# Analysis

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```
#install.packages("units")
install.packages("ggplot2")
```

```
## Installing package into '/home/rstudio-user/R/x86_64-pc-linux-gnu-library/3.6'
## (as 'lib' is unspecified)
```

```
#library("units")
library("ggplot2")
```

# Data Cleansing

```
dataSet <- read.csv(file = "framingham.csv")
head(dataSet)
```

```
##   male age education currentSmoker cigsPerDay BPMeds prevalentStroke
## 1    1  39         4             0          0      0               0
## 2    0  46         2             0          0      0               0
## 3    1  48         1             1         20      0               0
## 4    0  61         3             1         30      0               0
## 5    0  46         3             1         23      0               0
## 6    0  43         2             0          0      0               0
##   prevalentHyp diabetes totChol sysBP diaBP   BMI heartRate glucose TenYearCHD
## 1            0        0     195 106.0    70 26.97        80      77          0
## 2            0        0     250 121.0    81 28.73        95      76          0
## 3            0        0     245 127.5    80 25.34        75      70          0
## 4            1        0     225 150.0    95 28.58        65     103          1
## 5            0        0     285 130.0    84 23.10        85      85          0
## 6            1        0     228 180.0   110 30.30        77      99          0
```

```
summary(dataSet)
```

```
##       male             age          education     currentSmoker
##  Min.   :0.0000   Min.   :32.00   Min.   :1.000   Min.   :0.0000
##  1st Qu.:0.0000   1st Qu.:42.00   1st Qu.:1.000   1st Qu.:0.0000
##  Median :0.0000   Median :49.00   Median :2.000   Median :0.0000
##  Mean   :0.4292   Mean   :49.58   Mean   :1.979   Mean   :0.4941
##  3rd Qu.:1.0000   3rd Qu.:56.00   3rd Qu.:3.000   3rd Qu.:1.0000
##  Max.   :1.0000   Max.   :70.00   Max.   :4.000   Max.   :1.0000
##                                   NA's   :105
##    cigsPerDay         BPMeds        prevalentStroke     prevalentHyp
##  Min.   : 0.000   Min.   :0.00000   Min.   :0.000000   Min.   :0.0000
##  1st Qu.: 0.000   1st Qu.:0.00000   1st Qu.:0.000000   1st Qu.:0.0000
##  Median : 0.000   Median :0.00000   Median :0.000000   Median :0.0000
##  Mean   : 9.006   Mean   :0.02962   Mean   :0.005896   Mean   :0.3106
##  3rd Qu.:20.000   3rd Qu.:0.00000   3rd Qu.:0.000000   3rd Qu.:1.0000
##  Max.   :70.000   Max.   :1.00000   Max.   :1.000000   Max.   :1.0000
##  NA's   :29       NA's   :53
##     diabetes          totChol          sysBP           diaBP
##  Min.   :0.00000   Min.   :107.0   Min.   : 83.5   Min.   : 48.0
##  1st Qu.:0.00000   1st Qu.:206.0   1st Qu.:117.0   1st Qu.: 75.0
##  Median :0.00000   Median :234.0   Median :128.0   Median : 82.0
##  Mean   :0.02571   Mean   :236.7   Mean   :132.4   Mean   : 82.9
##  3rd Qu.:0.00000   3rd Qu.:263.0   3rd Qu.:144.0   3rd Qu.: 90.0
##  Max.   :1.00000   Max.   :696.0   Max.   :295.0   Max.   :142.5
##                    NA's   :50
##       BMI          heartRate         glucose         TenYearCHD
##  Min.   :15.54   Min.   : 44.00   Min.   : 40.00   Min.   :0.0000
##  1st Qu.:23.07   1st Qu.: 68.00   1st Qu.: 71.00   1st Qu.:0.0000
##  Median :25.40   Median : 75.00   Median : 78.00   Median :0.0000
##  Mean   :25.80   Mean   : 75.88   Mean   : 81.96   Mean   :0.1519
##  3rd Qu.:28.04   3rd Qu.: 83.00   3rd Qu.: 87.00   3rd Qu.:0.0000
##  Max.   :56.80   Max.   :143.00   Max.   :394.00   Max.   :1.0000
##  NA's   :19      NA's   :1        NA's   :388
```

```
data <- dataSet[complete.cases(dataSet), ]
head(data)
```

```
##   male age education currentSmoker cigsPerDay BPMeds prevalentStroke
## 1    1  39         4             0          0      0               0
## 2    0  46         2             0          0      0               0
## 3    1  48         1             1         20      0               0
## 4    0  61         3             1         30      0               0
## 5    0  46         3             1         23      0               0
## 6    0  43         2             0          0      0               0
##   prevalentHyp diabetes totChol sysBP diaBP   BMI heartRate glucose TenYearCHD
## 1            0        0     195 106.0    70 26.97        80      77          0
## 2            0        0     250 121.0    81 28.73        95      76          0
## 3            0        0     245 127.5    80 25.34        75      70          0
## 4            1        0     225 150.0    95 28.58        65     103          1
## 5            0        0     285 130.0    84 23.10        85      85          0
## 6            1        0     228 180.0   110 30.30        77      99          0
```

```
summary(data)
```

```
##       male             age          education    currentSmoker
##  Min.   :0.0000   Min.   :32.00   Min.   :1.00   Min.   :0.0000
##  1st Qu.:0.0000   1st Qu.:42.00   1st Qu.:1.00   1st Qu.:0.0000
##  Median :0.0000   Median :49.00   Median :2.00   Median :0.0000
##  Mean   :0.4437   Mean   :49.55   Mean   :1.98   Mean   :0.4891
##  3rd Qu.:1.0000   3rd Qu.:56.00   3rd Qu.:3.00   3rd Qu.:1.0000
##  Max.   :1.0000   Max.   :70.00   Max.   :4.00   Max.   :1.0000
##    cigsPerDay         BPMeds        prevalentStroke     prevalentHyp
##  Min.   : 0.000   Min.   :0.00000   Min.   :0.000000   Min.   :0.0000
##  1st Qu.: 0.000   1st Qu.:0.00000   1st Qu.:0.000000   1st Qu.:0.0000
##  Median : 0.000   Median :0.00000   Median :0.000000   Median :0.0000
##  Mean   : 9.025   Mean   :0.03034   Mean   :0.005741   Mean   :0.3116
##  3rd Qu.:20.000   3rd Qu.:0.00000   3rd Qu.:0.000000   3rd Qu.:1.0000
##  Max.   :70.000   Max.   :1.00000   Max.   :1.000000   Max.   :1.0000
##     diabetes          totChol          sysBP           diaBP
##  Min.   :0.00000   Min.   :113.0   Min.   : 83.5   Min.   : 48.00
##  1st Qu.:0.00000   1st Qu.:206.0   1st Qu.:117.0   1st Qu.: 75.00
##  Median :0.00000   Median :234.0   Median :128.0   Median : 82.00
##  Mean   :0.02706   Mean   :236.8   Mean   :132.4   Mean   : 82.92
##  3rd Qu.:0.00000   3rd Qu.:263.0   3rd Qu.:143.9   3rd Qu.: 90.00
##  Max.   :1.00000   Max.   :600.0   Max.   :295.0   Max.   :142.50
##       BMI          heartRate         glucose         TenYearCHD
##  Min.   :15.54   Min.   : 44.00   Min.   : 40.00   Min.   :0.0000
##  1st Qu.:23.08   1st Qu.: 68.00   1st Qu.: 71.00   1st Qu.:0.0000
##  Median :25.38   Median : 75.00   Median : 78.00   Median :0.0000
##  Mean   :25.78   Mean   : 75.73   Mean   : 81.85   Mean   :0.1523
##  3rd Qu.:28.04   3rd Qu.: 82.00   3rd Qu.: 87.00   3rd Qu.:0.0000
##  Max.   :56.80   Max.   :143.00   Max.   :394.00   Max.   :1.0000
```

```
names(data) <- c("Gender", "Age", "Education", "SmokingBehavior", "CigarettesPerDay", "BloodPressureMedication", "PrevalentStroke", "PrevalentHypertension", "DiabeticCondition", "TotalCholestrol", "SystolicBloodPressure", "DiastolicBloodPressure", "BodyMassIndex", "HeartRate", "GlucoseLevel", "TenYearCoronaryHeartDisease")
```

```
head(data)
```

```
##   Gender Age Education SmokingBehavior CigarettesPerDay BloodPressureMedication
## 1      1  39         4               0               0                        0
## 2      0  46         2               0               0                        0
## 3      1  48         1               1              20                        0
## 4      0  61         3               1              30                        0
## 5      0  46         3               1              23                        0
## 6      0  43         2               0               0                        0
##   PrevalentStroke PrevalentHypertension DiabeticCondition TotalCholestrol
## 1               0                     0                 0             195
## 2               0                     0                 0             250
## 3               0                     0                 0             245
## 4               0                     1                 0             225
## 5               0                     0                 0             285
## 6               0                     1                 0             228
##   SystolicBloodPressure DiastolicBloodPressure BodyMassIndex HeartRate
## 1                 106.0                    70         26.97        80
## 2                 121.0                    81         28.73        95
## 3                 127.5                    80         25.34        75
## 4                 150.0                    95         28.58        65
## 5                 130.0                    84         23.10        85
## 6                 180.0                   110         30.30        77
##   GlucoseLevel TenYearCoronaryHeartDisease
## 1           77                          0
## 2           76                          0
## 3           70                          0
## 4          103                          1
## 5           85                          0
## 6           99                          0
```

```
data$Gender[data$Gender == 0] <- "Female"
data$Gender[data$Gender == 1] <- "Male"
data$Education[data$Education == 1] <- "High School"
data$Education[data$Education == 2] <- "General Education Development"
data$Education[data$Education == 3] <- "Vocational School"
data$Education[data$Education == 4] <- "College"
data$SmokingBehavior[data$SmokingBehavior == 0] <- "Non Smoker"
data$SmokingBehavior[data$SmokingBehavior == 1] <- "Smoker"
data$BloodPressureMedication[data$BloodPressureMedication == 0] <- "Not Under BP Medication"
data$BloodPressureMedication[data$BloodPressureMedication == 1] <- "Under BP Medication"
data$PrevalentStroke[data$PrevalentStroke == 0] <- "No"
data$PrevalentStroke[data$PrevalentStroke == 1] <- "Yes"
data$PrevalentHypertension[data$PrevalentHypertension == 0] <- "No"
data$PrevalentHypertension[data$PrevalentHypertension == 1] <- "Yes"
data$DiabeticCondition[data$DiabeticCondition == 0] <- "Non Diabetic"
data$DiabeticCondition[data$DiabeticCondition == 1] <- "Diabetic"
data$TenYearCoronaryHeartDisease[data$TenYearCoronaryHeartDisease == 0] <- "Immune"
data$TenYearCoronaryHeartDisease[data$TenYearCoronaryHeartDisease == 1] <- "Vulnerable"
```

```
data$Gender <- as.factor(data$Gender)
data$Education <- as.factor(data$Education)
data$SmokingBehavior <- as.factor(data$SmokingBehavior)
data$BloodPressureMedication <- as.factor(data$BloodPressureMedication)
data$PrevalentStroke <- as.factor(data$PrevalentStroke)
data$PrevalentHypertension <- as.factor(data$PrevalentHypertension)
data$DiabeticCondition <- as.factor(data$DiabeticCondition)
data$TenYearCoronaryHeartDisease <- as.factor(data$TenYearCoronaryHeartDisease)
```

```
head(data)
```

```
##   Gender Age                     Education SmokingBehavior CigarettesPerDay
## 1   Male  39                       College      Non Smoker                0
## 2 Female  46 General Education Development      Non Smoker                0
## 3   Male  48                   High School          Smoker               20
## 4 Female  61             Vocational School          Smoker               30
## 5 Female  46             Vocational School          Smoker               23
## 6 Female  43 General Education Development      Non Smoker                0
##   BloodPressureMedication PrevalentStroke PrevalentHypertension
## 1 Not Under BP Medication              No                   No
## 2 Not Under BP Medication              No                   No
## 3 Not Under BP Medication              No                   No
## 4 Not Under BP Medication              No                  Yes
## 5 Not Under BP Medication              No                   No
## 6 Not Under BP Medication              No                  Yes
##   DiabeticCondition TotalCholestrol SystolicBloodPressure
## 1      Non Diabetic             195                 106.0
## 2      Non Diabetic             250                 121.0
## 3      Non Diabetic             245                 127.5
## 4      Non Diabetic             225                 150.0
## 5      Non Diabetic             285                 130.0
## 6      Non Diabetic             228                 180.0
##   DiastolicBloodPressure BodyMassIndex HeartRate GlucoseLevel
## 1                     70         26.97        80           77
## 2                     81         28.73        95           76
## 3                     80         25.34        75           70
## 4                     95         28.58        65          103
## 5                     84         23.10        85           85
## 6                    110         30.30        77           99
##   TenYearCoronaryHeartDisease
## 1                      Immune
## 2                      Immune
## 3                      Immune
## 4                  Vulnerable
## 5                      Immune
## 6                      Immune
```

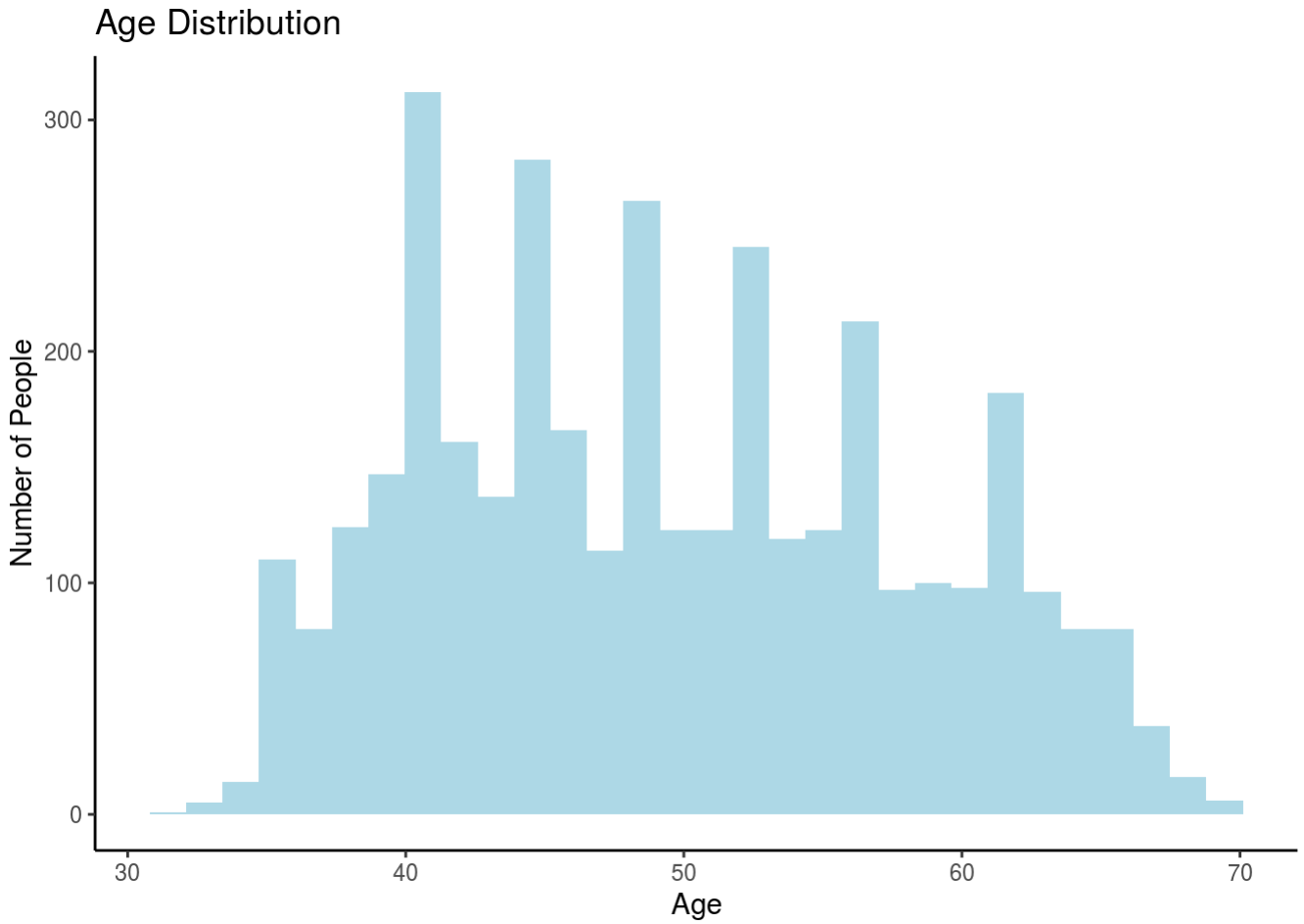
```
#units(data$Age) <- "years"
#units(data$TotalCholestrol) <- "mg/dL"
#units(data$SystolicBloodPressure) <- "mmHg"
#units(data$DiastolicBloodPressure) <- "mmHg"
#units(data$BodyMassIndex) <- "kg/m^2"
#units(data$GlucoseLevel) <- "mg/dL"
#head(data)
```

```
summary(data)
```

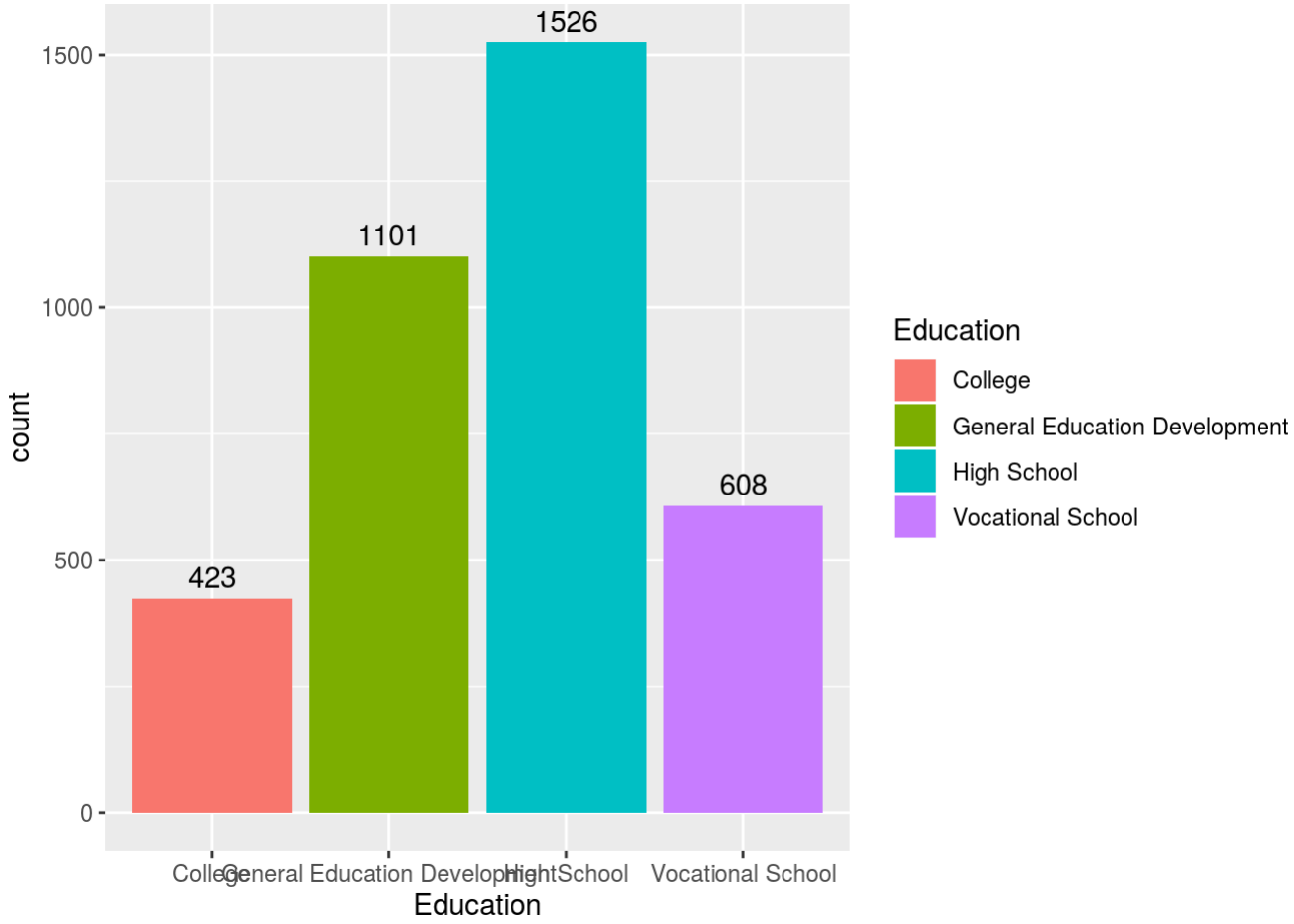
```
##     Gender          Age                                Education
##  Female:2035   Min.   :32.00   College                       : 423
##  Male  :1623   1st Qu.:42.00   General Education Development:1101
##                Median :49.00   High School                   :1526
##                Mean   :49.55   Vocational School             : 608
##                3rd Qu.:56.00
##                Max.   :70.00
##    SmokingBehavior CigarettesPerDay            BloodPressureMedication
##  Non Smoker:1869   Min.   : 0.000   Not Under BP Medication:3547
##  Smoker    :1789   1st Qu.: 0.000   Under BP Medication    : 111
##                    Median : 0.000
##                    Mean   : 9.025
##                    3rd Qu.:20.000
##                    Max.   :70.000
##  PrevalentStroke PrevalentHypertension    DiabeticCondition TotalCholestrol
##  No :3637        No :2518              Diabetic    :  99    Min.   :113.0
##  Yes:  21        Yes:1140              Non Diabetic:3559    1st Qu.:206.0
##                                                             Median :234.0
##                                                             Mean   :236.8
##                                                             3rd Qu.:263.0
##                                                             Max.   :600.0
##  SystolicBloodPressure DiastolicBloodPressure BodyMassIndex     HeartRate
##  Min.   : 83.5         Min.   : 48.00         Min.   :15.54   Min.   : 44.00
##  1st Qu.:117.0         1st Qu.: 75.00         1st Qu.:23.08   1st Qu.: 68.00
##  Median :128.0         Median : 82.00         Median :25.38   Median : 75.00
##  Mean   :132.4         Mean   : 82.92         Mean   :25.78   Mean   : 75.73
##  3rd Qu.:143.9         3rd Qu.: 90.00         3rd Qu.:28.04   3rd Qu.: 82.00
##  Max.   :295.0         Max.   :142.50         Max.   :56.80   Max.   :143.00
##   GlucoseLevel    TenYearCoronaryHeartDisease
##  Min.   : 40.00   Immune    :3101
##  1st Qu.: 71.00   Vulnerable: 557
##  Median : 78.00
##  Mean   : 81.85
##  3rd Qu.: 87.00
##  Max.   :394.00
```

# Exploratory Analysis

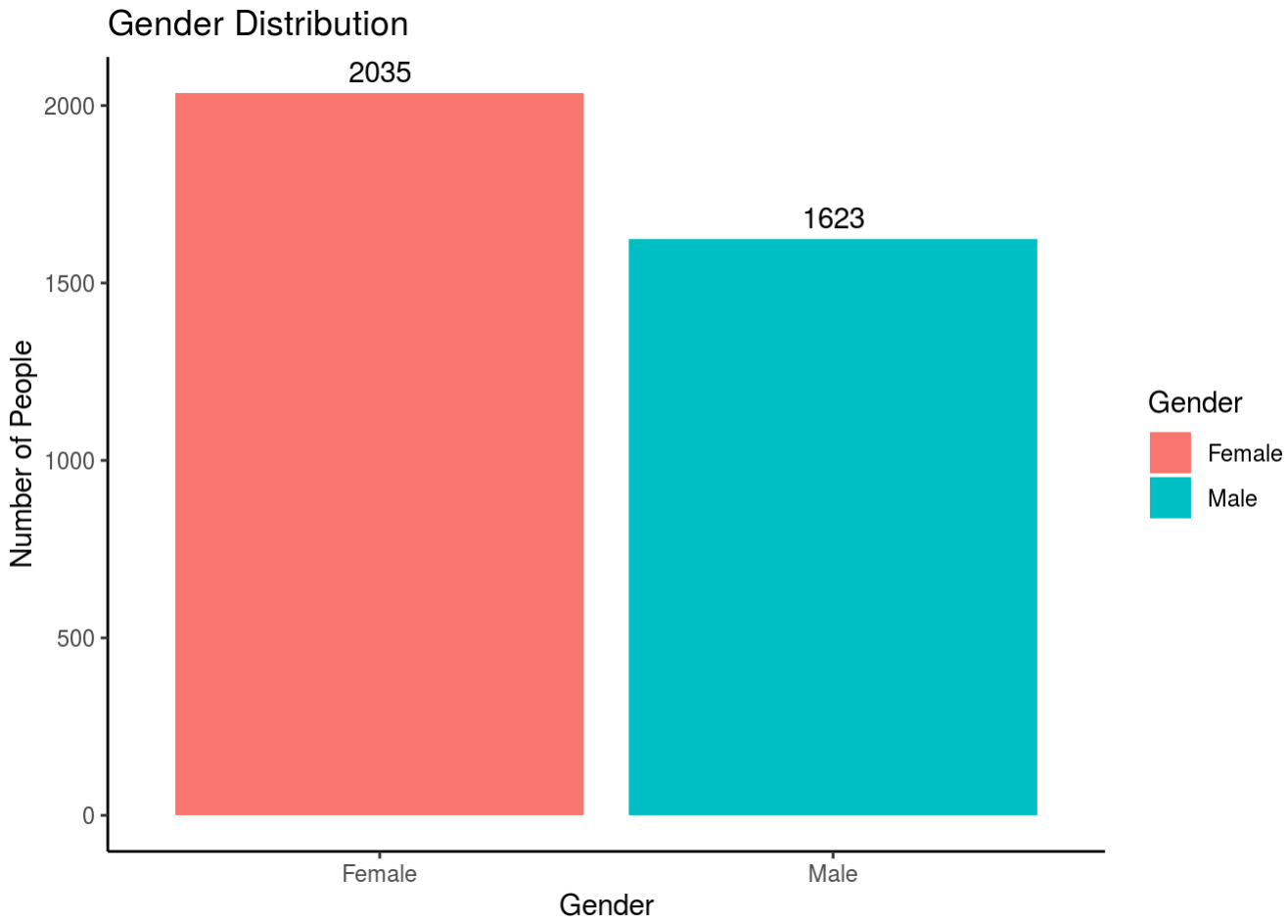
```
ggplot(data, aes(x = Age)) +
  geom_histogram(bins = 30, fill = "lightblue") +
  theme_bw() + theme_classic() +
  ggtitle("Age Distribution") + ylab("Number of People")
```



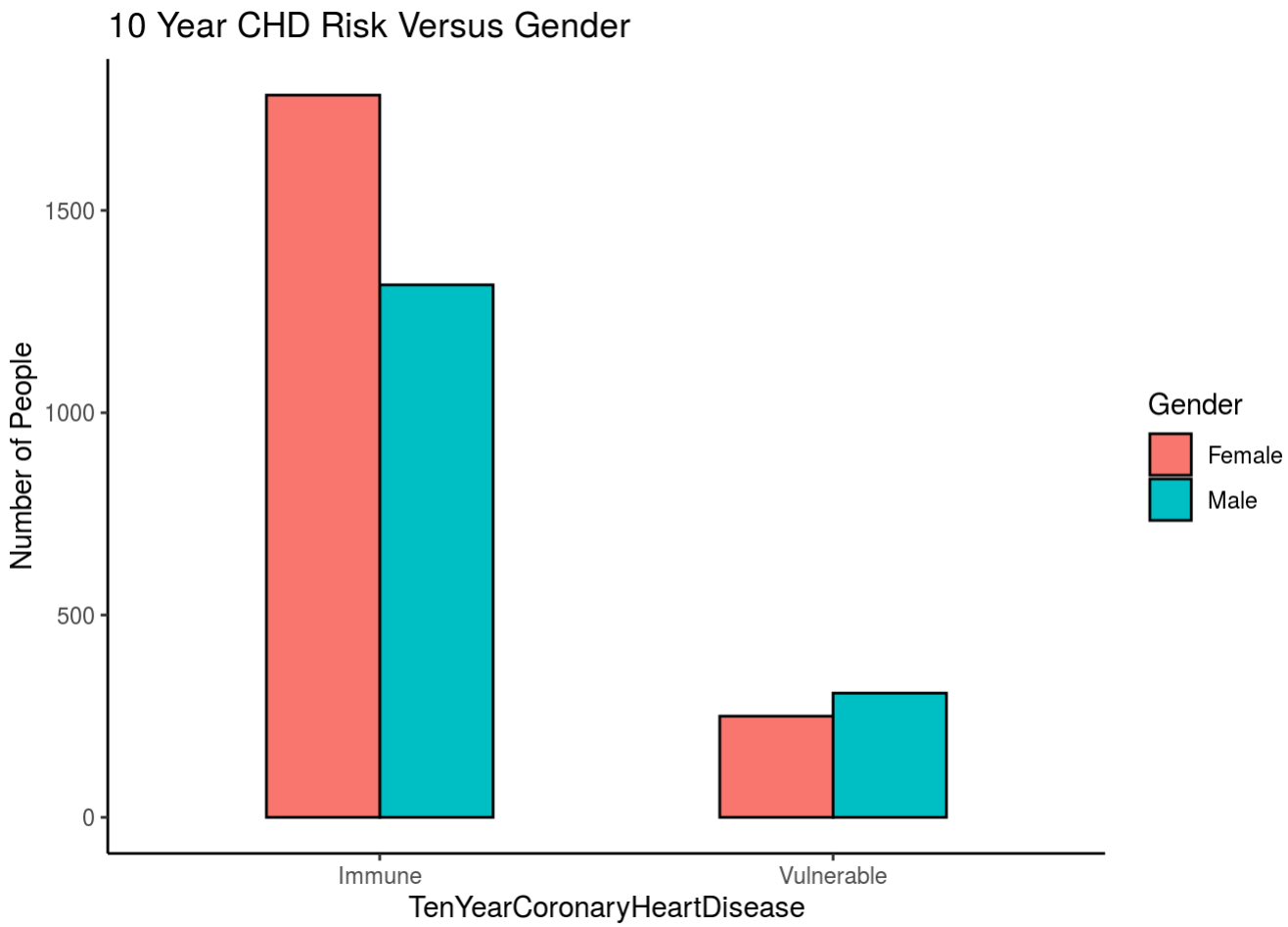

```
ggplot(data, aes(x = Education, fill = Education)) +
  geom_bar() +
  geom_text(stat = 'count', aes(label =..count..), vjust = -0.5)
```



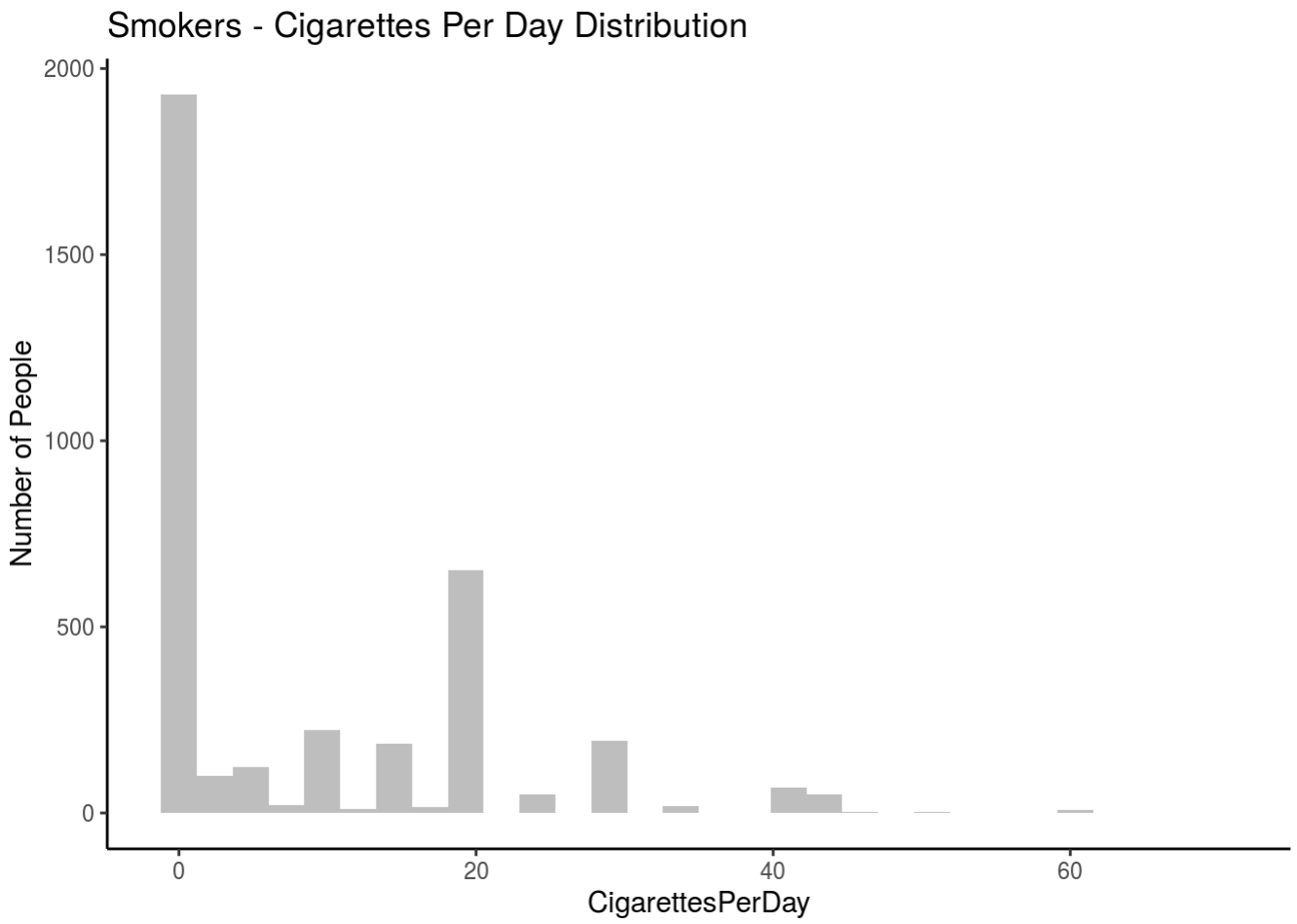

```
ggplot(data, aes(x = Gender, fill = Gender)) +
  geom_bar() +
  geom_text(stat = 'count', aes(label =..count..), vjust = -0.5) +
  theme_bw() + theme_classic() +
  ggtitle("Gender Distribution") + ylab("Number of People")
```



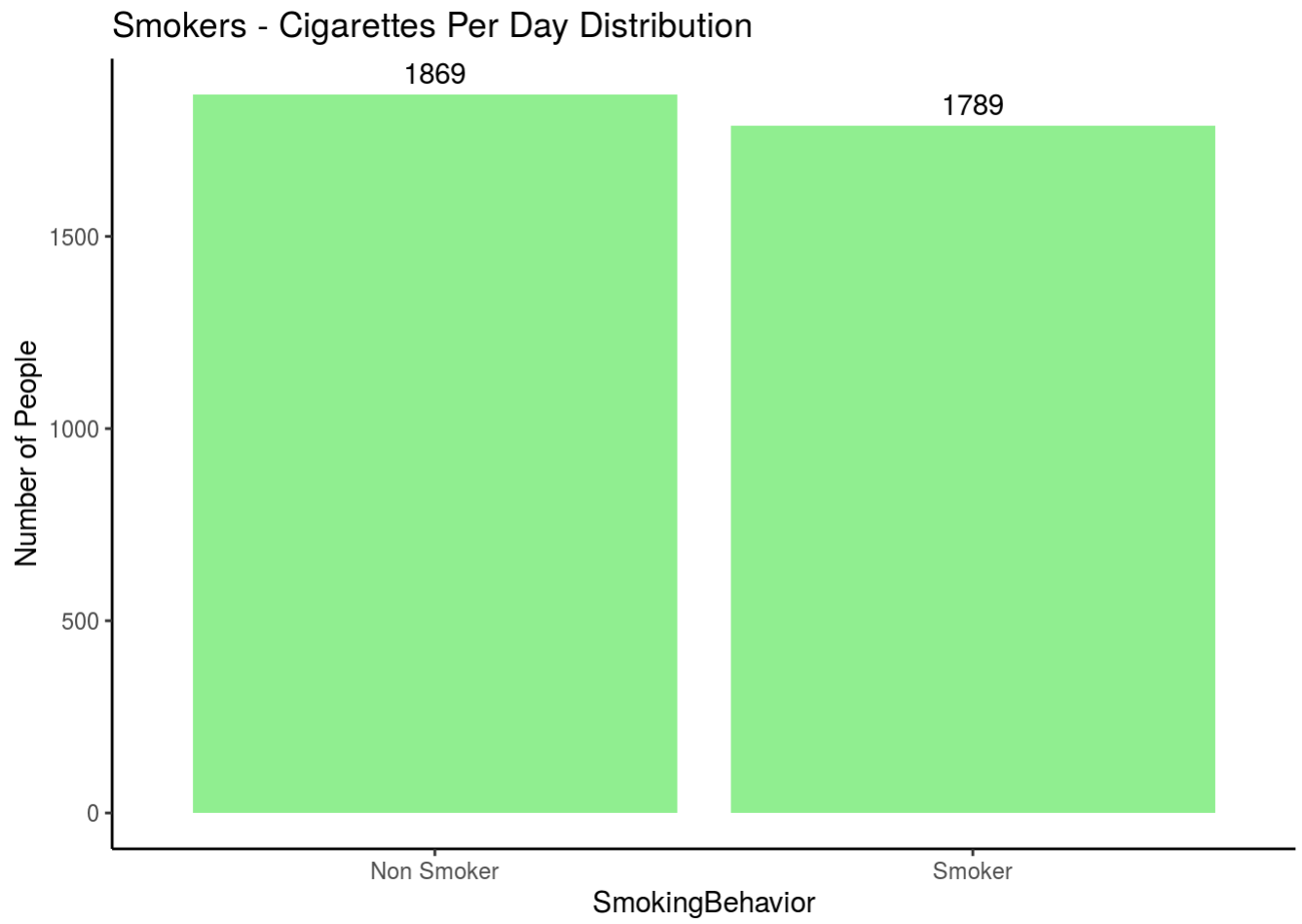

```
ggplot(data, aes(x = TenYearCoronaryHeartDisease)) +
  geom_bar(aes(fill = Gender), position = 'dodge', width = 0.5, color='black') +
  theme_bw() + theme_classic() +
  ylab("Number of People") + ggtitle("10 Year CHD Risk Versus Gender")
```



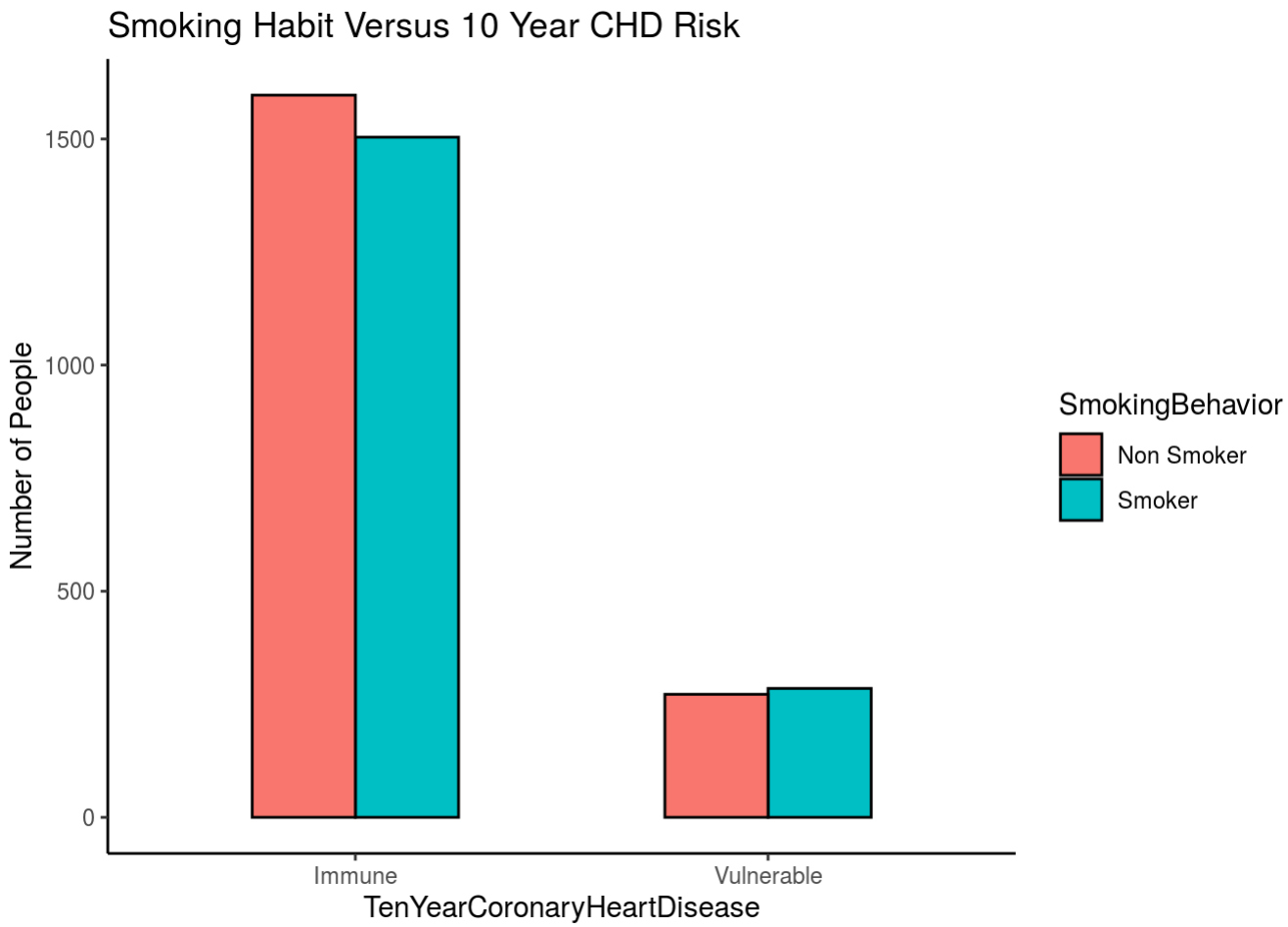

```
ggplot(data, aes(x = CigarettesPerDay)) +
  geom_histogram(bins = 30, fill = "gray") +
  theme_bw() + theme_classic() +
  ggtitle("Smokers - Cigarettes Per Day Distribution") + ylab("Number of People")
```



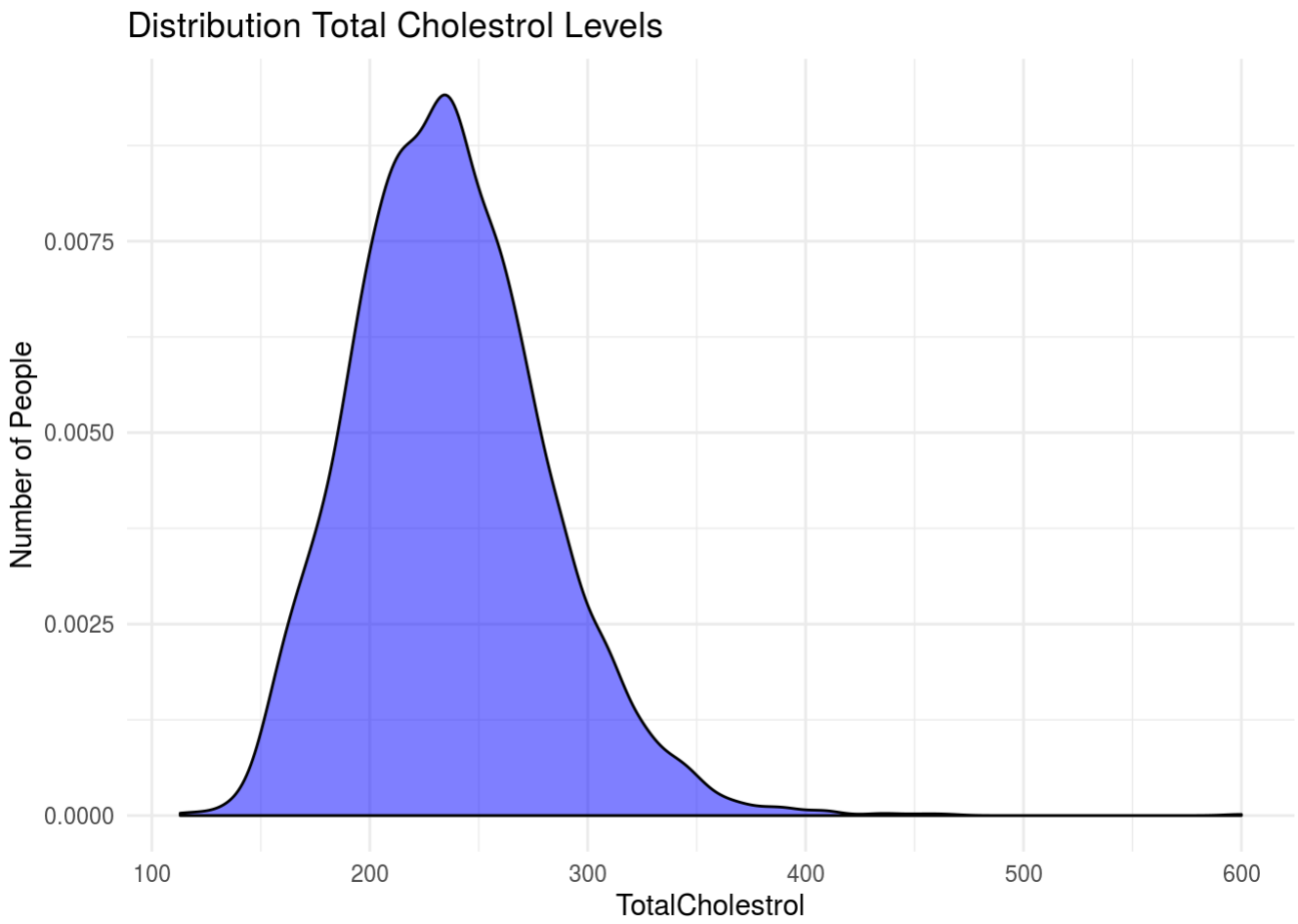

