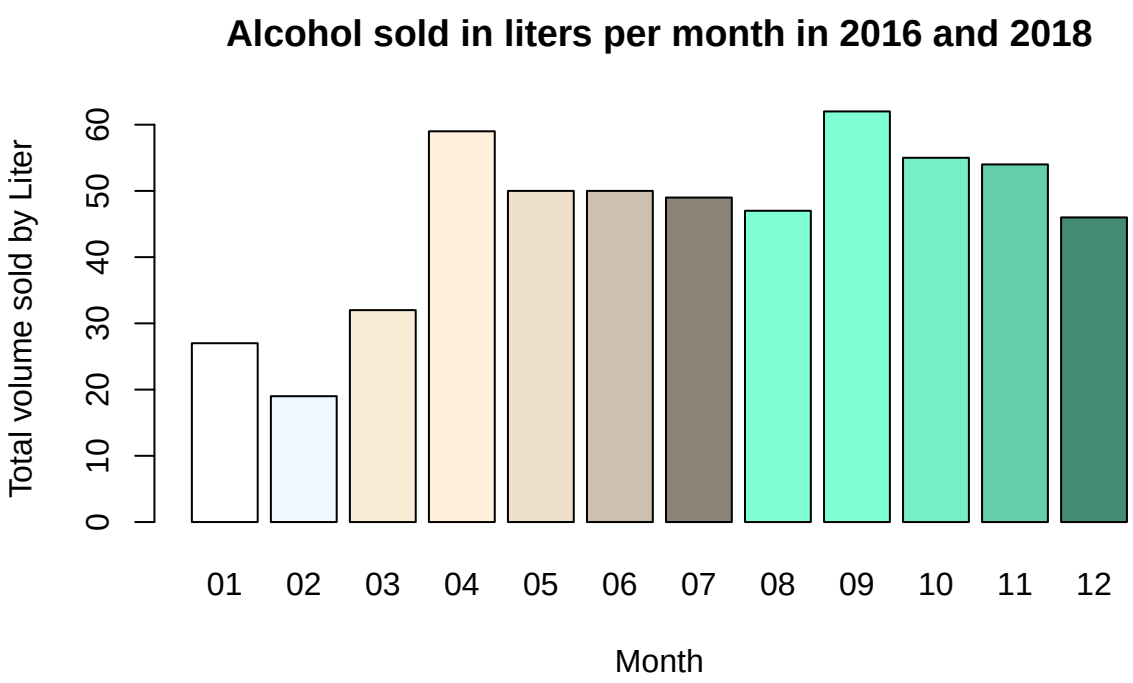
I used median to nullify the effect of outliers, and the reason COVID 19 affected the price is because it may have been harder to export alcohol from other countries as a result of COVID 19 restrictions.

In addition, I will attempt to find the effect that COVID 19 had on the amount of alcohol sold. To illustrate the point that the amount of volume sold is effected by COVID 19, I will construct two barplots by month. The reason why I do this is to find the effect which the national emergency, implemented in March, had on the amount of alcohol sold. One barplot is of 2020 and the other is of 2016&2018 combined.

```
sampledata2020 <- sampleData[which(sampleData$Year ==2020),]
volumebyMonth2020 <- tapply(sampledata2020$`Volume Sold (Liters)`, sampledata2020$Month, sum)
barplot(volumebyMonth2020, col = colors(), xlab = "Month", ylab = "Total volume sold by Liter", main =
```




```
sampledata20162018 <- sampleData[which(sampleData$Year ==2016 | sampleData$Year ==2018),]
volumebyMonth20162018 <- tapply(sampledata20162018$`Volume Sold (Liters)`, sampledata20162018$Month, su
barplot(table(sampledata20162018$Month), col = colors(), xlab = "Month", ylab = "Total volume sold by L
```



As we can see from the data, the national emergency did in fact have an effect on the amount of alcohol sold. This is because in March 2020, the month of the declared national emergency, we see a huge spike in the amount of alcohol sold. To be sure that this is not just a coincidence, I plotted amount of alcohol sold by month in the years 2016 and 2018 combined, and we can see that in March, there is no spike in the amount of alcohol sold, showing that COVID 19 did have an affect the amount of alcohol sold. Additionally, the scale of the 2020 graph is much greater as it peaks at 330 in March, while the 2016 and 2018 combined graph peaks at just 60 liters of alcohol sold in September.