```
ggplot(data, aes(x = SmokingBehavior)) +
  geom_bar(fill = "lightgreen") +
  geom_text(stat = 'count', aes(label =..count..), vjust = -0.5) +
  theme_bw() + theme_classic() +
  ggtitle("Smokers - Cigarettes Per Day Distribution") + ylab("Number of People")
```



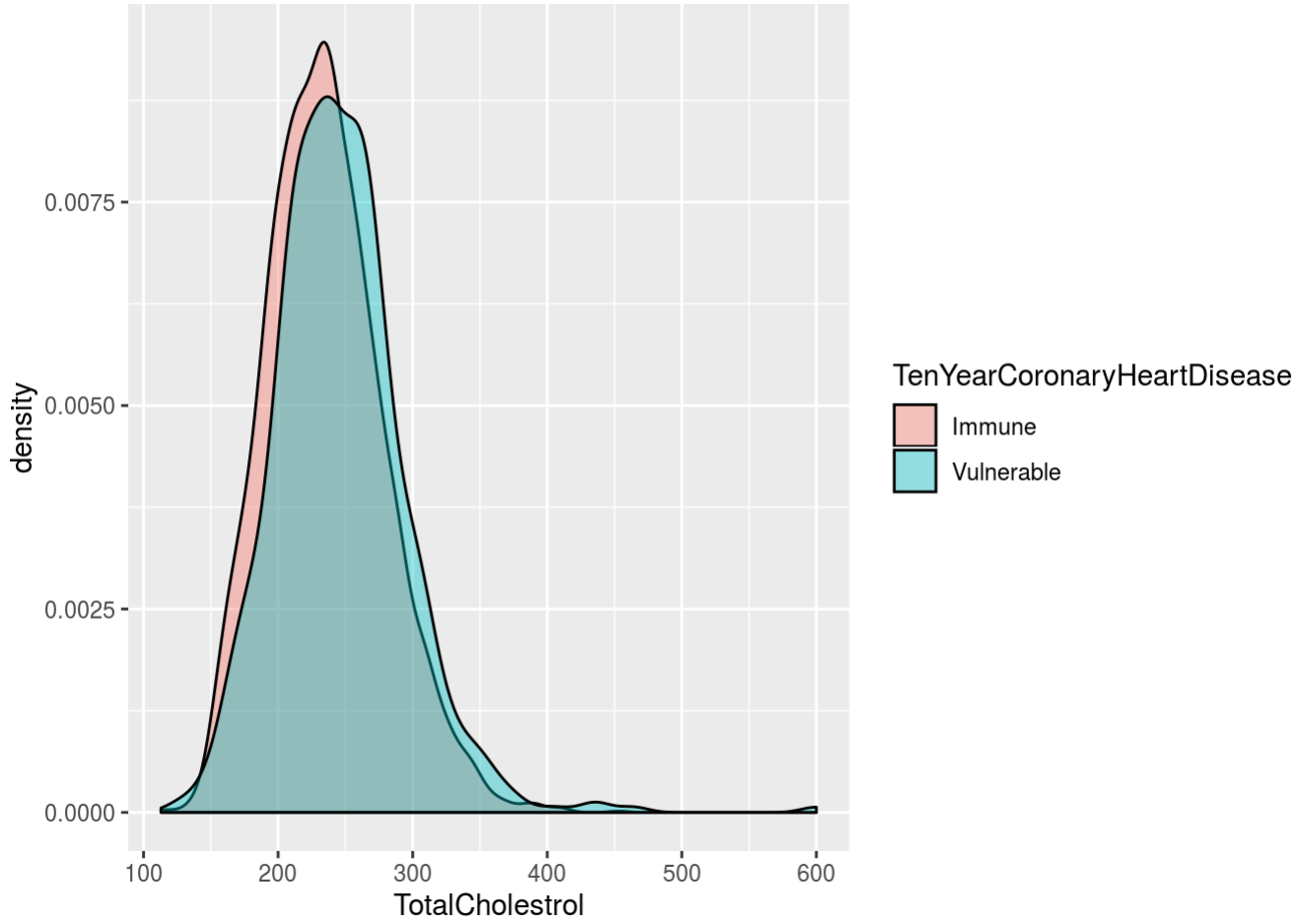

```
ggplot(data, aes(x = TenYearCoronaryHeartDisease)) +
  geom_bar(aes(fill = SmokingBehavior), position = 'dodge', width = 0.5, color= 'black') +
  theme_bw() + theme_classic() +
  ylab("Number of People") + ggtitle("Smoking Habit Versus 10 Year CHD Risk")
```



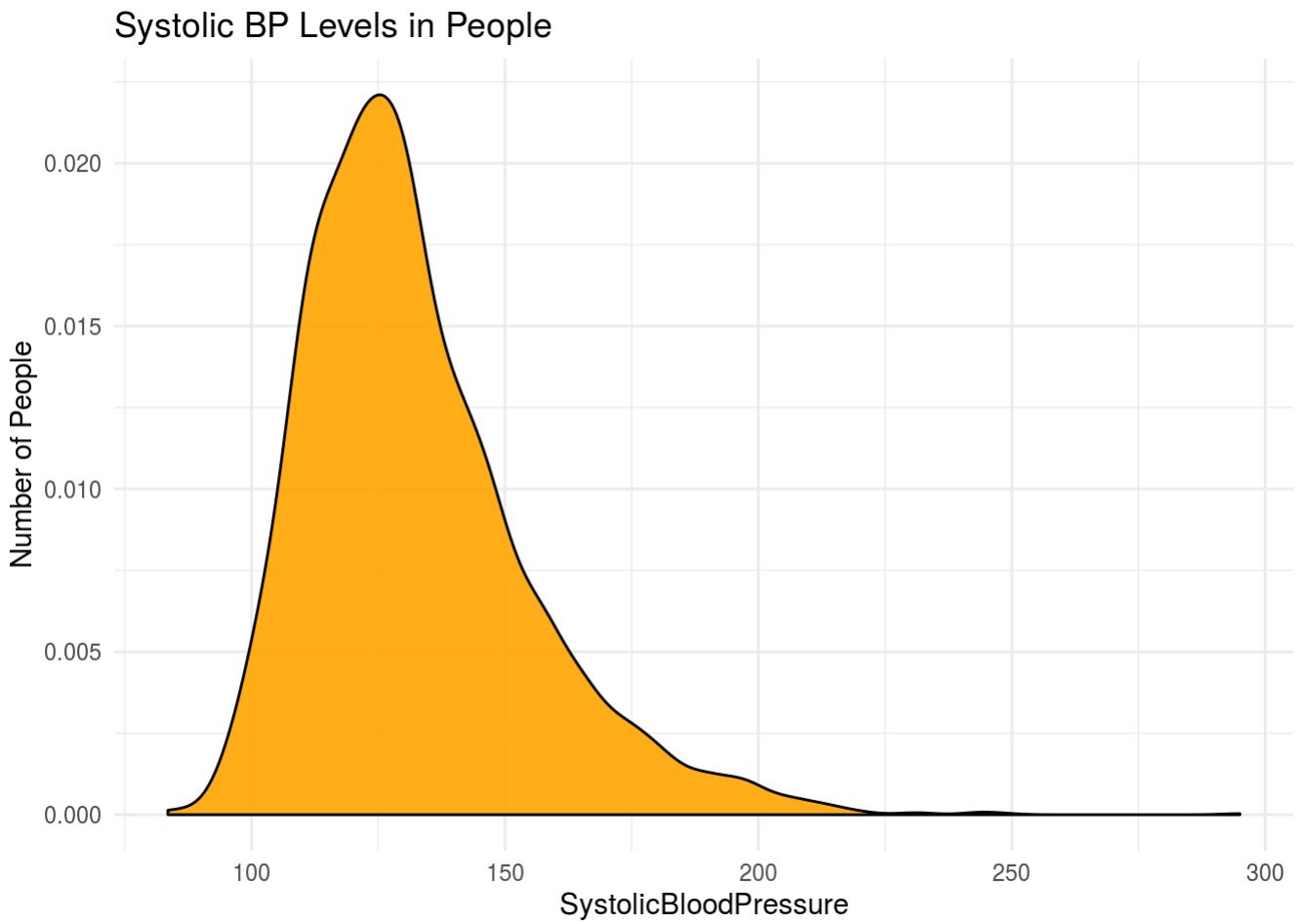

```
ggplot(data, aes(x = TotalCholestrol)) +
  geom_density(fill = "blue", alpha = 0.5) +
  theme_minimal() +
  ggtitle("Distribution Total Cholestrol Levels") + ylab("Number of People")
```



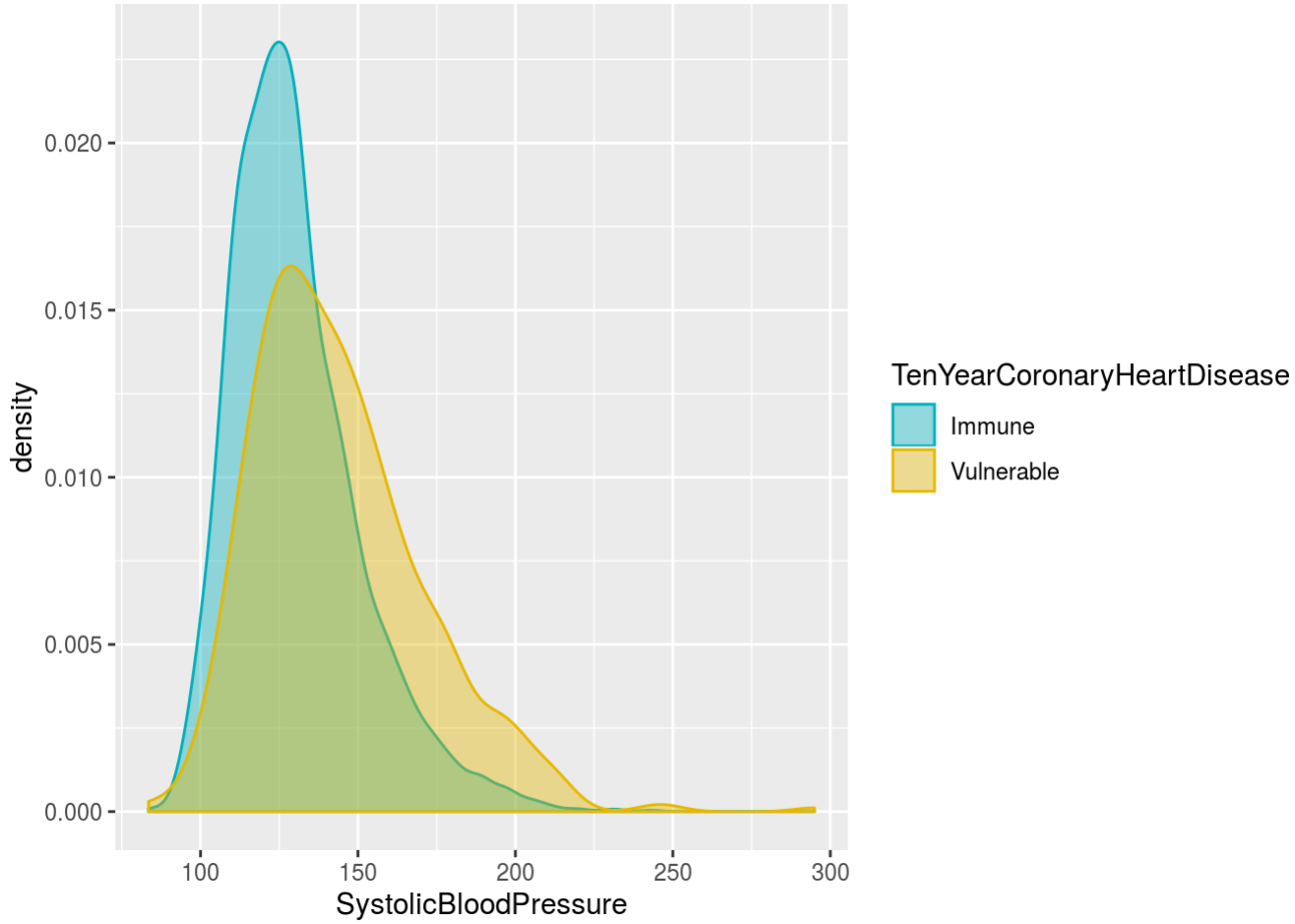

```
ggplot(data, aes(x = TotalCholestrol)) +
  geom_density(aes(fill = TenYearCoronaryHeartDisease), alpha = 0.4)
```



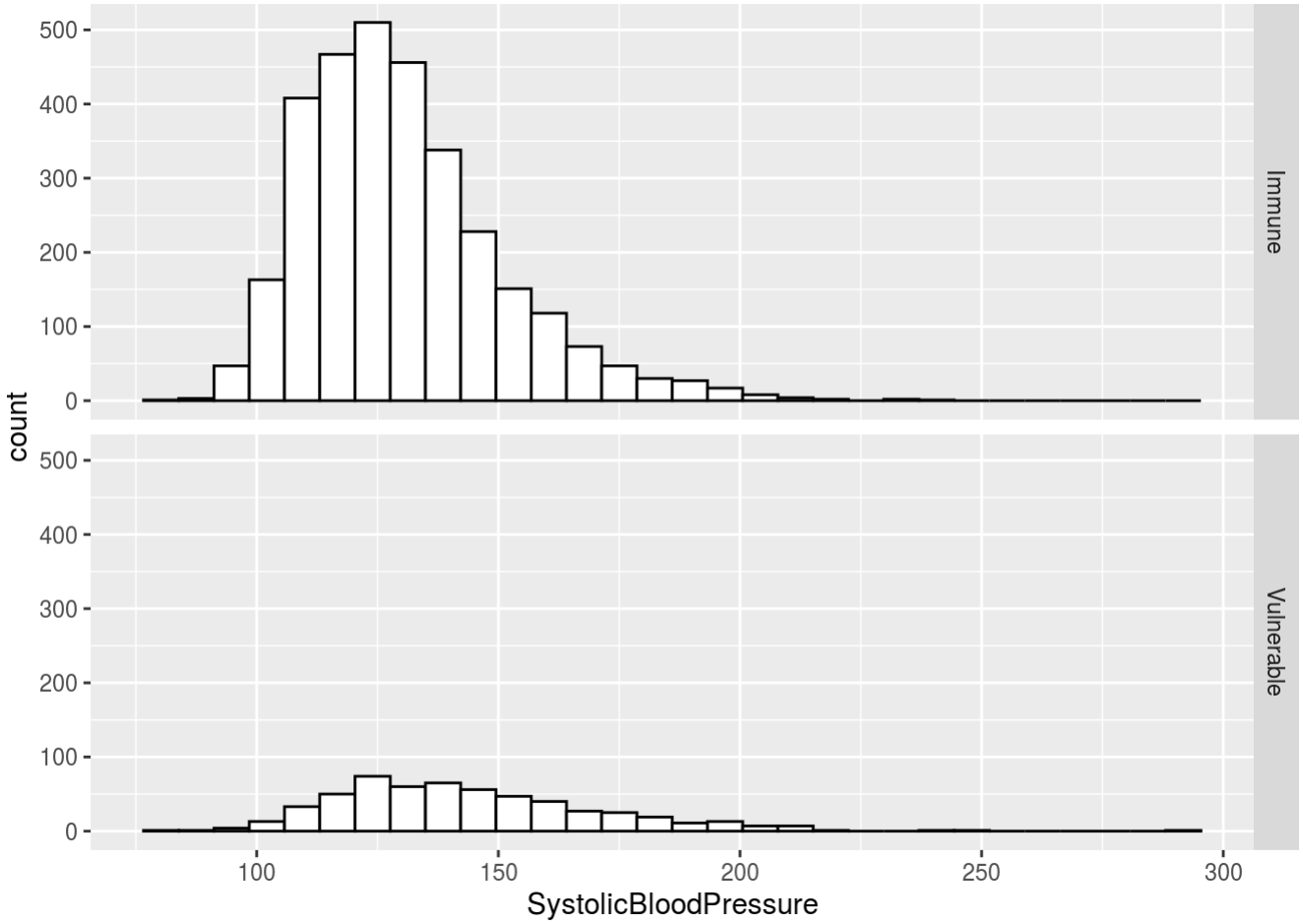

```
ggplot(data, aes(x = SystolicBloodPressure)) +
  geom_density(fill ="orange", alpha = 0.9) +
  theme_minimal() +
  ggtitle("Systolic BP Levels in People") + ylab("Number of People")
```



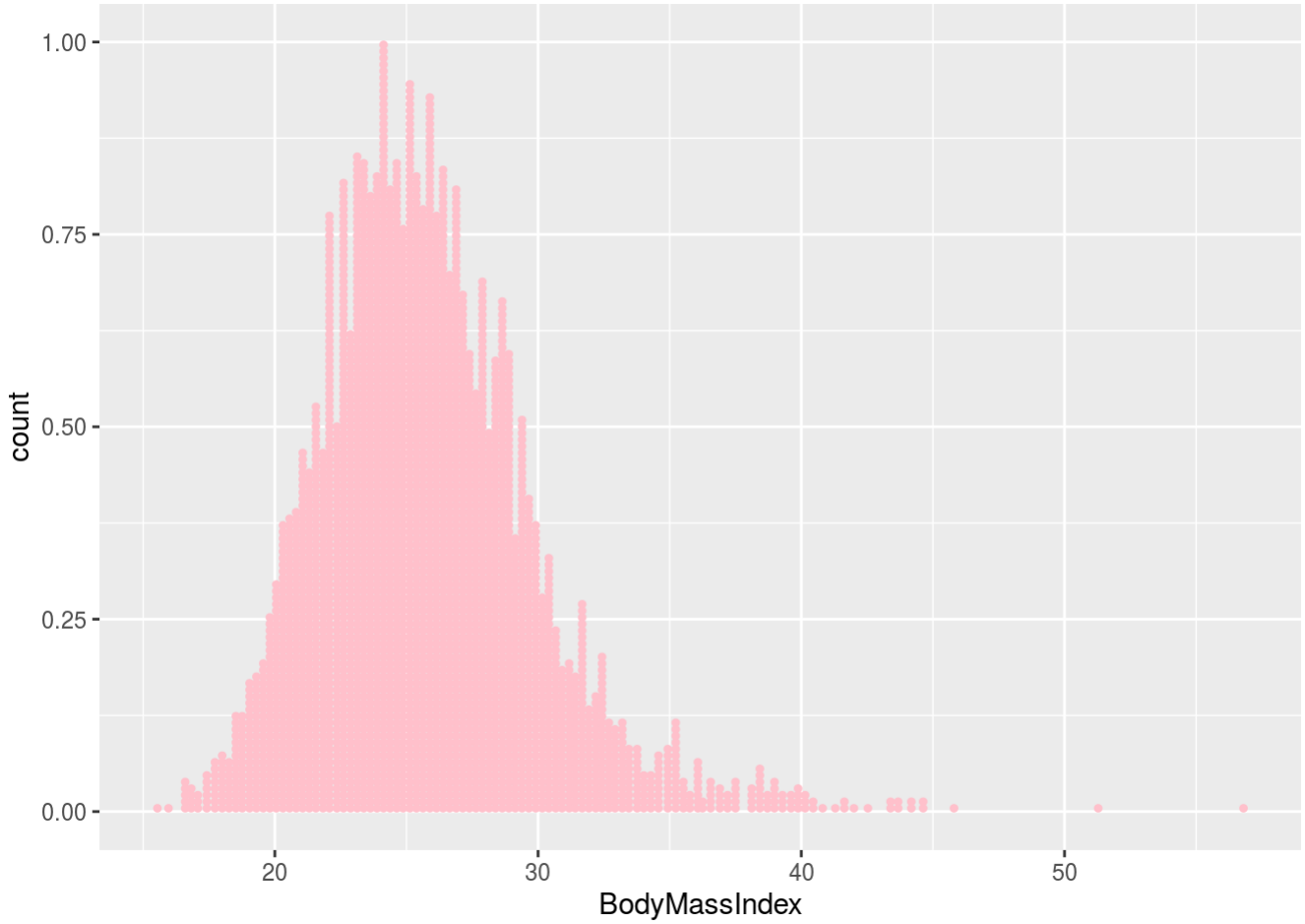

```
ggplot(data, aes(x = SystolicBloodPressure)) +
  geom_density(aes(color = TenYearCoronaryHeartDisease, fill = TenYearCoronaryHeartDisease), alp
ha = 0.4, position = "identity") +
  scale_fill_manual(values = c("#00AFBB", "#E7B800")) +
  scale_color_manual(values = c("#00AFBB", "#E7B800"))
```



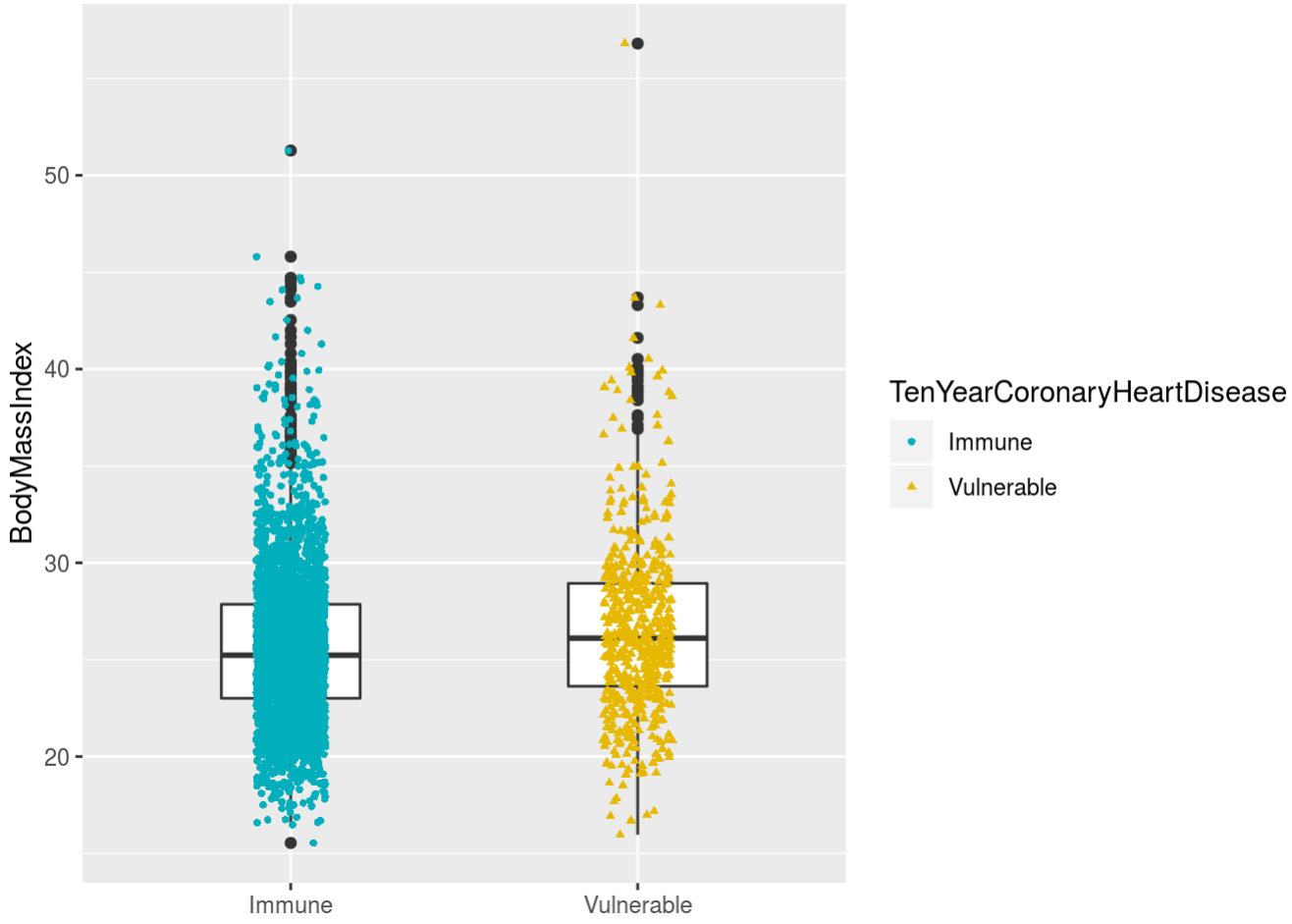

```
# Systolic Blood Pressure vs Ten Year Coronary Heart Disease
ggplot(data, aes(x = SystolicBloodPressure))+
  geom_histogram(bins = 30, color="black", fill="white")+
  facet_grid(TenYearCoronaryHeartDisease ~ .)
```



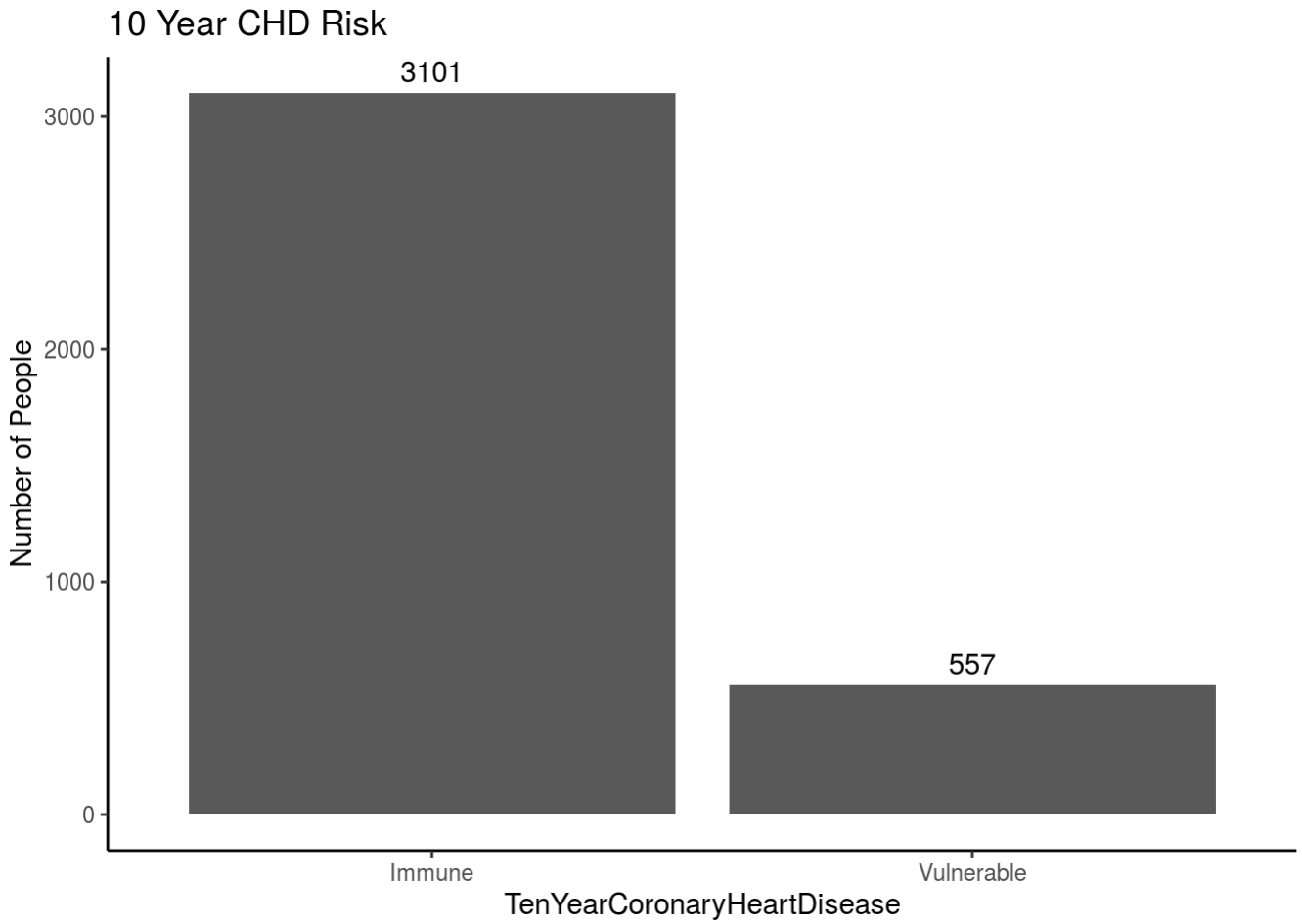

```
ggplot(data, aes(x =BodyMassIndex)) +
  geom_dotplot(color = "pink", fill = "pink", binwidth = 1/4)
```




```
ggplot(data, aes(x = TenYearCoronaryHeartDisease, y = BodyMassIndex)) +
  geom_boxplot(width = 0.4, fill = "white") +
  geom_jitter(aes(color = TenYearCoronaryHeartDisease, shape = TenYearCoronaryHeartDisease),
              width = 0.1, size = 1) +
  scale_color_manual(values = c("#00AFBB", "#E7B800")) +
  labs(x = NULL)
```



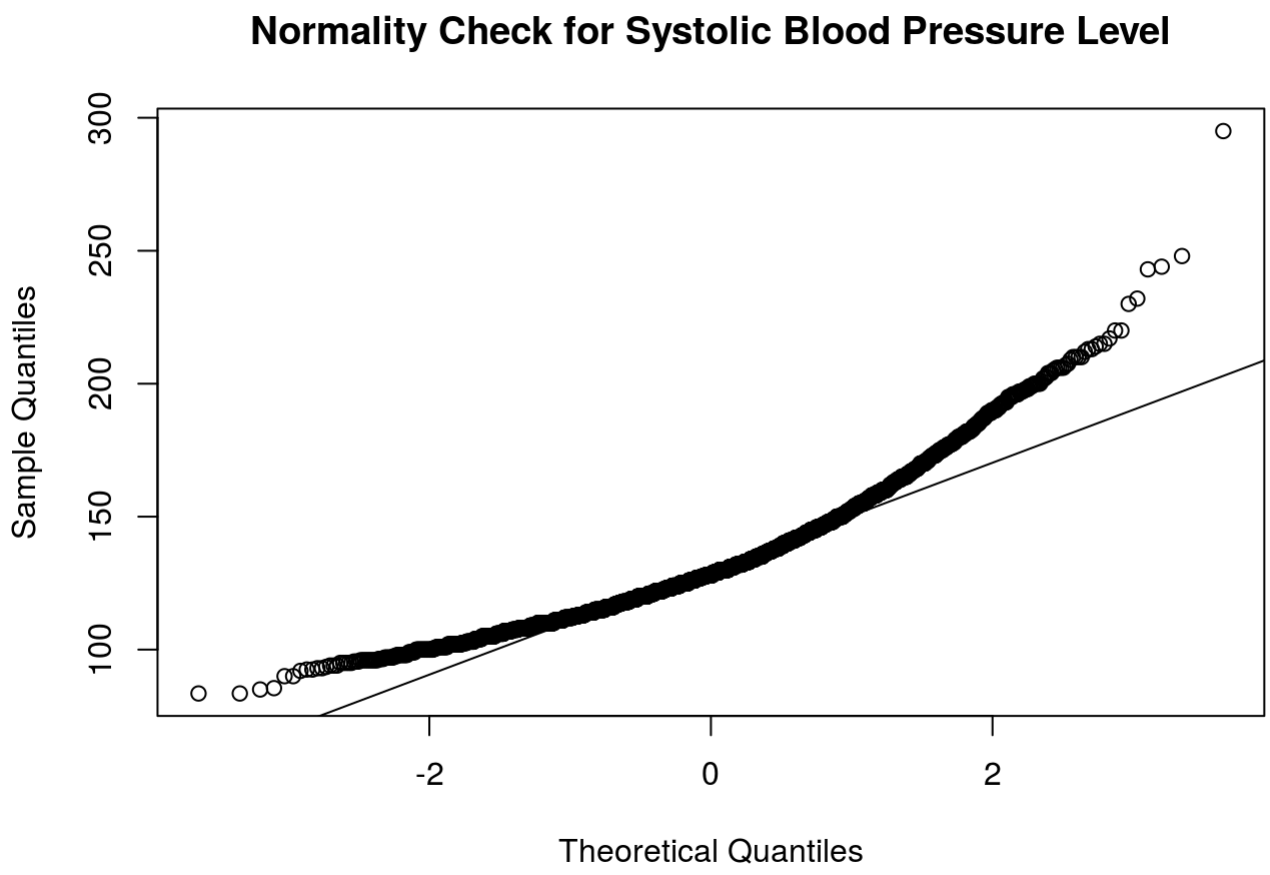

```
ggplot(data, aes(x = TenYearCoronaryHeartDisease)) +
  geom_bar() +
  geom_text(stat = 'count', aes(label =..count..), vjust = -0.5) +
  theme_bw() + theme_classic() +
  ggtitle("10 Year CHD Risk") + ylab("Number of People")
```



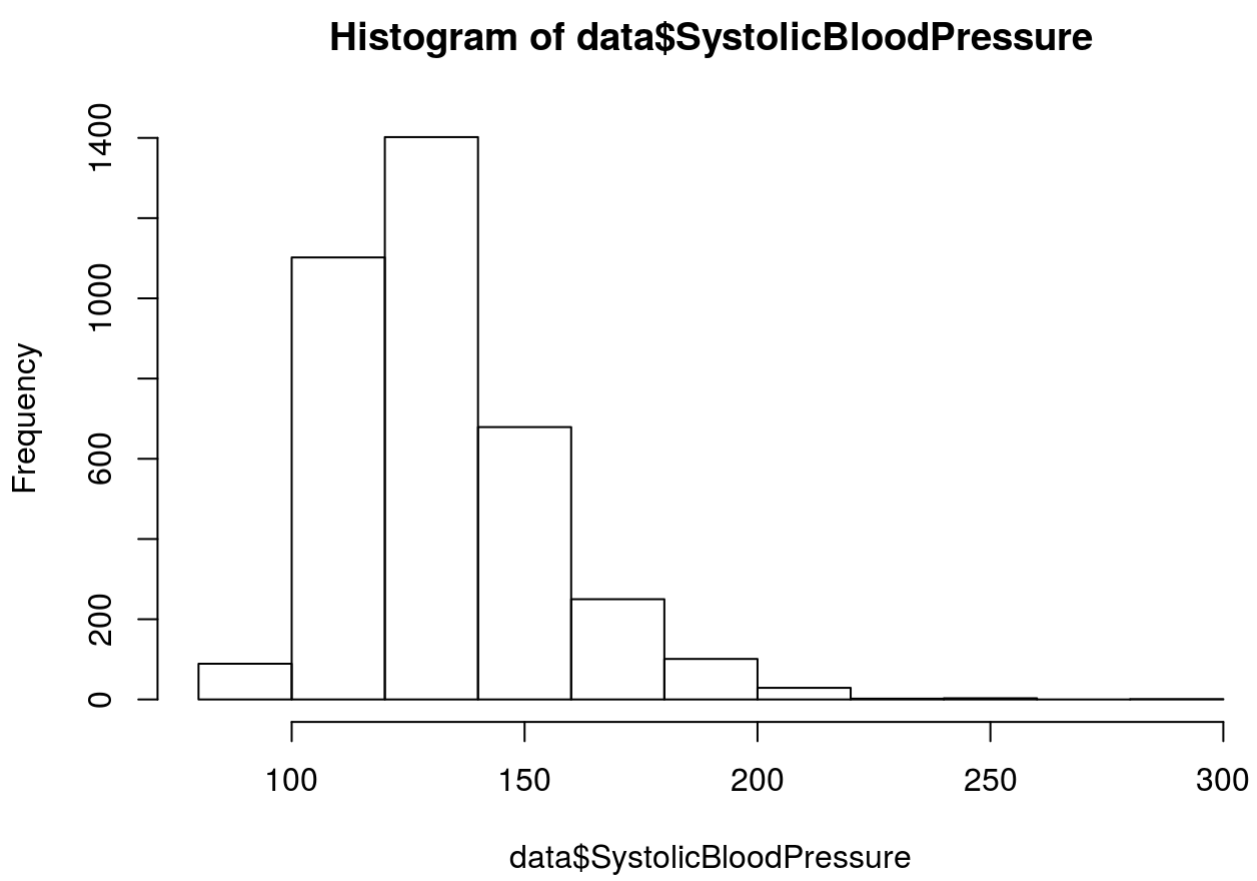

# Statistical Analysis

## 1. One Sample t-Test

```
qqnorm(data$SystolicBloodPressure, main ="Normality Check for Systolic Blood Pressure Level")
qqline(data$SystolicBloodPressure)
```




```
hist(data$SystolicBloodPressure)
```




## (a) Traditional Statistical Tools

### Hypothesis:

$$H_0 \ : \ \mu = 120 \, mmHg$$

Null Hypothesis: The true mean Systolic Blood Pressure Level of people is 120 mmHg

$$H_A \ : \ \mu \neq 120 \, mmHg$$

Alternate Hypothesis: The true mean Systolic Blood Pressure Level of people is different than 120 mmHg

### Parameter

The population parameter we want to make inference to is

$$\mu$$

### Sample Statistic

The sample statistic is the sample mean Systolic Blood Pressure

$$\overline{x}$$

### Test Statistic

$$t_{n-1} = \frac{\overline{x} - \mu_0}{\frac{s}{\sqrt{n}}}$$

```
# the parts of the test statistic
# sample mean
x_bar <- mean(data$SystolicBloodPressure)
# null hypothesized population mean
mu_0 <- 120
# sample st. dev
s <- sd(data$SystolicBloodPressure)
# sample size
n <- length(data$SystolicBloodPressure)
# t-test test statistic
t <- (x_bar - mu_0)/(s/sqrt(n))
t
```

```
## [1] 33.87482
```

## P-Value

```
# two-sided p-value so multiply by 2
two_sided_t_pval <- pt(q = t, df = n-1, lower.tail = FALSE)*2
two_sided_t_pval
```

```
## [1] 5.135369e-219
```

## Confidence Interval

```
qt(0.025, n-1)
```

```
## [1] -1.960613
```

```
# lower bound
x_bar + (qt(0.025, n-1)*(s/sqrt(n))) # alternately you can use x_bar-(qt(0.975, n-1)*(s/sqrt
(n)))
```

```
## [1] 131.6546
```

```
# upper bound
x_bar + (qt(0.975, n-1)*(s/sqrt(n))) # alternately you can use x_bar-(qt(0.025, n-1)*(s/sqrt
(n)))
```

```
## [1] 133.0865
```

## Interpretation

There is strong evidence (p-value = 5.135369e-219) to suggest that the true mean Systolic Blood Pressure Level of people is different from the given mean of 120 mmHg. We reject the null hypothesis that the true mean Systolic Blood Pressure Level of people is 26 minutes at the level. With 95% confidence, the true mean Systolic Blood Pressure Level is between 131.6546 mmHg and 133.0865 mmHg which suggests that the true mean commute time is greater than 120 mmHg.

## R built in t.test

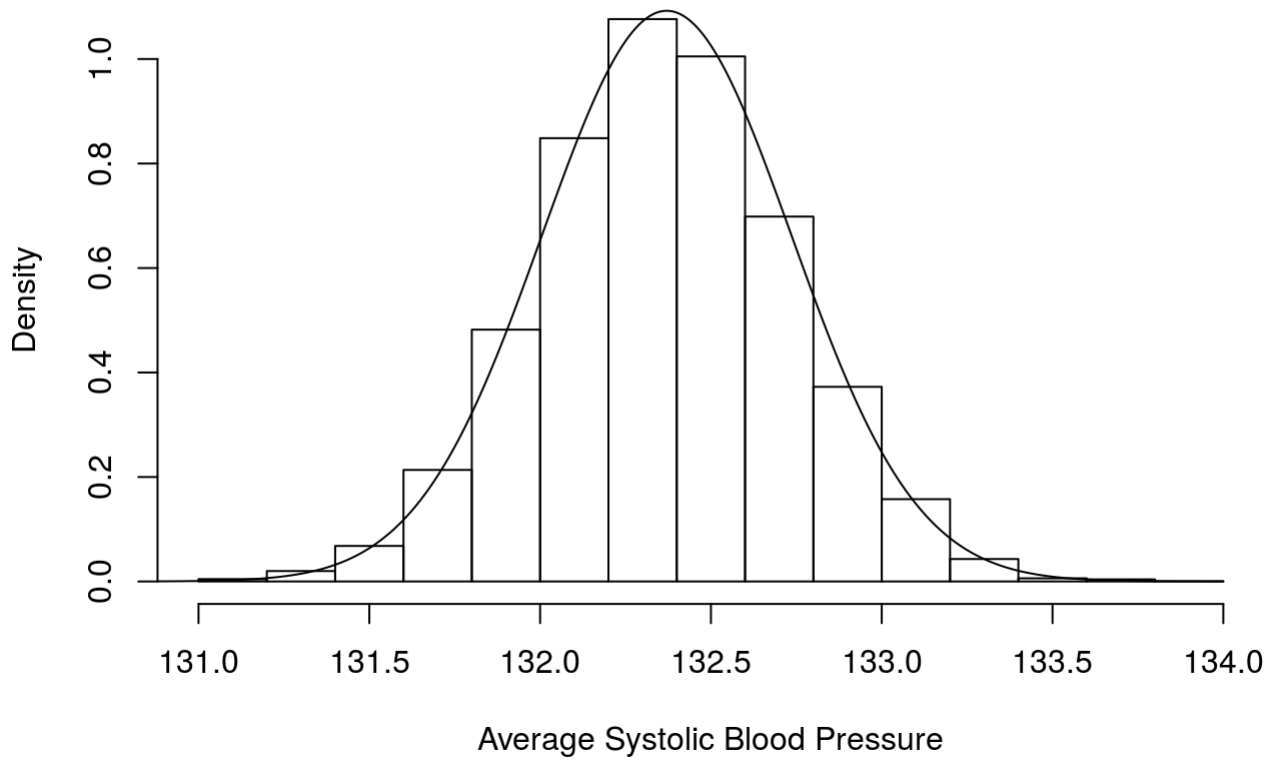
```
t.test(data$SystolicBloodPressure, alternative = "two.sided", mu = 120)
```

```
##
##  One Sample t-test
##
## data:  data$SystolicBloodPressure
## t = 33.875, df = 3657, p-value < 2.2e-16
## alternative hypothesis: true mean is not equal to 120
## 95 percent confidence interval:
##  131.6546 133.0865
## sample estimates:
## mean of x
##  132.3706
```

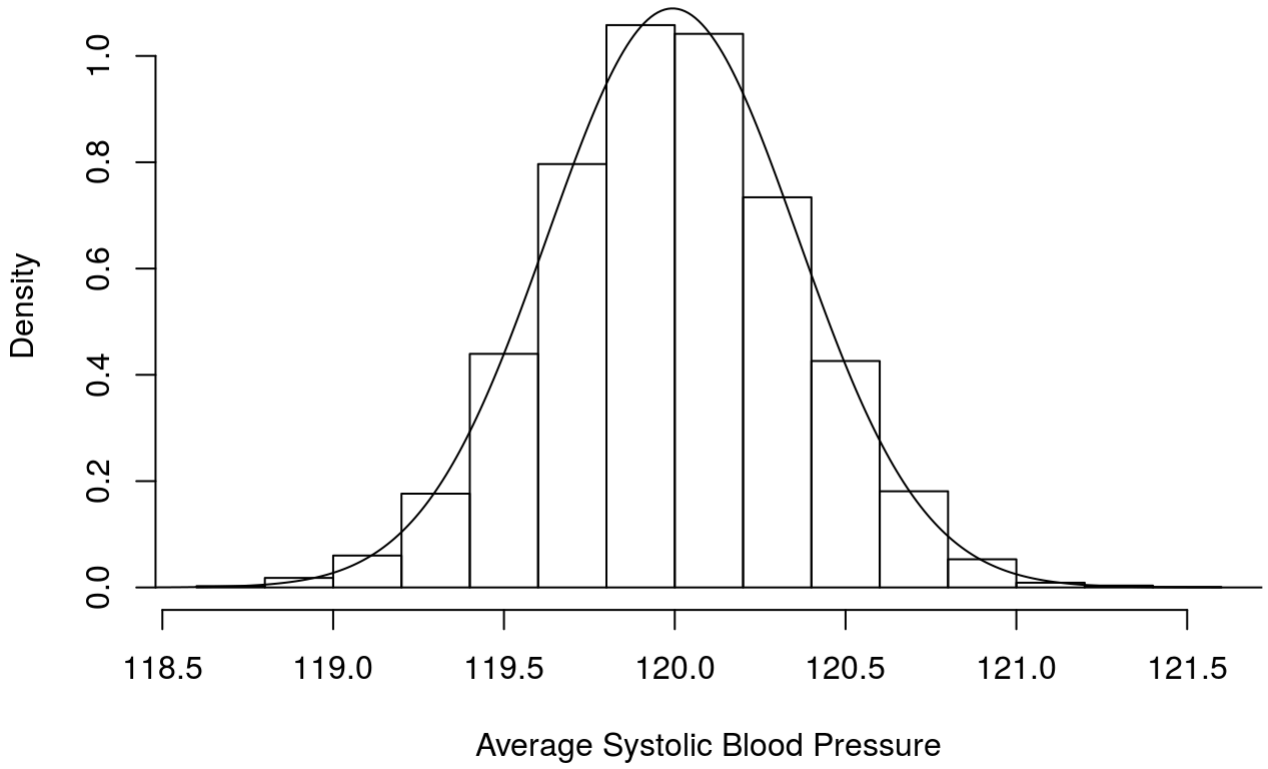
## (b) Bootstrap Methods

### Bootstrap Approach

```
set.seed(0)
# This data is pretty skewed so even though n is large, I'm going to do a lot of simulations
num_sims <- 10000
# A vector to store my results
results <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 results[i] <- mean(sample(x = data$SystolicBloodPressure,
 size = n,
 replace = TRUE))
}
# Finally plot the results
hist(results, freq = FALSE, main='Sampling Distribution of the Sample Mean', xlab = 'Average Sys
tolic Blood Pressure', ylab = 'Density')
# estimate a normal curve over it - this looks pretty good!
lines(x = seq(130, 134, .01), dnorm(seq(130, 134, .01), mean = x_bar, sd = s/sqrt(n)))
```




```
set.seed(0)
# Shift the sample so that the null hypothesis is true
bp_given_H0_true <- data$SystolicBloodPressure - mean(data$SystolicBloodPressure) + mu_0
# This data is pretty skewed so even though n is large, I'm going to do a lot of simulations
num_sims <- 10000
# A vector to store my results
results_given_H0_true <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 results_given_H0_true[i] <- mean(sample(x = bp_given_H0_true,
 size = n,
 replace = TRUE))
}
# Finally plot the results
hist(results_given_H0_true, freq = FALSE, main='Sampling Distribution of the Sample Mean, Given
 Null Hypothesis is True', xlab = 'Average Systolic Blood Pressure', ylab = 'Density')
# add line to show values more extreme on upper end
abline(v=x_bar, col = "red")
# add line to show values more extreme on lower end
low_end_extreme <- mean(results_given_H0_true)+(mean(results_given_H0_true)-x_bar)
lines(x = seq(117, 122, .01), dnorm(seq(117, 122, .01), mean = mean(results_given_H0_true), sd =
sd(results_given_H0_true)))
abline(v=low_end_extreme, col="red")
```




```
# counts of values more extreme than the test statistic in our original sample, given H0 is true
# two sided given the alternate hypothesis
count_of_more_extreme_lower_tail <- sum(results_given_H0_true <= low_end_extreme)
count_of_more_extreme_upper_tail <- sum(results_given_H0_true >= x_bar)
bootstrap_pvalue <- (count_of_more_extreme_lower_tail + count_of_more_extreme_upper_tail)/num_si
ms
bootstrap_pvalue
```

```
## [1] 0
```

```
# two sided t p-value
two_sided_t_pval
```

```
## [1] 5.135369e-219
```

```
# need the standard error which is the standard deviation of the results
bootstrap_SE_X_bar <- sd(results)
# an estimate is to use the formula statistic +/- 2*SE
c(x_bar - 2*bootstrap_SE_X_bar, x_bar + 2*bootstrap_SE_X_bar)
```

```
## [1] 131.6381 133.1030
```

```
# you can also use the 5th and 95th quantiles to determine the bounds:
c(quantile(results, c(.025, .975)))
```

```
##     2.5%    97.5%
## 131.6484 133.0807
```

```
# compare to our t-methods
c(x_bar+(qt(0.025, n-1)*(s/sqrt(n))), x_bar+(qt(0.975, n-1)*(s/sqrt(n))))
```

```
## [1] 131.6546 133.0865
```

# 2. One Sample Test of Proportion

## (a) Traditional Statistical Tools

### Hypotheses

$$H_0 \ : \ p_F = 0.48$$

Null Hypotheses: The true proportion of Female in the population is 52%

$$H_A \ : \ p_R > 0.48$$

Alternate Hypotheses: The true proportion of Female in the population is greater than 52%

```
p_0 <- 0.48
p_0
```

```
## [1] 0.48
```

```
p <- length(data$Gender[data$Gender == "Female"])
p
```

```
## [1] 2035
```

```
n <- length(data$Gender)
n
```

```
## [1] 3658
```

```
p_hat <- p/n
p_hat
```

```
## [1] 0.5563149
```

### Parameter

The population parameter we want to make inference to is the population proportion females in the given population

$$p_F$$

### Sample Statistic

$$The\ sample\ statistic\ is\ \hat{p} = \frac{2035}{3658} = 0.5563149$$

### Test Statistic

$$z = \frac{p - p_0}{\sqrt{\frac{p_0 \times (1 - p_0)}{n}}}$$

```
z <- (p_hat - p_0) / sqrt((p_0*(1-p_0)) / n)
z
```

```
## [1] 9.238661
```

### P-Value

```
binom.test(x = p, n = n, p = p_0, alternative = "greater")
```

```
##
##  Exact binomial test
##
## data:  p and n
## number of successes = 2035, number of trials = 3658, p-value < 2.2e-16
## alternative hypothesis: true probability of success is greater than 0.48
## 95 percent confidence interval:
##  0.5426369 1.0000000
## sample estimates:
## probability of success
##              0.5563149
```

```
pnorm(z, lower.tail = FALSE)
```

```
## [1] 1.248001e-20
```

### Confidence Interval

```
cat("Exact Binomial Test")
```

```
## Exact Binomial Test
```

```
binom.test(x = p, n = n, p = p_0, alternative = "greater")$conf.int
```

```
## [1] 0.5426369 1.0000000
## attr(,"conf.level")
## [1] 0.95
```

```
cat("Normal Approx")
```

```
## Normal Approx
```

```
c(p_hat - (1.64)*sqrt(((p_hat)*(1-p_hat))/n), 1)
```

```
## [1] 0.5428433 1.0000000
```

### Interpretation

Using the exact binomial methods for a one-sample test of proportion, there is strong evidence (p-value = 5.141e-12) to suggest that the true proportion of Female in the population is greater than 48%. We can successfully reject the null hypothesis that the true proportion of male in the population is equal to 48% at the level. The true proportion of male in the population is between 0.5428433 and 1.0000000.

## (b) Bootstrap Methods

### Bootstrap

```
female <- data$Gender
female
```

```
##    [1] Male   Female Male   Female Female Female Female Female Male   Male
##   [11] Female Female Male   Female Female Male   Female Female Male   Female
##   [21] Female Female Male   Male   Male   Female Female Male   Male   Female
##   [31] Male   Male   Male   Female Male   Female Female Male   Female Female
##   [41] Female Male   Female Female Male   Female Female Female Female Male
##   [51] Male   Female Male   Female Male   Female Male   Female Female Male
##   [61] Female Female Male   Female Female Female Female Female Male   Male
##   [71] Male   Female Female Female Female Female Female Male   Male   Male
##   [81] Male   Female Female Male   Female Female Female Female Female Female
##   [91] Female Female Female Female Female Male   Female Male   Female Male
##  [101] Female Male   Male   Female Male   Male   Female Female Male   Female
##  [111] Female Male   Male   Male   Male   Female Male   Male   Female Female
##  [121] Male   Female Male   Female Female Male   Male   Female Female Male
##  [131] Female Female Male   Female Female Female Female Female Male   Female
##  [141] Female Female Female Female Male   Female Male   Male   Female Male
##  [151] Female Male   Female Female Male   Female Female Female Male   Female
##  [161] Female Female Female Female Male   Male   Female Female Female Male
##  [171] Male   Female Male   Male   Male   Female Female Male   Female Female
##  [181] Male   Female Male   Male   Female Male   Female Female Female Male
##  [191] Male   Female Female Male   Female Female Female Female Female Female
##  [201] Female Male   Male   Male   Female Male   Female Female Male   Female
##  [211] Male   Female Male   Female Female Male   Male   Male   Female Female
##  [221] Male   Male   Female Female Female Male   Male   Female Male   Male
##  [231] Female Female Male   Male   Female Male   Male   Male   Female Male
##  [241] Female Female Female Male   Female Female Male   Female Female Female
##  [251] Female Female Male   Female Female Male   Female Male   Female Male
##  [261] Female Male   Female Male   Female Male   Female Female Male   Female
##  [271] Female Male   Male   Male   Female Male   Male   Male   Male   Female
##  [281] Female Male   Female Male   Male   Female Female Female Female Female
##  [291] Male   Female Male   Female Female Female Female Female Female Female
##  [301] Male   Female Female Female Male   Male   Male   Male   Male   Female
##  [311] Female Male   Male   Female Female Female Male   Male   Male   Male
##  [321] Male   Female Female Male   Female Female Female Female Female Male
##  [331] Male   Female Female Female Male   Male   Male   Female Female Female
##  [341] Female Male   Female Female Male   Female Male   Female Male   Male
##  [351] Male   Female Female Male   Male   Female Male   Male   Male   Female
##  [361] Female Female Male   Female Female Female Female Female Female Female
##  [371] Female Female Female Male   Male   Male   Male   Male   Female Female
##  [381] Female Female Male   Male   Male   Male   Female Female Female Female
##  [391] Female Female Male   Female Female Female Female Female Male   Male
##  [401] Male   Female Female Female Male   Male   Male   Male   Male   Male
##  [411] Female Female Male   Female Female Male   Male   Female Male   Female
##  [421] Female Female Male   Female Male   Male   Male   Male   Male   Male
##  [431] Female Female Female Female Female Male   Female Female Female Female
##  [441] Female Female Male   Male   Male   Male   Male   Female Female Male
##  [451] Female Male   Female Female Male   Male   Female Female Female Female
##  [461] Female Male   Male   Male   Female Male   Female Female Female Male
##  [471] Female Male   Male   Female Male   Male   Male   Female Male   Female
##  [481] Female Female Male   Female Female Female Female Female Male   Female
##  [491] Male   Female Female Female Male   Female Female Female Male   Male
##  [501] Male   Female Male   Female Female Male   Female Male   Male   Female
##  [511] Female Female Male   Female Female Male   Male   Male   Female Male
##  [521] Female Female Male   Female Male   Female Male   Female Male   Male
```

```
##  [531] Female Female Male   Female Female Male   Female Male   Female Male
##  [541] Female Male   Male   Female Male   Female Male   Female Male   Male
##  [551] Female Female Female Female Female Female Male   Female Male   Male
##  [561] Female Female Male   Male   Male   Female Female Female Female Female
##  [571] Male   Female Male   Male   Male   Female Female Male   Female Female
##  [581] Female Female Female Male   Female Female Female Male   Male   Male
##  [591] Female Male   Male   Female Male   Male   Female Female Female Male
##  [601] Female Female Male   Female Male   Female Female Female Female Male
##  [611] Female Male   Female Female Male   Female Male   Female Male   Male
##  [621] Male   Male   Male   Female Male   Female Female Female Male   Male
##  [631] Female Male   Female Male   Female Female Female Female Female Female
##  [641] Male   Male   Female Male   Male   Male   Female Female Male   Female
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##  [661] Female Female Female Male   Female Male   Female Male   Male   Male
##  [671] Male   Male   Female Male   Female Female Female Female Female Male
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##  [691] Female Male   Female Female Male   Male   Female Female Female Female
##  [701] Male   Male   Female Male   Female Female Male   Male   Male   Male
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##  [731] Male   Female Female Male   Female Male   Female Female Female Male
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##  [811] Female Female Male   Female Female Male   Female Male   Female Female
##  [821] Female Male   Female Female Female Male   Female Female Male   Female
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```

```
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## [1601] Female Female Female Female Male   Male   Male   Female Male   Female
```

```
## [1611] Male   Female Male   Female Female Female Male   Female Female Female
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## [1681] Female Female Male   Female Female Male   Male   Female Female Female
## [1691] Male   Female Female Female Male   Female Female Male   Male   Female
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## [1711] Male   Female Male   Female Female Male   Female Female Female Female
## [1721] Female Male   Female Male   Male   Female Female Female Male   Female
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## [1741] Male   Female Male   Female Female Male   Female Male   Female Female
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## [1761] Male   Male   Female Female Male   Male   Male   Male   Male   Male
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## [1781] Female Female Male   Female Female Female Female Male   Male   Male
## [1791] Female Female Male   Female Male   Male   Female Female Female Female
## [1801] Female Female Male   Female Male   Male   Male   Male   Female Male
## [1811] Male   Female Female Female Female Male   Female Male   Female Male
## [1821] Female Male   Female Male   Female Female Female Female Female Female
## [1831] Male   Female Male   Male   Male   Female Female Female Male   Male
## [1841] Female Female Female Male   Female Male   Male   Female Female Female
## [1851] Female Male   Female Female Female Male   Male   Female Female Male
## [1861] Female Female Female Male   Male   Female Female Female Male   Male
## [1871] Male   Male   Female Male   Male   Male   Male   Male   Female Male
## [1881] Male   Female Male   Female Female Male   Male   Male   Female Female
## [1891] Female Male   Female Male   Female Male   Male   Male   Male   Male
## [1901] Female Female Female Male   Female Female Male   Female Male   Male
## [1911] Female Female Male   Male   Female Female Male   Male   Male   Male
## [1921] Female Male   Female Female Male   Female Female Female Female Male
## [1931] Male   Male   Male   Male   Male   Male   Female Male   Male   Male
## [1941] Male   Female Male   Female Male   Female Male   Female Female Male
## [1951] Female Male   Female Female Male   Male   Female Female Female Male
## [1961] Female Female Male   Female Female Female Male   Male   Male   Female
## [1971] Female Male   Female Male   Male   Female Female Female Female Male
## [1981] Female Female Male   Female Female Male   Male   Female Male   Male
## [1991] Male   Male   Male   Male   Female Male   Male   Female Female Male
## [2001] Female Female Male   Female Female Female Male   Female Male   Male
## [2011] Female Female Male   Female Female Female Female Female Male   Female
## [2021] Female Male   Female Male   Female Male   Male   Male   Female Female
## [2031] Female Female Female Female Female Female Male   Male   Female Male
## [2041] Female Male   Female Male   Female Male   Female Male   Female Female
## [2051] Female Female Male   Male   Female Male   Female Female Female Female
## [2061] Female Female Male   Male   Male   Female Female Female Male   Female
## [2071] Male   Male   Female Female Male   Male   Female Female Female Female
## [2081] Male   Male   Female Male   Male   Female Male   Male   Female Female
## [2091] Male   Female Male   Male   Female Male   Female Male   Male   Female
## [2101] Female Female Male   Female Male   Male   Female Male   Male   Female
## [2111] Female Female Male   Male   Female Male   Male   Female Female Male
## [2121] Male   Male   Male   Male   Male   Male   Female Female Male   Male
## [2131] Male   Male   Female Male   Female Female Female Female Female Male
## [2141] Female Female Male   Female Male   Female Male   Female Male   Male
```

```
## [2151] Female Male   Female Male   Male   Male   Male   Female Female Female
## [2161] Female Female Female Female Female Female Male   Female Male   Male
## [2171] Male   Male   Female Male   Female Male   Male   Female Female Male
## [2181] Male   Female Male   Male   Female Female Male   Female Female Female
## [2191] Female Female Female Female Female Female Male   Female Female Male
## [2201] Female Female Male   Female Male   Female Female Female Male   Female
## [2211] Male   Female Female Female Male   Male   Female Male   Female Male
## [2221] Male   Female Male   Female Female Female Male   Male   Female Female
## [2231] Female Male   Female Male   Female Male   Male   Male   Female Female
## [2241] Female Male   Female Female Male   Male   Female Male   Male   Male
## [2251] Female Female Male   Male   Male   Female Female Female Female Female
## [2261] Female Female Male   Male   Female Female Female Female Male   Female
## [2271] Female Male   Male   Male   Female Female Female Female Female Male
## [2281] Male   Male   Female Male   Female Male   Male   Female Female Female
## [2291] Male   Male   Female Male   Female Female Female Male   Male   Male
## [2301] Male   Male   Male   Female Female Female Female Female Female Male
## [2311] Female Male   Male   Female Female Male   Female Female Male   Female
## [2321] Female Female Female Male   Female Female Male   Female Female Male
## [2331] Male   Male   Female Male   Female Male   Female Male   Female Male
## [2341] Female Male   Female Female Female Male   Female Male   Female Male
## [2351] Female Male   Male   Male   Female Female Female Male   Female Male
## [2361] Male   Female Male   Female Male   Male   Female Female Male   Male
## [2371] Female Female Female Female Male   Male   Female Female Male   Female
## [2381] Female Female Female Female Female Male   Female Male   Male   Female
## [2391] Male   Male   Female Female Female Female Male   Male   Female Female
## [2401] Male   Male   Female Male   Male   Male   Female Female Female Male
## [2411] Female Male   Male   Female Female Female Female Male   Male   Female
## [2421] Male   Female Male   Male   Male   Female Male   Male   Male   Female
## [2431] Female Female Male   Male   Female Female Female Female Male   Female
## [2441] Male   Male   Male   Female Male   Female Female Male   Male   Female
## [2451] Male   Male   Female Female Male   Male   Male   Male   Female Male
## [2461] Female Female Female Female Male   Male   Male   Female Male   Male
## [2471] Male   Female Female Female Male   Female Male   Male   Female Male
## [2481] Female Female Male   Female Female Female Female Female Male   Male
## [2491] Male   Female Female Female Male   Male   Female Female Male   Female
## [2501] Female Female Female Female Female Female Female Female Male   Female
## [2511] Male   Male   Male   Male   Male   Male   Female Male   Female Male
## [2521] Female Male   Male   Female Female Female Female Female Male   Male
## [2531] Female Female Male   Female Female Female Female Male   Female Female
## [2541] Male   Female Male   Male   Male   Female Male   Male   Male   Male
## [2551] Female Female Female Male   Female Male   Male   Male   Male   Female
## [2561] Female Male   Female Male   Male   Female Male   Female Female Female
## [2571] Female Male   Female Female Male   Male   Male   Male   Female Male
## [2581] Male   Female Female Male   Male   Male   Female Male   Male   Female
## [2591] Female Female Female Female Male   Female Female Male   Male   Female
## [2601] Female Female Female Female Female Female Male   Female Male   Male
## [2611] Female Male   Male   Female Male   Female Male   Female Female Male
## [2621] Female Female Female Male   Male   Female Female Male   Female Male
## [2631] Male   Male   Male   Female Male   Female Female Male   Male   Female
## [2641] Male   Female Female Female Female Female Male   Male   Male   Female
## [2651] Male   Male   Male   Female Male   Female Male   Female Male   Female
## [2661] Female Female Female Male   Female Female Male   Female Male   Male
## [2671] Male   Female Female Male   Female Female Female Female Male   Male
## [2681] Female Male   Female Male   Female Male   Female Male   Female Female
```

```
## [2691] Female Male   Female Female Female Female Female Female Female Female
## [2701] Female Male   Female Female Male   Male   Male   Female Male   Male
## [2711] Male   Female Male   Female Female Male   Male   Female Female Female
## [2721] Female Male   Female Male   Female Male   Female Female Female Male
## [2731] Female Male   Male   Female Female Female Female Male   Male   Male
## [2741] Female Male   Female Female Male   Female Male   Female Male   Female
## [2751] Male   Male   Female Male   Male   Female Female Female Female Female
## [2761] Female Female Female Female Female Female Female Female Female Male
## [2771] Female Female Female Female Female Female Male   Female Male   Female
## [2781] Male   Male   Male   Male   Male   Male   Female Female Male   Female
## [2791] Male   Female Male   Male   Female Female Female Male   Male   Female
## [2801] Male   Female Female Male   Male   Male   Male   Female Male   Female
## [2811] Female Male   Female Male   Female Male   Female Female Male   Male
## [2821] Male   Female Female Female Female Female Female Male   Female Female
## [2831] Female Female Female Male   Female Male   Male   Female Female Male
## [2841] Female Male   Female Female Female Male   Female Male   Female Female
## [2851] Male   Female Female Male   Female Male   Male   Male   Female Female
## [2861] Male   Female Female Male   Female Female Female Female Female Male
## [2871] Male   Female Male   Male   Male   Female Female Female Female Male
## [2881] Male   Male   Male   Female Male   Female Female Male   Female Male
## [2891] Female Female Female Male   Female Female Male   Male   Male   Female
## [2901] Male   Female Male   Female Male   Male   Male   Male   Male   Female
## [2911] Female Female Male   Female Male   Male   Male   Female Female Male
## [2921] Male   Male   Male   Female Male   Male   Male   Female Female Male
## [2931] Female Male   Female Female Female Male   Female Male   Female Male
## [2941] Female Male   Female Female Female Male   Male   Female Male   Male
## [2951] Female Male   Male   Male   Male   Male   Male   Female Female Male
## [2961] Female Female Female Male   Female Female Female Female Female Female
## [2971] Female Male   Female Male   Female Female Male   Male   Male   Male
## [2981] Male   Female Female Female Female Male   Male   Male   Female Male
## [2991] Female Male   Male   Female Male   Female Male   Female Female Female
## [3001] Female Male   Male   Female Female Female Male   Male   Male   Female
## [3011] Female Female Male   Female Female Male   Female Male   Male   Male
## [3021] Male   Female Female Female Male   Male   Female Male   Male   Female
## [3031] Male   Female Male   Female Female Male   Male   Male   Female Female
## [3041] Male   Male   Female Male   Male   Female Female Male   Female Female
## [3051] Female Male   Male   Female Female Female Female Female Female Male
## [3061] Female Female Male   Female Male   Female Female Female Male   Male
## [3071] Female Female Male   Female Female Female Female Female Male   Female
## [3081] Female Female Female Female Female Male   Female Male   Male   Male
## [3091] Female Male   Female Female Female Male   Female Female Female Female
## [3101] Female Female Male   Male   Female Male   Female Male   Female Female
## [3111] Male   Female Female Male   Male   Male   Male   Female Male   Female
## [3121] Male   Male   Female Female Female Female Female Male   Female Female
## [3131] Female Female Female Female Male   Female Male   Female Female Male
## [3141] Female Female Female Male   Female Female Female Female Female Female
## [3151] Male   Male   Male   Male   Female Female Male   Female Female Male
## [3161] Male   Male   Male   Female Female Female Male   Male   Female Male
## [3171] Female Male   Female Female Male   Male   Female Male   Male   Female
## [3181] Male   Female Female Female Male   Male   Male   Male   Male   Female
## [3191] Male   Female Male   Male   Male   Female Female Female Female Male
## [3201] Female Male   Female Male   Female Female Female Male   Male   Male
## [3211] Male   Female Female Female Female Male   Female Female Male   Male
## [3221] Female Female Female Female Female Female Female Female Female Male
```

```
## [3231] Female Male   Female Female Male   Female Male   Female Male   Male
## [3241] Male   Male   Male   Male   Female Male   Female Female Female Female
## [3251] Female Female Female Female Male   Male   Male   Female Female Male
## [3261] Female Female Female Male   Male   Male   Female Female Female Male
## [3271] Female Male   Female Female Male   Male   Female Male   Female Female
## [3281] Male   Male   Male   Female Female Male   Male   Female Female Female
## [3291] Female Female Female Female Male   Male   Male   Male   Male   Male
## [3301] Female Female Female Female Male   Female Female Female Male   Female
## [3311] Male   Male   Male   Female Male   Male   Female Female Male   Male
## [3321] Male   Female Female Female Female Female Female Male   Male   Male
## [3331] Male   Female Female Male   Male   Female Female Female Male   Male
## [3341] Female Male   Male   Female Male   Male   Male   Female Female Female
## [3351] Male   Female Female Female Male   Male   Male   Male   Male   Female
## [3361] Male   Female Female Male   Male   Female Male   Male   Female Female
## [3371] Male   Female Female Male   Male   Female Male   Male   Female Female
## [3381] Male   Female Female Male   Female Female Male   Female Male   Female
## [3391] Female Male   Female Female Female Female Female Female Male   Female
## [3401] Female Female Female Male   Male   Female Male   Male   Female Female
## [3411] Female Female Male   Male   Female Female Female Male   Female Female
## [3421] Female Male   Female Female Male   Female Female Female Female Male
## [3431] Female Female Female Male   Female Female Female Male   Female Female
## [3441] Female Male   Male   Female Female Male   Female Male   Male   Male
## [3451] Male   Male   Male   Female Female Male   Male   Male   Female Male
## [3461] Male   Male   Male   Female Male   Male   Male   Female Male   Male
## [3471] Female Female Female Female Female Female Male   Male   Female Male
## [3481] Male   Female Male   Male   Male   Female Male   Male   Male   Female
## [3491] Female Male   Male   Female Female Male   Male   Female Female Male
## [3501] Female Male   Male   Male   Female Female Female Male   Male   Female
## [3511] Male   Female Male   Male   Male   Female Female Female Female Female
## [3521] Female Male   Female Male   Male   Female Female Male   Male   Female
## [3531] Male   Female Male   Female Male   Female Female Male   Female Female
## [3541] Female Male   Male   Female Male   Female Female Female Male   Male
## [3551] Female Male   Male   Male   Male   Female Male   Female Male   Male
## [3561] Female Male   Female Female Male   Female Female Female Male   Male
## [3571] Male   Male   Male   Male   Male   Female Male   Female Female Female
## [3581] Female Male   Male   Female Female Female Male   Female Male   Male
## [3591] Female Male   Female Female Female Male   Male   Female Male   Male
## [3601] Female Female Male   Female Male   Male   Male   Female Male   Female
## [3611] Female Female Male   Female Female Male   Female Male   Female Female
## [3621] Female Female Female Female Male   Female Male   Female Female Female
## [3631] Female Male   Male   Male   Male   Male   Female Female Female Female
## [3641] Female Male   Male   Male   Male   Male   Male   Male   Male   Male
## [3651] Female Male   Male   Male   Male   Female Male   Female
## Levels: Female Male
```

```
female <- relevel(female, "Male")
levels(female) <- c(0, 1)
female
```

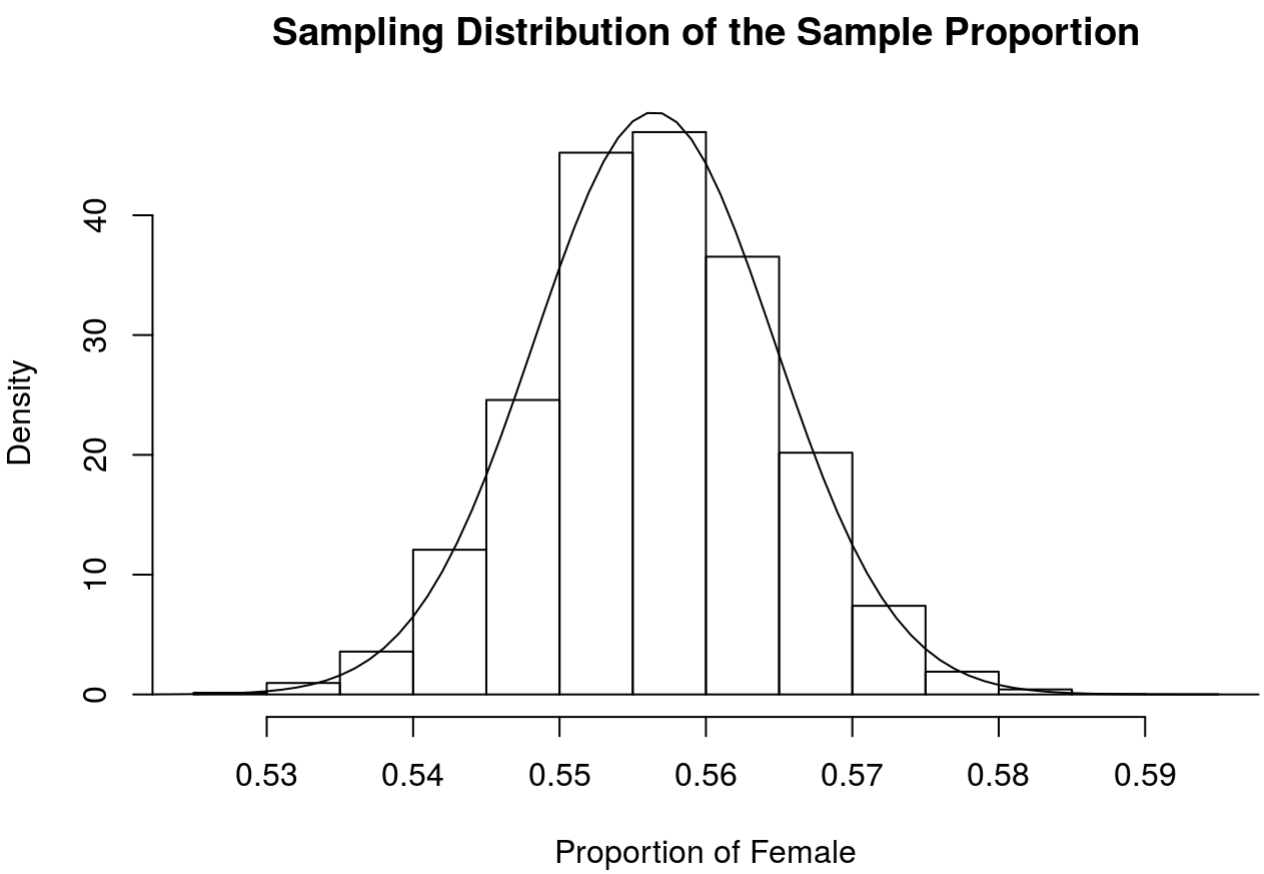
```
##    [1] 0 1 0 1 1 1 1 1 0 0 1 1 0 1 1 0 1 1 0 1 1 1 0 0 0 1 1 0 0 1 0 0 0 1 0 1 1
##   [38] 0 1 1 1 0 1 1 0 1 1 1 1 1 0 0 1 0 1 0 1 0 1 1 0 1 1 0 1 1 1 1 1 0 0 0 1 1 1
##   [75] 1 1 1 0 0 0 0 1 1 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1 0 1 0 0 1 0 0 1 1 0 1 1
##  [112] 0 0 0 0 1 0 0 1 1 0 1 0 1 1 0 0 1 1 0 1 1 0 1 1 1 1 1 0 1 1 1 1 1 0 1 0 0
##  [149] 1 0 1 0 1 1 0 1 1 1 0 1 1 1 1 1 1 0 0 1 1 1 0 0 1 0 0 0 1 1 0 1 1 0 1 0 0 1
##  [186] 0 1 1 1 0 0 1 1 0 1 1 1 1 1 1 1 1 0 0 0 1 0 1 1 0 1 0 1 0 1 1 0 0 0 1 1 0 0
##  [223] 1 1 1 0 0 1 0 0 1 1 0 0 1 0 0 0 1 0 1 1 1 0 1 1 0 1 1 1 1 1 1 0 1 1 0 1 0 1
##  [260] 0 1 0 1 0 1 0 1 1 0 1 1 0 0 0 1 0 0 0 0 1 1 0 1 0 0 1 1 1 1 1 1 0 1 0 1 1 1
##  [297] 1 1 1 1 0 1 1 1 0 0 0 0 0 1 1 0 0 1 1 1 0 0 0 0 0 1 1 0 1 1 1 1 1 0 0 1 1
##  [334] 1 0 0 0 1 1 1 1 0 1 1 0 1 0 1 0 0 0 1 1 0 0 1 0 0 0 1 1 1 0 1 1 1 1 1 1 1
##  [371] 1 1 1 0 0 0 0 0 1 1 1 1 1 0 0 0 0 1 1 1 1 1 1 1 0 1 1 1 1 1 0 0 0 1 1 1 0 0 0
##  [408] 0 0 0 1 1 0 1 1 0 0 1 0 1 1 1 0 1 0 0 0 0 0 0 1 1 1 1 1 0 1 1 1 1 1 1 0 0
##  [445] 0 0 0 1 1 0 1 0 1 1 0 0 1 1 1 1 1 1 0 0 0 1 0 1 1 1 0 1 0 0 1 0 0 0 1 0 1 1
##  [482] 1 0 1 1 1 1 1 1 0 1 0 1 1 1 0 1 1 1 0 0 0 1 0 1 1 0 1 0 0 1 1 1 0 1 1 0 0 0
##  [519] 1 0 1 1 0 1 0 1 0 1 0 0 1 1 0 1 1 0 1 0 1 0 1 0 0 1 0 1 0 1 0 0 1 1 1 1 1
##  [556] 1 0 1 0 0 1 1 0 0 0 1 1 1 1 1 1 0 1 0 0 0 1 1 0 1 1 1 1 1 1 0 1 1 1 0 0 0 1 0
##  [593] 0 1 0 0 1 1 1 1 0 1 1 0 1 0 1 1 1 1 1 0 1 0 1 1 0 1 0 1 0 0 0 0 0 0 1 0 1 1 1 0
##  [630] 0 1 0 1 0 1 1 1 1 1 1 1 0 0 1 0 0 0 1 1 0 1 1 1 0 0 0 0 1 1 0 0 1 1 1 1 0 1 0
##  [667] 1 0 0 0 0 0 0 1 0 1 1 1 1 1 1 0 0 1 0 0 0 1 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 1
##  [704] 0 1 1 0 0 0 0 0 0 0 0 0 1 1 1 1 1 0 0 0 1 1 1 0 1 0 0 1 1 0 1 1 0 1 0 1 1 1 1 0
##  [741] 1 0 1 1 1 0 0 1 1 0 1 0 1 1 1 1 1 1 0 1 0 0 0 0 0 1 1 0 0 0 1 0 1 0 1 0 0 0 0 1
##  [778] 0 0 1 1 0 1 1 0 1 0 1 1 1 1 0 1 0 1 0 1 1 1 1 0 1 0 1 1 1 0 1 1 0 0 0 1 1 0 1
##  [815] 1 0 1 0 1 1 1 1 0 1 1 1 1 0 1 1 1 0 1 1 0 1 1 0 0 1 1 1 1 1 1 0 1 1 1 1 0 1 1 0 0 0
##  [852] 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 1 1 1 1 0 1 1 1 0 1 1 1 0 1 1 0 1 0 0 1 0 0 0 0 0 0 1
##  [889] 0 1 0 1 0 0 0 1 0 1 0 1 0 1 1 0 0 0 1 1 0 0 0 0 0 0 0 0 1 0 0 0 0 1 1 1 1
##  [926] 0 0 1 1 0 0 1 0 1 1 1 1 1 1 0 1 1 1 1 0 1 1 1 1 0 1 1 0 0 0 1 0 1 0 0 1 1 0 1 0
##  [963] 1 0 1 1 1 1 1 1 0 1 0 1 0 0 1 1 0 1 1 1 1 1 1 1 1 0 1 1 0 0 0 1 1 1 0 0 1 0 1
## [1000] 1 1 1 1 1 1 1 1 1 1 0 0 1 1 0 1 1 0 0 0 1 1 0 0 1 0 1 1 0 0 0 1 1 0 1 1 1 0
## [1037] 1 1 1 0 0 1 0 0 1 1 1 1 1 0 1 1 0 1 0 1 0 1 0 1 1 0 0 1 1 1 0 0 1 0 0 0 0 1
## [1074] 1 0 0 1 1 1 0 1 1 0 1 0 1 0 1 0 0 0 1 1 1 0 0 0 1 0 1 1 1 1 0 1 1 0 0 0 0
## [1111] 1 0 0 1 1 1 1 1 1 0 1 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 1 0 1 0 1 1 1 1 1 0 0 1
## [1148] 0 0 1 1 0 1 0 0 1 1 1 1 0 1 0 0 1 1 1 1 1 0 0 1 1 0 0 0 0 0 0 0 1 0 1 1 1 1 1
## [1185] 0 1 0 0 0 1 0 1 1 1 1 1 0 0 1 0 1 1 1 0 1 0 0 1 0 0 0 1 1 1 0 1 1 1 0 1 0 1
## [1222] 1 0 1 0 0 1 1 1 1 1 1 1 0 1 0 0 0 1 1 0 1 1 1 0 0 1 1 0 0 1 1 1 1 0 1 0 0 1
## [1259] 0 1 1 0 1 0 1 1 0 1 1 0 0 0 1 1 0 0 1 1 1 1 1 1 0 1 0 0 0 0 1 0 1 1 1 1 1
## [1296] 1 1 1 1 0 1 0 0 1 1 0 0 0 1 1 1 1 0 1 0 1 1 0 1 0 1 1 1 1 1 1 1 1 0 1 0 1
## [1333] 1 1 1 0 1 0 0 1 0 1 1 1 0 1 0 1 0 1 1 1 0 1 0 1 0 1 1 0 0 1 0 1 0 1 1 1 1 1 0
## [1370] 0 1 0 0 1 1 1 1 0 1 1 1 1 0 1 1 0 1 1 1 1 0 1 0 1 1 0 0 1 1 1 1 0 1 1 0 0 1 1 0
## [1407] 0 1 1 1 1 0 1 0 1 0 0 0 1 0 1 0 1 1 1 1 1 1 1 0 1 1 0 1 1 0 1 0 1 1 1 1 1 0 1 1
## [1444] 0 1 0 0 0 0 0 1 1 0 1 1 1 1 1 0 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1
## [1481] 1 0 0 1 0 1 0 0 1 0 1 1 1 1 0 0 1 1 1 1 0 1 1 1 0 0 1 1 0 1 0 0 0 1 0 1 1 0
## [1518] 1 1 0 0 1 1 1 1 1 0 0 1 1 1 1 0 0 0 1 0 1 0 1 1 1 1 0 0 1 1 1 0 0 0 0 0 0 1 1 0
## [1555] 0 0 0 1 1 0 1 1 1 0 0 0 0 1 1 1 0 1 1 0 0 0 1 1 0 1 1 1 1 1 1 1 1 1 0 1 1
## [1592] 0 0 0 0 0 0 1 0 1 1 1 1 1 1 0 0 0 1 0 1 0 1 0 1 1 1 0 1 1 1 1 0 1 1 1 1 0 1
## [1629] 0 1 1 0 1 0 1 0 1 0 0 1 1 1 1 1 1 0 1 1 0 1 0 1 1 1 0 0 0 0 1 0 1 1 0 0 1 1
## [1666] 0 1 1 0 1 0 1 1 1 0 1 1 0 1 0 1 1 0 1 1 0 0 1 1 1 0 1 1 1 0 1 1 0 0 1 1 1
## [1703] 0 0 0 1 0 0 1 1 0 1 0 1 1 0 1 1 1 1 1 0 1 0 0 1 1 1 0 1 0 0 0 1 0 1 1 1 1
## [1740] 1 0 1 0 1 1 0 1 0 1 1 0 1 0 0 1 1 0 1 0 1 0 0 1 1 0 0 0 0 0 0 1 0 0 0 1 1
## [1777] 0 1 1 0 1 1 0 1 1 1 1 1 0 0 0 1 1 0 1 0 0 1 1 1 1 1 1 1 0 1 0 0 0 0 1 0 0 1 1
## [1814] 1 1 0 1 0 1 0 1 0 1 0 1 1 1 1 1 1 1 0 1 0 0 0 1 1 1 0 0 1 1 1 0 1 0 0 1 1 1
## [1851] 1 0 1 1 1 0 0 1 1 0 1 1 1 0 0 1 1 1 0 0 0 0 1 0 0 0 0 0 0 1 0 0 1 0 1 1 0 0
## [1888] 0 1 1 1 0 1 0 1 0 0 0 0 0 1 1 1 0 1 1 0 1 0 0 1 1 0 0 1 1 0 0 0 0 1 0 1 1
## [1925] 0 1 1 1 1 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 1 0 1 0 1 1 0 1 0 1 1 0 0 1 1 1 0 1
```

```
## [1962] 1 0 1 1 1 0 0 0 1 1 0 1 0 0 1 1 1 1 0 1 1 0 1 1 0 0 1 0 0 0 0 0 0 1 0 0 1
## [1999] 1 0 1 1 0 1 1 1 0 1 0 0 1 1 0 1 1 1 1 1 0 1 1 0 1 0 1 0 0 0 1 1 1 1 1 1 1
## [2036] 1 0 0 1 0 1 0 1 0 1 0 1 0 1 1 1 1 0 0 1 0 1 1 1 1 1 1 0 0 0 1 1 1 0 1 0 0
## [2073] 1 1 0 0 1 1 1 1 1 0 0 1 0 0 1 0 0 1 1 0 1 0 0 1 0 1 0 0 1 1 1 0 1 0 0 1 0 0
## [2110] 1 1 1 0 0 1 0 0 1 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 1 0 1 1 1 1 1 0 1 1 0 1 0 1
## [2147] 0 1 0 0 1 0 1 0 0 0 0 1 1 1 1 1 1 1 1 1 0 1 0 0 0 0 1 0 1 0 0 1 1 0 0 1 0
## [2184] 0 1 1 0 1 1 1 1 1 1 1 1 1 0 1 1 0 1 1 0 1 0 1 1 1 0 1 0 1 1 1 0 0 1 0 1 0
## [2221] 0 1 0 1 1 1 0 0 1 1 1 0 1 0 1 0 0 0 1 1 1 0 1 1 0 0 1 0 0 0 1 1 0 0 0 1 1
## [2258] 1 1 1 1 1 0 0 1 1 1 1 0 1 1 0 0 0 1 1 1 1 1 0 0 0 1 0 1 0 0 1 1 1 0 0 1 0
## [2295] 1 1 1 0 0 0 0 0 0 1 1 1 1 1 1 0 1 0 0 1 1 0 1 1 0 1 1 1 1 0 1 1 0 1 1 0 0
## [2332] 0 1 0 1 0 1 0 1 0 1 0 1 1 1 0 1 0 1 0 1 0 0 0 1 1 1 0 1 0 0 1 0 1 0 0 1 1
## [2369] 0 0 1 1 1 1 0 0 1 1 0 1 1 1 1 1 1 0 1 0 0 1 0 0 1 1 1 1 0 0 1 1 0 0 1 0 0
## [2406] 0 1 1 1 0 1 0 0 1 1 1 1 0 0 1 0 1 0 0 0 1 0 0 0 1 1 1 0 0 1 1 1 1 0 1 0 0
## [2443] 0 1 0 1 1 0 0 1 0 0 1 1 0 0 0 0 1 0 1 1 1 1 0 0 0 1 0 0 0 1 1 1 0 1 0 0 1
## [2480] 0 1 1 0 1 1 1 1 1 0 0 0 1 1 1 0 0 1 1 0 1 1 1 1 1 1 1 1 1 0 1 0 0 0 0 0 0
## [2517] 1 0 1 0 1 0 0 1 1 1 1 1 1 0 0 1 1 0 1 1 1 1 0 1 1 0 1 0 0 0 1 0 0 0 0 1 1 1
## [2554] 0 1 0 0 0 0 1 1 0 1 0 0 1 0 1 1 1 1 0 1 1 0 0 0 0 1 0 0 1 1 0 0 0 1 0 0 1
## [2591] 1 1 1 1 0 1 1 0 0 1 1 1 1 1 1 1 0 1 0 0 1 0 0 1 0 1 0 1 1 0 1 1 1 0 0 1 1
## [2628] 0 1 0 0 0 0 1 0 1 1 0 0 1 0 1 1 1 1 1 0 0 0 1 0 0 0 1 0 1 0 1 0 1 1 1 1 0
## [2665] 1 1 0 1 0 0 0 1 1 0 1 1 1 1 0 0 1 0 1 0 1 0 1 0 1 1 1 0 1 1 1 1 1 1 1 1 1
## [2702] 0 1 1 0 0 0 1 0 0 0 1 0 1 1 0 0 1 1 1 1 0 1 0 1 0 1 1 1 0 1 0 0 1 1 1 1 0
## [2739] 0 0 1 0 1 1 0 1 0 1 0 1 0 0 1 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 1 1
## [2776] 1 0 1 0 1 0 0 0 0 0 0 1 1 0 1 0 1 0 0 1 1 1 0 0 1 0 1 1 0 0 0 0 1 0 1 1 0
## [2813] 1 0 1 0 1 1 0 0 0 1 1 1 1 1 1 0 1 1 1 1 1 0 1 0 0 1 1 0 1 0 1 1 1 0 1 0 1
## [2850] 1 0 1 1 0 1 0 0 0 1 1 0 1 1 0 1 1 1 1 1 1 0 0 1 0 0 0 1 1 1 1 0 0 0 0 1 0 1
## [2887] 1 0 1 0 1 1 1 0 1 1 0 0 0 1 0 1 0 1 0 0 0 0 0 1 1 1 0 1 0 0 0 1 1 0 0 0 0
## [2924] 1 0 0 0 1 1 0 1 0 1 1 1 0 1 0 1 0 1 0 1 1 1 0 0 1 0 0 1 0 0 0 0 0 0 1 1 0
## [2961] 1 1 1 0 1 1 1 1 1 1 1 0 1 0 1 1 0 0 0 0 0 1 1 1 1 0 0 0 1 0 1 0 0 1 0 1 0
## [2998] 1 1 1 1 0 0 1 1 1 0 0 0 1 1 1 0 1 1 0 1 0 0 0 0 0 1 1 1 0 0 1 0 0 1 0 1 0 1
## [3035] 1 0 0 0 1 1 0 0 1 0 0 1 1 0 1 1 1 0 0 1 1 1 1 1 1 0 1 1 0 1 0 1 1 1 0 0 1
## [3072] 1 0 1 1 1 1 1 0 1 1 1 1 1 1 0 1 0 0 0 1 0 1 1 1 0 1 1 1 1 1 1 0 0 1 0 1 0
## [3109] 1 1 0 1 1 0 0 0 0 1 0 1 0 0 1 1 1 1 1 1 0 1 1 1 1 1 1 0 1 0 1 1 0 1 1 1 0 1
## [3146] 1 1 1 1 1 0 0 0 0 1 1 0 1 1 0 0 0 0 1 1 1 0 0 1 0 1 0 1 1 0 0 1 0 0 1 0 1
## [3183] 1 1 0 0 0 0 0 1 0 1 0 0 0 1 1 1 1 0 1 0 1 0 1 1 1 0 0 0 0 1 1 1 1 0 1 1 0
## [3220] 0 1 1 1 1 1 1 1 1 1 1 0 1 0 1 1 0 1 0 1 0 0 0 0 0 0 1 0 1 1 1 1 1 1 1 1 0 0
## [3257] 0 1 1 0 1 1 1 0 0 0 1 1 1 0 1 0 1 1 0 0 1 0 1 1 0 0 0 1 1 0 0 1 1 1 1 1 1
## [3294] 1 0 0 0 0 0 0 0 1 1 1 1 0 1 1 1 0 1 0 0 0 1 0 0 1 1 0 0 0 1 1 1 1 1 1 0 0 0
## [3331] 0 1 1 0 0 1 1 1 0 0 1 0 0 1 0 0 0 1 1 1 0 1 1 1 0 0 0 0 0 1 0 1 1 0 0 1 0
## [3368] 0 1 1 0 1 1 0 0 1 0 0 1 1 0 1 1 0 1 1 0 1 0 1 1 0 1 1 1 1 1 1 0 1 1 1 1 0
## [3405] 0 1 0 0 1 1 1 1 1 0 0 1 1 1 1 0 1 1 1 0 1 1 0 1 1 1 1 1 0 1 1 1 0 1 1 1 0 1 1 1
## [3442] 0 0 1 1 0 1 0 0 0 0 0 0 1 1 0 0 0 1 0 0 0 0 1 0 0 0 1 0 0 1 1 1 1 1 1 0 0
## [3479] 1 0 0 1 0 0 0 1 0 0 0 1 1 0 0 1 1 0 0 1 1 0 1 0 0 0 1 1 1 0 0 1 0 1 0 0 0
## [3516] 1 1 1 1 1 1 1 0 1 0 0 1 1 0 0 1 0 1 0 1 0 1 1 0 1 1 1 0 0 1 0 1 1 1 0 0 1 0
## [3553] 0 0 0 1 0 1 0 0 1 0 1 1 0 1 1 1 0 0 0 0 0 0 0 1 0 1 1 1 1 0 0 1 1 1 0 1 0
## [3590] 0 1 0 1 1 1 0 0 1 0 0 1 1 0 1 0 0 0 1 0 1 1 1 0 1 1 0 1 0 1 1 1 1 1 1 1 0 1
## [3627] 0 1 1 1 1 0 0 0 0 0 1 1 1 1 1 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 1
## Levels: 0 1
```

```
table(female)
```

```
## female
##    0    1
## 1623 2035
```

```
set.seed(0)
# This data is pretty skewed so even though n is large, I'm going to do a lot of simulations
num_sims <- 10000
# A vector to store my results
results <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 results[i] <- mean(as.numeric(sample(x = female, size = n, replace = TRUE))-1)
}
# Finally plot the results
hist(results, freq = FALSE, main='Sampling Distribution of the Sample Proportion', xlab = 'Propo
rtion of Female', ylab = 'Density')
# estimate a normal curve over it - this looks pretty good!
lines(x = seq(.52, .60, .001), dnorm(seq(.52, .60, .001), mean = mean(results), sd = sd(result
s)))
```




```
cat("Bootstrap Confidence Interval")
```

```
## Bootstrap Confidence Interval
```

```
c(quantile(results, c(0.05,1)))
```

```
##        5%      100% 
## 0.5431930 0.5918535
```

```
cat("exact binomial test")
```

```
## exact binomial test
```

```
binom.test(x = p, n = n, p = p_0, alternative = "greater")$conf.int
```

```
## [1] 0.5426369 1.0000000
## attr(,"conf.level")
## [1] 0.95
```

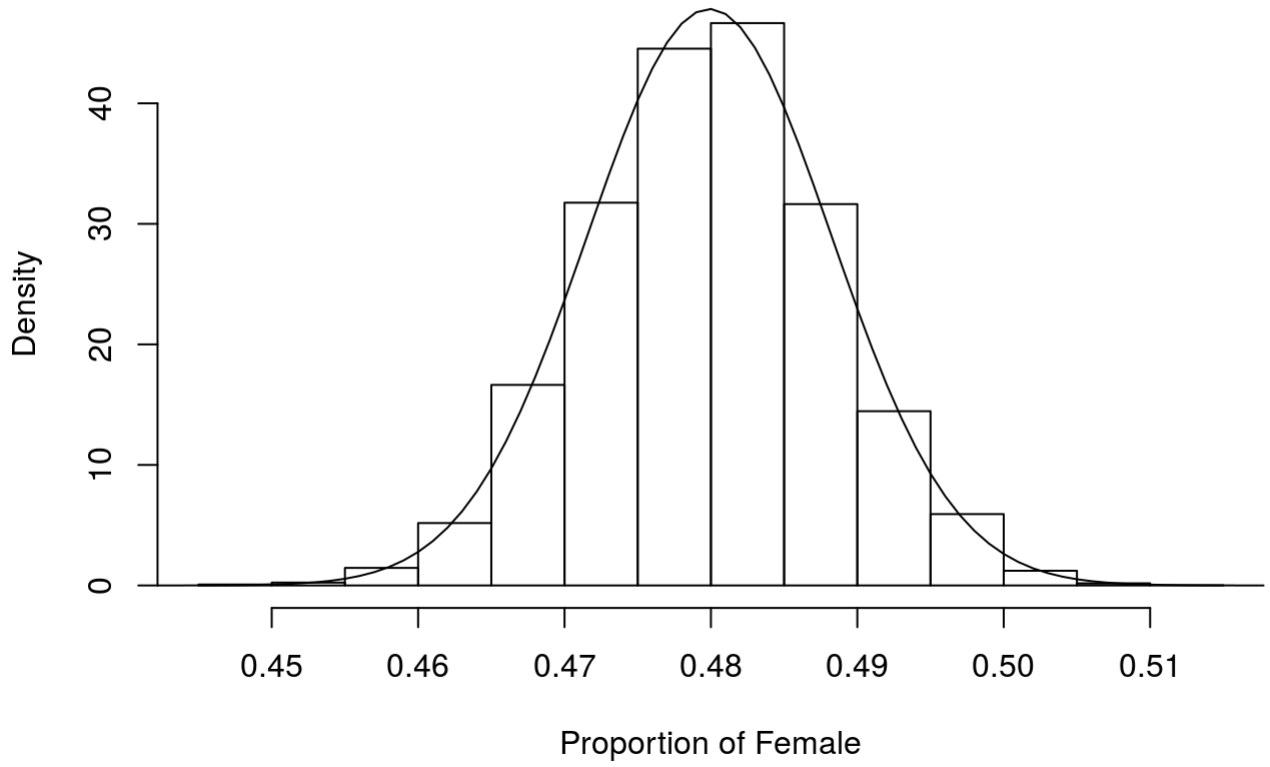
```
cat("normal approx")
```

```
## normal approx
```

```
c(p_hat - (1.64)*sqrt(((p_hat)*(1-p_hat))/n),1)
```

```
## [1] 0.5428433 1.0000000
```

```
# Under the assumption that the null hypothesis is true, we have 48% female
female_sim <- rep(c(1, 0), c(.48*n, (1-.48)*n))
num_sims <- 10000
# A vector to store my results
results_H0_true <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 results_H0_true[i] <- mean(sample(x = female_sim,
 size = n,
 replace = TRUE))
}
# Finally plot the results
hist(results_H0_true, freq = FALSE, main='Sampling Distribution of the Sample Proportion under H
_0:p = 0.48', xlab = 'Proportion of Female', ylab = 'Density')
# estimate a normal curve over it - this looks pretty good!
lines(x = seq(.30, .65, .001), dnorm(seq(.30, .65, .001), mean = mean(results_H0_true), sd = sd
(results_H0_true)))
abline(v=p_hat, col="red")
```




```
count_of_more_extreme_upper_tail <- sum(results_H0_true >= p_hat)
bootstrap_pvalue <- count_of_more_extreme_upper_tail/num_sims
cat("Bootstrap p-value")
```

```
## Bootstrap p-value
```

```
bootstrap_pvalue
```

```
## [1] 0
```

```
cat("Exact Binomial p-value")
```

```
## Exact Binomial p-value
```

```
binom.test(x = p, n = n, p = p_0, alternative = "greater")$p.value
```

```
## [1] 1.468325e-20
```

```
cat("Normal Approximation p-value")
```

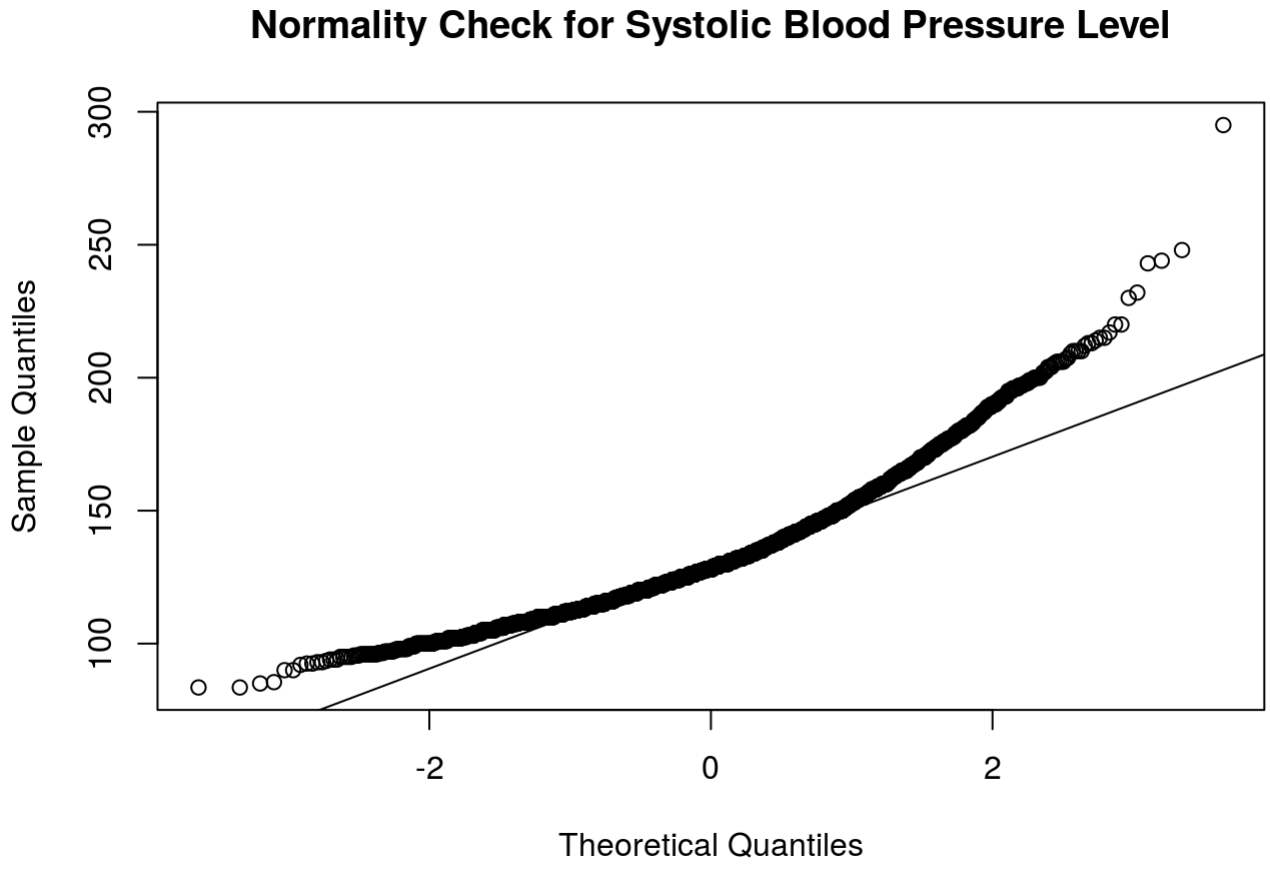
```
## Normal Approximation p-value
```

```
pnorm(z, lower.tail = FALSE)
```

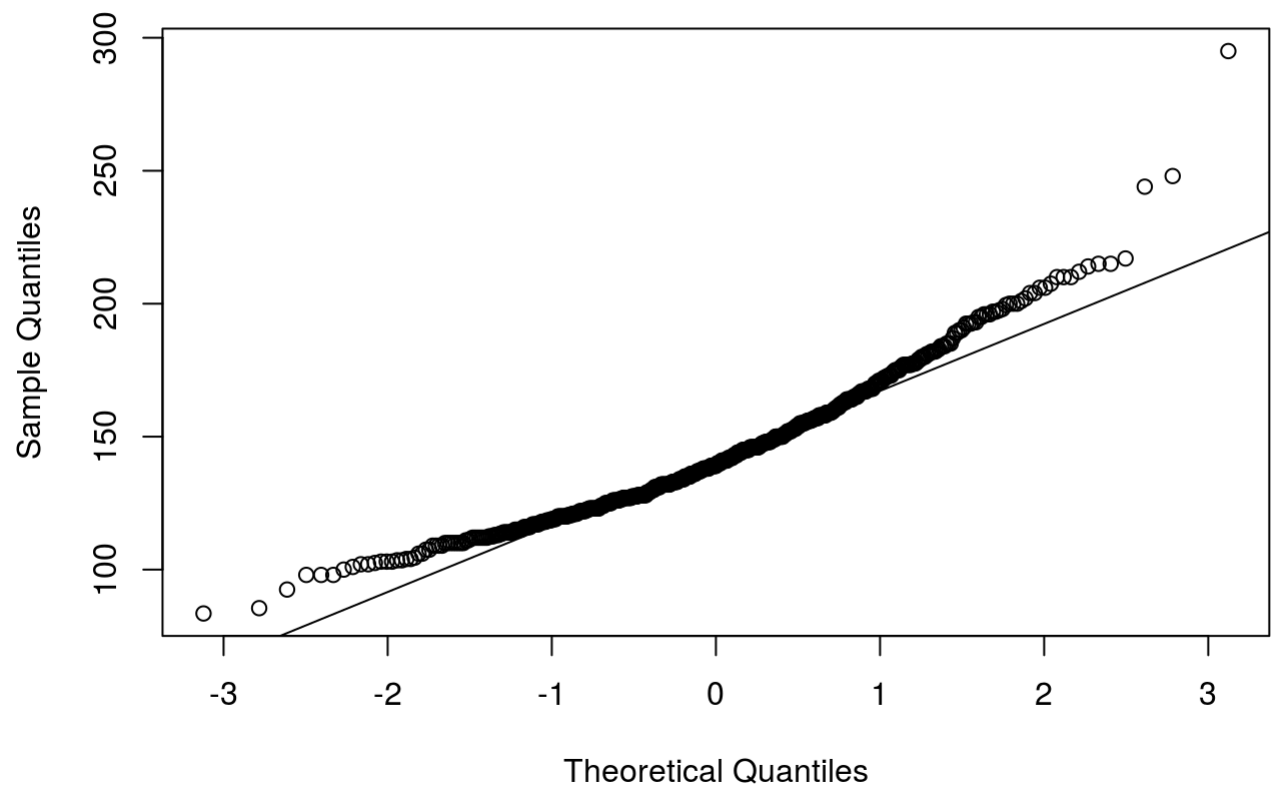
```
## [1] 1.248001e-20
```

# 3. Two sample t-Test for Difference in Means

```
qqnorm(data$SystolicBloodPressure, main ="Normality Check for Systolic Blood Pressure Level")
qqline(data$SystolicBloodPressure)
```

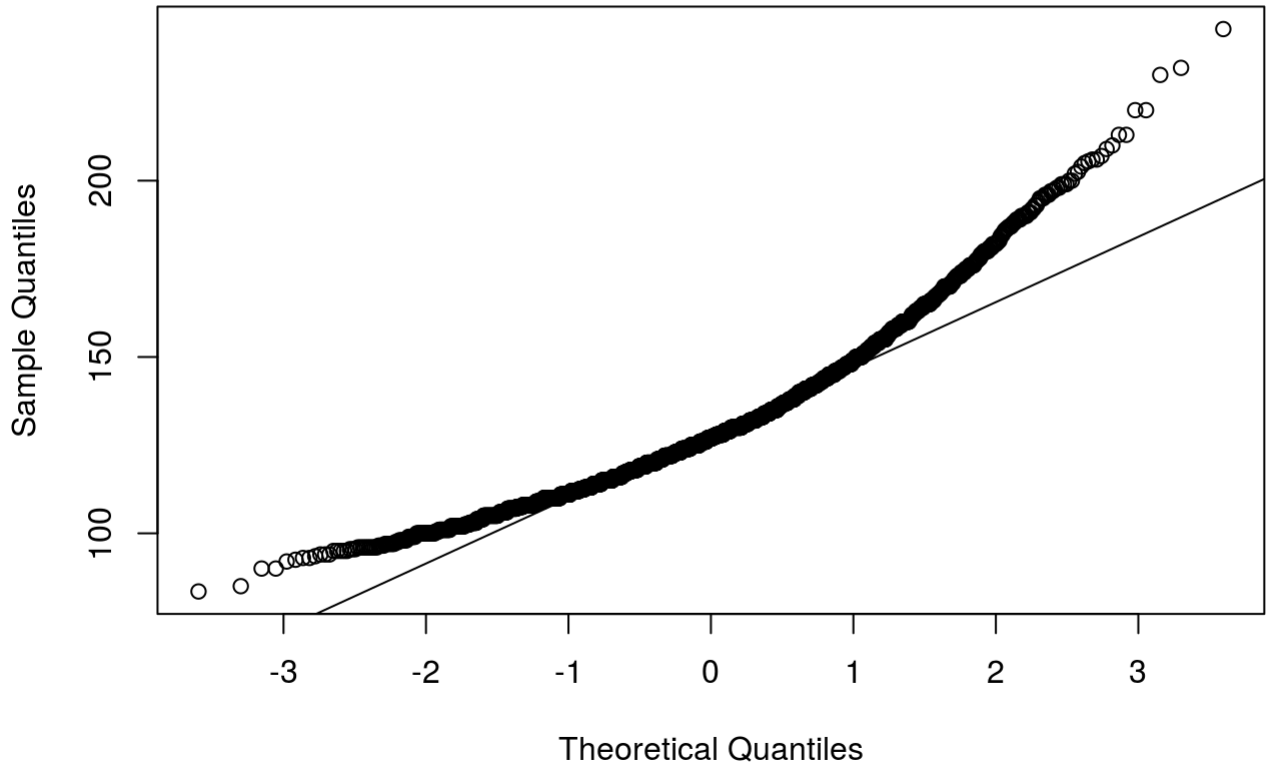



```
qqnorm(data$SystolicBloodPressure[data$TenYearCoronaryHeartDisease == "Vulnerable"], main ="Norm
ality Check for Systolic Blood Pressure of patients Vulnerable to 10 Year CHD")
qqline(data$SystolicBloodPressure[data$TenYearCoronaryHeartDisease == "Vulnerable"])
```




```
qqnorm(data$SystolicBloodPressure[data$TenYearCoronaryHeartDisease == "Immune"], main ="Normalit
y Check for Systolic Blood Pressure of patients Immune to 10 Year CHD")
qqline(data$SystolicBloodPressure[data$TenYearCoronaryHeartDisease == "Immune"])
```

## lormality Check for Systolic Blood Pressure of patients Immune to 10 Year




## Sub-Sampling

```
set.seed(0)
immunePatientsData <- subset(data, data$TenYearCoronaryHeartDisease == "Immune")
immuneDataSample <- immunePatientsData[sample(nrow(immunePatientsData), 300), ]
head(immuneDataSample)
```

```
##      Gender Age                    Education SmokingBehavior CigarettesPerDay
## 1942 Female  45            Vocational School      Non Smoker                0
## 1402   Male  36                      College      Non Smoker                0
## 939  Female  47 General Education Development          Smoker                2
## 2993 Female  38 General Education Development          Smoker                2
## 1279   Male  53                  High School          Smoker               30
## 2117 Female  39                      College          Smoker                9
##      BloodPressureMedication PrevalentStroke PrevalentHypertension
## 1942 Not Under BP Medication             No                    No
## 1402 Not Under BP Medication             No                    No
## 939  Not Under BP Medication             No                    No
## 2993 Not Under BP Medication             No                    No
## 1279 Not Under BP Medication             No                    No
## 2117 Not Under BP Medication             No                    No
##      DiabeticCondition TotalCholestrol SystolicBloodPressure
## 1942      Non Diabetic             237                 118.0
## 1402      Non Diabetic             172                 122.5
## 939       Non Diabetic             232                 133.0
## 2993      Non Diabetic             172                  98.0
## 1279      Non Diabetic             253                 121.0
## 2117      Non Diabetic             180                 113.0
##      DiastolicBloodPressure BodyMassIndex HeartRate GlucoseLevel
## 1942                   84.0         22.53        68           78
## 1402                   82.5         28.53        82           75
## 939                    86.0         20.15        72           74
## 2993                   53.0         22.18        68           82
## 1279                   85.5         28.52        80           68
## 2117                   73.0         17.65        70           73
##      TenYearCoronaryHeartDisease
## 1942                      Immune
## 1402                      Immune
## 939                       Immune
## 2993                      Immune
## 1279                      Immune
## 2117                      Immune
```

```
set.seed(0)
vulnerablePatientsData <- subset(data, data$TenYearCoronaryHeartDisease == "Vulnerable")
vulnerableDataSample <- vulnerablePatientsData[sample(nrow(vulnerablePatientsData), 300), ]
head(vulnerableDataSample)
```

```
##      Gender Age         Education SmokingBehavior CigarettesPerDay
## 3051 Female  63 Vocational School      Non Smoker                0
## 878  Female  64       High School      Non Smoker                0
## 3876 Female  56       High School          Smoker               40
## 3646   Male  68       High School          Smoker               15
## 2329   Male  66           College          Smoker               20
## 2088   Male  57 Vocational School      Non Smoker                0
##      BloodPressureMedication PrevalentStroke PrevalentHypertension
## 3051 Not Under BP Medication             No                   Yes
## 878  Not Under BP Medication             No                   Yes
## 3876 Not Under BP Medication             No                   Yes
## 3646 Not Under BP Medication             No                    No
## 2329 Not Under BP Medication             No                   Yes
## 2088 Not Under BP Medication             No                    No
##      DiabeticCondition TotalCholestrol SystolicBloodPressure
## 3051      Non Diabetic             241                   153
## 878       Non Diabetic             255                   153
## 3876      Non Diabetic             214                   147
## 3646      Non Diabetic             157                   106
## 2329      Non Diabetic             273                   145
## 2088      Non Diabetic             213                   141
##      DiastolicBloodPressure BodyMassIndex HeartRate GlucoseLevel
## 3051                     89         32.57        65           75
## 878                      75         23.39        60           74
## 3876                     65         17.68       110           87
## 3646                     48         26.73        65           65
## 2329                     88         25.41        69           74
## 2088                     90         30.77        60           77
##      TenYearCoronaryHeartDisease
## 3051                  Vulnerable
## 878                   Vulnerable
## 3876                  Vulnerable
## 3646                  Vulnerable
## 2329                  Vulnerable
## 2088                  Vulnerable
```

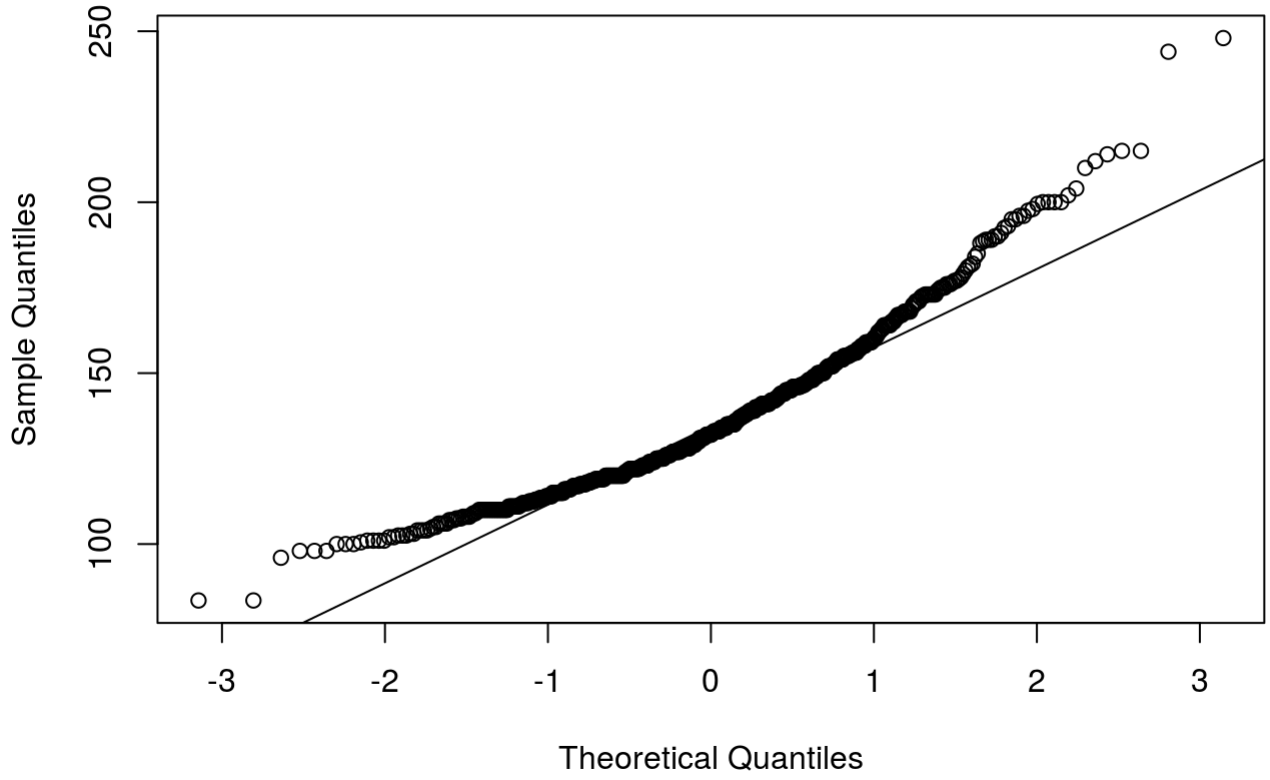
```
sampleData <- rbind(immuneDataSample, vulnerableDataSample)
head(sampleData)
```

```
##      Gender Age                    Education SmokingBehavior CigarettesPerDay
## 1942 Female  45            Vocational School      Non Smoker                0
## 1402   Male  36                      College      Non Smoker                0
## 939  Female  47 General Education Development          Smoker                2
## 2993 Female  38 General Education Development          Smoker                2
## 1279   Male  53                  High School          Smoker               30
## 2117 Female  39                      College          Smoker                9
##      BloodPressureMedication PrevalentStroke PrevalentHypertension
## 1942 Not Under BP Medication             No                    No
## 1402 Not Under BP Medication             No                    No
## 939  Not Under BP Medication             No                    No
## 2993 Not Under BP Medication             No                    No
## 1279 Not Under BP Medication             No                    No
## 2117 Not Under BP Medication             No                    No
##      DiabeticCondition TotalCholestrol SystolicBloodPressure
## 1942      Non Diabetic             237                 118.0
## 1402      Non Diabetic             172                 122.5
## 939       Non Diabetic             232                 133.0
## 2993      Non Diabetic             172                  98.0
## 1279      Non Diabetic             253                 121.0
## 2117      Non Diabetic             180                 113.0
##      DiastolicBloodPressure BodyMassIndex HeartRate GlucoseLevel
## 1942                   84.0         22.53        68           78
## 1402                   82.5         28.53        82           75
## 939                    86.0         20.15        72           74
## 2993                   53.0         22.18        68           82
## 1279                   85.5         28.52        80           68
## 2117                   73.0         17.65        70           73
##      TenYearCoronaryHeartDisease
## 1942                      Immune
## 1402                      Immune
## 939                       Immune
## 2993                      Immune
## 1279                      Immune
## 2117                      Immune
```

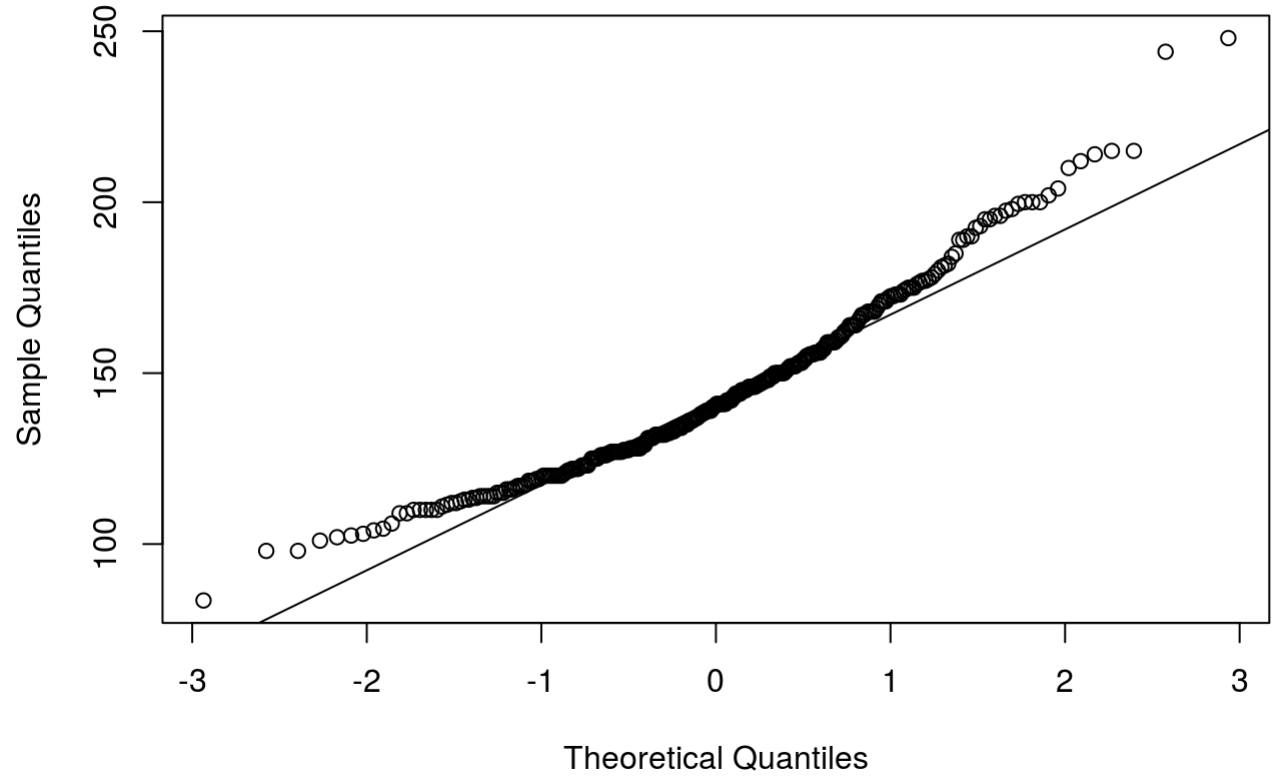
```
summary(sampleData)
```

```
##     Gender         Age                                 Education
##  Female:292   Min.   :33.00   College                       : 74
##  Male  :308   1st Qu.:44.00   General Education Development:164
##               Median :52.00   High School                   :273
##               Mean   :51.51   Vocational School             : 89
##               3rd Qu.:59.00
##               Max.   :69.00
##    SmokingBehavior CigarettesPerDay            BloodPressureMedication
##  Non Smoker:310    Min.   : 0.000   Not Under BP Medication:573
##  Smoker    :290    1st Qu.: 0.000   Under BP Medication    : 27
##                    Median : 0.000
##                    Mean   : 9.158
##                    3rd Qu.:20.000
##                    Max.   :50.000
##  PrevalentStroke PrevalentHypertension    DiabeticCondition TotalCholestrol
##  No :596         No :365               Diabetic    : 27     Min.   :143.0
##  Yes:  4         Yes:235               Non Diabetic:573     1st Qu.:209.8
##                                                             Median :237.0
##                                                             Mean   :240.1
##                                                             3rd Qu.:265.2
##                                                             Max.   :464.0
##  SystolicBloodPressure DiastolicBloodPressure BodyMassIndex     HeartRate
##  Min.   : 83.5         Min.   : 48.00         Min.   :16.71   Min.   : 44.0
##  1st Qu.:119.0         1st Qu.: 75.00         1st Qu.:23.28   1st Qu.: 67.0
##  Median :132.0         Median : 83.00         Median :25.80   Median : 75.0
##  Mean   :136.9         Mean   : 84.31         Mean   :26.15   Mean   : 75.4
##  3rd Qu.:150.0         3rd Qu.: 92.00         3rd Qu.:28.57   3rd Qu.: 81.0
##  Max.   :248.0         Max.   :140.00         Max.   :56.80   Max.   :125.0
##   GlucoseLevel    TenYearCoronaryHeartDisease
##  Min.   : 40.00   Immune    :300
##  1st Qu.: 72.00   Vulnerable:300
##  Median : 78.00
##  Mean   : 85.92
##  3rd Qu.: 87.00
##  Max.   :394.00
```

```
qqnorm(sampleData$SystolicBloodPressure, main ="Sample Data - Normality Check for Systolic Blood Pressure Level")
qqline(sampleData$SystolicBloodPressure)
```

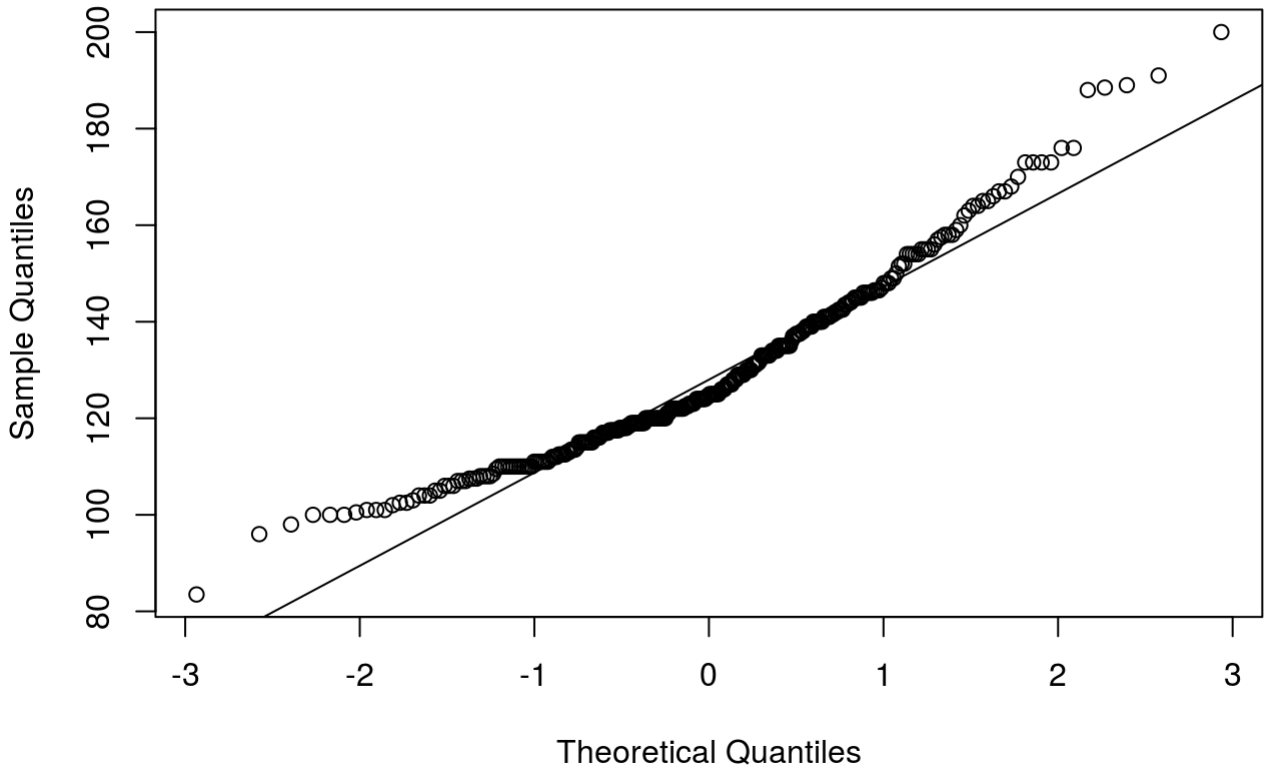



```
qqnorm(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"],
main ="Sample - Data Normality Check for Systolic Blood Pressure of patients Vulnerable to 10 Ye
ar CHD")
qqline(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"])
```




```
qqnorm(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"], mai
n ="Sample Data - Normality Check for Systolic Blood Pressure of patients Immune to 10 Year CHD"
)
qqline(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"])
```

## Data - Normality Check for Systolic Blood Pressure of patients Immune to




## (a) Traditional Statistical Tools

### Hypothesis

Null Hypothesis: The true population mean Systolic Blood Pressure of Patients Vulnerable to Heart Disease is equal to the true population mean Systolic Blood Pressure of Patients Immune to Heart Disease.

$$H_0 : \mu_v - \mu_i = 0 \; or \; \mu_v = \mu_i$$

Alternate Hypothesis: The true population mean Systolic Blood Pressure of Patients Vulnerable to Heart Disease is not equal to the true population mean Systolic Blood Pressure of Patients Immune to Heart Disease.

$$H_{A1} : \mu_v - \mu_i \neq 0 \; or \; \mu_v \neq \mu_i$$

### Parameter

We are interested in the true population mean difference in Systolic Blood Pressure Levels between those who are Vulnerable to Heart Disease and those who are Immune to Heart Disease

$$\overline{\mu}_v - \overline{\mu}_i$$

### Sample Statistic: Difference in Means

$$\overline{x}_v - \overline{x}_i$$

### Test-statistic

$$t = \frac{(\overline{x}_v - \overline{x}_i) - (\mu_v - \mu_i)}{\sqrt{\frac{\sigma_v^2}{n_v} + \frac{\sigma_i^2}{n_i}}}$$

$$\mu_0 = \mu_v - \mu_i = 0$$

## Two Sample t-test

Calculating p-value using R in-built function t.test()

```
t.test(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"],
sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"])
```

```
##
##  Welch Two Sample t-test
##
## data:  sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease ==  and sample
Data$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease ==     "Vulnerable"] and
"Immune"]
## t = 7.9666, df = 545.18, p-value = 9.577e-15
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  11.47974 18.99359
## sample estimates:
## mean of x mean of y
##  144.5017  129.2650
```

Calculating p-value manually using given formulas.

```
# Mean Systolic Blood Pressure of Vulnerable Patients
mu_v <- mean(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Vulnera
ble'])
mu_v
```

```
## [1] 144.5017
```

```
# Mean Systolic Blood Pressure of Immune Patients
mu_i <- mean(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Immune'
])
mu_i
```

```
## [1] 129.265
```

```
# Null Hypothesis
mu_0 <- 0
```

```
# Variance of Systolic Blood Pressure of Vulnerable Patients
var_v <- var(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Vulnera
ble'])
var_v
```

```
## [1] 719.4858
```

```
# Variance of Systolic Blood Pressure of Vulnerable Patients
var_i <- var(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Immune'
])
var_i
```

```
## [1] 377.9003
```

```
# Sample Size of Systolic Blood Pressure of Vulnerable Patients
n_v <- length(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Vulner
able'])
n_v
```

```
## [1] 300
```

```
# Sample Size of Systolic Blood Pressure of Vulnerable Patients
n_i <- length(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Immun
e'])
n_i
```

```
## [1] 300
```

```
# t-value (test statistic)
t <- (mu_v - mu_i - mu_0)/sqrt(var_v/n_v + var_i/n_i)
t
```

```
## [1] 7.966561
```

```
# p-value for 2 sided t-test
p_value <- pt(q = t, df = min(n_v, n_i) - 1, lower.tail = FALSE)*2
p_value
```

```
## [1] 3.450811e-14
```

```
# Lower Boundary of Confidence Interval
lowerBound <- mu_v - mu_i + qt(0.05, min(n_v, n_i) - 1)*sqrt(var_v/n_v + var_i/n_i)
lowerBound
```

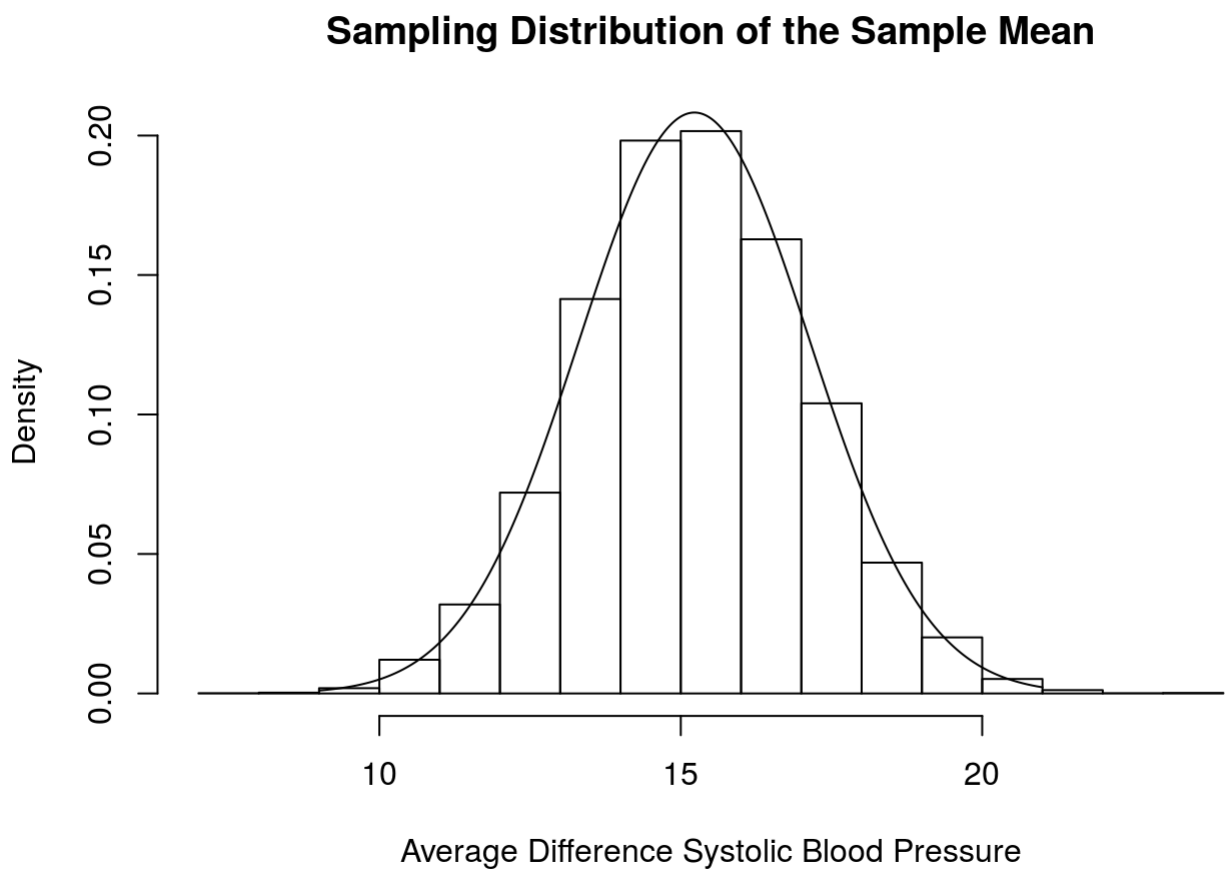
```
## [1] 12.08098
```

```
# Upper Boundary of Confidence Interval
upperBound <- mu_v - mu_i + qt(0.95, min(n_v, n_i) - 1)*sqrt(var_v/n_v + var_i/n_i)
upperBound
```

```
## [1] 18.39235
```

## (b) Bootstrap Methods

```
set.seed(0)
num_sims <- 10000
# A vector to store my results
results <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 mean_immune <- mean(sample(x = sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeart
Disease == 'Immune'],
 size = 300,
 replace = TRUE))
 mean_vulnerable <- mean(sample(x = sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryH
eartDisease == 'Vulnerable'],
 size = 300,
 replace = TRUE))
 results[i] <- mean_vulnerable - mean_immune
}
# Finally plot the results
hist(results, freq = FALSE, main='Sampling Distribution of the Sample Mean', xlab = 'Average Dif
ference Systolic Blood Pressure', ylab = 'Density')
lines(x = seq(9, 21, .01), dnorm(seq(9, 21, .01), mean = mean(results), sd = sd(results)))
```



```
# Bootstrap one-sided CI
c(quantile(results, c(.025, .975)))
```

```
##     2.5%    97.5%
## 11.43804 19.04338
```

```
t.test(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"],
sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"])$conf.int
```

```
## [1] 11.47974 18.99359
## attr(,"conf.level")
## [1] 0.95
```

```
set.seed(0)
transform(sampleData,Group=sample(TenYearCoronaryHeartDisease))
```

```
##      Gender Age                    Education SmokingBehavior CigarettesPerDay
## 1942 Female  45             Vocational School      Non Smoker                0
## 1402   Male  36                       College      Non Smoker                0
## 939  Female  47 General Education Development          Smoker                2
## 2993 Female  38 General Education Development          Smoker                2
## 1279   Male  53                   High School          Smoker               30
## 2117 Female  39                       College          Smoker                9
## 652  Female  56                   High School          Smoker               18
## 3224 Female  50 General Education Development          Smoker               20
## 382  Female  42 General Education Development      Non Smoker                0
## 1651   Male  42                   High School          Smoker               25
## 825  Female  37 General Education Development          Smoker               10
## 1773   Male  55                       College      Non Smoker                0
## 2701 Female  63                   High School      Non Smoker                0
## 462  Female  35 General Education Development          Smoker               15
## 2467   Male  64                   High School      Non Smoker                0
## 2226   Male  38                       College      Non Smoker                0
## 2402 Female  37                       College          Smoker               10
## 54   Female  62                   High School      Non Smoker                0
## 1537 Female  44                   High School          Smoker                9
## 1009   Male  53                   High School          Smoker               20
## 1216   Male  46             Vocational School      Non Smoker                0
## 669  Female  38                   High School          Smoker               15
## 2503   Male  53                   High School      Non Smoker                0
## 3999 Female  37                   High School          Smoker                9
## 3330   Male  65                   High School          Smoker                3
## 1335   Male  44                   High School          Smoker               20
## 3903   Male  52                   High School          Smoker               20
## 3972   Male  64             Vocational School      Non Smoker                0
## 4071 Female  40             Vocational School      Non Smoker                0
## 3260 Female  37                       College      Non Smoker                0
## 3264   Male  36 General Education Development          Smoker               20
## 760    Male  53 General Education Development      Non Smoker                0
## 1974   Male  48                       College          Smoker               20
## 2967   Male  54             Vocational School      Non Smoker                0
## 2666   Male  58                   High School          Smoker               15
## 3525 Female  50                   High School          Smoker               20
## 2106 Female  53                   High School          Smoker                9
## 3554 Female  68             Vocational School      Non Smoker                0
## 4017   Male  62 General Education Development          Smoker               20
## 478  Female  46             Vocational School          Smoker               15
## 3596 Female  58                   High School          Smoker               10
## 58     Male  49                   High School          Smoker                2
## 734    Male  64                   High School          Smoker                8
## 3320   Male  36 General Education Development          Smoker               25
## 351  Female  45             Vocational School      Non Smoker                0
## 1666   Male  50 General Education Development          Smoker               30
## 3325 Female  58 General Education Development          Smoker               10
## 2856   Male  59                       College      Non Smoker                0
## 3402   Male  58                       College          Smoker                9
## 3915 Female  56 General Education Development      Non Smoker                0
## 1930   Male  40 General Education Development      Non Smoker                0
## 1777   Male  37 General Education Development          Smoker               15
```

```
## 2327   Male  46                      College          Smoker                20
## 723    Male  64                  High School      Non Smoker                 0
## 3685   Male  38                  High School          Smoker                 9
## 1464   Male  51                  High School          Smoker                50
## 1946   Male  45            Vocational School          Smoker                35
## 31     Male  36                      College          Smoker                35
## 2394 Female  59            Vocational School          Smoker                15
## 2426 Female  63                  High School      Non Smoker                 0
## 3077 Female  43                  High School          Smoker                10
## 1902 Female  59                  High School      Non Smoker                 0
## 3483   Male  38 General Education Development      Non Smoker                 0
## 1536 Female  59                      College      Non Smoker                 0
## 1347 Female  42 General Education Development      Non Smoker                 0
## 2456 Female  39 General Education Development          Smoker                20
## 2084 Female  62                  High School      Non Smoker                 0
## 2256   Male  41                      College          Smoker                10
## 2254   Male  56                  High School          Smoker                20
## 1165 Female  45                      College      Non Smoker                 0
## 645    Male  36                      College      Non Smoker                 0
## 1368 Female  53 General Education Development      Non Smoker                 0
## 2141 Female  50 General Education Development      Non Smoker                 0
## 1636   Male  52                  High School          Smoker                 2
## 1544   Male  52            Vocational School      Non Smoker                 0
## 118  Female  37 General Education Development          Smoker                 5
## 2595   Male  45                      College      Non Smoker                 0
## 1586 Female  63                  High School      Non Smoker                 0
## 3162 Female  62                  High School      Non Smoker                 0
## 3807 Female  52 General Education Development          Smoker                20
## 4185   Male  44                  High School          Smoker                20
## 3649 Female  50                  High School          Smoker                15
## 1811   Male  45 General Education Development          Smoker                 5
## 765    Male  45            Vocational School      Non Smoker                 0
## 2313 Female  44                  High School          Smoker                 5
## 405    Male  45                      College          Smoker                20
## 3640 Female  50 General Education Development      Non Smoker                 0
## 3263 Female  69            Vocational School      Non Smoker                 0
## 3468 Female  54            Vocational School      Non Smoker                 0
## 3976   Male  43 General Education Development          Smoker                43
## 3971 Female  43 General Education Development          Smoker                 5
## 2094   Male  66                  High School          Smoker                20
## 1186   Male  46                  High School      Non Smoker                 0
## 2522   Male  53                  High School          Smoker                20
## 3647 Female  37                  High School          Smoker                15
## 799    Male  54 General Education Development      Non Smoker                 0
## 1357   Male  40                  High School      Non Smoker                 0
## 445    Male  44            Vocational School      Non Smoker                 0
## 1470 Female  54            Vocational School      Non Smoker                 0
## 1013 Female  54 General Education Development          Smoker                20
## 1793   Male  40                      College      Non Smoker                 0
## 3694   Male  52            Vocational School      Non Smoker                 0
## 4235   Male  51            Vocational School          Smoker                43
## 1126 Female  46            Vocational School      Non Smoker                 0
## 1312   Male  59                  High School          Smoker                20
## 3203   Male  38            Vocational School          Smoker                23
```

```
## 1588 Female  42                      College      Non Smoker                0
## 3206 Female  49                  High School      Non Smoker                0
## 2345   Male  43                      College      Non Smoker                0
## 689  Female  57 General Education Development      Non Smoker                0
## 3501 Female  46 General Education Development      Non Smoker                0
## 733  Female  48                  High School          Smoker                5
## 3746 Female  61                  High School      Non Smoker                0
## 1354   Male  33 General Education Development      Non Smoker                0
## 3813 Female  61                  High School          Smoker                9
## 1462 Female  51            Vocational School      Non Smoker                0
## 1413 Female  46 General Education Development          Smoker               20
## 41   Female  43 General Education Development          Smoker               10
## 2660   Male  44 General Education Development          Smoker               20
## 1159 Female  46            Vocational School          Smoker                5
## 2494   Male  46            Vocational School      Non Smoker                0
## 2277   Male  42                      College          Smoker               20
## 3134 Female  64 General Education Development      Non Smoker                0
## 1796   Male  42 General Education Development          Smoker               35
## 794  Female  44                  High School      Non Smoker                0
## 2688   Male  63            Vocational School      Non Smoker                0
## 515    Male  56                  High School          Smoker               20
## 3423 Female  66                  High School      Non Smoker                0
## 120    Male  50            Vocational School          Smoker               40
## 2071 Female  35 General Education Development      Non Smoker                0
## 3261   Male  54                      College      Non Smoker                0
## 2262   Male  57            Vocational School      Non Smoker                0
## 496    Male  44                  High School          Smoker               20
## 2527 Female  40 General Education Development      Non Smoker                0
## 3917   Male  62                  High School          Smoker               30
## 1468   Male  40 General Education Development      Non Smoker                0
## 505  Female  50            Vocational School      Non Smoker                0
## 1828   Male  39 General Education Development      Non Smoker                0
## 1727 Female  49            Vocational School      Non Smoker                0
## 3842 Female  52 General Education Development      Non Smoker                0
## 2523 Female  37            Vocational School          Smoker               15
## 3924   Male  59                  High School      Non Smoker                0
## 350  Female  59                  High School      Non Smoker                0
## 1035   Male  39                  High School          Smoker               20
## 308    Male  49                  High School          Smoker               20
## 183    Male  36                  High School          Smoker               40
## 156    Male  39                  High School          Smoker               40
## 729  Female  37                  High School          Smoker               20
## 3324 Female  45            Vocational School          Smoker               20
## 570  Female  44            Vocational School          Smoker               15
## 2192 Female  52                  High School          Smoker               20
## 1257 Female  45            Vocational School      Non Smoker                0
## 3441 Female  50            Vocational School          Smoker                3
## 2994   Male  61                  High School      Non Smoker                0
## 4108 Female  43 General Education Development          Smoker               30
## 2516   Male  54 General Education Development      Non Smoker                0
## 502  Female  52                  High School      Non Smoker                0
## 2956 Female  47            Vocational School          Smoker                5
## 1559 Female  61                  High School      Non Smoker                0
## 2799   Male  57                  High School      Non Smoker                0
```

```
## 1503   Male  64 General Education Development      Non Smoker                0
## 1694 Female  43 General Education Development      Non Smoker                0
## 1660 Female  47             Vocational School      Non Smoker                0
## 25     Male  44 General Education Development          Smoker               30
## 386    Male  39 General Education Development      Non Smoker                0
## 585    Male  37                    High School      Non Smoker                0
## 2731 Female  46 General Education Development          Smoker               20
## 2160 Female  42             Vocational School          Smoker               15
## 3385   Male  41 General Education Development      Non Smoker                0
## 1200   Male  40                    High School          Smoker               10
## 950  Female  34 General Education Development          Smoker               20
## 562  Female  54                    High School      Non Smoker                0
## 2221   Male  42                    High School          Smoker               20
## 1429   Male  44                    High School          Smoker               20
## 1458 Female  59                    High School      Non Smoker                0
## 2471   Male  37                        College          Smoker               16
## 1135 Female  64                    High School      Non Smoker                0
## 3624 Female  48             Vocational School      Non Smoker                0
## 875    Male  52             Vocational School      Non Smoker                0
## 919    Male  49                    High School      Non Smoker                0
## 995  Female  46 General Education Development      Non Smoker                0
## 3849   Male  37                        College          Smoker               30
## 3721   Male  44                        College      Non Smoker                0
## 3130 Female  42             Vocational School      Non Smoker                0
## 590  Female  45                    High School      Non Smoker                0
## 588    Male  40 General Education Development          Smoker               30
## 1356   Male  38                    High School      Non Smoker                0
## 190  Female  55                    High School      Non Smoker                0
## 173  Female  50 General Education Development          Smoker               20
## 1372 Female  55 General Education Development      Non Smoker                0
## 4006 Female  52                        College      Non Smoker                0
## 3189   Male  63                    High School      Non Smoker                0
## 1565   Male  54                    High School      Non Smoker                0
## 3590   Male  53                    High School          Smoker               43
## 2122 Female  39 General Education Development      Non Smoker                0
## 694    Male  40                        College          Smoker               30
## 2033 Female  38                    High School      Non Smoker                0
## 499    Male  56                        College      Non Smoker                0
## 1084 Female  54 General Education Development      Non Smoker                0
## 2990 Female  40                        College          Smoker                3
## 3689 Female  43 General Education Development          Smoker               20
## 2167 Female  42                        College      Non Smoker                0
## 432  Female  57                    High School      Non Smoker                0
## 2512 Female  39 General Education Development          Smoker               20
## 3375   Male  37                        College          Smoker               30
## 1344 Female  44                        College          Smoker               25
## 3587   Male  63                    High School          Smoker               15
## 176    Male  62                    High School          Smoker               20
## 438    Male  45                    High School          Smoker               30
## 617    Male  39 General Education Development      Non Smoker                0
## 3964 Female  52                    High School      Non Smoker                0
## 651  Female  58             Vocational School          Smoker               20
## 3566 Female  49             Vocational School      Non Smoker                0
## 1854 Female  39                    High School      Non Smoker                0
```

```
## 2496   Male  45 General Education Development      Non Smoker                0
## 2455 Female  44                    High School      Non Smoker                0
## 487  Female  39 General Education Development      Non Smoker                0
## 1234   Male  59                    High School      Non Smoker                0
## 816    Male  37                    High School          Smoker               15
## 2677   Male  51                        College          Smoker               20
## 655  Female  41                    High School          Smoker                5
## 3041   Male  57                    High School      Non Smoker                0
## 3485   Male  56                    High School      Non Smoker                0
## 3993 Female  43                    High School          Smoker               15
## 1309   Male  59                    High School          Smoker               20
## 635  Female  38 General Education Development          Smoker               20
## 3293 Female  41             Vocational School          Smoker               15
## 2901 Female  36 General Education Development      Non Smoker                0
## 2172 Female  62                    High School      Non Smoker                0
## 20     Male  41 General Education Development      Non Smoker                0
## 88   Female  61 General Education Development          Smoker                1
## 545  Female  38             Vocational School      Non Smoker                0
## 2293   Male  60                        College      Non Smoker                0
## 1451 Female  48 General Education Development      Non Smoker                0
## 532  Female  61                    High School      Non Smoker                0
## 2588   Male  53                        College      Non Smoker                0
## 2911 Female  42 General Education Development          Smoker               20
## 4210   Male  65 General Education Development      Non Smoker                0
## 1842   Male  41             Vocational School      Non Smoker                0
## 3709   Male  60                    High School      Non Smoker                0
## 2846   Male  44             Vocational School          Smoker               15
## 3547 Female  54                    High School      Non Smoker                0
## 2760 Female  41                    High School      Non Smoker                0
## 3822   Male  39 General Education Development          Smoker               25
## 1443   Male  61                    High School          Smoker                3
## 2887 Female  47                    High School      Non Smoker                0
## 1597   Male  45             Vocational School          Smoker               30
## 1103   Male  43 General Education Development          Smoker                9
## 2201 Female  46             Vocational School      Non Smoker                0
## 1320 Female  35 General Education Development          Smoker                5
## 466    Male  38 General Education Development          Smoker               40
## 3918 Female  44 General Education Development          Smoker               10
## 1760   Male  57                    High School          Smoker                9
## 2937 Female  61                    High School      Non Smoker                0
## 3777   Male  37 General Education Development      Non Smoker                0
## 846  Female  46 General Education Development      Non Smoker                0
## 1726   Male  52                    High School      Non Smoker                0
## 2850   Male  48 General Education Development          Smoker               20
## 3405 Female  62                    High School      Non Smoker                0
## 4064 Female  46                    High School      Non Smoker                0
## 3115   Male  38                        College          Smoker               30
## 3892 Female  57                        College      Non Smoker                0
## 2963   Male  51 General Education Development          Smoker               20
## 3984 Female  41 General Education Development          Smoker               14
## 1763 Female  39 General Education Development      Non Smoker                0
## 4045 Female  39                    High School      Non Smoker                0
## 3100 Female  40 General Education Development      Non Smoker                0
## 1857   Male  61                        College      Non Smoker                0
```

```
## 2247   Male  50                      College          Smoker                20
## 2419   Male  45 General Education Development          Smoker                 9
## 2215 Female  53                      College      Non Smoker                 0
## 4035 Female  40 General Education Development          Smoker                20
## 787    Male  45             Vocational School      Non Smoker                 0
## 1377 Female  43 General Education Development      Non Smoker                 0
## 1024 Female  57                   High School      Non Smoker                 0
## 2386 Female  57                   High School          Smoker                 1
## 3857   Male  58                   High School          Smoker                20
## 3088   Male  39 General Education Development      Non Smoker                 0
## 1882 Female  55                   High School      Non Smoker                 0
## 161  Female  36             Vocational School          Smoker                20
## 2800 Female  61 General Education Development      Non Smoker                 0
## 3687 Female  51 General Education Development          Smoker                 5
## 1711 Female  57             Vocational School      Non Smoker                 0
## 2322   Male  63             Vocational School          Smoker                 9
## 2005 Female  44                   High School      Non Smoker                 0
## 1665 Female  53                   High School      Non Smoker                 0
## 642    Male  34 General Education Development          Smoker                25
## 2678   Male  52 General Education Development      Non Smoker                 0
## 4226   Male  45                      College          Smoker                43
## 3136 Female  49                   High School      Non Smoker                 0
## 3503   Male  38                   High School          Smoker                15
## 2056 Female  52                   High School      Non Smoker                 0
## 3050 Female  60             Vocational School          Smoker                 3
## 1510   Male  39                      College          Smoker                20
## 3850 Female  46 General Education Development          Smoker                15
## 569  Female  34 General Education Development      Non Smoker                 0
## 3257 Female  44                      College      Non Smoker                 0
## 2786 Female  41 General Education Development          Smoker                 1
## 1011   Male  42                   High School          Smoker                30
## 257    Male  36                      College      Non Smoker                 0
## 3051 Female  63             Vocational School      Non Smoker                 0
## 878  Female  64                   High School      Non Smoker                 0
## 3876 Female  56                   High School          Smoker                40
## 3646   Male  68                   High School          Smoker                15
## 2329   Male  66                      College          Smoker                20
## 2088   Male  57             Vocational School      Non Smoker                 0
## 1364   Male  55                   High School          Smoker                40
## 2363   Male  58                   High School      Non Smoker                 0
## 2126   Male  58                   High School          Smoker                20
## 3811 Female  49                   High School          Smoker                 5
## 2500 Female  46 General Education Development          Smoker                15
## 206    Male  42 General Education Development      Non Smoker                 0
## 735    Male  44                   High School          Smoker                30
## 3780 Female  67                      College      Non Smoker                 0
## 2928   Male  48 General Education Development          Smoker                20
## 2479   Male  59                   High School      Non Smoker                 0
## 4195   Male  65                   High School          Smoker                20
## 3255   Male  51                      College          Smoker                30
## 764  Female  58                   High School      Non Smoker                 0
## 3086   Male  49 General Education Development          Smoker                 9
## 4101   Male  69                   High School          Smoker                 1
## 3859 Female  43 General Education Development          Smoker                20
```

```
## 2638   Male  61                   High School          Smoker                20
## 834  Female  53                   High School      Non Smoker                 0
## 228    Male  56             Vocational School      Non Smoker                 0
## 2894   Male  62             Vocational School      Non Smoker                 0
## 1905   Male  64                   High School          Smoker                20
## 1459   Male  52 General Education Development      Non Smoker                 0
## 2910 Female  67 General Education Development      Non Smoker                 0
## 227    Male  54                   High School          Smoker                43
## 3364 Female  66                   High School      Non Smoker                 0
## 2965   Male  68                   High School          Smoker                15
## 2138 Female  41             Vocational School          Smoker                15
## 260  Female  60                   High School      Non Smoker                 0
## 3078 Female  67                   High School      Non Smoker                 0
## 139  Female  41             Vocational School          Smoker                30
## 1392   Male  51                       College          Smoker                10
## 2871   Male  63                   High School          Smoker                43
## 3834   Male  68                   High School      Non Smoker                 0
## 716  Female  45                   High School      Non Smoker                 0
## 4172   Male  41 General Education Development          Smoker                43
## 3806   Male  51                   High School          Smoker                40
## 3588   Male  61                   High School      Non Smoker                 0
## 1242   Male  51                   High School          Smoker                20
## 2671 Female  65                   High School      Non Smoker                 0
## 2137 Female  56 General Education Development      Non Smoker                 0
## 759  Female  53                   High School          Smoker                 9
## 559  Female  44             Vocational School          Smoker                10
## 2751   Male  44                   High School      Non Smoker                 0
## 169    Male  48                   High School          Smoker                20
## 949    Male  56 General Education Development          Smoker                20
## 1924   Male  37 General Education Development          Smoker                20
## 3123 Female  54 General Education Development      Non Smoker                 0
## 1679   Male  66                   High School      Non Smoker                 0
## 3169 Female  53                   High School      Non Smoker                 0
## 753    Male  62 General Education Development      Non Smoker                 0
## 2344   Male  37                       College      Non Smoker                 0
## 191    Male  38 General Education Development          Smoker                20
## 4044   Male  56                   High School          Smoker                40
## 986  Female  53 General Education Development          Smoker                10
## 2207   Male  46                   High School          Smoker                15
## 696  Female  54 General Education Development          Smoker                 5
## 971    Male  52                   High School          Smoker                 3
## 2499   Male  57                   High School      Non Smoker                 0
## 3791 Female  56                       College      Non Smoker                 0
## 4116 Female  63 General Education Development      Non Smoker                 0
## 2606   Male  59             Vocational School          Smoker                40
## 792    Male  46                   High School          Smoker                20
## 2673   Male  51                   High School          Smoker                15
## 3840   Male  63                   High School      Non Smoker                 0
## 746  Female  66                   High School      Non Smoker                 0
## 377  Female  45 General Education Development          Smoker                20
## 3684   Male  57                   High School          Smoker                20
## 1716 Female  47                   High School      Non Smoker                 0
## 708    Male  47                   High School          Smoker                30
## 2417   Male  56 General Education Development          Smoker                20
```

```
## 312    Male  62                  High School          Smoker                20
## 3847   Male  57                  High School      Non Smoker                 0
## 2228 Female  55                  High School      Non Smoker                 0
## 930  Female  53                  High School          Smoker                 5
## 4233   Male  68                  High School      Non Smoker                 0
## 4222   Male  50                  High School      Non Smoker                 0
## 3440   Male  48                  High School          Smoker                20
## 2176   Male  49                  High School          Smoker                20
## 963  Female  36 General Education Development          Smoker                 1
## 3419 Female  63                  High School      Non Smoker                 0
## 2195   Male  42            Vocational School          Smoker                43
## 3144 Female  58                  High School          Smoker                15
## 1187   Male  49            Vocational School      Non Smoker                 0
## 278  Female  67                  High School      Non Smoker                 0
## 1519 Female  47 General Education Development          Smoker                 9
## 2272   Male  52                      College          Smoker                30
## 144  Female  57                  High School      Non Smoker                 0
## 1341 Female  48                  High School          Smoker                25
## 1609 Female  46            Vocational School      Non Smoker                 0
## 2299   Male  60                  High School          Smoker                40
## 1723   Male  49            Vocational School          Smoker                40
## 3805 Female  53                      College      Non Smoker                 0
## 3798   Male  53 General Education Development      Non Smoker                 0
## 1099   Male  50                      College      Non Smoker                 0
## 239  Female  55            Vocational School          Smoker                 1
## 4    Female  61            Vocational School          Smoker                30
## 3875   Male  38                      College          Smoker                15
## 525    Male  52                  High School          Smoker                25
## 3854 Female  55                      College      Non Smoker                 0
## 3963 Female  66                  High School      Non Smoker                 0
## 2188   Male  52                  High School          Smoker                30
## 785  Female  43 General Education Development          Smoker                15
## 1784   Male  62                  High School          Smoker                10
## 2267   Male  41 General Education Development          Smoker                20
## 370  Female  67                  High School      Non Smoker                 0
## 3339 Female  47 General Education Development          Smoker                30
## 2828 Female  57                  High School          Smoker                20
## 574  Female  63                      College      Non Smoker                 0
## 2493 Female  59                  High School          Smoker                10
## 3907 Female  47            Vocational School      Non Smoker                 0
## 2736   Male  41 General Education Development          Smoker                20
## 4214   Male  48 General Education Development      Non Smoker                 0
## 2334 Female  50                  High School          Smoker                15
## 281  Female  51 General Education Development      Non Smoker                 0
## 2776 Female  52 General Education Development      Non Smoker                 0
## 3739 Female  57                  High School          Smoker                 1
## 1843   Male  49 General Education Development          Smoker                50
## 1879   Male  56                  High School          Smoker                20
## 2350 Female  63            Vocational School      Non Smoker                 0
## 2353 Female  58                  High School      Non Smoker                 0
## 1889   Male  63                  High School          Smoker                30
## 1821 Female  55                  High School          Smoker                 5
## 1664 Female  63                  High School      Non Smoker                 0
## 899  Female  62 General Education Development          Smoker                 6
```

```
## 4145   Male  59 General Education Development      Non Smoker                0
## 117    Male  60                    High School      Non Smoker                0
## 2904 Female  57                    High School          Smoker               20
## 3636   Male  50                    High School          Smoker               10
## 3732   Male  60                    High School      Non Smoker                0
## 329  Female  59                    High School      Non Smoker                0
## 3071 Female  41                    High School          Smoker                5
## 2746   Male  58                    High School          Smoker               15
## 879    Male  51                    High School          Smoker               20
## 3797 Female  59                    High School      Non Smoker                0
## 392  Female  54                    High School      Non Smoker                0
## 3403   Male  53                    High School          Smoker               11
## 4227   Male  58                    High School      Non Smoker                0
## 4193   Male  45                    High School          Smoker               20
## 841  Female  59                    High School      Non Smoker                0
## 524  Female  53             Vocational School          Smoker                9
## 1661   Male  56                    High School          Smoker                7
## 625    Male  63             Vocational School          Smoker               20
## 1408 Female  42                    High School      Non Smoker                0
## 116    Male  50                    High School      Non Smoker                0
## 2107   Male  67             Vocational School      Non Smoker                0
## 177  Female  60             Vocational School      Non Smoker                0
## 3408   Male  44                    High School          Smoker               40
## 1204   Male  64                    High School          Smoker               30
## 3080 Female  51                    High School      Non Smoker                0
## 1812   Male  43                    High School          Smoker               20
## 521  Female  59             Vocational School      Non Smoker                0
## 95     Male  60                        College          Smoker               30
## 4110   Male  54                    High School          Smoker               20
## 2034   Male  38             Vocational School      Non Smoker                0
## 3349   Male  51 General Education Development          Smoker                5
## 604  Female  61                    High School          Smoker               20
## 836    Male  57 General Education Development          Smoker               20
## 1052   Male  53 General Education Development          Smoker               20
## 4190   Male  54 General Education Development          Smoker               20
## 1571 Female  47 General Education Development      Non Smoker                0
## 399    Male  59                    High School          Smoker               43
## 1906 Female  64                    High School      Non Smoker                0
## 1092   Male  47                    High School          Smoker               30
## 1761   Male  48 General Education Development          Smoker               17
## 936  Female  59                    High School      Non Smoker                0
## 865  Female  59 General Education Development      Non Smoker                0
## 76   Female  59                    High School      Non Smoker                0
## 3490 Female  62 General Education Development      Non Smoker                0
## 3239   Male  42                    High School      Non Smoker                0
## 2089   Male  50                        College      Non Smoker                0
## 3228 Female  43 General Education Development          Smoker               15
## 3221 Female  65 General Education Development      Non Smoker                0
## 2750 Female  64                    High School      Non Smoker                0
## 3137 Female  60                    High School          Smoker               15
## 1592 Female  60                    High School      Non Smoker                0
## 868    Male  56 General Education Development          Smoker               30
## 890    Male  64                        College      Non Smoker                0
## 231  Female  53                    High School      Non Smoker                0
```

```
## 2797   Male  49                     College      Non Smoker                0
## 2497   Male  53                 High School      Non Smoker                0
## 197    Male  48                 High School          Smoker               10
## 3352 Female  64 General Education Development          Smoker               15
## 2311   Male  38                 High School      Non Smoker                0
## 3784 Female  60                     College      Non Smoker                0
## 3681 Female  47 General Education Development          Smoker               20
## 2374 Female  50                 High School      Non Smoker                0
## 3304   Male  47                 High School      Non Smoker                0
## 2794   Male  47                 High School          Smoker               20
## 2658 Female  55                 High School      Non Smoker                0
## 788    Male  42             Vocational School          Smoker               25
## 2804   Male  62                 High School      Non Smoker                0
## 3818   Male  47 General Education Development          Smoker               20
## 285    Male  68                 High School      Non Smoker                0
## 2577   Male  40 General Education Development          Smoker               20
## 2198 Female  63                 High School      Non Smoker                0
## 1940   Male  64                 High School      Non Smoker                0
## 2707 Female  67                 High School      Non Smoker                0
## 495    Male  56             Vocational School          Smoker               20
## 3518 Female  62                 High School      Non Smoker                0
## 1141   Male  50 General Education Development          Smoker               30
## 2876   Male  41 General Education Development          Smoker               20
## 2934   Male  51                 High School          Smoker               30
## 772  Female  63                     College      Non Smoker                0
## 1789 Female  58                 High School          Smoker               20
## 4112 Female  61             Vocational School      Non Smoker                0
## 501  Female  40             Vocational School          Smoker               10
## 153  Female  61                 High School      Non Smoker                0
## 2884 Female  59                 High School      Non Smoker                0
## 82     Male  39 General Education Development      Non Smoker                0
## 2269 Female  63                 High School      Non Smoker                0
## 372    Male  55                     College      Non Smoker                0
## 887  Female  64                 High School      Non Smoker                0
## 195  Female  42             Vocational School      Non Smoker                0
## 3845 Female  62             Vocational School          Smoker               20
## 3182   Male  45                     College          Smoker               20
## 1359   Male  64 General Education Development      Non Smoker                0
## 3676   Male  67             Vocational School      Non Smoker                0
## 1056   Male  67                 High School          Smoker                9
## 3506   Male  58 General Education Development      Non Smoker                0
## 4194 Female  63                 High School      Non Smoker                0
## 1947 Female  55                 High School      Non Smoker                0
## 1772   Male  57                 High School          Smoker               20
## 154  Female  66                 High School      Non Smoker                0
## 2634 Female  43 General Education Development      Non Smoker                0
## 979    Male  57                 High School          Smoker               20
## 4224   Male  56                     College      Non Smoker                0
## 2900   Male  58                 High School          Smoker               40
## 2326   Male  60                     College          Smoker               12
## 368    Male  59                 High School      Non Smoker                0
## 3494 Female  63                 High School      Non Smoker                0
## 2529   Male  65 General Education Development      Non Smoker                0
## 2064 Female  56             Vocational School      Non Smoker                0
```

```
## 605    Male  62                  High School          Smoker               23
## 3215 Female  57                  High School      Non Smoker                0
## 1513 Female  63                  High School      Non Smoker                0
## 3165   Male  39 General Education Development          Smoker               30
## 3672   Male  56                  High School      Non Smoker                0
## 1837 Female  61 General Education Development      Non Smoker                0
## 3836 Female  62                  High School      Non Smoker                0
## 2626 Female  60            Vocational School      Non Smoker                0
## 2881   Male  49 General Education Development          Smoker               17
## 3446 Female  58                  High School          Smoker                2
## 1650 Female  43                  High School      Non Smoker                0
## 4058 Female  57 General Education Development          Smoker               10
## 3481   Male  63                  High School      Non Smoker                0
## 3844   Male  53                  High School          Smoker                3
## 4189 Female  44            Vocational School      Non Smoker                0
## 4221   Male  60                  High School      Non Smoker                0
## 3450 Female  56                  High School          Smoker               10
## 1584   Male  36 General Education Development          Smoker               20
## 621    Male  67                  High School      Non Smoker                0
## 3769   Male  49 General Education Development          Smoker                2
## 2734   Male  53            Vocational School          Smoker               30
## 4156   Male  47                      College          Smoker               43
## 345  Female  63                  High School          Smoker               20
## 4164   Male  65                      College          Smoker                6
## 1477 Female  60 General Education Development      Non Smoker                0
## 1953   Male  59                      College      Non Smoker                0
## 1486   Male  52 General Education Development          Smoker               20
## 3075 Female  63 General Education Development      Non Smoker                0
## 7    Female  63                  High School      Non Smoker                0
## 2717   Male  62                      College      Non Smoker                0
## 883    Male  52                      College          Smoker               20
## 3488 Female  35 General Education Development          Smoker               20
## 2835   Male  54                  High School      Non Smoker                0
## 1077 Female  58 General Education Development      Non Smoker                0
## 1456   Male  46                  High School          Smoker                5
## 1675   Male  56            Vocational School      Non Smoker                0
## 1797 Female  59                  High School      Non Smoker                0
## 3533   Male  44            Vocational School          Smoker                3
## 1196   Male  62                  High School          Smoker               20
## 554    Male  53                  High School      Non Smoker                0
## 1580   Male  61 General Education Development          Smoker               15
## 3335   Male  63                  High School          Smoker               20
## 2918   Male  61                  High School      Non Smoker                0
## 3760 Female  55            Vocational School      Non Smoker                0
## 1932 Female  58 General Education Development      Non Smoker                0
## 1299   Male  40                  High School      Non Smoker                0
## 1096   Male  51                  High School          Smoker               20
## 3718 Female  60            Vocational School      Non Smoker                0
## 3555 Female  46                  High School          Smoker                7
## 1132 Female  52 General Education Development      Non Smoker                0
## 3382   Male  51 General Education Development      Non Smoker                0
## 1380 Female  66 General Education Development      Non Smoker                0
## 1094   Male  43                      College          Smoker               40
## 3867   Male  48                  High School      Non Smoker                0
```

```
## 3344 Female  51 General Education Development          Smoker               20
## 2960 Female  55                   High School      Non Smoker                0
## 4077 Female  61                   High School      Non Smoker                0
## 3447   Male  57                       College      Non Smoker                0
## 146    Male  48                       College      Non Smoker                0
## 544    Male  47 General Education Development          Smoker               18
## 1692 Female  64                   High School      Non Smoker                0
## 1515   Male  58 General Education Development          Smoker               20
##      BloodPressureMedication PrevalentStroke PrevalentHypertension
## 1942 Not Under BP Medication             No                   No
## 1402 Not Under BP Medication             No                   No
## 939  Not Under BP Medication             No                   No
## 2993 Not Under BP Medication             No                   No
## 1279 Not Under BP Medication             No                   No
## 2117 Not Under BP Medication             No                   No
## 652  Not Under BP Medication             No                   No
## 3224 Not Under BP Medication             No                   No
## 382  Not Under BP Medication             No                  Yes
## 1651 Not Under BP Medication             No                   No
## 825  Not Under BP Medication             No                   No
## 1773 Not Under BP Medication             No                  Yes
## 2701 Not Under BP Medication             No                   No
## 462  Not Under BP Medication             No                   No
## 2467 Not Under BP Medication             No                  Yes
## 2226 Not Under BP Medication             No                   No
## 2402 Not Under BP Medication             No                   No
## 54   Not Under BP Medication             No                   No
## 1537 Not Under BP Medication             No                   No
## 1009 Not Under BP Medication             No                  Yes
## 1216 Not Under BP Medication             No                  Yes
## 669  Not Under BP Medication             No                   No
## 2503 Not Under BP Medication             No                  Yes
## 3999 Not Under BP Medication             No                   No
## 3330 Not Under BP Medication             No                   No
## 1335 Not Under BP Medication             No                   No
## 3903 Not Under BP Medication             No                  Yes
## 3972 Not Under BP Medication             No                  Yes
## 4071 Not Under BP Medication             No                  Yes
## 3260 Not Under BP Medication             No                   No
## 3264 Not Under BP Medication             No                   No
## 760  Not Under BP Medication             No                  Yes
## 1974 Not Under BP Medication             No                   No
## 2967 Not Under BP Medication             No                  Yes
## 2666 Not Under BP Medication             No                   No
## 3525 Not Under BP Medication             No                   No
## 2106 Not Under BP Medication             No                   No
## 3554 Not Under BP Medication             No                  Yes
## 4017 Not Under BP Medication             No                   No
## 478  Not Under BP Medication             No                   No
## 3596 Not Under BP Medication             No                  Yes
## 58   Not Under BP Medication             No                  Yes
## 734  Not Under BP Medication             No                   No
## 3320 Not Under BP Medication             No                   No
## 351  Not Under BP Medication             No                  Yes
```

```
## 1666 Not Under BP Medication             No                    No
## 3325 Not Under BP Medication             No                    No
## 2856 Not Under BP Medication             No                    No
## 3402 Not Under BP Medication             No                    No
## 3915 Not Under BP Medication             No                   Yes
## 1930 Not Under BP Medication             No                    No
## 1777 Not Under BP Medication             No                    No
## 2327 Not Under BP Medication             No                    No
## 723  Not Under BP Medication             No                    No
## 3685 Not Under BP Medication             No                    No
## 1464 Not Under BP Medication             No                    No
## 1946 Not Under BP Medication             No                    No
## 31   Not Under BP Medication             No                    No
## 2394 Not Under BP Medication             No                    No
## 2426 Not Under BP Medication             No                    No
## 3077 Not Under BP Medication             No                    No
## 1902 Not Under BP Medication             No                   Yes
## 3483 Not Under BP Medication             No                   Yes
## 1536 Not Under BP Medication             No                    No
## 1347 Not Under BP Medication             No                   Yes
## 2456 Not Under BP Medication             No                    No
## 2084 Not Under BP Medication             No                   Yes
## 2256 Not Under BP Medication             No                    No
## 2254 Not Under BP Medication             No                   Yes
## 1165 Not Under BP Medication             No                    No
## 645  Not Under BP Medication             No                    No
## 1368 Not Under BP Medication             No                   Yes
## 2141 Not Under BP Medication             No                   Yes
## 1636 Not Under BP Medication             No                    No
## 1544 Not Under BP Medication             No                   Yes
## 118  Not Under BP Medication             No                    No
## 2595 Not Under BP Medication             No                    No
## 1586 Not Under BP Medication             No                    No
## 3162 Not Under BP Medication             No                   Yes
## 3807 Not Under BP Medication             No                    No
## 4185 Not Under BP Medication             No                    No
## 3649 Not Under BP Medication             No                   Yes
## 1811 Not Under BP Medication             No                   Yes
## 765  Not Under BP Medication             No                    No
## 2313 Not Under BP Medication             No                    No
## 405  Not Under BP Medication             No                    No
## 3640 Not Under BP Medication             No                    No
## 3263 Not Under BP Medication             No                    No
## 3468 Not Under BP Medication             No                    No
## 3976 Not Under BP Medication             No                    No
## 3971 Not Under BP Medication             No                    No
## 2094 Not Under BP Medication             No                   Yes
## 1186 Not Under BP Medication             No                    No
## 2522 Not Under BP Medication             No                   Yes
## 3647 Not Under BP Medication             No                    No
## 799  Not Under BP Medication             No                    No
## 1357 Not Under BP Medication             No                    No
## 445  Not Under BP Medication             No                    No
## 1470 Not Under BP Medication             No                   Yes
```

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## 1013 Not Under BP Medication             No                    No
## 1793 Not Under BP Medication             No                    No
## 3694 Not Under BP Medication             No                    No
## 4235 Not Under BP Medication             No                    No
## 1126 Not Under BP Medication             No                   Yes
## 1312 Not Under BP Medication             No                    No
## 3203 Not Under BP Medication             No                   Yes
## 1588 Not Under BP Medication             No                    No
## 3206 Not Under BP Medication             No                    No
## 2345 Not Under BP Medication             No                    No
## 689  Not Under BP Medication             No                    No
## 3501 Not Under BP Medication             No                    No
## 733  Not Under BP Medication             No                    No
## 3746 Not Under BP Medication             No                   Yes
## 1354 Not Under BP Medication             No                   Yes
## 3813 Not Under BP Medication             No                    No
## 1462 Not Under BP Medication             No                    No
## 1413 Not Under BP Medication             No                    No
## 41   Not Under BP Medication             No                    No
## 2660 Not Under BP Medication             No                    No
## 1159 Not Under BP Medication             No                    No
## 2494 Not Under BP Medication             No                   Yes
## 2277 Not Under BP Medication             No                    No
## 3134 Not Under BP Medication             No                    No
## 1796 Not Under BP Medication             No                   Yes
## 794  Not Under BP Medication             No                    No
## 2688 Not Under BP Medication             No                   Yes
## 515  Not Under BP Medication             No                    No
## 3423 Not Under BP Medication             No                   Yes
## 120  Not Under BP Medication             No                   Yes
## 2071 Not Under BP Medication             No                    No
## 3261 Not Under BP Medication             No                    No
## 2262 Not Under BP Medication             No                    No
## 496  Not Under BP Medication             No                    No
## 2527 Not Under BP Medication             No                    No
## 3917 Not Under BP Medication             No                    No
## 1468 Not Under BP Medication             No                    No
## 505  Not Under BP Medication             No                   Yes
## 1828 Not Under BP Medication             No                   Yes
## 1727 Not Under BP Medication             No                    No
## 3842 Not Under BP Medication             No                    No
## 2523 Not Under BP Medication             No                    No
## 3924 Not Under BP Medication             No                   Yes
## 350  Not Under BP Medication             No                    No
## 1035 Not Under BP Medication             No                   Yes
## 308  Not Under BP Medication             No                    No
## 183  Not Under BP Medication             No                    No
## 156  Not Under BP Medication             No                    No
## 729  Not Under BP Medication             No                    No
## 3324 Not Under BP Medication             No                    No
## 570  Not Under BP Medication             No                    No
## 2192 Not Under BP Medication             No                    No
## 1257 Not Under BP Medication             No                    No
## 3441 Not Under BP Medication             No                    No
```

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## 2994 Not Under BP Medication             No                   Yes
## 4108 Not Under BP Medication             No                    No
## 2516 Not Under BP Medication             No                    No
## 502  Not Under BP Medication             No                    No
## 2956 Not Under BP Medication             No                    No
## 1559 Not Under BP Medication             No                   Yes
## 2799 Not Under BP Medication             No                    No
## 1503 Not Under BP Medication             No                    No
## 1694 Not Under BP Medication             No                   Yes
## 1660 Not Under BP Medication             No                   Yes
## 25   Not Under BP Medication             No                   Yes
## 386  Not Under BP Medication             No                    No
## 585  Not Under BP Medication             No                    No
## 2731 Not Under BP Medication             No                    No
## 2160 Not Under BP Medication             No                    No
## 3385 Not Under BP Medication             No                    No
## 1200 Not Under BP Medication             No                    No
## 950  Not Under BP Medication             No                    No
## 562  Not Under BP Medication             No                    No
## 2221 Not Under BP Medication             No                    No
## 1429 Not Under BP Medication             No                    No
## 1458 Not Under BP Medication             No                    No
## 2471 Not Under BP Medication             No                    No
## 1135 Not Under BP Medication             No                    No
## 3624 Not Under BP Medication             No                    No
## 875  Not Under BP Medication             No                    No
## 919  Not Under BP Medication             No                   Yes
## 995  Not Under BP Medication             No                    No
## 3849 Not Under BP Medication             No                    No
## 3721 Not Under BP Medication             No                    No
## 3130 Not Under BP Medication             No                    No
## 590  Not Under BP Medication             No                    No
## 588  Not Under BP Medication             No                    No
## 1356 Not Under BP Medication             No                    No
## 190  Not Under BP Medication             No                    No
## 173  Not Under BP Medication             No                    No
## 1372 Not Under BP Medication             No                   Yes
## 4006 Not Under BP Medication             No                    No
## 3189 Not Under BP Medication             No                   Yes
## 1565 Not Under BP Medication             No                    No
## 3590 Not Under BP Medication             No                   Yes
## 2122 Not Under BP Medication             No                    No
## 694  Not Under BP Medication             No                   Yes
## 2033 Not Under BP Medication             No                    No
## 499  Not Under BP Medication             No                    No
## 1084 Not Under BP Medication             No                    No
## 2990 Not Under BP Medication             No                    No
## 3689 Not Under BP Medication             No                    No
## 2167 Not Under BP Medication             No                   Yes
## 432  Not Under BP Medication             No                    No
## 2512 Not Under BP Medication             No                    No
## 3375 Not Under BP Medication             No                    No
## 1344 Not Under BP Medication             No                    No
## 3587 Not Under BP Medication             No                   Yes
```

```
## 176  Not Under BP Medication             No                   Yes
## 438  Not Under BP Medication             No                    No
## 617  Not Under BP Medication             No                    No
## 3964 Not Under BP Medication             No                    No
## 651  Not Under BP Medication             No                    No
## 3566 Not Under BP Medication             No                    No
## 1854 Not Under BP Medication             No                    No
## 2496 Not Under BP Medication             No                    No
## 2455 Not Under BP Medication             No                    No
## 487  Not Under BP Medication             No                    No
## 1234 Not Under BP Medication             No                    No
## 816  Not Under BP Medication             No                    No
## 2677 Not Under BP Medication             No                    No
## 655  Not Under BP Medication             No                    No
## 3041 Not Under BP Medication             No                   Yes
## 3485 Not Under BP Medication             No                   Yes
## 3993 Not Under BP Medication             No                    No
## 1309 Not Under BP Medication             No                   Yes
## 635  Not Under BP Medication             No                    No
## 3293 Not Under BP Medication             No                    No
## 2901 Not Under BP Medication             No                    No
## 2172 Not Under BP Medication             No                    No
## 20   Not Under BP Medication             No                    No
## 88   Not Under BP Medication             No                   Yes
## 545  Not Under BP Medication             No                    No
## 2293 Not Under BP Medication             No                    No
## 1451 Not Under BP Medication             No                    No
## 532  Not Under BP Medication             No                   Yes
## 2588 Not Under BP Medication             No                    No
## 2911 Not Under BP Medication             No                    No
## 4210 Not Under BP Medication             No                    No
## 1842 Not Under BP Medication             No                    No
## 3709 Not Under BP Medication             No                   Yes
## 2846 Not Under BP Medication             No                    No
## 3547 Not Under BP Medication             No                    No
## 2760 Not Under BP Medication             No                    No
## 3822 Not Under BP Medication             No                    No
## 1443 Not Under BP Medication             No                   Yes
## 2887 Not Under BP Medication             No                    No
## 1597 Not Under BP Medication             No                   Yes
## 1103 Not Under BP Medication             No                    No
## 2201 Not Under BP Medication             No                   Yes
## 1320 Not Under BP Medication             No                    No
## 466  Not Under BP Medication             No                   Yes
## 3918 Not Under BP Medication             No                    No
## 1760 Not Under BP Medication             No                   Yes
## 2937 Not Under BP Medication             No                    No
## 3777 Not Under BP Medication             No                    No
## 846  Not Under BP Medication             No                    No
## 1726 Not Under BP Medication             No                    No
## 2850 Not Under BP Medication             No                    No
## 3405 Not Under BP Medication             No                   Yes
## 4064 Not Under BP Medication             No                   Yes
## 3115 Not Under BP Medication             No                    No
```

```
## 3892 Not Under BP Medication             No                   Yes
## 2963 Not Under BP Medication             No                    No
## 3984 Not Under BP Medication             No                   Yes
## 1763     Under BP Medication             No                   Yes
## 4045 Not Under BP Medication             No                    No
## 3100 Not Under BP Medication             No                    No
## 1857     Under BP Medication             No                   Yes
## 2247 Not Under BP Medication             No                   Yes
## 2419 Not Under BP Medication             No                   Yes
## 2215 Not Under BP Medication             No                   Yes
## 4035 Not Under BP Medication             No                    No
## 787      Under BP Medication             No                   Yes
## 1377 Not Under BP Medication             No                    No
## 1024 Not Under BP Medication             No                    No
## 2386 Not Under BP Medication             No                    No
## 3857 Not Under BP Medication             No                    No
## 3088 Not Under BP Medication             No                    No
## 1882 Not Under BP Medication             No                    No
## 161  Not Under BP Medication             No                    No
## 2800 Not Under BP Medication             No                   Yes
## 3687 Not Under BP Medication             No                    No
## 1711 Not Under BP Medication             No                   Yes
## 2322 Not Under BP Medication             No                    No
## 2005 Not Under BP Medication             No                    No
## 1665 Not Under BP Medication             No                    No
## 642  Not Under BP Medication             No                    No
## 2678 Not Under BP Medication             No                    No
## 4226 Not Under BP Medication             No                    No
## 3136 Not Under BP Medication             No                    No
## 3503 Not Under BP Medication             No                    No
## 2056 Not Under BP Medication             No                    No
## 3050 Not Under BP Medication             No                    No
## 1510 Not Under BP Medication             No                    No
## 3850 Not Under BP Medication             No                    No
## 569  Not Under BP Medication             No                    No
## 3257 Not Under BP Medication             No                   Yes
## 2786 Not Under BP Medication             No                    No
## 1011 Not Under BP Medication             No                    No
## 257  Not Under BP Medication             No                   Yes
## 3051 Not Under BP Medication             No                   Yes
## 878  Not Under BP Medication             No                   Yes
## 3876 Not Under BP Medication             No                   Yes
## 3646 Not Under BP Medication             No                    No
## 2329 Not Under BP Medication             No                   Yes
## 2088 Not Under BP Medication             No                    No
## 1364 Not Under BP Medication             No                    No
## 2363 Not Under BP Medication             No                    No
## 2126 Not Under BP Medication             No                    No
## 3811 Not Under BP Medication             No                    No
## 2500 Not Under BP Medication             No                    No
## 206  Not Under BP Medication             No                    No
## 735  Not Under BP Medication             No                    No
## 3780 Not Under BP Medication             No                    No
## 2928 Not Under BP Medication             No                   Yes
```

```
## 2479 Not Under BP Medication             No                    No
## 4195     Under BP Medication             No                   Yes
## 3255 Not Under BP Medication             No                    No
## 764  Not Under BP Medication            Yes                   Yes
## 3086 Not Under BP Medication             No                   Yes
## 4101 Not Under BP Medication             No                    No
## 3859 Not Under BP Medication             No                    No
## 2638 Not Under BP Medication             No                    No
## 834  Not Under BP Medication             No                   Yes
## 228  Not Under BP Medication             No                   Yes
## 2894 Not Under BP Medication             No                    No
## 1905 Not Under BP Medication             No                    No
## 1459 Not Under BP Medication             No                    No
## 2910     Under BP Medication             No                   Yes
## 227  Not Under BP Medication             No                    No
## 3364 Not Under BP Medication             No                   Yes
## 2965 Not Under BP Medication             No                    No
## 2138 Not Under BP Medication             No                    No
## 260  Not Under BP Medication             No                   Yes
## 3078 Not Under BP Medication             No                    No
## 139  Not Under BP Medication             No                   Yes
## 1392 Not Under BP Medication             No                    No
## 2871 Not Under BP Medication             No                   Yes
## 3834 Not Under BP Medication             No                   Yes
## 716  Not Under BP Medication             No                    No
## 4172 Not Under BP Medication             No                    No
## 3806 Not Under BP Medication             No                   Yes
## 3588 Not Under BP Medication             No                   Yes
## 1242 Not Under BP Medication             No                   Yes
## 2671     Under BP Medication             No                   Yes
## 2137 Not Under BP Medication             No                   Yes
## 759  Not Under BP Medication             No                    No
## 559  Not Under BP Medication             No                    No
## 2751 Not Under BP Medication             No                    No
## 169  Not Under BP Medication             No                    No
## 949  Not Under BP Medication             No                   Yes
## 1924 Not Under BP Medication             No                    No
## 3123 Not Under BP Medication             No                    No
## 1679 Not Under BP Medication             No                    No
## 3169 Not Under BP Medication             No                    No
## 753  Not Under BP Medication             No                    No
## 2344 Not Under BP Medication             No                    No
## 191  Not Under BP Medication             No                   Yes
## 4044 Not Under BP Medication             No                    No
## 986  Not Under BP Medication             No                    No
## 2207 Not Under BP Medication             No                   Yes
## 696  Not Under BP Medication             No                    No
## 971  Not Under BP Medication             No                   Yes
## 2499 Not Under BP Medication             No                    No
## 3791 Not Under BP Medication             No                   Yes
## 4116 Not Under BP Medication             No                   Yes
## 2606 Not Under BP Medication             No                   Yes
## 792  Not Under BP Medication             No                   Yes
## 2673 Not Under BP Medication             No                    No
```

```
## 3840 Not Under BP Medication             No                   Yes
## 746  Not Under BP Medication             No                   Yes
## 377  Not Under BP Medication             No                    No
## 3684 Not Under BP Medication             No                    No
## 1716     Under BP Medication             No                   Yes
## 708  Not Under BP Medication             No                    No
## 2417 Not Under BP Medication             No                   Yes
## 312  Not Under BP Medication             No                   Yes
## 3847     Under BP Medication             No                   Yes
## 2228 Not Under BP Medication             No                   Yes
## 930  Not Under BP Medication             No                    No
## 4233 Not Under BP Medication             No                   Yes
## 4222 Not Under BP Medication             No                    No
## 3440 Not Under BP Medication             No                    No
## 2176 Not Under BP Medication             No                    No
## 963  Not Under BP Medication             No                    No
## 3419 Not Under BP Medication             No                   Yes
## 2195 Not Under BP Medication             No                   Yes
## 3144 Not Under BP Medication             No                   Yes
## 1187 Not Under BP Medication             No                   Yes
## 278  Not Under BP Medication             No                   Yes
## 1519 Not Under BP Medication             No                   Yes
## 2272 Not Under BP Medication             No                    No
## 144  Not Under BP Medication             No                   Yes
## 1341 Not Under BP Medication             No                    No
## 1609 Not Under BP Medication             No                   Yes
## 2299 Not Under BP Medication             No                   Yes
## 1723 Not Under BP Medication             No                   Yes
## 3805 Not Under BP Medication             No                   Yes
## 3798 Not Under BP Medication             No                    No
## 1099 Not Under BP Medication             No                    No
## 239  Not Under BP Medication             No                    No
## 4    Not Under BP Medication             No                   Yes
## 3875 Not Under BP Medication             No                    No
## 525  Not Under BP Medication             No                   Yes
## 3854 Not Under BP Medication             No                   Yes
## 3963 Not Under BP Medication             No                    No
## 2188     Under BP Medication             No                   Yes
## 785  Not Under BP Medication             No                    No
## 1784 Not Under BP Medication             No                    No
## 2267 Not Under BP Medication             No                    No
## 370  Not Under BP Medication             No                   Yes
## 3339 Not Under BP Medication             No                    No
## 2828 Not Under BP Medication             No                    No
## 574  Not Under BP Medication             No                   Yes
## 2493     Under BP Medication             No                   Yes
## 3907 Not Under BP Medication             No                    No
## 2736 Not Under BP Medication             No                   Yes
## 4214 Not Under BP Medication             No                    No
## 2334 Not Under BP Medication             No                    No
## 281  Not Under BP Medication             No                    No
## 2776 Not Under BP Medication             No                   Yes
## 3739 Not Under BP Medication             No                   Yes
## 1843 Not Under BP Medication             No                    No
```

```
## 1879 Not Under BP Medication             No                  Yes
## 2350 Not Under BP Medication             No                  Yes
## 2353 Not Under BP Medication             No                  Yes
## 1889 Not Under BP Medication             No                  Yes
## 1821 Not Under BP Medication             No                  Yes
## 1664 Not Under BP Medication             No                  Yes
## 899  Not Under BP Medication             No                  Yes
## 4145 Not Under BP Medication             No                   No
## 117  Not Under BP Medication             No                  Yes
## 2904 Not Under BP Medication             No                   No
## 3636 Not Under BP Medication             No                  Yes
## 3732 Not Under BP Medication             No                  Yes
## 329  Not Under BP Medication             No                  Yes
## 3071 Not Under BP Medication             No                   No
## 2746 Not Under BP Medication             No                   No
## 879  Not Under BP Medication             No                  Yes
## 3797 Not Under BP Medication             No                   No
## 392  Not Under BP Medication             No                   No
## 3403     Under BP Medication             No                  Yes
## 4227 Not Under BP Medication             No                   No
## 4193 Not Under BP Medication             No                   No
## 841  Not Under BP Medication             No                   No
## 524  Not Under BP Medication             No                   No
## 1661 Not Under BP Medication             No                  Yes
## 625  Not Under BP Medication             No                  Yes
## 1408 Not Under BP Medication             No                   No
## 116  Not Under BP Medication             No                  Yes
## 2107 Not Under BP Medication             No                   No
## 177  Not Under BP Medication             No                  Yes
## 3408 Not Under BP Medication             No                   No
## 1204 Not Under BP Medication             No                  Yes
## 3080 Not Under BP Medication             No                  Yes
## 1812 Not Under BP Medication             No                   No
## 521  Not Under BP Medication             No                   No
## 95   Not Under BP Medication             No                   No
## 4110 Not Under BP Medication             No                  Yes
## 2034 Not Under BP Medication             No                   No
## 3349 Not Under BP Medication             No                  Yes
## 604  Not Under BP Medication             No                  Yes
## 836  Not Under BP Medication             No                   No
## 1052 Not Under BP Medication             No                  Yes
## 4190 Not Under BP Medication             No                   No
## 1571 Not Under BP Medication             No                   No
## 399  Not Under BP Medication             No                   No
## 1906 Not Under BP Medication             No                  Yes
## 1092 Not Under BP Medication             No                   No
## 1761 Not Under BP Medication             No                  Yes
## 936  Not Under BP Medication             No                   No
## 865      Under BP Medication             No                  Yes
## 76   Not Under BP Medication             No                  Yes
## 3490     Under BP Medication             No                  Yes
## 3239 Not Under BP Medication             No                  Yes
## 2089 Not Under BP Medication             No                  Yes
## 3228 Not Under BP Medication             No                   No
```

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## 3221     Under BP Medication             No                   Yes
## 2750 Not Under BP Medication             No                    No
## 3137 Not Under BP Medication            Yes                   Yes
## 1592 Not Under BP Medication             No                   Yes
## 868  Not Under BP Medication             No                    No
## 890  Not Under BP Medication             No                    No
## 231  Not Under BP Medication             No                   Yes
## 2797     Under BP Medication             No                   Yes
## 2497 Not Under BP Medication             No                    No
## 197  Not Under BP Medication             No                    No
## 3352 Not Under BP Medication             No                   Yes
## 2311 Not Under BP Medication             No                    No
## 3784 Not Under BP Medication             No                    No
## 3681 Not Under BP Medication             No                   Yes
## 2374 Not Under BP Medication             No                    No
## 3304 Not Under BP Medication             No                    No
## 2794 Not Under BP Medication             No                   Yes
## 2658 Not Under BP Medication             No                   Yes
## 788  Not Under BP Medication             No                    No
## 2804 Not Under BP Medication             No                   Yes
## 3818 Not Under BP Medication             No                   Yes
## 285  Not Under BP Medication             No                   Yes
## 2577 Not Under BP Medication             No                    No
## 2198 Not Under BP Medication             No                   Yes
## 1940 Not Under BP Medication             No                    No
## 2707     Under BP Medication             No                   Yes
## 495  Not Under BP Medication             No                    No
## 3518     Under BP Medication             No                   Yes
## 1141 Not Under BP Medication             No                    No
## 2876 Not Under BP Medication             No                    No
## 2934 Not Under BP Medication             No                    No
## 772  Not Under BP Medication             No                   Yes
## 1789 Not Under BP Medication             No                    No
## 4112 Not Under BP Medication             No                    No
## 501  Not Under BP Medication             No                    No
## 153  Not Under BP Medication             No                    No
## 2884     Under BP Medication             No                   Yes
## 82   Not Under BP Medication             No                   Yes
## 2269 Not Under BP Medication             No                   Yes
## 372  Not Under BP Medication             No                   Yes
## 887  Not Under BP Medication             No                   Yes
## 195  Not Under BP Medication             No                    No
## 3845     Under BP Medication             No                   Yes
## 3182 Not Under BP Medication             No                   Yes
## 1359 Not Under BP Medication             No                    No
## 3676     Under BP Medication             No                   Yes
## 1056 Not Under BP Medication             No                    No
## 3506 Not Under BP Medication             No                   Yes
## 4194 Not Under BP Medication             No                   Yes
## 1947 Not Under BP Medication             No                    No
## 1772 Not Under BP Medication             No                    No
## 154  Not Under BP Medication             No                   Yes
## 2634 Not Under BP Medication             No                    No
## 979  Not Under BP Medication             No                   Yes
```

```
## 4224     Under BP Medication             No                  Yes
## 2900 Not Under BP Medication             No                  Yes
## 2326 Not Under BP Medication             No                   No
## 368  Not Under BP Medication             No                   No
## 3494 Not Under BP Medication            Yes                  Yes
## 2529 Not Under BP Medication             No                   No
## 2064 Not Under BP Medication             No                   No
## 605  Not Under BP Medication             No                  Yes
## 3215 Not Under BP Medication             No                   No
## 1513 Not Under BP Medication             No                   No
## 3165 Not Under BP Medication             No                  Yes
## 3672     Under BP Medication            Yes                  Yes
## 1837 Not Under BP Medication             No                  Yes
## 3836 Not Under BP Medication             No                   No
## 2626 Not Under BP Medication             No                  Yes
## 2881 Not Under BP Medication             No                   No
## 3446 Not Under BP Medication             No                   No
## 1650 Not Under BP Medication             No                  Yes
## 4058     Under BP Medication             No                  Yes
## 3481 Not Under BP Medication             No                  Yes
## 3844 Not Under BP Medication             No                   No
## 4189 Not Under BP Medication             No                   No
## 4221 Not Under BP Medication             No                   No
## 3450     Under BP Medication             No                  Yes
## 1584 Not Under BP Medication             No                   No
## 621  Not Under BP Medication             No                   No
## 3769 Not Under BP Medication             No                   No
## 2734     Under BP Medication             No                  Yes
## 4156 Not Under BP Medication             No                   No
## 345  Not Under BP Medication             No                   No
## 4164 Not Under BP Medication             No                   No
## 1477 Not Under BP Medication             No                  Yes
## 1953 Not Under BP Medication             No                   No
## 1486 Not Under BP Medication             No                   No
## 3075 Not Under BP Medication             No                  Yes
## 7    Not Under BP Medication             No                   No
## 2717 Not Under BP Medication             No                  Yes
## 883  Not Under BP Medication             No                  Yes
## 3488 Not Under BP Medication             No                   No
## 2835 Not Under BP Medication             No                  Yes
## 1077 Not Under BP Medication             No                   No
## 1456 Not Under BP Medication             No                   No
## 1675 Not Under BP Medication             No                   No
## 1797 Not Under BP Medication             No                  Yes
## 3533 Not Under BP Medication             No                  Yes
## 1196 Not Under BP Medication             No                  Yes
## 554  Not Under BP Medication             No                  Yes
## 1580 Not Under BP Medication             No                   No
## 3335 Not Under BP Medication             No                  Yes
## 2918 Not Under BP Medication             No                  Yes
## 3760 Not Under BP Medication             No                  Yes
## 1932 Not Under BP Medication             No                  Yes
## 1299 Not Under BP Medication             No                  Yes
## 1096 Not Under BP Medication             No                   No
```

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## 3718 Not Under BP Medication             No                  Yes
## 3555     Under BP Medication             No                  Yes
## 1132 Not Under BP Medication             No                  Yes
## 3382 Not Under BP Medication             No                  Yes
## 1380 Not Under BP Medication             No                   No
## 1094 Not Under BP Medication             No                   No
## 3867 Not Under BP Medication             No                  Yes
## 3344 Not Under BP Medication             No                   No
## 2960 Not Under BP Medication             No                  Yes
## 4077     Under BP Medication             No                  Yes
## 3447 Not Under BP Medication             No                  Yes
## 146  Not Under BP Medication             No                  Yes
## 544  Not Under BP Medication             No                  Yes
## 1692 Not Under BP Medication             No                  Yes
## 1515 Not Under BP Medication             No                   No
##      DiabeticCondition TotalCholestrol SystolicBloodPressure
## 1942      Non Diabetic             237                 118.0
## 1402      Non Diabetic             172                 122.5
## 939       Non Diabetic             232                 133.0
## 2993      Non Diabetic             172                  98.0
## 1279      Non Diabetic             253                 121.0
## 2117      Non Diabetic             180                 113.0
## 652       Non Diabetic             292                 111.0
## 3224      Non Diabetic             258                 123.0
## 382       Non Diabetic             246                 125.0
## 1651      Non Diabetic             231                 122.0
## 825       Non Diabetic             217                 110.0
## 1773      Non Diabetic             180                 170.0
## 2701      Non Diabetic             219                 124.0
## 462       Non Diabetic             177                 110.0
## 2467      Non Diabetic             189                 156.0
## 2226      Non Diabetic             240                 122.5
## 2402      Non Diabetic             156                 120.0
## 54        Non Diabetic             240                 145.0
## 1537      Non Diabetic             185                 133.0
## 1009      Non Diabetic             186                 167.0
## 1216      Non Diabetic             305                 150.0
## 669       Non Diabetic             199                 112.0
## 2503      Non Diabetic             219                 141.0
## 3999      Non Diabetic             205                 111.0
## 3330      Non Diabetic             194                 122.0
## 1335      Non Diabetic             214                 128.0
## 3903      Non Diabetic             232                 155.0
## 3972          Diabetic             195                 176.0
## 4071      Non Diabetic             202                 158.0
## 3260      Non Diabetic             165                 108.0
## 3264      Non Diabetic             226                 124.5
## 760       Non Diabetic             254                 160.0
## 1974      Non Diabetic             236                 112.5
## 2967      Non Diabetic             248                 155.0
## 2666      Non Diabetic             175                  83.5
## 3525      Non Diabetic             195                 131.5
## 2106      Non Diabetic             309                 130.0
## 3554      Non Diabetic             241                 154.0
```

```
## 4017      Non Diabetic             264                 129.0
## 478       Non Diabetic             247                 125.0
## 3596      Non Diabetic             252                 135.0
## 58        Non Diabetic             255                 143.5
## 734       Non Diabetic             211                 120.0
## 3320      Non Diabetic             215                 110.0
## 351       Non Diabetic             231                 157.5
## 1666      Non Diabetic             258                 124.0
## 3325      Non Diabetic             226                 125.0
## 2856          Diabetic             314                 135.0
## 3402      Non Diabetic             229                 140.0
## 3915      Non Diabetic             233                 173.0
## 1930      Non Diabetic             222                 112.0
## 1777      Non Diabetic             158                 129.0
## 2327      Non Diabetic             259                 101.0
## 723       Non Diabetic             271                 134.0
## 3685      Non Diabetic             163                 117.5
## 1464      Non Diabetic             335                 125.5
## 1946      Non Diabetic             161                 122.0
## 31        Non Diabetic             295                 102.0
## 2394          Diabetic             342                 137.0
## 2426      Non Diabetic             229                 120.0
## 3077      Non Diabetic             269                 139.0
## 1902      Non Diabetic             261                 141.0
## 3483      Non Diabetic             256                 123.0
## 1536      Non Diabetic             239                 124.0
## 1347      Non Diabetic             230                 142.5
## 2456      Non Diabetic             236                 127.0
## 2084      Non Diabetic             308                 152.0
## 2256      Non Diabetic             213                 120.0
## 2254      Non Diabetic             197                 140.0
## 1165      Non Diabetic             250                 116.0
## 645       Non Diabetic             194                 117.0
## 1368      Non Diabetic             272                 146.0
## 2141      Non Diabetic             259                 152.0
## 1636      Non Diabetic             246                 122.0
## 1544      Non Diabetic             238                 131.0
## 118       Non Diabetic             185                 100.0
## 2595      Non Diabetic             221                 105.0
## 1586      Non Diabetic             234                 140.0
## 3162      Non Diabetic             240                 154.0
## 3807      Non Diabetic             410                 105.0
## 4185      Non Diabetic             232                 137.5
## 3649      Non Diabetic             204                 147.0
## 1811      Non Diabetic             238                 141.0
## 765       Non Diabetic             162                 125.0
## 2313      Non Diabetic             205                 120.0
## 405       Non Diabetic             226                 119.0
## 3640      Non Diabetic             270                 142.5
## 3263      Non Diabetic             286                 117.0
## 3468      Non Diabetic             230                 135.0
## 3976      Non Diabetic             240                 126.0
## 3971      Non Diabetic             250                 112.5
## 2094      Non Diabetic             228                 188.0
```

```
## 1186      Non Diabetic            205                 118.0
## 2522      Non Diabetic            216                 110.0
## 3647      Non Diabetic            275                 118.0
## 799       Non Diabetic            175                 116.0
## 1357      Non Diabetic            204                 115.0
## 445       Non Diabetic            243                 146.0
## 1470      Non Diabetic            258                 148.0
## 1013      Non Diabetic            187                 133.0
## 1793      Non Diabetic            209                 123.5
## 3694      Non Diabetic            225                 119.0
## 4235      Non Diabetic            207                 126.5
## 1126      Non Diabetic            259                 173.0
## 1312      Non Diabetic            206                 115.0
## 3203      Non Diabetic            165                 128.0
## 1588      Non Diabetic            212                 110.0
## 3206      Non Diabetic            224                 140.0
## 2345      Non Diabetic            217                 115.0
## 689       Non Diabetic            289                 125.0
## 3501      Non Diabetic            221                 108.0
## 733       Non Diabetic            296                 117.0
## 3746      Non Diabetic            240                 163.0
## 1354      Non Diabetic            165                 141.5
## 3813      Non Diabetic            252                 119.0
## 1462      Non Diabetic            214                 139.0
## 1413      Non Diabetic            161                 100.0
## 41        Non Diabetic            243                 116.5
## 2660      Non Diabetic            211                 145.0
## 1159      Non Diabetic            291                 107.5
## 2494      Non Diabetic            300                 146.0
## 2277      Non Diabetic            166                 110.0
## 3134      Non Diabetic            280                 133.0
## 1796      Non Diabetic            211                 138.0
## 794       Non Diabetic            219                 129.0
## 2688      Non Diabetic            204                 158.0
## 515       Non Diabetic            278                 133.0
## 3423      Non Diabetic            260                 167.0
## 120       Non Diabetic            175                 157.0
## 2071      Non Diabetic            165                 117.5
## 3261      Non Diabetic            265                 121.0
## 2262      Non Diabetic            314                 109.5
## 496       Non Diabetic            277                 114.0
## 2527      Non Diabetic            212                 110.0
## 3917      Non Diabetic            373                 138.5
## 1468      Non Diabetic            234                 127.0
## 505       Non Diabetic            258                 144.0
## 1828      Non Diabetic            196                 124.5
## 1727      Non Diabetic            286                 119.0
## 3842      Non Diabetic            209                 111.0
## 2523      Non Diabetic            222                 110.0
## 3924      Non Diabetic            248                 151.5
## 350       Non Diabetic            339                 110.0
## 1035      Non Diabetic            222                 141.5
## 308       Non Diabetic            221                 101.0
## 183       Non Diabetic            215                 118.0
```

```
## 156       Non Diabetic             209                 134.0
## 729       Non Diabetic             168                 117.0
## 3324      Non Diabetic             198                 119.0
## 570       Non Diabetic             242                 135.0
## 2192      Non Diabetic             232                 115.0
## 1257      Non Diabetic             225                 108.5
## 3441      Non Diabetic             271                 112.5
## 2994      Non Diabetic             239                 122.0
## 4108      Non Diabetic             199                 104.0
## 2516      Non Diabetic             334                 133.5
## 502       Non Diabetic             248                 155.0
## 2956      Non Diabetic             237                 110.0
## 1559      Non Diabetic             250                 173.0
## 2799      Non Diabetic             207                 111.0
## 1503      Non Diabetic             217                 129.0
## 1694      Non Diabetic             170                 134.0
## 1660      Non Diabetic             248                 143.5
## 25        Non Diabetic             270                 137.5
## 386       Non Diabetic             235                 120.0
## 585       Non Diabetic             300                 118.5
## 2731      Non Diabetic             211                 120.0
## 2160      Non Diabetic             212                 115.0
## 3385      Non Diabetic             245                 139.0
## 1200      Non Diabetic             304                 125.0
## 950       Non Diabetic             220                 117.5
## 562       Non Diabetic             275                 113.5
## 2221      Non Diabetic             182                 120.0
## 1429      Non Diabetic             271                 136.0
## 1458      Non Diabetic             246                 135.0
## 2471      Non Diabetic             212                 120.0
## 1135      Non Diabetic             262                 122.0
## 3624      Non Diabetic             202                 146.5
## 875       Non Diabetic             205                 122.0
## 919       Non Diabetic             152                 120.0
## 995       Non Diabetic             270                 122.0
## 3849      Non Diabetic             170                 111.0
## 3721      Non Diabetic             175                 104.0
## 3130      Non Diabetic             260                 118.5
## 590       Non Diabetic             220                 126.0
## 588       Non Diabetic             197                 116.0
## 1356      Non Diabetic             198                 119.0
## 190       Non Diabetic             245                 144.5
## 173       Non Diabetic             265                 110.0
## 1372      Non Diabetic             340                 140.0
## 4006      Non Diabetic             309                 142.0
## 3189      Non Diabetic             190                 148.0
## 1565      Non Diabetic             179                 103.0
## 3590      Non Diabetic             246                 176.0
## 2122      Non Diabetic             195                 137.0
## 694       Non Diabetic             267                 146.0
## 2033      Non Diabetic             196                 100.0
## 499       Non Diabetic             258                 111.0
## 1084      Non Diabetic             279                 127.0
## 2990      Non Diabetic             230                 107.5
```

```
## 3689      Non Diabetic            250                123.0
## 2167      Non Diabetic            165                146.0
## 432       Non Diabetic            197                 96.0
## 2512      Non Diabetic            206                102.5
## 3375      Non Diabetic            210                120.0
## 1344      Non Diabetic            200                111.0
## 3587      Non Diabetic            207                165.0
## 176       Non Diabetic            245                158.0
## 438       Non Diabetic            240                141.0
## 617       Non Diabetic            203                117.5
## 3964      Non Diabetic            292                125.0
## 651       Non Diabetic            281                134.0
## 3566      Non Diabetic            273                154.0
## 1854      Non Diabetic            214                123.0
## 2496      Non Diabetic            215                104.0
## 2455      Non Diabetic            242                124.0
## 487       Non Diabetic            190                120.0
## 1234      Non Diabetic            229                100.5
## 816       Non Diabetic            231                135.0
## 2677      Non Diabetic            215                115.0
## 655       Non Diabetic            240                107.0
## 3041      Non Diabetic            287                149.0
## 3485      Non Diabetic            254                166.0
## 3993      Non Diabetic            179                101.0
## 1309      Non Diabetic            280                164.0
## 635       Non Diabetic            229                117.5
## 3293      Non Diabetic            205                120.0
## 2901      Non Diabetic            203                112.5
## 2172      Non Diabetic            205                118.0
## 20        Non Diabetic            195                139.0
## 88        Non Diabetic            326                200.0
## 545       Non Diabetic            171                110.0
## 2293      Non Diabetic            227                119.0
## 1451      Non Diabetic            231                115.0
## 532       Non Diabetic            217                189.0
## 2588      Non Diabetic            207                102.5
## 2911      Non Diabetic            223                129.0
## 4210      Non Diabetic            286                135.0
## 1842      Non Diabetic            256                107.0
## 3709      Non Diabetic            225                149.0
## 2846      Non Diabetic            237                124.0
## 3547      Non Diabetic            241                106.0
## 2760      Non Diabetic            170                113.5
## 3822      Non Diabetic            206                124.0
## 1443      Non Diabetic            256                165.0
## 2887      Non Diabetic            205                122.0
## 1597      Non Diabetic            270                140.0
## 1103      Non Diabetic            229                131.0
## 2201      Non Diabetic            230                154.0
## 1320      Non Diabetic            186                106.0
## 466       Non Diabetic            245                154.0
## 3918      Non Diabetic            222                130.0
## 1760      Non Diabetic            274                173.0
## 2937      Non Diabetic            295                191.0
```

```
## 3777      Non Diabetic             228                 113.0
## 846       Non Diabetic             304                 131.5
## 1726      Non Diabetic             222                 110.0
## 2850          Diabetic             172                 131.0
## 3405      Non Diabetic             258                 162.0
## 4064      Non Diabetic             246                 142.5
## 3115      Non Diabetic             275                 117.5
## 3892      Non Diabetic             236                 164.0
## 2963      Non Diabetic             274                 108.0
## 3984      Non Diabetic             188                 145.0
## 1763      Non Diabetic             283                 159.0
## 4045      Non Diabetic             195                 129.5
## 3100      Non Diabetic             230                 127.0
## 1857      Non Diabetic             204                 120.0
## 2247      Non Diabetic             250                 148.0
## 2419      Non Diabetic             188                 132.0
## 2215      Non Diabetic             243                 188.5
## 4035      Non Diabetic             213                 130.0
## 787       Non Diabetic             258                 126.0
## 1377      Non Diabetic             232                 138.0
## 1024      Non Diabetic             277                 133.0
## 2386      Non Diabetic             240                 142.0
## 3857      Non Diabetic             290                 124.0
## 3088      Non Diabetic             216                 122.5
## 1882      Non Diabetic             310                 135.0
## 161       Non Diabetic             159                 121.5
## 2800      Non Diabetic             224                 155.0
## 3687      Non Diabetic             315                 119.0
## 1711      Non Diabetic             366                 146.5
## 2322      Non Diabetic             176                 116.0
## 2005      Non Diabetic             192                 112.0
## 1665      Non Diabetic             246                 115.0
## 642       Non Diabetic             250                 119.0
## 2678      Non Diabetic             210                 128.0
## 4226      Non Diabetic             216                 137.5
## 3136      Non Diabetic             286                 144.0
## 3503      Non Diabetic             183                 107.5
## 2056      Non Diabetic             210                 146.5
## 3050      Non Diabetic             270                 130.0
## 1510      Non Diabetic             217                 107.0
## 3850          Diabetic             233                 106.0
## 569       Non Diabetic             189                 108.0
## 3257          Diabetic             254                 145.0
## 2786      Non Diabetic             189                 113.5
## 1011      Non Diabetic             232                 111.5
## 257       Non Diabetic             212                 168.0
## 3051      Non Diabetic             241                 153.0
## 878       Non Diabetic             255                 153.0
## 3876      Non Diabetic             214                 147.0
## 3646      Non Diabetic             157                 106.0
## 2329      Non Diabetic             273                 145.0
## 2088      Non Diabetic             213                 141.0
## 1364          Diabetic             205                 127.0
## 2363      Non Diabetic             200                 128.0
```

```
## 2126      Non Diabetic             200                136.0
## 3811      Non Diabetic             350                135.0
## 2500      Non Diabetic             232                115.0
## 206       Non Diabetic             227                144.0
## 735       Non Diabetic             334                131.0
## 3780      Non Diabetic             281                101.0
## 2928      Non Diabetic             230                140.5
## 2479      Non Diabetic             252                146.0
## 4195      Non Diabetic             246                179.0
## 3255      Non Diabetic             342                110.0
## 764           Diabetic             267                157.0
## 3086      Non Diabetic             278                152.0
## 4101      Non Diabetic             245                123.0
## 3859      Non Diabetic             163                104.5
## 2638      Non Diabetic             215                114.0
## 834           Diabetic             248                200.0
## 228       Non Diabetic             239                177.5
## 2894          Diabetic             346                102.5
## 1905      Non Diabetic             232                113.5
## 1459      Non Diabetic             310                135.0
## 2910          Diabetic             303                204.0
## 227       Non Diabetic             243                135.0
## 3364      Non Diabetic             312                150.0
## 2965      Non Diabetic             193                145.0
## 2138      Non Diabetic             195                120.5
## 260       Non Diabetic             352                197.5
## 3078      Non Diabetic             223                111.0
## 139       Non Diabetic             187                154.0
## 1392      Non Diabetic             185                125.0
## 2871      Non Diabetic             253                172.0
## 3834      Non Diabetic             276                127.0
## 716       Non Diabetic             211                127.5
## 4172      Non Diabetic             249                125.0
## 3806      Non Diabetic             227                162.5
## 3588      Non Diabetic             206                143.0
## 1242      Non Diabetic             246                128.0
## 2671      Non Diabetic             230                159.0
## 2137      Non Diabetic             290                185.0
## 759       Non Diabetic             278                131.0
## 559       Non Diabetic             250                136.5
## 2751      Non Diabetic             229                132.0
## 169       Non Diabetic             210                109.0
## 949       Non Diabetic             285                198.0
## 1924      Non Diabetic             211                116.5
## 3123      Non Diabetic             240                125.0
## 1679      Non Diabetic             270                120.0
## 3169      Non Diabetic             265                132.0
## 753       Non Diabetic             214                110.0
## 2344      Non Diabetic             266                110.0
## 191       Non Diabetic             253                133.0
## 4044      Non Diabetic             296                111.5
## 986       Non Diabetic             300                127.0
## 2207      Non Diabetic             405                181.5
## 696       Non Diabetic             272                132.5
```

```
## 971      Non Diabetic             199                 134.0
## 2499         Diabetic             300                 121.0
## 3791     Non Diabetic             246                 136.0
## 4116     Non Diabetic             250                 190.0
## 2606     Non Diabetic             243                 162.0
## 792      Non Diabetic             208                 164.0
## 2673     Non Diabetic             339                 137.5
## 3840         Diabetic             260                 155.5
## 746      Non Diabetic             232                 175.0
## 377      Non Diabetic             285                 116.0
## 3684     Non Diabetic             260                 123.0
## 1716     Non Diabetic             277                 138.5
## 708      Non Diabetic             143                 114.0
## 2417     Non Diabetic             205                 210.0
## 312          Diabetic             194                 151.5
## 3847     Non Diabetic             321                 192.5
## 2228     Non Diabetic             232                 170.0
## 930      Non Diabetic             247                 139.0
## 4233     Non Diabetic             176                 168.0
## 4222     Non Diabetic             260                 119.0
## 3440     Non Diabetic             170                 122.0
## 2176     Non Diabetic             247                 150.0
## 963      Non Diabetic             160                  98.0
## 3419     Non Diabetic             361                 167.0
## 2195     Non Diabetic             272                 128.0
## 3144     Non Diabetic             275                 140.0
## 1187     Non Diabetic             267                 160.5
## 278      Non Diabetic             302                 147.0
## 1519     Non Diabetic             253                 129.0
## 2272     Non Diabetic             346                 133.0
## 144      Non Diabetic             266                 151.0
## 1341         Diabetic             304                 102.0
## 1609     Non Diabetic             237                 196.0
## 2299     Non Diabetic             230                 149.0
## 1723     Non Diabetic             260                 142.0
## 3805     Non Diabetic             263                 173.0
## 3798         Diabetic             234                 113.0
## 1099     Non Diabetic             220                 114.0
## 239      Non Diabetic             273                 122.0
## 4        Non Diabetic             225                 150.0
## 3875     Non Diabetic             248                 110.0
## 525      Non Diabetic             206                 173.0
## 3854     Non Diabetic             260                 172.5
## 3963     Non Diabetic             304                 161.0
## 2188     Non Diabetic             238                 184.0
## 785      Non Diabetic             199                 137.0
## 1784     Non Diabetic             157                 134.0
## 2267     Non Diabetic             199                 139.0
## 370      Non Diabetic             248                 215.0
## 3339     Non Diabetic             198                 143.0
## 2828     Non Diabetic             252                 139.0
## 574      Non Diabetic             263                 150.0
## 2493     Non Diabetic             312                 175.0
## 3907     Non Diabetic             230                 137.0
```

```
## 2736      Non Diabetic            236                 127.0
## 4214      Non Diabetic            193                 141.0
## 2334      Non Diabetic            168                 120.0
## 281       Non Diabetic            284                 132.0
## 2776      Non Diabetic            260                 171.0
## 3739      Non Diabetic            254                 146.5
## 1843      Non Diabetic            252                 156.0
## 1879      Non Diabetic            217                 200.0
## 2350      Non Diabetic            380                 175.0
## 2353      Non Diabetic            281                 150.0
## 1889      Non Diabetic            225                 146.0
## 1821      Non Diabetic            280                 144.0
## 1664      Non Diabetic            320                 155.0
## 899       Non Diabetic            244                 168.0
## 4145      Non Diabetic            237                 131.5
## 117       Non Diabetic            278                 160.5
## 2904      Non Diabetic            174                 120.0
## 3636      Non Diabetic            202                 189.0
## 3732      Non Diabetic            220                 167.5
## 329       Non Diabetic            246                 189.0
## 3071      Non Diabetic            192                 123.0
## 2746      Non Diabetic            264                 156.0
## 879       Non Diabetic            239                 168.0
## 3797      Non Diabetic            254                 116.0
## 392       Non Diabetic            245                 117.0
## 3403      Non Diabetic            228                 132.5
## 4227      Non Diabetic            233                 125.5
## 4193      Non Diabetic            241                 129.0
## 841       Non Diabetic            241                 120.0
## 524       Non Diabetic            210                 132.0
## 1661      Non Diabetic            222                 159.0
## 625       Non Diabetic            269                 180.0
## 1408      Non Diabetic            170                 113.0
## 116       Non Diabetic            257                 127.0
## 2107      Non Diabetic            250                 120.0
## 177       Non Diabetic            325                 182.0
## 3408      Non Diabetic            158                 150.5
## 1204      Non Diabetic            253                 178.0
## 3080      Non Diabetic            177                 141.0
## 1812      Non Diabetic            180                 131.0
## 521       Non Diabetic            271                 117.5
## 95        Non Diabetic            243                 126.0
## 4110      Non Diabetic            299                 146.5
## 2034      Non Diabetic            244                 118.5
## 3349      Non Diabetic            290                 168.0
## 604       Non Diabetic            245                 140.0
## 836       Non Diabetic            205                 127.0
## 1052      Non Diabetic            266                 163.0
## 4190      Non Diabetic            261                 117.0
## 1571      Non Diabetic            187                 127.5
## 399       Non Diabetic            207                 132.5
## 1906      Non Diabetic            229                 145.0
## 1092      Non Diabetic            210                 112.0
## 1761      Non Diabetic            250                 177.0
```

```
## 936       Non Diabetic             250                 127.5
## 865       Non Diabetic             264                 244.0
## 76        Non Diabetic             258                 138.5
## 3490      Non Diabetic             298                 248.0
## 3239      Non Diabetic             327                 134.0
## 2089      Non Diabetic             259                 171.0
## 3228      Non Diabetic             300                 120.0
## 3221      Non Diabetic             279                 152.0
## 2750      Non Diabetic             305                 126.5
## 3137      Non Diabetic             254                 177.0
## 1592      Non Diabetic             170                 146.0
## 868       Non Diabetic             197                 113.5
## 890       Non Diabetic             273                 123.0
## 231       Non Diabetic             303                 128.0
## 2797      Non Diabetic             280                 166.0
## 2497      Non Diabetic             235                 130.0
## 197       Non Diabetic             308                 117.0
## 3352      Non Diabetic             259                 195.0
## 2311      Non Diabetic             203                 116.0
## 3784      Non Diabetic             247                 131.0
## 3681          Diabetic             211                 159.5
## 2374      Non Diabetic             189                 144.0
## 3304      Non Diabetic             259                 139.0
## 2794      Non Diabetic             286                 148.0
## 2658      Non Diabetic             208                 190.0
## 788       Non Diabetic             256                 121.5
## 2804      Non Diabetic             191                 156.0
## 3818          Diabetic             296                 141.0
## 285           Diabetic             164                 142.0
## 2577      Non Diabetic             275                 112.5
## 2198      Non Diabetic             293                 193.0
## 1940      Non Diabetic             296                 142.0
## 2707      Non Diabetic             228                 144.0
## 495       Non Diabetic             340                 134.0
## 3518      Non Diabetic             186                 176.5
## 1141      Non Diabetic             249                 133.0
## 2876      Non Diabetic             264                 126.5
## 2934      Non Diabetic             240                 127.0
## 772       Non Diabetic             210                 148.0
## 1789      Non Diabetic             215                 119.5
## 4112      Non Diabetic             257                 141.0
## 501       Non Diabetic             210                 103.0
## 153       Non Diabetic             312                 136.5
## 2884      Non Diabetic             234                 181.0
## 82        Non Diabetic             285                 155.0
## 2269      Non Diabetic             275                 148.0
## 372       Non Diabetic             239                 159.0
## 887       Non Diabetic             194                 176.0
## 195       Non Diabetic             464                 128.0
## 3845          Diabetic             358                 215.0
## 3182      Non Diabetic             271                 164.0
## 1359      Non Diabetic             210                 120.0
## 3676      Non Diabetic             223                 214.0
## 1056      Non Diabetic             245                 126.0
```

```
## 3506      Non Diabetic             149                  98.0
## 4194      Non Diabetic             306                 195.0
## 1947      Non Diabetic             232                 119.0
## 1772      Non Diabetic             193                 104.0
## 154       Non Diabetic             214                 212.0
## 2634      Non Diabetic             202                 121.5
## 979       Non Diabetic             158                 154.0
## 4224      Non Diabetic             287                 149.0
## 2900      Non Diabetic             231                 171.0
## 2326      Non Diabetic             233                 135.0
## 368       Non Diabetic             282                 114.0
## 3494      Non Diabetic             273                 152.0
## 2529          Diabetic             238                 122.0
## 2064      Non Diabetic             220                 122.0
## 605       Non Diabetic             286                 164.0
## 3215      Non Diabetic             194                 199.5
## 1513      Non Diabetic             222                 146.0
## 3165      Non Diabetic             292                 153.0
## 3672      Non Diabetic             208                 167.0
## 1837      Non Diabetic             183                 150.0
## 3836      Non Diabetic             266                 124.0
## 2626      Non Diabetic             232                 152.5
## 2881      Non Diabetic             211                 128.0
## 3446      Non Diabetic             271                 146.0
## 1650          Diabetic             231                 155.5
## 4058      Non Diabetic             272                 157.0
## 3481      Non Diabetic             222                 159.0
## 3844      Non Diabetic             218                 120.0
## 4189      Non Diabetic             180                 110.0
## 4221      Non Diabetic             252                 128.0
## 3450          Diabetic             241                 174.0
## 1584      Non Diabetic             242                 118.5
## 621       Non Diabetic             214                 127.5
## 3769      Non Diabetic             262                 115.0
## 2734      Non Diabetic             190                 141.0
## 4156      Non Diabetic             227                 126.0
## 345       Non Diabetic             238                 136.0
## 4164      Non Diabetic             236                 118.5
## 1477      Non Diabetic             334                 132.0
## 1953      Non Diabetic             210                 134.0
## 1486          Diabetic             258                 132.0
## 3075      Non Diabetic             184                 196.0
## 7         Non Diabetic             205                 138.0
## 2717      Non Diabetic             240                 152.0
## 883       Non Diabetic             225                 156.0
## 3488      Non Diabetic             168                  83.5
## 2835      Non Diabetic             230                 126.0
## 1077      Non Diabetic             190                 132.0
## 1456      Non Diabetic             198                 109.0
## 1675          Diabetic             214                 115.0
## 1797      Non Diabetic             240                 155.5
## 3533      Non Diabetic             352                 164.0
## 1196      Non Diabetic             270                 145.5
## 554       Non Diabetic             240                 174.5
```

```
## 1580      Non Diabetic            204                120.0
## 3335      Non Diabetic            228                141.0
## 2918      Non Diabetic            243                142.0
## 3760      Non Diabetic            262                122.5
## 1932          Diabetic            240                150.0
## 1299      Non Diabetic            175                173.0
## 1096      Non Diabetic            219                125.0
## 3718      Non Diabetic            286                172.5
## 3555      Non Diabetic            280                202.0
## 1132      Non Diabetic            215                159.0
## 3382      Non Diabetic            227                158.0
## 1380      Non Diabetic            305                138.0
## 1094      Non Diabetic            263                114.0
## 3867      Non Diabetic            259                147.5
## 3344      Non Diabetic            326                112.0
## 2960      Non Diabetic            180                165.0
## 4077          Diabetic            265                200.0
## 3447      Non Diabetic            310                147.5
## 146       Non Diabetic            293                149.0
## 544       Non Diabetic            439                145.0
## 1692      Non Diabetic            372                169.0
## 1515      Non Diabetic            220                129.0
##      DiastolicBloodPressure BodyMassIndex HeartRate GlucoseLevel
## 1942                   84.0         22.53        68           78
## 1402                   82.5         28.53        82           75
## 939                    86.0         20.15        72           74
## 2993                   53.0         22.18        68           82
## 1279                   85.5         28.52        80           68
## 2117                   73.0         17.65        70           73
## 652                    70.0         23.17        72           74
## 3224                   70.0         19.72        80           71
## 382                    80.0         29.02       100           98
## 1651                   84.0         27.63        66           72
## 825                    78.5         32.26       110           84
## 1773                  105.0         26.79        50           90
## 2701                   75.0         28.57        66           76
## 462                    70.0         25.71        65           84
## 2467                   69.0         21.68        66          100
## 2226                   80.0         23.97        60           43
## 2402                   87.0         21.80        66           89
## 54                     82.5         28.27        63           75
## 1537                   69.0         22.34        70           76
## 1009                   96.5         25.09       112          113
## 1216                   88.0         26.82        75           75
## 669                    68.5         23.88        85           67
## 2503                  105.0         26.86        62           60
## 3999                   60.5         21.80        65           82
## 3330                   68.0         26.08        60           73
## 1335                   94.0         23.51        72           66
## 3903                   80.5         29.60        72           67
## 3972                   78.0         24.90        95          370
## 4071                  103.0         28.35       125           80
## 3260                   75.0         21.84        75           83
## 3264                   84.5         21.63        68           74
```

```
## 760    92.0  25.61  60  80
## 1974   75.0  30.43  72  67
## 2967   92.5  29.86  85  66
## 2666   58.0  29.66  95 115
## 3525   83.0  24.61  75  78
## 2106   86.0  22.37  82  80
## 3554   96.0  30.12 103  70
## 4017   85.0  26.15  73  63
## 478    80.0  21.51  60  80
## 3596   84.0  28.24  85  79
## 58     81.0  25.65  75  80
## 734    75.0  18.70  52  61
## 3320   67.0  23.10  63  84
## 351   104.5  22.86  75  92
## 1666   78.0  24.33  72  83
## 3325   75.0  24.00  75  73
## 2856   77.5  22.17  75 170
## 3402   89.5  25.96  80  83
## 3915   98.5  21.88  62  76
## 1930   82.0  23.71  77  85
## 1777   87.0  24.66  62  67
## 2327   71.0  20.10  80  73
## 723    79.0  24.95 106  90
## 3685   75.0  28.30  75  70
## 1464   94.0  27.77  80  67
## 1946   82.0  26.09  65  91
## 31     68.0  28.15  60  63
## 2394   83.5  25.18  86 140
## 2426   82.0  25.58  78  73
## 3077   96.0  24.38  77  71
## 1902   78.0  25.32  68  76
## 3483   92.0  25.42  62  82
## 1536   72.0  19.34  80  70
## 1347   97.5  29.94  75  75
## 2456   78.0  17.51  75  76
## 2084   98.0  35.42  75  76
## 2256   78.0  28.78  80  70
## 2254   86.0  25.16  90  71
## 1165   79.0  28.59  93  87
## 645    90.0  27.08  73  87
## 1368   89.0  25.50  73  67
## 2141   97.0  33.68  75  76
## 1636   81.0  27.61  90  98
## 1544   99.0  31.19  96  86
## 118    68.0  18.38  70  72
## 2595   70.0  23.95  52  83
## 1586   93.0  28.69  60  87
## 3162   92.0  29.49  55  67
## 3807   67.5  27.33  75  90
## 4185   87.5  30.03  88  70
## 3649  100.0  39.94  85  90
## 1811   87.0  26.46  54  68
## 765    89.0  27.98  85  83
## 2313   83.5  24.30  67  77
```

```
## 405    75.0   25.34   70   66
## 3640   85.0   21.86   72   75
## 3263   73.0   20.92   85  103
## 3468   85.0   19.18   86   89
## 3976   79.0   21.38   88   40
## 3971   76.5   25.23   66   63
## 2094  128.0   29.58   84   67
## 1186   76.5   23.48   75   77
## 2522   79.0   24.76   75   74
## 3647   71.0   23.10   64   95
## 799    78.5   25.82   94   67
## 1357   83.0   25.05   75   76
## 445    91.0   26.72   80  104
## 1470   93.0   20.51   74   95
## 1013   88.0   31.82   75   77
## 1793   83.0   28.06   72   63
## 3694   65.0   26.89   62   74
## 4235   80.0   19.71   65   68
## 1126  102.0   27.22   85   75
## 1312   70.0   24.79   84   76
## 3203   80.0   25.62   90   85
## 1588   65.0   23.64   53   63
## 3206   88.0   23.79   80   86
## 2345   80.0   28.82   52   70
## 689    74.0   18.64   66   69
## 3501   73.0   20.06   73   85
## 733    73.0   24.59   70   78
## 3746  112.5   26.80   75   82
## 1354   95.0   26.74   54   77
## 3813   77.0   23.20   65   65
## 1462   93.0   29.80   67   82
## 1413   64.0   20.66   75   60
## 41     80.0   26.87   68   78
## 2660   88.0   23.39   60   79
## 1159   65.0   24.10   82   78
## 2494   98.5   30.41   60   79
## 2277   70.0   19.97   75   69
## 3134   82.0   28.92   54   65
## 1796   90.0   25.49   69   73
## 794    90.0   33.47   88   73
## 2688  109.0   28.40   75   71
## 515    84.0   22.67   85   96
## 3423   96.0   29.04   65   82
## 120    88.0   25.09   88   85
## 2071   72.5   27.86   63   67
## 3261   82.0   23.52   60   67
## 2262   72.0   25.62   72   71
## 496    81.0   27.51   62   76
## 2527   70.0   22.98   85   85
## 3917   85.0   23.35   80   67
## 1468   79.0   26.56   60   92
## 505    88.0   24.19  100   83
## 1828   99.0   28.41   83   73
## 1727   85.5   22.29   60   72
```

```
## 3842  79.0  23.63  96  70
## 2523  71.0  18.30  80  67
## 3924  71.0  27.14  75 110
## 350   69.0  26.89  75  73
## 1035  91.0  27.06  63  73
## 308   61.0  23.94  75  79
## 183   76.0  18.99  96  97
## 156   82.0  28.34  70  75
## 729   74.0  21.51  67  77
## 3324  80.0  22.18  78  79
## 570   89.0  23.29  70  77
## 2192  80.0  28.79  72  68
## 1257  71.5  25.74  72  80
## 3441  60.0  23.29  60  61
## 2994  83.0  28.85  62  94
## 4108  79.0  20.12  72  64
## 2516  80.0  23.40  85  77
## 502   93.0  23.09  75  70
## 2956  77.0  25.62 100  83
## 1559  89.0  29.25  90  87
## 2799  80.0  37.15  63  70
## 1503  61.0  21.85  68  81
## 1694  90.0  32.93  95  73
## 1660 109.0  32.43  76  66
## 25    90.0  21.96  75  83
## 386   80.0  27.23  62  87
## 585   85.5  25.83  68  82
## 2731  84.0  22.53  94  87
## 2160  72.0  23.72  73 100
## 3385  84.0  28.76  95  68
## 1200  86.0  30.07  80  84
## 950   67.5  20.79  63  86
## 562   75.5  19.63  66  78
## 2221  83.0  27.26  85  87
## 1429  90.0  25.24  80  64
## 1458  70.0  18.43  80 107
## 2471  72.0  23.51  75  80
## 1135  87.5  24.77  95  85
## 3624  79.0  22.19  82  95
## 875   73.0  22.73  70  85
## 919   90.0  23.03  77  93
## 995   76.0  21.35  77  88
## 3849  74.0  26.00  80  67
## 3721  78.0  26.26  55  82
## 3130  74.5  22.19  60  75
## 590   82.0  23.87  79  90
## 588   73.0  24.01  80  83
## 1356  73.0  30.27  68  70
## 190   83.5  28.96  72  65
## 173   74.0  25.26  80  88
## 1372  83.0  26.18  75  83
## 4006  87.0  24.22  86 110
## 3189  90.0  27.13  72  86
## 1565  73.0  21.03  60  84
```

```
## 3590  109.0  32.32  72  59
## 2122   93.0  26.39  88  75
## 694    93.5  27.47  87  89
## 2033   80.0  22.90  78  74
## 499    68.5  24.04  60  70
## 1084   70.0  23.48  92  79
## 2990   75.0  26.38  75  76
## 3689   74.0  26.01  75  90
## 2167   90.0  28.78  60  74
## 432    64.0  18.59  60  77
## 2512   65.0  19.80  80  85
## 3375   72.0  23.80  75  97
## 1344   79.0  27.29  95  74
## 3587  100.0  21.33  72  77
## 176    86.5  26.51  90  74
## 438    89.0  25.01  95  76
## 617    77.5  27.29  88  60
## 3964   87.0  31.92  75  67
## 651    81.0  22.54  58  74
## 3566   80.0  20.26  75  63
## 1854   78.0  38.06  66  62
## 2496   72.0  30.34  70  79
## 2455   72.5  23.07  67  83
## 487    80.0  27.16  70  85
## 1234   66.0  25.18  44  81
## 816    79.0  28.46  73  67
## 2677   69.0  25.70  68  77
## 655    68.5  23.47  65  83
## 3041   86.0  26.33  62  65
## 3485  107.0  21.97  75  83
## 3993   68.5  19.83  79  76
## 1309   81.0  29.76  80  68
## 635    67.5  23.47  78  80
## 3293   80.0  20.67  86  64
## 2901   73.5  24.47  70  73
## 2172   79.5  30.21  82  75
## 20     88.0  26.88  85  65
## 88    104.0  38.46  57  78
## 545    71.0  21.80  82  78
## 2293   76.0  24.80  71  92
## 1451   69.0  25.48  90  77
## 532   121.0  37.41  85 100
## 2588   72.5  26.50  72  95
## 2911   79.0  28.04  98 100
## 4210   80.0  28.06  70 116
## 1842   73.0  26.38  60  65
## 3709   96.0  27.73  80  60
## 2846   83.0  27.17  70  88
## 3547   77.0  27.64  78  74
## 2760   65.5  31.71  73  93
## 3822   78.0  19.98  69  80
## 1443   80.0  24.12  75  97
## 2887   78.0  23.78  67  83
## 1597   94.0  30.39  75  80
```

```
## 1103  87.0  23.31  80  74
## 2201  98.0  28.23  75  90
## 1320  78.0  24.73  60  70
## 466   95.5  30.02  92  87
## 3918  86.0  27.42 100  84
## 1760 102.0  27.26  69  75
## 2937  97.0  31.27  62  90
## 3777  83.0  24.81  58  73
## 846   78.5  21.02  68 112
## 1726  71.0  29.82  66 104
## 2850  79.0  35.12  75 108
## 3405  97.5  30.53  76  87
## 4064  95.0  24.28  88  99
## 3115  85.0  28.94  72  74
## 3892 100.0  25.45  90  67
## 2963  75.0  23.60  70  68
## 3984  99.0  28.60  85  74
## 1763 105.0  30.06  80  76
## 4045  93.5  34.84  85  85
## 3100  72.0  29.62  85  70
## 1857  67.0  24.84  63  75
## 2247 108.0  24.00  80  86
## 2419  91.0  28.04  70  77
## 2215 106.5  29.82  68  70
## 4035  80.0  19.98  96  76
## 787   82.0  27.18  72  70
## 1377  88.0  22.53  70  96
## 1024  84.0  36.21  62  74
## 2386  85.0  22.55  80  77
## 3857  76.0  21.65  63  81
## 3088  77.0  24.06  60  67
## 1882  76.5  26.31 110  74
## 161   73.0  20.41  72  75
## 2800  71.0  25.98  75  86
## 3687  75.0  25.79  75  55
## 1711  80.0  24.19  85  73
## 2322  83.0  27.80  65  75
## 2005  62.0  30.47  75  82
## 1665  61.0  25.96  80  60
## 642   77.0  29.04  63  80
## 2678  87.0  26.25  67  61
## 4226  85.0  24.24  83 105
## 3136  91.0  29.35  65  67
## 3503  71.0  23.74  57  74
## 2056  82.0  32.27  85  72
## 3050  72.5  20.84  75 102
## 1510  73.0  23.98  73  67
## 3850  60.0  20.84  75 348
## 569   66.0  20.81  78  88
## 3257  85.0  21.27  75 137
## 2786  61.0  23.08  55  73
## 1011  70.0  28.30  90  80
## 257   98.0  29.77  72  75
## 3051  89.0  32.57  65  75
```

```
## 878    75.0   23.39   60   74
## 3876   65.0   17.68  110   87
## 3646   48.0   26.73   65   65
## 2329   88.0   25.41   69   74
## 2088   90.0   30.77   60   77
## 1364   76.0   22.24   90  325
## 2363   83.0   29.63   68   80
## 2126   88.0   26.25   75   73
## 3811   86.5   25.56   75   83
## 2500   70.0   25.18   75   59
## 206    78.0   23.75   62   97
## 735    74.0   28.82   80   77
## 3780   59.0   23.10   63   85
## 2928   89.0   23.34   66   80
## 2479   92.0   27.88   68   80
## 4195   96.0   19.34   95   76
## 3255   70.0   28.86   72   87
## 764    94.0   33.32   92  205
## 3086   93.0   29.76   64   63
## 4101   77.0   26.58   70   81
## 3859   65.0   17.84   75   71
## 2638   72.5   25.86   65   61
## 834   140.0   43.30  107  130
## 228    98.0   29.44   82  105
## 2894   66.5   17.17   80  394
## 1905   70.0   21.03   80   58
## 1459   89.0   29.51   64   74
## 2910   96.0   27.86   75  394
## 227    92.0   31.30   90   65
## 3364   74.0   25.59   72   90
## 2965   67.0   23.13   75   72
## 2138   76.0   22.91   75   70
## 260   105.0   36.29   75   95
## 3078   73.0   27.89   90   63
## 139   100.0   20.50   66   78
## 1392   85.0   29.43   56   72
## 2871   82.0   24.19   66  137
## 3834   66.5   25.78   75  104
## 716    80.0   27.05   72   68
## 4172   87.0   27.13   75   81
## 3806  104.0   34.97   90   65
## 3588   96.0   27.04   70   87
## 1242   69.0   27.57   80   72
## 2671   87.0   22.91   70   65
## 2137  107.5   26.45   82   84
## 759    87.0   33.38   63   74
## 559    83.5   21.33   70   95
## 2751   94.0   34.39  110   80
## 169    77.0   24.12   73   79
## 949   107.0   24.87   80   97
## 1924   77.5   24.50   68   78
## 3123   87.0   28.76   76   76
## 1679   76.0   19.09   64   98
## 3169   80.0   26.25   67   76
```

```
## 753   62.5  23.80  77  95
## 2344  72.5  26.09  77  73
## 191   92.0  28.82  80  63
## 4044  74.0  23.38  80  71
## 986   89.0  25.46  75  70
## 2207 102.5  26.33  98  97
## 696   91.0  23.09  70  78
## 971   98.0  27.78  75  89
## 2499  74.0  28.09  80 155
## 3791  87.0  26.21  80  72
## 4116  88.0  24.16  94 118
## 2606  91.0  33.00  85  81
## 792  107.0  20.63  63  70
## 2673  81.0  24.22  80  85
## 3840  98.0  30.08  67 109
## 746   94.0  29.84  95  67
## 377   87.0  23.85  65  55
## 3684  73.0  27.51  65  83
## 1716  99.0  39.64  85  81
## 708   79.0  26.59  69  72
## 2417 130.0  25.49  95 127
## 312   88.0  21.61  75 105
## 3847 113.0  25.94  63  90
## 2228  92.0  26.09  96  74
## 930   88.0  23.71  60  53
## 4233  97.0  23.14  60  79
## 4222  74.0  21.85  80  72
## 3440  70.0  23.62  90  73
## 2176  88.0  27.92  75  74
## 963   66.0  25.07  68  73
## 3419 100.0  27.31  85 103
## 2195  83.0  33.26  80  63
## 3144  78.0  19.18  78  74
## 1187 109.0  28.33  70  75
## 278   92.0  25.23  80  87
## 1519  81.0  22.18  70 122
## 2272  96.0  25.95  65 126
## 144   95.0  38.39  96 109
## 1341  66.5  28.90 100  66
## 1609 120.0  31.64  58  60
## 2299  95.0  26.68  67  92
## 1723  54.0  25.40  67  95
## 3805  89.0  23.03  65  82
## 3798  68.0  24.80  76 108
## 1099  78.0  26.26  79  83
## 239   84.0  27.15  75  97
## 4     95.0  28.58  65 103
## 3875  61.0  22.17  85  55
## 525  117.0  29.63  75  77
## 3854 100.5  32.27  58  72
## 3963  90.0  23.48  80  57
## 2188 102.0  28.88  90  94
## 785   81.0  21.85  70  72
## 1784  84.0  25.95 105  76
```

```
## 2267  80.0  25.51  62  62
## 370  105.0  22.91  90  97
## 3339  87.0  20.86  85  79
## 2828  82.0  26.36  84  70
## 574  96.5  24.85  72  75
## 2493  82.0  39.82  120  85
## 3907  79.0  27.13  75  76
## 2736  84.0  31.12  80  83
## 4214  95.0  27.89  75  84
## 2334  80.0  25.26  96  60
## 281  78.0  21.94  68  94
## 2776  118.0  28.33  69  80
## 3739  81.0  41.61  72  85
## 1843  91.0  25.35  70  114
## 1879  120.0  33.71  68  72
## 2350  78.0  20.15  68  95
## 2353  101.0  36.91  72  97
## 1889  82.0  27.17  70  85
## 1821  79.0  19.50  79  75
## 1664  81.0  31.71  64  80
## 899  102.0  26.39  76  105
## 4145  84.0  24.17  90  94
## 117  96.0  26.40  55  75
## 2904  62.0  25.13  95  77
## 3636  121.0  33.81  65  72
## 3732  110.0  30.41  90  84
## 329  111.0  19.88  90  85
## 3071  72.0  19.16  62  90
## 2746  86.0  26.05  92  103
## 879  102.0  30.38  82  68
## 3797  71.0  25.48  75  98
## 392  76.0  26.64  65  76
## 3403  55.0  19.97  90  83
## 4227  84.0  26.05  67  76
## 4193  80.0  27.11  65  65
## 841  73.0  23.76  60  88
## 524  84.5  27.08  110  84
## 1661  91.5  27.12  70  80
## 625  101.0  24.42  72  84
## 1408  79.0  21.31  70  65
## 116  82.0  32.23  75  117
## 2107  83.0  22.36  65  78
## 177  106.0  27.61  80  77
## 3408  87.0  21.44  75  98
## 1204  106.0  24.68  100  76
## 3080  92.0  29.64  72  130
## 1812  92.0  27.18  65  85
## 521  65.0  19.77  70  89
## 95  79.0  28.57  80  65
## 4110  92.0  26.38  100  71
## 2034  88.0  28.68  77  65
## 3349  103.0  29.11  80  64
## 604  73.0  30.74  90  91
## 836  75.0  20.55  80  65
```

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## 1052  105.0  28.04  90  79
## 4190   74.0  20.88  80  77
## 1571   90.0  24.63 110  72
## 399    66.0  26.84  65  76
## 1906   85.0  29.67  70  74
## 1092   66.0  24.58  70  84
## 1761  124.0  26.40  75  69
## 936    80.0  29.16  92 108
## 865   124.0  19.61  76 120
## 76     85.0  34.55  65 103
## 3490  130.0  37.10  96  77
## 3239   93.0  25.14  70  72
## 2089  120.0  29.38  72  85
## 3228   78.0  28.18  75 106
## 3221  102.0  30.43  95  78
## 2750   67.0  25.77  67  66
## 3137  101.0  23.27  92  79
## 1592   89.0  32.41  68  81
## 868    74.0  21.03  90  81
## 890    73.5  22.30  75  84
## 231    91.0  27.35  60  77
## 2797   98.0  23.03  70  72
## 2497   80.0  28.15  84  78
## 197    76.0  30.85  65  54
## 3352  110.0  20.09  75  63
## 2311   81.0  30.19  62  80
## 3784   81.0  22.19  95  94
## 3681   82.5  34.08  86 250
## 2374   88.0  39.08  60  87
## 3304   79.0  29.34  70  71
## 2794   98.0  29.98  80  93
## 2658  130.0  56.80  90  86
## 788    74.0  23.59  70 115
## 2804   91.0  31.20  68  75
## 3818   93.0  28.50  68 332
## 285    85.0  30.28  70 120
## 2577   85.0  28.04  73  71
## 2198   63.0  30.00  70  76
## 1940   84.0  27.01  52  83
## 2707   85.0  27.59  65  75
## 495    89.5  21.91  50  72
## 3518   92.0  22.53  79  60
## 1141   88.0  28.50  75  75
## 2876   82.0  23.96  75  78
## 2934   80.0  28.85  70  67
## 772    85.5  24.01  76  88
## 1789   73.0  29.86  67  93
## 4112   80.0  33.90  85  60
## 501    71.0  24.40  73  68
## 153    76.0  31.13  71  85
## 2884  107.0  39.40  80  90
## 82    110.0  32.51  84  70
## 2269   75.0  28.87  70  83
## 372   102.0  32.35  75  71
```

```
## 887   97.0  33.19  68  89
## 195   87.0  22.90  72  72
## 3845  110.0 37.62  110 368
## 3182  98.0  26.05  94  81
## 1359  68.0  24.77  80  77
## 3676  94.0  25.86  80  87
## 1056  68.0  29.04  70  94
## 3506  60.0  24.73  105 71
## 4194  105.0 27.96  75  87
## 1947  81.0  30.00  60  100
## 1772  64.0  26.00  62  87
## 154   104.0 25.32  57  84
## 2634  86.5  20.82  92  77
## 979   100.0 24.07  92  70
## 4224  98.0  21.68  90  75
## 2900  95.0  26.11  85  77
## 2326  75.0  22.17  75  60
## 368   67.0  28.04  58  79
## 3494  70.0  19.69  80  79
## 2529  81.0  23.95  67  150
## 2064  74.0  25.66  71  93
## 605   88.0  19.53  85  126
## 3215  107.0 26.84  60  69
## 1513  78.0  16.92  65  74
## 3165  100.0 28.09  110 69
## 3672  92.0  24.66  60  75
## 1837  86.0  25.05  66  70
## 3836  69.0  22.90  66  82
## 2626  85.0  23.03  85  123
## 2881  89.0  31.07  75  76
## 3446  92.0  23.07  75  83
## 1650  99.5  34.95  68  274
## 4058  80.0  25.15  70  95
## 3481  90.0  21.90  80  95
## 3844  80.0  29.87  90  73
## 4189  70.0  23.98  92  67
## 4221  82.0  21.18  75  70
## 3450  97.0  29.22  90  135
## 1584  84.5  24.04  78  103
## 621   80.0  22.11  69  84
## 3769  83.0  22.86  65  57
## 2734  115.0 21.01  115 86
## 4156  84.0  19.14  68  74
## 345   66.0  20.20  60  92
## 4164  77.5  24.30  52  65
## 1477  94.0  25.38  80  98
## 1953  84.0  25.64  58  77
## 1486  80.0  27.52  90  268
## 3075  101.0 28.27  86  82
## 7     71.0  33.11  60  85
## 2717  95.0  25.37  63  70
## 883   98.0  30.93  80  100
## 3488  55.0  16.71  79  63
## 2835  93.0  25.36  80  84
```

```
## 1077                  67.0         23.08        65           70
## 1456                  81.0         23.28        62           85
## 1675                  80.0         25.09        70          292
## 1797                 100.5         33.54        72          116
## 3533                 119.0         28.92        73           72
## 1196                  87.5         23.88        81           67
## 554                  103.0         29.82        81           74
## 1580                  80.0         25.71        80           83
## 3335                  82.0         25.84        82           81
## 2918                  89.0         27.30        65           67
## 3760                  84.0         28.68        66           76
## 1932                  80.0         26.45        66          255
## 1299                  59.0         27.99        70           75
## 1096                  71.0         21.19        77           75
## 3718                  85.0         22.00        72           71
## 3555                 124.0         28.06        66           63
## 1132                  64.0         24.56        58          124
## 3382                 105.0         27.22        60           96
## 1380                  86.0         20.74        75           62
## 1094                  81.0         25.68        70           74
## 3867                  87.5         25.10        65           73
## 3344                  83.0         20.82       104           70
## 2960                  88.0         22.57        68           77
## 4077                 125.0         29.50        68          256
## 3447                  90.0         32.09        67           73
## 146                  100.0         31.61        87           76
## 544                   74.0         22.42       100           90
## 1692                  85.0         26.01        75           79
## 1515                  82.0         26.33        72           80
##      TenYearCoronaryHeartDisease      Group
## 1942                      Immune Vulnerable
## 1402                      Immune     Immune
## 939                       Immune Vulnerable
## 2993                      Immune Vulnerable
## 1279                      Immune     Immune
## 2117                      Immune     Immune
## 652                       Immune     Immune
## 3224                      Immune Vulnerable
## 382                       Immune     Immune
## 1651                      Immune Vulnerable
## 825                       Immune Vulnerable
## 1773                      Immune     Immune
## 2701                      Immune     Immune
## 462                       Immune Vulnerable
## 2467                      Immune Vulnerable
## 2226                      Immune Vulnerable
## 2402                      Immune Vulnerable
## 54                        Immune Vulnerable
## 1537                      Immune Vulnerable
## 1009                      Immune     Immune
## 1216                      Immune Vulnerable
## 669                       Immune Vulnerable
## 2503                      Immune Vulnerable
## 3999                      Immune Vulnerable
```

```
## 3330                    Immune Vulnerable
## 1335                    Immune     Immune
## 3903                    Immune     Immune
## 3972                    Immune Vulnerable
## 4071                    Immune Vulnerable
## 3260                    Immune     Immune
## 3264                    Immune     Immune
## 760                     Immune Vulnerable
## 1974                    Immune     Immune
## 2967                    Immune Vulnerable
## 2666                    Immune Vulnerable
## 3525                    Immune     Immune
## 2106                    Immune Vulnerable
## 3554                    Immune     Immune
## 4017                    Immune Vulnerable
## 478                     Immune     Immune
## 3596                    Immune     Immune
## 58                      Immune Vulnerable
## 734                     Immune Vulnerable
## 3320                    Immune     Immune
## 351                     Immune Vulnerable
## 1666                    Immune Vulnerable
## 3325                    Immune Vulnerable
## 2856                    Immune Vulnerable
## 3402                    Immune     Immune
## 3915                    Immune Vulnerable
## 1930                    Immune     Immune
## 1777                    Immune     Immune
## 2327                    Immune     Immune
## 723                     Immune     Immune
## 3685                    Immune     Immune
## 1464                    Immune Vulnerable
## 1946                    Immune     Immune
## 31                      Immune     Immune
## 2394                    Immune Vulnerable
## 2426                    Immune Vulnerable
## 3077                    Immune Vulnerable
## 1902                    Immune Vulnerable
## 3483                    Immune     Immune
## 1536                    Immune Vulnerable
## 1347                    Immune     Immune
## 2456                    Immune     Immune
## 2084                    Immune Vulnerable
## 2256                    Immune     Immune
## 2254                    Immune     Immune
## 1165                    Immune Vulnerable
## 645                     Immune     Immune
## 1368                    Immune     Immune
## 2141                    Immune Vulnerable
## 1636                    Immune Vulnerable
## 1544                    Immune     Immune
## 118                     Immune     Immune
## 2595                    Immune Vulnerable
## 1586                    Immune Vulnerable
```

```
## 3162                    Immune     Immune
## 3807                    Immune     Immune
## 4185                    Immune Vulnerable
## 3649                    Immune     Immune
## 1811                    Immune     Immune
## 765                     Immune Vulnerable
## 2313                    Immune Vulnerable
## 405                     Immune     Immune
## 3640                    Immune Vulnerable
## 3263                    Immune Vulnerable
## 3468                    Immune Vulnerable
## 3976                    Immune Vulnerable
## 3971                    Immune Vulnerable
## 2094                    Immune     Immune
## 1186                    Immune     Immune
## 2522                    Immune Vulnerable
## 3647                    Immune Vulnerable
## 799                     Immune     Immune
## 1357                    Immune Vulnerable
## 445                     Immune     Immune
## 1470                    Immune Vulnerable
## 1013                    Immune Vulnerable
## 1793                    Immune     Immune
## 3694                    Immune     Immune
## 4235                    Immune     Immune
## 1126                    Immune     Immune
## 1312                    Immune Vulnerable
## 3203                    Immune     Immune
## 1588                    Immune Vulnerable
## 3206                    Immune Vulnerable
## 2345                    Immune Vulnerable
## 689                     Immune     Immune
## 3501                    Immune Vulnerable
## 733                     Immune Vulnerable
## 3746                    Immune Vulnerable
## 1354                    Immune     Immune
## 3813                    Immune Vulnerable
## 1462                    Immune     Immune
## 1413                    Immune Vulnerable
## 41                      Immune Vulnerable
## 2660                    Immune Vulnerable
## 1159                    Immune     Immune
## 2494                    Immune     Immune
## 2277                    Immune     Immune
## 3134                    Immune     Immune
## 1796                    Immune     Immune
## 794                     Immune     Immune
## 2688                    Immune     Immune
## 515                     Immune Vulnerable
## 3423                    Immune Vulnerable
## 120                     Immune     Immune
## 2071                    Immune Vulnerable
## 3261                    Immune Vulnerable
## 2262                    Immune     Immune
```

```
## 496                    Immune Vulnerable
## 2527                   Immune     Immune
## 3917                   Immune     Immune
## 1468                   Immune     Immune
## 505                    Immune Vulnerable
## 1828                   Immune     Immune
## 1727                   Immune Vulnerable
## 3842                   Immune     Immune
## 2523                   Immune     Immune
## 3924                   Immune     Immune
## 350                    Immune     Immune
## 1035                   Immune     Immune
## 308                    Immune     Immune
## 183                    Immune     Immune
## 156                    Immune     Immune
## 729                    Immune     Immune
## 3324                   Immune Vulnerable
## 570                    Immune Vulnerable
## 2192                   Immune     Immune
## 1257                   Immune     Immune
## 3441                   Immune     Immune
## 2994                   Immune     Immune
## 4108                   Immune Vulnerable
## 2516                   Immune     Immune
## 502                    Immune Vulnerable
## 2956                   Immune Vulnerable
## 1559                   Immune Vulnerable
## 2799                   Immune Vulnerable
## 1503                   Immune     Immune
## 1694                   Immune     Immune
## 1660                   Immune     Immune
## 25                     Immune     Immune
## 386                    Immune Vulnerable
## 585                    Immune Vulnerable
## 2731                   Immune Vulnerable
## 2160                   Immune Vulnerable
## 3385                   Immune     Immune
## 1200                   Immune Vulnerable
## 950                    Immune     Immune
## 562                    Immune Vulnerable
## 2221                   Immune     Immune
## 1429                   Immune Vulnerable
## 1458                   Immune Vulnerable
## 2471                   Immune Vulnerable
## 1135                   Immune Vulnerable
## 3624                   Immune Vulnerable
## 875                    Immune     Immune
## 919                    Immune Vulnerable
## 995                    Immune     Immune
## 3849                   Immune     Immune
## 3721                   Immune Vulnerable
## 3130                   Immune     Immune
## 590                    Immune     Immune
## 588                    Immune Vulnerable
```

```
## 1356                    Immune Vulnerable
## 190                     Immune     Immune
## 173                     Immune Vulnerable
## 1372                    Immune     Immune
## 4006                    Immune     Immune
## 3189                    Immune Vulnerable
## 1565                    Immune Vulnerable
## 3590                    Immune Vulnerable
## 2122                    Immune     Immune
## 694                     Immune     Immune
## 2033                    Immune Vulnerable
## 499                     Immune     Immune
## 1084                    Immune     Immune
## 2990                    Immune Vulnerable
## 3689                    Immune     Immune
## 2167                    Immune     Immune
## 432                     Immune     Immune
## 2512                    Immune Vulnerable
## 3375                    Immune     Immune
## 1344                    Immune     Immune
## 3587                    Immune Vulnerable
## 176                     Immune Vulnerable
## 438                     Immune Vulnerable
## 617                     Immune Vulnerable
## 3964                    Immune     Immune
## 651                     Immune Vulnerable
## 3566                    Immune     Immune
## 1854                    Immune Vulnerable
## 2496                    Immune Vulnerable
## 2455                    Immune     Immune
## 487                     Immune     Immune
## 1234                    Immune     Immune
## 816                     Immune Vulnerable
## 2677                    Immune     Immune
## 655                     Immune Vulnerable
## 3041                    Immune Vulnerable
## 3485                    Immune     Immune
## 3993                    Immune     Immune
## 1309                    Immune     Immune
## 635                     Immune Vulnerable
## 3293                    Immune Vulnerable
## 2901                    Immune     Immune
## 2172                    Immune     Immune
## 20                      Immune Vulnerable
## 88                      Immune Vulnerable
## 545                     Immune     Immune
## 2293                    Immune Vulnerable
## 1451                    Immune Vulnerable
## 532                     Immune     Immune
## 2588                    Immune     Immune
## 2911                    Immune Vulnerable
## 4210                    Immune Vulnerable
## 1842                    Immune Vulnerable
## 3709                    Immune     Immune
```

```
## 2846                    Immune Vulnerable
## 3547                    Immune Vulnerable
## 2760                    Immune     Immune
## 3822                    Immune Vulnerable
## 1443                    Immune Vulnerable
## 2887                    Immune Vulnerable
## 1597                    Immune     Immune
## 1103                    Immune Vulnerable
## 2201                    Immune     Immune
## 1320                    Immune     Immune
## 466                     Immune Vulnerable
## 3918                    Immune Vulnerable
## 1760                    Immune     Immune
## 2937                    Immune Vulnerable
## 3777                    Immune     Immune
## 846                     Immune     Immune
## 1726                    Immune     Immune
## 2850                    Immune Vulnerable
## 3405                    Immune     Immune
## 4064                    Immune Vulnerable
## 3115                    Immune     Immune
## 3892                    Immune Vulnerable
## 2963                    Immune Vulnerable
## 3984                    Immune     Immune
## 1763                    Immune     Immune
## 4045                    Immune     Immune
## 3100                    Immune Vulnerable
## 1857                    Immune     Immune
## 2247                    Immune Vulnerable
## 2419                    Immune     Immune
## 2215                    Immune     Immune
## 4035                    Immune Vulnerable
## 787                     Immune     Immune
## 1377                    Immune Vulnerable
## 1024                    Immune Vulnerable
## 2386                    Immune Vulnerable
## 3857                    Immune     Immune
## 3088                    Immune     Immune
## 1882                    Immune     Immune
## 161                     Immune     Immune
## 2800                    Immune     Immune
## 3687                    Immune     Immune
## 1711                    Immune Vulnerable
## 2322                    Immune     Immune
## 2005                    Immune     Immune
## 1665                    Immune     Immune
## 642                     Immune Vulnerable
## 2678                    Immune Vulnerable
## 4226                    Immune Vulnerable
## 3136                    Immune Vulnerable
## 3503                    Immune Vulnerable
## 2056                    Immune     Immune
## 3050                    Immune     Immune
## 1510                    Immune     Immune
```

```
## 3850                    Immune     Immune
## 569                     Immune Vulnerable
## 3257                    Immune Vulnerable
## 2786                    Immune     Immune
## 1011                    Immune     Immune
## 257                     Immune     Immune
## 3051                Vulnerable Vulnerable
## 878                 Vulnerable Vulnerable
## 3876                Vulnerable     Immune
## 3646                Vulnerable     Immune
## 2329                Vulnerable Vulnerable
## 2088                Vulnerable     Immune
## 1364                Vulnerable Vulnerable
## 2363                Vulnerable     Immune
## 2126                Vulnerable Vulnerable
## 3811                Vulnerable     Immune
## 2500                Vulnerable     Immune
## 206                 Vulnerable     Immune
## 735                 Vulnerable Vulnerable
## 3780                Vulnerable Vulnerable
## 2928                Vulnerable     Immune
## 2479                Vulnerable Vulnerable
## 4195                Vulnerable     Immune
## 3255                Vulnerable Vulnerable
## 764                 Vulnerable Vulnerable
## 3086                Vulnerable Vulnerable
## 4101                Vulnerable     Immune
## 3859                Vulnerable     Immune
## 2638                Vulnerable     Immune
## 834                 Vulnerable Vulnerable
## 228                 Vulnerable     Immune
## 2894                Vulnerable Vulnerable
## 1905                Vulnerable     Immune
## 1459                Vulnerable Vulnerable
## 2910                Vulnerable     Immune
## 227                 Vulnerable Vulnerable
## 3364                Vulnerable     Immune
## 2965                Vulnerable     Immune
## 2138                Vulnerable     Immune
## 260                 Vulnerable     Immune
## 3078                Vulnerable     Immune
## 139                 Vulnerable Vulnerable
## 1392                Vulnerable     Immune
## 2871                Vulnerable     Immune
## 3834                Vulnerable     Immune
## 716                 Vulnerable Vulnerable
## 4172                Vulnerable Vulnerable
## 3806                Vulnerable Vulnerable
## 3588                Vulnerable Vulnerable
## 1242                Vulnerable Vulnerable
## 2671                Vulnerable     Immune
## 2137                Vulnerable Vulnerable
## 759                 Vulnerable Vulnerable
## 559                 Vulnerable     Immune
```

```
## 2751                Vulnerable Vulnerable
## 169                 Vulnerable Vulnerable
## 949                 Vulnerable     Immune
## 1924                Vulnerable Vulnerable
## 3123                Vulnerable     Immune
## 1679                Vulnerable Vulnerable
## 3169                Vulnerable Vulnerable
## 753                 Vulnerable     Immune
## 2344                Vulnerable     Immune
## 191                 Vulnerable     Immune
## 4044                Vulnerable Vulnerable
## 986                 Vulnerable     Immune
## 2207                Vulnerable Vulnerable
## 696                 Vulnerable Vulnerable
## 971                 Vulnerable     Immune
## 2499                Vulnerable Vulnerable
## 3791                Vulnerable Vulnerable
## 4116                Vulnerable     Immune
## 2606                Vulnerable     Immune
## 792                 Vulnerable     Immune
## 2673                Vulnerable Vulnerable
## 3840                Vulnerable Vulnerable
## 746                 Vulnerable Vulnerable
## 377                 Vulnerable Vulnerable
## 3684                Vulnerable Vulnerable
## 1716                Vulnerable     Immune
## 708                 Vulnerable Vulnerable
## 2417                Vulnerable     Immune
## 312                 Vulnerable     Immune
## 3847                Vulnerable Vulnerable
## 2228                Vulnerable Vulnerable
## 930                 Vulnerable Vulnerable
## 4233                Vulnerable     Immune
## 4222                Vulnerable     Immune
## 3440                Vulnerable     Immune
## 2176                Vulnerable     Immune
## 963                 Vulnerable Vulnerable
## 3419                Vulnerable Vulnerable
## 2195                Vulnerable     Immune
## 3144                Vulnerable Vulnerable
## 1187                Vulnerable     Immune
## 278                 Vulnerable     Immune
## 1519                Vulnerable     Immune
## 2272                Vulnerable     Immune
## 144                 Vulnerable     Immune
## 1341                Vulnerable Vulnerable
## 1609                Vulnerable     Immune
## 2299                Vulnerable Vulnerable
## 1723                Vulnerable Vulnerable
## 3805                Vulnerable     Immune
## 3798                Vulnerable Vulnerable
## 1099                Vulnerable Vulnerable
## 239                 Vulnerable Vulnerable
## 4                   Vulnerable Vulnerable
```

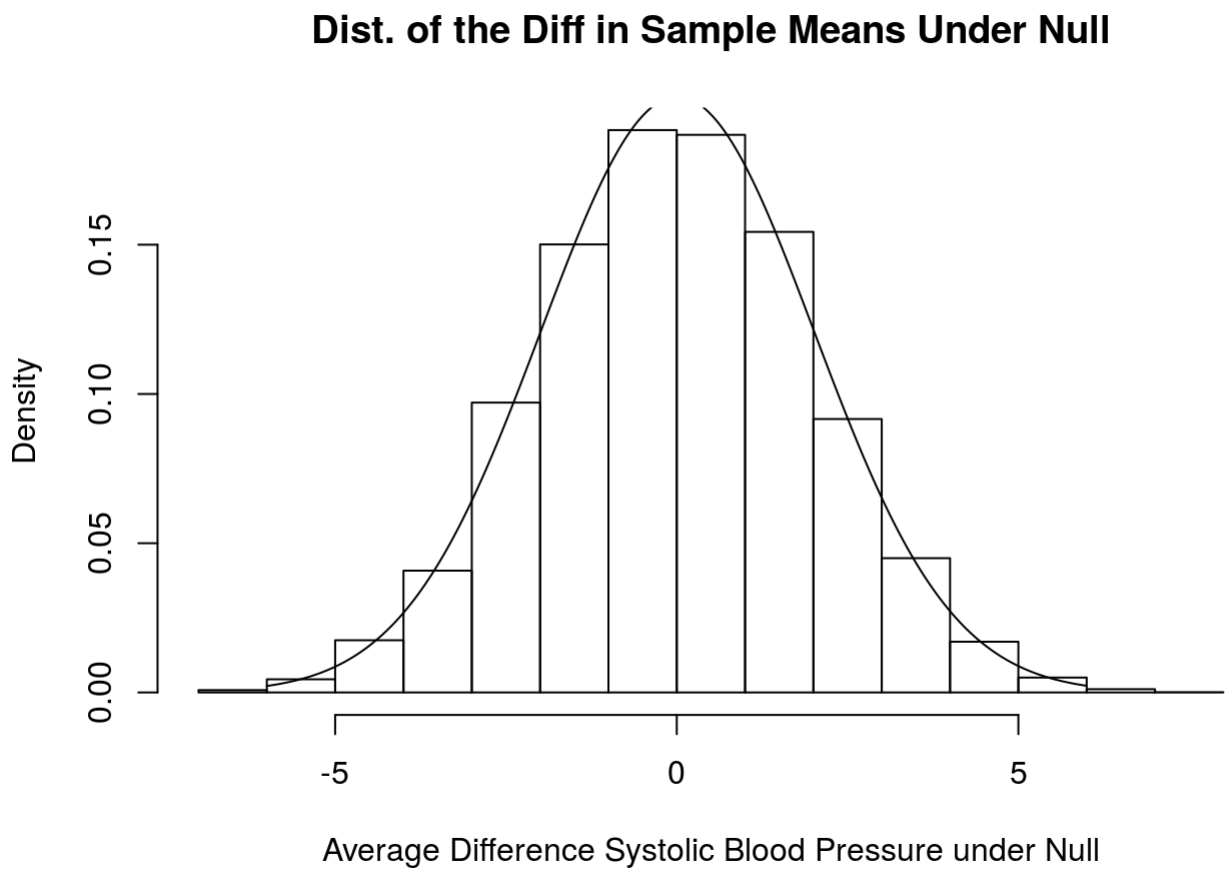
```
## 3875                Vulnerable     Immune
## 525                 Vulnerable     Immune
## 3854                Vulnerable Vulnerable
## 3963                Vulnerable Vulnerable
## 2188                Vulnerable     Immune
## 785                 Vulnerable     Immune
## 1784                Vulnerable     Immune
## 2267                Vulnerable     Immune
## 370                 Vulnerable     Immune
## 3339                Vulnerable     Immune
## 2828                Vulnerable     Immune
## 574                 Vulnerable Vulnerable
## 2493                Vulnerable     Immune
## 3907                Vulnerable Vulnerable
## 2736                Vulnerable     Immune
## 4214                Vulnerable Vulnerable
## 2334                Vulnerable     Immune
## 281                 Vulnerable Vulnerable
## 2776                Vulnerable     Immune
## 3739                Vulnerable Vulnerable
## 1843                Vulnerable Vulnerable
## 1879                Vulnerable     Immune
## 2350                Vulnerable     Immune
## 2353                Vulnerable     Immune
## 1889                Vulnerable     Immune
## 1821                Vulnerable     Immune
## 1664                Vulnerable Vulnerable
## 899                 Vulnerable Vulnerable
## 4145                Vulnerable Vulnerable
## 117                 Vulnerable     Immune
## 2904                Vulnerable Vulnerable
## 3636                Vulnerable     Immune
## 3732                Vulnerable     Immune
## 329                 Vulnerable Vulnerable
## 3071                Vulnerable     Immune
## 2746                Vulnerable     Immune
## 879                 Vulnerable Vulnerable
## 3797                Vulnerable Vulnerable
## 392                 Vulnerable     Immune
## 3403                Vulnerable     Immune
## 4227                Vulnerable Vulnerable
## 4193                Vulnerable     Immune
## 841                 Vulnerable     Immune
## 524                 Vulnerable Vulnerable
## 1661                Vulnerable Vulnerable
## 625                 Vulnerable Vulnerable
## 1408                Vulnerable     Immune
## 116                 Vulnerable Vulnerable
## 2107                Vulnerable     Immune
## 177                 Vulnerable     Immune
## 3408                Vulnerable     Immune
## 1204                Vulnerable Vulnerable
## 3080                Vulnerable     Immune
## 1812                Vulnerable Vulnerable
```

```
## 521                 Vulnerable     Immune
## 95                  Vulnerable     Immune
## 4110                Vulnerable Vulnerable
## 2034                Vulnerable     Immune
## 3349                Vulnerable     Immune
## 604                 Vulnerable Vulnerable
## 836                 Vulnerable     Immune
## 1052                Vulnerable Vulnerable
## 4190                Vulnerable Vulnerable
## 1571                Vulnerable     Immune
## 399                 Vulnerable Vulnerable
## 1906                Vulnerable     Immune
## 1092                Vulnerable     Immune
## 1761                Vulnerable Vulnerable
## 936                 Vulnerable     Immune
## 865                 Vulnerable Vulnerable
## 76                  Vulnerable     Immune
## 3490                Vulnerable     Immune
## 3239                Vulnerable     Immune
## 2089                Vulnerable Vulnerable
## 3228                Vulnerable Vulnerable
## 3221                Vulnerable Vulnerable
## 2750                Vulnerable     Immune
## 3137                Vulnerable Vulnerable
## 1592                Vulnerable Vulnerable
## 868                 Vulnerable Vulnerable
## 890                 Vulnerable     Immune
## 231                 Vulnerable Vulnerable
## 2797                Vulnerable Vulnerable
## 2497                Vulnerable Vulnerable
## 197                 Vulnerable Vulnerable
## 3352                Vulnerable     Immune
## 2311                Vulnerable Vulnerable
## 3784                Vulnerable Vulnerable
## 3681                Vulnerable Vulnerable
## 2374                Vulnerable     Immune
## 3304                Vulnerable Vulnerable
## 2794                Vulnerable Vulnerable
## 2658                Vulnerable Vulnerable
## 788                 Vulnerable Vulnerable
## 2804                Vulnerable Vulnerable
## 3818                Vulnerable Vulnerable
## 285                 Vulnerable     Immune
## 2577                Vulnerable     Immune
## 2198                Vulnerable     Immune
## 1940                Vulnerable Vulnerable
## 2707                Vulnerable Vulnerable
## 495                 Vulnerable     Immune
## 3518                Vulnerable Vulnerable
## 1141                Vulnerable     Immune
## 2876                Vulnerable     Immune
## 2934                Vulnerable     Immune
## 772                 Vulnerable Vulnerable
## 1789                Vulnerable     Immune
```

```
## 4112                Vulnerable Vulnerable
## 501                 Vulnerable     Immune
## 153                 Vulnerable Vulnerable
## 2884                Vulnerable Vulnerable
## 82                  Vulnerable Vulnerable
## 2269                Vulnerable     Immune
## 372                 Vulnerable     Immune
## 887                 Vulnerable     Immune
## 195                 Vulnerable Vulnerable
## 3845                Vulnerable     Immune
## 3182                Vulnerable Vulnerable
## 1359                Vulnerable     Immune
## 3676                Vulnerable Vulnerable
## 1056                Vulnerable Vulnerable
## 3506                Vulnerable Vulnerable
## 4194                Vulnerable Vulnerable
## 1947                Vulnerable Vulnerable
## 1772                Vulnerable     Immune
## 154                 Vulnerable     Immune
## 2634                Vulnerable     Immune
## 979                 Vulnerable     Immune
## 4224                Vulnerable     Immune
## 2900                Vulnerable Vulnerable
## 2326                Vulnerable     Immune
## 368                 Vulnerable Vulnerable
## 3494                Vulnerable Vulnerable
## 2529                Vulnerable Vulnerable
## 2064                Vulnerable     Immune
## 605                 Vulnerable     Immune
## 3215                Vulnerable     Immune
## 1513                Vulnerable Vulnerable
## 3165                Vulnerable     Immune
## 3672                Vulnerable Vulnerable
## 1837                Vulnerable     Immune
## 3836                Vulnerable     Immune
## 2626                Vulnerable     Immune
## 2881                Vulnerable Vulnerable
## 3446                Vulnerable     Immune
## 1650                Vulnerable Vulnerable
## 4058                Vulnerable Vulnerable
## 3481                Vulnerable     Immune
## 3844                Vulnerable Vulnerable
## 4189                Vulnerable     Immune
## 4221                Vulnerable     Immune
## 3450                Vulnerable     Immune
## 1584                Vulnerable Vulnerable
## 621                 Vulnerable Vulnerable
## 3769                Vulnerable Vulnerable
## 2734                Vulnerable     Immune
## 4156                Vulnerable     Immune
## 345                 Vulnerable     Immune
## 4164                Vulnerable Vulnerable
## 1477                Vulnerable Vulnerable
## 1953                Vulnerable Vulnerable
```

```
## 1486                Vulnerable     Immune
## 3075                Vulnerable Vulnerable
## 7                   Vulnerable Vulnerable
## 2717                Vulnerable     Immune
## 883                 Vulnerable     Immune
## 3488                Vulnerable     Immune
## 2835                Vulnerable Vulnerable
## 1077                Vulnerable     Immune
## 1456                Vulnerable     Immune
## 1675                Vulnerable Vulnerable
## 1797                Vulnerable Vulnerable
## 3533                Vulnerable Vulnerable
## 1196                Vulnerable Vulnerable
## 554                 Vulnerable Vulnerable
## 1580                Vulnerable Vulnerable
## 3335                Vulnerable Vulnerable
## 2918                Vulnerable     Immune
## 3760                Vulnerable Vulnerable
## 1932                Vulnerable Vulnerable
## 1299                Vulnerable Vulnerable
## 1096                Vulnerable     Immune
## 3718                Vulnerable Vulnerable
## 3555                Vulnerable Vulnerable
## 1132                Vulnerable     Immune
## 3382                Vulnerable Vulnerable
## 1380                Vulnerable Vulnerable
## 1094                Vulnerable     Immune
## 3867                Vulnerable     Immune
## 3344                Vulnerable     Immune
## 2960                Vulnerable     Immune
## 4077                Vulnerable     Immune
## 3447                Vulnerable Vulnerable
## 146                 Vulnerable     Immune
## 544                 Vulnerable Vulnerable
## 1692                Vulnerable Vulnerable
## 1515                Vulnerable     Immune
```

```
set.seed(0)
num_sims <- 10000
# A vector to store my results
results_given_H0_true <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 # idea here is if there is no relationshipm we should be able to shuffle the groups
  shuffled_groups <- transform(sampleData,Group=sample(TenYearCoronaryHeartDisease))
  mean_immune <- mean(shuffled_groups$SystolicBloodPressure[shuffled_groups$Group=="Immune"])
  mean_vulnerable <- mean(shuffled_groups$SystolicBloodPressure[shuffled_groups$Group=="Vulnerab
le"])
  results_given_H0_true[i] <- mean_vulnerable - mean_immune
}
# Finally plot the results
hist(results_given_H0_true, freq = FALSE, main='Dist. of the Diff in Sample Means Under Null', x
lab = 'Average Difference Systolic Blood Pressure under Null', ylab = 'Density')
diff_in_sample_means <- mean(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDis
ease=="Vulnerable"]) - mean(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDise
ase=="Immune"])
low_end_extreme <- mean(results_given_H0_true) + (mean(results_given_H0_true) - diff_in_sample_m
eans)
lines(x = seq(-6, 6, .01), dnorm(seq(-6, 6, .01), mean = mean(results_given_H0_true), sd = sd(re
sults_given_H0_true)))
abline(v=diff_in_sample_means, col = "blue")
abline(v=abs(diff_in_sample_means), col = "red")
```



```
# counts of values more extreme than the test statistic in our original sample, given H0 is true
# two sided given the alternate hypothesis
count_of_more_extreme_lower_tail <- sum(results_given_H0_true <= low_end_extreme)
count_of_more_extreme_upper_tail <- sum(results_given_H0_true >= diff_in_sample_means)
bootstrap_pvalue <- (count_of_more_extreme_lower_tail + count_of_more_extreme_upper_tail)/num_sims
cat("Bootstrap p-value")
```

```
## Bootstrap p-value
```

```
bootstrap_pvalue
```

```
## [1] 0
```

```
cat("t-test p-value")
```

```
## t-test p-value
```

```
t.test(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"], sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"])$p.value
```

```
## [1] 9.576796e-15
```

### Interpretation

There is strong evidence (p-value=0.056) to suggest that the true population mean Systolic Blood Pressure for the Patients Vulnerable to Heart Disease is different than those who are Immune too Heart Disease. We succeed to reject the null hypothesis that there is no difference between the mean Systolic Blood Pressure between the Vulnerable and Immune groups at the level. With 95% confidence, the true difference in the mean Systolic Blood Pressure between those who are Vulnerable and those who are Immune is between 11.47974 and 18.99359. The null hypothesized difference between the mean Systolic Blood Pressure is zero and zero is not in the 95% confidence interval - this result is not consistent with the results of our hypothesis test but it is possible to have this type of inconsistency when using the bootstrap methods. The values of the confidence interval suggest that on average those who are Immune to Heart Disease have a lower Systolic Blood Pressure Level than those who are Vulnerable to Heart Diesease.

# 4. Two sample test for Difference in Proportions

## (a) Traditional Statistical Tools

### Hypotheses

$$H_0 \ : \ p_M - p_F = 0$$

Null Hypotheses: There is no difference between the true population proportion of Male Patients Vulnerable to Heart Disease and the true population proportion of Female Patients Vulnerable to Heart Disease.

$$H_A \ : \ p_M - p_F \neq 0$$

Null Hypotheses: There is a difference between the true population proportion of Male Patients Vulnerable to Heart Disease and the true population proportion of Female Patients Vulnerable to Heart Disease.

### Paramter

We are in interested in the difference between the true population proportion of Male who are Vulnerable to Heart Disease and true population proportion of Female who are Vulnerable to Heart Disease.

$$p_M - p_F$$

### Sample Statistic

$$\hat{p_M} - \hat{p_F}$$

### Test Statistic

$$z = \frac{(\hat{p_M} - \hat{p_F}) - (p_M - p_F)}{\sqrt{\frac{\hat{p_M}(1-\hat{p_M})}{n_M} + \frac{\hat{p_F}(1-\hat{p_F})}{n_F}}}$$

```
# the parts of the test statistic
# sample props
p_hat_M <- length(data$Gender[data$Gender == "Male" & data$TenYearCoronaryHeartDisease == "Vulne
rable"])/length(data$Gender[data$Gender == "Male"])
p_hat_F <- length(data$Gender[data$Gender == "Female" & data$TenYearCoronaryHeartDisease == "Vul
nerable"])/length(data$Gender[data$Gender == "Female"])
# null hypothesized population prop difference between the two groups
p_0 <- 0
# sample size
n_M <- length(data$Gender[data$Gender == "Male"])
n_F <- length(data$Gender[data$Gender == "Female"])
# sample variances
den_p_M <- (p_hat_M*(1-p_hat_M))/n_M
den_p_F <- (p_hat_F*(1-p_hat_F))/n_F
# z-test test statistic
z <- (p_hat_M - p_hat_F - p_0)/sqrt(den_p_M + den_p_F)
z
```

```
## [1] 5.460385
```

```
# two sided p-value
two_sided_diff_prop_pval <- pnorm(q = z, lower.tail = FALSE)*2
two_sided_diff_prop_pval
```

```
## [1] 4.751036e-08
```

### Confidence interval

```
# lower bound
(p_hat_M - p_hat_F)+(qnorm(0.025)*sqrt(den_p_M + den_p_F))
```

```
## [1] 0.04250581
```

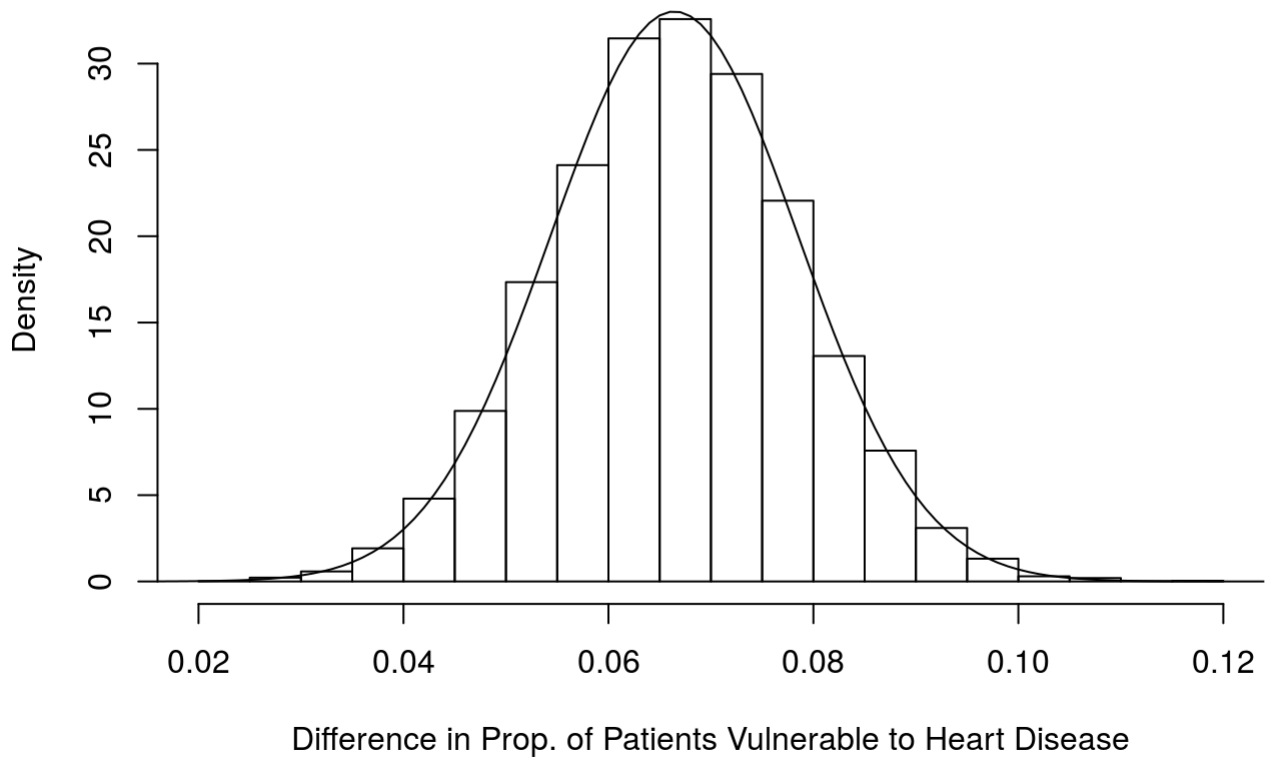
```
# upper bound
(p_hat_M - p_hat_F)+(qnorm(0.975)*sqrt(den_p_M + den_p_F))
```

```
## [1] 0.09010571
```

## (b) Bootstrap Methods

### Bootstrap + Randomization Approach

```
# Make the data
male <- rep(c(1, 0), c(length(data$Gender[data$Gender == "Male" & data$TenYearCoronaryHeartDisea
se == "Vulnerable"]), n_M - length(data$Gender[data$Gender == "Male" & data$TenYearCoronaryHeart
Disease == "Vulnerable"])))
female <- rep(c(1,0), c(length(data$Gender[data$Gender == "Female" & data$TenYearCoronaryHeartDi
sease == "Vulnerable"]), n_F - length(data$Gender[data$Gender == "Female" & data$TenYearCoronary
HeartDisease == "Vulnerable"])))
num_sims <- 10000
# A vector to store my results
results <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 prop_M <- mean(sample(male,
 size = n_M,
 replace = TRUE))
 prop_F <- mean(sample(x = female,
 size = n_F,
 replace = TRUE))
 results[i] <- prop_M - prop_F
}
# Finally plot the results
hist(results, freq = FALSE, main='Dist. of the Diff in Prop', xlab = 'Difference in Prop. of Pat
ients Vulnerable to Heart Disease', ylab = 'Density')
lines(x = seq(0.01, 0.13, .001), dnorm(seq(0.01, 0.13, .001), mean = mean(results), sd = sd(resu
lts)))
```




```
cat("Bootstrap")
```

```
## Bootstrap
```

```
c(quantile(results, c(.025, .975)))
```

```
##      2.5%     97.5%
## 0.0428200 0.0899613
```

```
cat("Normal Approximation")
```

```
## Normal Approximation
```

```
c((p_hat_M - p_hat_F)+(qnorm(0.025)*sqrt(den_p_M + den_p_F)), (p_hat_M - p_hat_F)+(qnorm(0.975)*
sqrt(den_p_M + den_p_F)))
```

```
## [1] 0.04250581 0.09010571
```

```
# Make the data
df_combined <- data.frame("vulnerable_patients" = c(male, female), "gender" = rep(c("male", "fem
ale"), c(n_M, n_F)))
# Sanity checks
summary(df_combined$gender)
```

```
## female   male
##   2035   1623
```

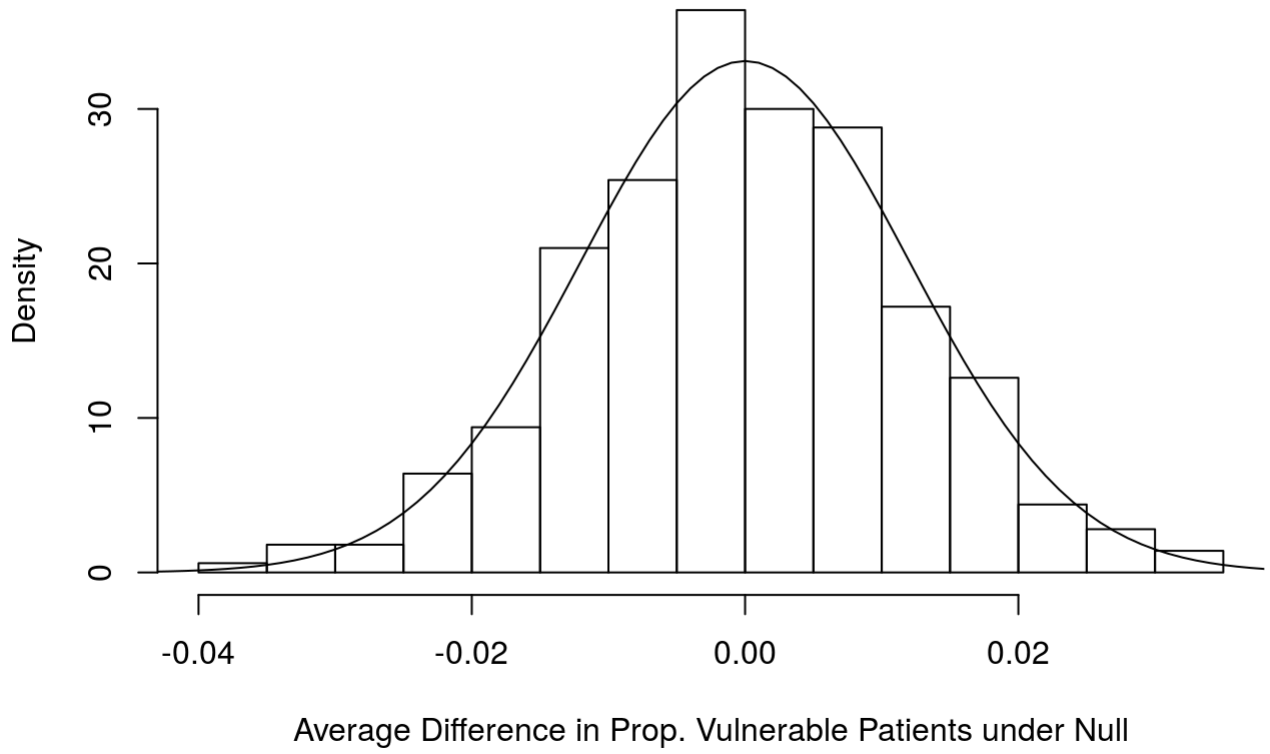
```
mean(df_combined$vulnerable_patients[df_combined$gender=="male"]) == p_hat_M
```

```
## [1] TRUE
```

```
mean(df_combined$vulnerable_patients[df_combined$gender=="female"]) == p_hat_F
```

```
## [1] TRUE
```

```
num_sims <- 1000
# A vector to store my results
results_given_H0_true <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 # idea here is if there is no relationshipm we should be able to shuffle the groups
 shuffled_groups <- transform(df_combined, gender=sample(gender))
 prop_M <- mean(shuffled_groups$vulnerable_patients[shuffled_groups$gender=="male"
])
 prop_F <- mean(shuffled_groups$vulnerable_patients[shuffled_groups$gender=="female"
])
 results_given_H0_true[i] <- prop_M - prop_F
}
# Finally plot the results
hist(results_given_H0_true, freq = FALSE,
 main='Dist. of the Diff in Sample Sample Props Under Null',
 xlab = 'Average Difference in Prop. Vulnerable Patients under Null',
 ylab = 'Density')
diff_in_sample_props <- p_hat_M - p_hat_F
lines(x = seq(-0.05, 0.05, .001), dnorm(seq(-0.05, 0.05, .001), mean = mean(results_given_H0_tru
e), sd = sd(results_given_H0_true)))
abline(v=diff_in_sample_props, col = "blue")
abline(v=-diff_in_sample_props, col = "red")
```




```
# counts of values more extreme than the test statistic in our original sample, given H0 is true
# two sided given the alternate hypothesis
count_of_more_extreme_lower_tail <- sum(results_given_H0_true <= -diff_in_sample_props)
count_of_more_extreme_upper_tail <- sum(results_given_H0_true >= diff_in_sample_props)
bootstrap_pvalue <- (count_of_more_extreme_lower_tail + count_of_more_extreme_upper_tail)/num_si
ms
cat("Bootstrap p-value")
```

```
## Bootstrap p-value
```

```
bootstrap_pvalue
```

```
## [1] 0
```

```
cat("Normal Approx p-value")
```

```
## Normal Approx p-value
```

```
two_sided_diff_prop_pval
```

```
## [1] 4.751036e-08
```

### Interpretation

Using randomization methods, there is strong evidence (p-value = 0) to suggest that there is a difference between the true proportion of Male Vulnerable to Heart Disease compared to their Female Counterparts. We successfully reject the null hypothesis that the true proportion of fMale Vulnerable to Heart Disease is equal to the true proportion of Female Vulnerable to Heart Disease at the level. Using confidence intervals created by the bootstrap method, we can say with 95% confidence that the true population proportion difference lies between 4.2% to 9.0% which means Male are more vulnerable to heart disease than the Female. The null hypothesized difference of 0 is outside the confidence interval which agrees with our rejection of the null hypothesis.

# 5.Chi-square goodness of fit

```
chiData <- data$Education
head(chiData)
```

```
## [1] College                      General Education Development
## [3] High School                  Vocational School
## [5] Vocational School            General Education Development
## 4 Levels: College General Education Development ... Vocational School
```

```
table(chiData)
```

```
## chiData
##                      College General Education Development
##                          423                           1101
##                  High School            Vocational School
##                         1526                            608
```

```
prop.table(table(chiData))
```

```
## chiData
##                      College General Education Development
##                    0.1156370                     0.3009841
##                  High School            Vocational School
##                    0.4171679                     0.1662110
```

## (a) Traditional Statistical Tools

### Hypotheses

$$H_0 \ : \ p_C = p_{GED} = p_{HS} = p_{VS} = 0.25$$

Null Hyptheses: The proportion of each level of education is the same and is equal to 0.25

$$H_A \ : \ Some \, p_i \neq 0.25$$

Alternate Hyptheses: At least one of the proportions is not equal to 0.25

### Parameter

We are in interested in the true proportions of people in each level of education

$$p_C, \ p_{GED}, \ p_{HS}, \ p_{VS}$$

### Sample Statistics

$$\hat{p_C},\ \hat{p_{GED}},\ \hat{p_{HS}},\ \hat{p_{VS}}$$

### Test Statistic and Distribution

$$\chi^2 = \sum_{i=1}^{k} \frac{(O_i - E)^2}{E} \tilde{} \chi^2_{k-1}$$

$$n = 3658$$
$$p_i = 0.25$$
$$expected\ count,\ np_i = 3658 \times 0.25$$
$$np_i = 914.5$$

```
n <- 3658
r <- 4
npi <- 914.5
tchi <- sum(((table(chiData) - npi)^2)/npi)
tchi
```

```
## [1] 813.8097
```

### P-Value

```
p_value <- pchisq(tchi, df = r-1, lower.tail = FALSE)
p_value
```

```
## [1] 4.377198e-176
```

### Confidence interval

There is no confidence interval for a goodness of fit test.

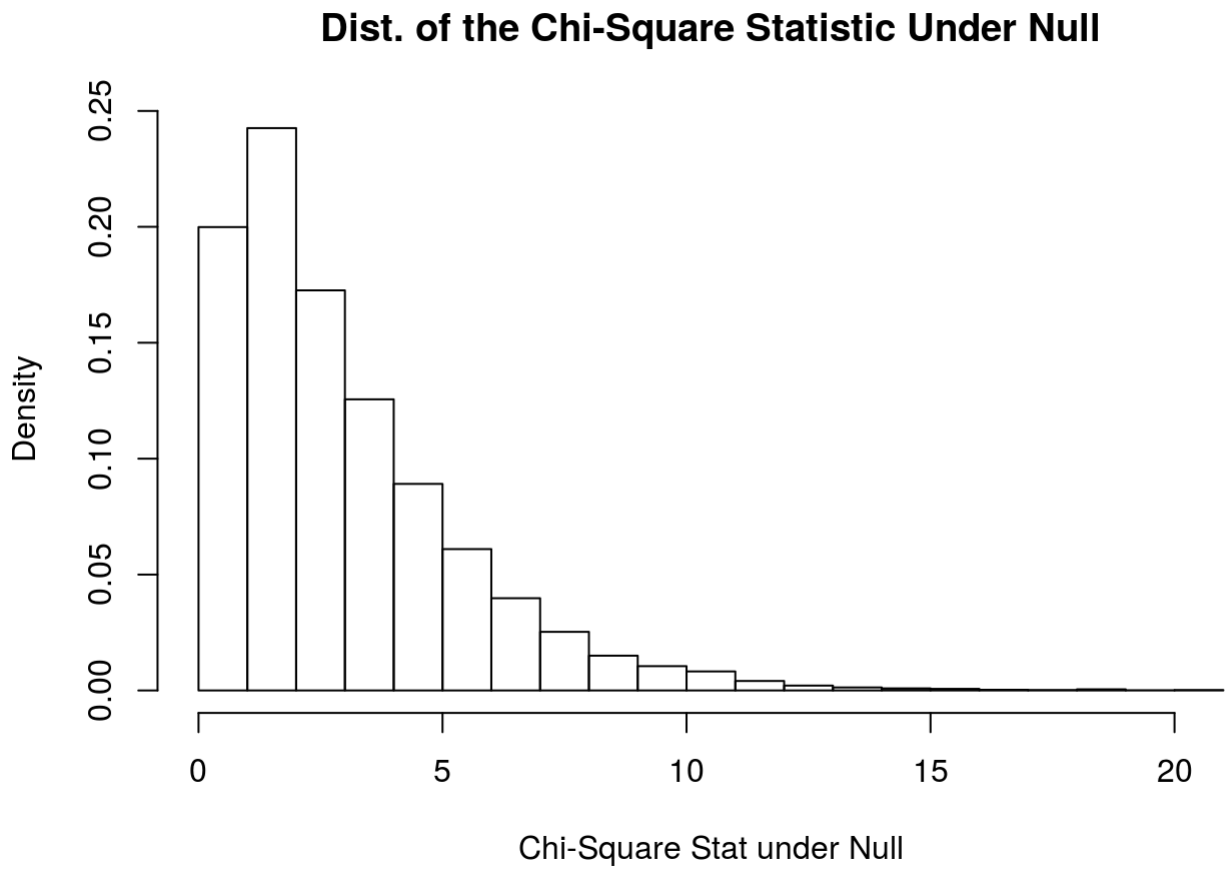
## (b) Randomization Approach

```
# Create our data under the assumption that H_0 is true
solutions_under_H_0 <- rep(c("C", "GED", "HS", "VS"), npi)
# Sanity Check
table(solutions_under_H_0)
```

```
## solutions_under_H_0
##   C GED  HS  VS
## 914 914 914 914
```

```
num_sims <- 10000
# A vector to store my results
chisq_stats_under_H0 <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 new_samp <- sample(solutions_under_H_0, n, replace = T)
 chisq_stats_under_H0[i] <- sum(((table(new_samp) - npi)^2)/npi)
}
```

```
hist(chisq_stats_under_H0, freq = FALSE,
 main='Dist. of the Chi-Square Statistic Under Null',
 xlab = 'Chi-Square Stat under Null',
 ylab = 'Density')
abline(v=sum(((table(chiData) - npi)^2)/npi), col="red")
```




```
#The randomization p-value
sum(chisq_stats_under_H0 >= sum(((table(chiData) - npi)^2)/npi))/num_sims
```

```
## [1] 0
```

# Appendix

```
knitr::opts_chunk$set(echo = TRUE)
#install.packages("units")
install.packages("ggplot2")
#library("units")
library("ggplot2")
dataSet <- read.csv(file = "framingham.csv")
head(dataSet)
summary(dataSet)
data <- dataSet[complete.cases(dataSet), ]
head(data)
summary(data)
names(data) <- c("Gender", "Age", "Education", "SmokingBehavior", "CigarettesPerDay", "BloodPres
sureMedication", "PrevalentStroke", "PrevalentHypertension", "DiabeticCondition", "TotalCholestr
ol", "SystolicBloodPressure", "DiastolicBloodPressure", "BodyMassIndex", "HeartRate", "GlucoseLe
vel", "TenYearCoronaryHeartDisease")
head(data)
data$Gender[data$Gender == 0] <- "Female"
data$Gender[data$Gender == 1] <- "Male"
data$Education[data$Education == 1] <- "High School"
data$Education[data$Education == 2] <- "General Education Development"
data$Education[data$Education == 3] <- "Vocational School"
data$Education[data$Education == 4] <- "College"
data$SmokingBehavior[data$SmokingBehavior == 0] <- "Non Smoker"
data$SmokingBehavior[data$SmokingBehavior == 1] <- "Smoker"
data$BloodPressureMedication[data$BloodPressureMedication == 0] <- "Not Under BP Medication"
data$BloodPressureMedication[data$BloodPressureMedication == 1] <- "Under BP Medication"
data$PrevalentStroke[data$PrevalentStroke == 0] <- "No"
data$PrevalentStroke[data$PrevalentStroke == 1] <- "Yes"
data$PrevalentHypertension[data$PrevalentHypertension == 0] <- "No"
data$PrevalentHypertension[data$PrevalentHypertension == 1] <- "Yes"
data$DiabeticCondition[data$DiabeticCondition == 0] <- "Non Diabetic"
data$DiabeticCondition[data$DiabeticCondition == 1] <- "Diabetic"
data$TenYearCoronaryHeartDisease[data$TenYearCoronaryHeartDisease == 0] <- "Immune"
data$TenYearCoronaryHeartDisease[data$TenYearCoronaryHeartDisease == 1] <- "Vulnerable"
data$Gender <- as.factor(data$Gender)
data$Education <- as.factor(data$Education)
data$SmokingBehavior <- as.factor(data$SmokingBehavior)
data$BloodPressureMedication <- as.factor(data$BloodPressureMedication)
data$PrevalentStroke <- as.factor(data$PrevalentStroke)
data$PrevalentHypertension <- as.factor(data$PrevalentHypertension)
data$DiabeticCondition <- as.factor(data$DiabeticCondition)
data$TenYearCoronaryHeartDisease <- as.factor(data$TenYearCoronaryHeartDisease)
head(data)
#units(data$Age) <- "years"
#units(data$TotalCholestrol) <- "mg/dL"
#units(data$SystolicBloodPressure) <- "mmHg"
#units(data$DiastolicBloodPressure) <- "mmHg"
#units(data$BodyMassIndex) <- "kg/m^2"
#units(data$GlucoseLevel) <- "mg/dL"
#head(data)
summary(data)
ggplot(data, aes(x = Age)) +
  geom_histogram(bins = 30, fill = "lightblue") +
```

```
  theme_bw() + theme_classic() +
  ggtitle("Age Distribution") + ylab("Number of People")
ggplot(data, aes(x = Education, fill = Education)) +
  geom_bar() +
  geom_text(stat = 'count', aes(label =..count..), vjust = -0.5)
ggplot(data, aes(x = Gender, fill = Gender)) +
  geom_bar() +
  geom_text(stat = 'count', aes(label =..count..), vjust = -0.5) +
  theme_bw() + theme_classic() +
  ggtitle("Gender Distribution") + ylab("Number of People")
ggplot(data, aes(x = TenYearCoronaryHeartDisease)) +
  geom_bar(aes(fill = Gender), position = 'dodge', width = 0.5, color='black') +
  theme_bw() + theme_classic() +
  ylab("Number of People") + ggtitle("10 Year CHD Risk Versus Gender")
ggplot(data, aes(x = CigarettesPerDay)) +
  geom_histogram(bins = 30, fill = "gray") +
  theme_bw() + theme_classic() +
  ggtitle("Smokers - Cigarettes Per Day Distribution") + ylab("Number of People")
ggplot(data, aes(x = SmokingBehavior)) +
  geom_bar(fill = "lightgreen") +
  geom_text(stat = 'count', aes(label =..count..), vjust = -0.5) +
  theme_bw() + theme_classic() +
  ggtitle("Smokers - Cigarettes Per Day Distribution") + ylab("Number of People")
ggplot(data, aes(x = TenYearCoronaryHeartDisease)) +
  geom_bar(aes(fill = SmokingBehavior), position = 'dodge', width = 0.5, color= 'black') +
  theme_bw() + theme_classic() +
  ylab("Number of People") + ggtitle("Smoking Habit Versus 10 Year CHD Risk")
ggplot(data, aes(x = TotalCholestrol)) +
  geom_density(fill = "blue", alpha = 0.5) +
  theme_minimal() +
  ggtitle("Distribution Total Cholestrol Levels") + ylab("Number of People")
ggplot(data, aes(x = TotalCholestrol)) +
  geom_density(aes(fill = TenYearCoronaryHeartDisease), alpha = 0.4)
ggplot(data, aes(x = SystolicBloodPressure)) +
  geom_density(fill ="orange", alpha = 0.9) +
  theme_minimal() +
  ggtitle("Systolic BP Levels in People") + ylab("Number of People")
ggplot(data, aes(x = SystolicBloodPressure)) +
  geom_density(aes(color = TenYearCoronaryHeartDisease, fill = TenYearCoronaryHeartDisease), alp
ha = 0.4, position = "identity") +
  scale_fill_manual(values = c("#00AFBB", "#E7B800")) +
  scale_color_manual(values = c("#00AFBB", "#E7B800"))
# Systolic Blood Pressure vs Ten Year Coronary Heart Disease
ggplot(data, aes(x = SystolicBloodPressure))+
  geom_histogram(bins = 30, color="black", fill="white")+
  facet_grid(TenYearCoronaryHeartDisease ~ .)
ggplot(data, aes(x =BodyMassIndex)) +
  geom_dotplot(color = "pink", fill = "pink", binwidth = 1/4)
ggplot(data, aes(x = TenYearCoronaryHeartDisease, y = BodyMassIndex)) +
  geom_boxplot(width = 0.4, fill = "white") +
  geom_jitter(aes(color = TenYearCoronaryHeartDisease, shape = TenYearCoronaryHeartDisease),
              width = 0.1, size = 1) +
  scale_color_manual(values = c("#00AFBB", "#E7B800")) +
  labs(x = NULL)
```

```
ggplot(data, aes(x = TenYearCoronaryHeartDisease)) +
  geom_bar() +
  geom_text(stat = 'count', aes(label =..count..), vjust = -0.5) +
  theme_bw() + theme_classic() +
  ggtitle("10 Year CHD Risk") + ylab("Number of People")
qqnorm(data$SystolicBloodPressure, main ="Normality Check for Systolic Blood Pressure Level")
qqline(data$SystolicBloodPressure)
hist(data$SystolicBloodPressure)
# the parts of the test statistic
# sample mean
x_bar <- mean(data$SystolicBloodPressure)
# null hypothesized population mean
mu_0 <- 120
# sample st. dev
s <- sd(data$SystolicBloodPressure)
# sample size
n <- length(data$SystolicBloodPressure)
# t-test test statistic
t <- (x_bar - mu_0)/(s/sqrt(n))
t
# two-sided p-value so multiply by 2
two_sided_t_pval <- pt(q = t, df = n-1, lower.tail = FALSE)*2
two_sided_t_pval
qt(0.025, n-1)
# lower bound
x_bar + (qt(0.025, n-1)*(s/sqrt(n))) # alternately you can use x_bar-(qt(0.975, n-1)*(s/sqrt
(n)))
# upper bound
x_bar + (qt(0.975, n-1)*(s/sqrt(n))) # alternately you can use x_bar-(qt(0.025, n-1)*(s/sqrt
(n)))
t.test(data$SystolicBloodPressure, alternative = "two.sided", mu = 120)
set.seed(0)
# This data is pretty skewed so even though n is large, I'm going to do a lot of simulations
num_sims <- 10000
# A vector to store my results
results <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 results[i] <- mean(sample(x = data$SystolicBloodPressure,
 size = n,
 replace = TRUE))
}
# Finally plot the results
hist(results, freq = FALSE, main='Sampling Distribution of the Sample Mean', xlab = 'Average Sys
tolic Blood Pressure', ylab = 'Density')
# estimate a normal curve over it - this looks pretty good!
lines(x = seq(130, 134, .01), dnorm(seq(130, 134, .01), mean = x_bar, sd = s/sqrt(n)))
set.seed(0)
# Shift the sample so that the null hypothesis is true
bp_given_H0_true <- data$SystolicBloodPressure - mean(data$SystolicBloodPressure) + mu_0
# This data is pretty skewed so even though n is large, I'm going to do a lot of simulations
num_sims <- 10000
# A vector to store my results
results_given_H0_true <- rep(NA, num_sims)
```

```
# A loop for completing the simulation
for(i in 1:num_sims){
 results_given_H0_true[i] <- mean(sample(x = bp_given_H0_true,
 size = n,
 replace = TRUE))
}
# Finally plot the results
hist(results_given_H0_true, freq = FALSE, main='Sampling Distribution of the Sample Mean, Given
 Null Hypothesis is True', xlab = 'Average Systolic Blood Pressure', ylab = 'Density')
# add line to show values more extreme on upper end
abline(v=x_bar, col = "red")
# add line to show values more extreme on lower end
low_end_extreme <- mean(results_given_H0_true)+(mean(results_given_H0_true)-x_bar)
lines(x = seq(117, 122, .01), dnorm(seq(117, 122, .01), mean = mean(results_given_H0_true), sd =
sd(results_given_H0_true)))
abline(v=low_end_extreme, col="red")
# counts of values more extreme than the test statistic in our original sample, given H0 is true
# two sided given the alternate hypothesis
count_of_more_extreme_lower_tail <- sum(results_given_H0_true <= low_end_extreme)
count_of_more_extreme_upper_tail <- sum(results_given_H0_true >= x_bar)
bootstrap_pvalue <- (count_of_more_extreme_lower_tail + count_of_more_extreme_upper_tail)/num_si
ms
bootstrap_pvalue
# two sided t p-value
two_sided_t_pval
# need the standard error which is the standard deviation of the results
bootstrap_SE_X_bar <- sd(results)
# an estimate is to use the formula statistic +/- 2*SE
c(x_bar - 2*bootstrap_SE_X_bar, x_bar + 2*bootstrap_SE_X_bar)
# you can also use the 5th and 95th quantiles to determine the bounds:
c(quantile(results, c(.025, .975)))
# compare to our t-methods
c(x_bar+(qt(0.025, n-1)*(s/sqrt(n))), x_bar+(qt(0.975, n-1)*(s/sqrt(n))))
p_0 <- 0.48
p_0
p <- length(data$Gender[data$Gender == "Female"])
p
n <- length(data$Gender)
n
p_hat <- p/n
p_hat
z <- (p_hat - p_0) / sqrt((p_0*(1-p_0)) / n)
z
binom.test(x = p, n = n, p = p_0, alternative = "greater")
pnorm(z, lower.tail = FALSE)
cat("Exact Binomial Test")
binom.test(x = p, n = n, p = p_0, alternative = "greater")$conf.int
cat("Normal Approx")
c(p_hat - (1.64)*sqrt(((p_hat)*(1-p_hat))/n), 1)
female <- data$Gender
female
female <- relevel(female, "Male")
levels(female) <- c(0, 1)
female
```

```
table(female)
set.seed(0)
# This data is pretty skewed so even though n is large, I'm going to do a lot of simulations
num_sims <- 10000
# A vector to store my results
results <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 results[i] <- mean(as.numeric(sample(x = female, size = n, replace = TRUE))-1)
}
# Finally plot the results
hist(results, freq = FALSE, main='Sampling Distribution of the Sample Proportion', xlab = 'Propo
rtion of Female', ylab = 'Density')
# estimate a normal curve over it - this looks pretty good!
lines(x = seq(.52, .60, .001), dnorm(seq(.52, .60, .001), mean = mean(results), sd = sd(result
s)))
cat("Bootstrap Confidence Interval")
c(quantile(results, c(0.05,1)))
cat("exact binomial test")
binom.test(x = p, n = n, p = p_0, alternative = "greater")$conf.int
cat("normal approx")
c(p_hat - (1.64)*sqrt(((p_hat)*(1-p_hat))/n),1)
# Under the assumption that the null hypothesis is true, we have 48% female
female_sim <- rep(c(1, 0), c(.48*n, (1-.48)*n))
num_sims <- 10000
# A vector to store my results
results_H0_true <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 results_H0_true[i] <- mean(sample(x = female_sim,
 size = n,
 replace = TRUE))
}
# Finally plot the results
hist(results_H0_true, freq = FALSE, main='Sampling Distribution of the Sample Proportion under H
_0:p = 0.48', xlab = 'Proportion of Female', ylab = 'Density')
# estimate a normal curve over it - this looks pretty good!
lines(x = seq(.30, .65, .001), dnorm(seq(.30, .65, .001), mean = mean(results_H0_true), sd = sd
(results_H0_true)))
abline(v=p_hat, col="red")
count_of_more_extreme_upper_tail <- sum(results_H0_true >= p_hat)
bootstrap_pvalue <- count_of_more_extreme_upper_tail/num_sims
cat("Bootstrap p-value")
bootstrap_pvalue
cat("Exact Binomial p-value")
binom.test(x = p, n = n, p = p_0, alternative = "greater")$p.value
cat("Normal Approximation p-value")
pnorm(z, lower.tail = FALSE)
qqnorm(data$SystolicBloodPressure, main ="Normality Check for Systolic Blood Pressure Level")
qqline(data$SystolicBloodPressure)
qqnorm(data$SystolicBloodPressure[data$TenYearCoronaryHeartDisease == "Vulnerable"], main ="Norm
ality Check for Systolic Blood Pressure of patients Vulnerable to 10 Year CHD")
qqline(data$SystolicBloodPressure[data$TenYearCoronaryHeartDisease == "Vulnerable"])
qqnorm(data$SystolicBloodPressure[data$TenYearCoronaryHeartDisease == "Immune"], main ="Normalit
```

```
y Check for Systolic Blood Pressure of patients Immune to 10 Year CHD")
qqline(data$SystolicBloodPressure[data$TenYearCoronaryHeartDisease == "Immune"])
set.seed(0)
immunePatientsData <- subset(data, data$TenYearCoronaryHeartDisease == "Immune")
immuneDataSample <- immunePatientsData[sample(nrow(immunePatientsData), 300), ]
head(immuneDataSample)
set.seed(0)
vulnerablePatientsData <- subset(data, data$TenYearCoronaryHeartDisease == "Vulnerable")
vulnerableDataSample <- vulnerablePatientsData[sample(nrow(vulnerablePatientsData), 300), ]
head(vulnerableDataSample)
sampleData <- rbind(immuneDataSample, vulnerableDataSample)
head(sampleData)
summary(sampleData)
qqnorm(sampleData$SystolicBloodPressure, main ="Sample Data - Normality Check for Systolic Blood
Pressure Level")
qqline(sampleData$SystolicBloodPressure)
qqnorm(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"],
main ="Sample - Data Normality Check for Systolic Blood Pressure of patients Vulnerable to 10 Ye
ar CHD")
qqline(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"])
qqnorm(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"], mai
n ="Sample Data - Normality Check for Systolic Blood Pressure of patients Immune to 10 Year CHD"
)
qqline(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"])
t.test(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"],
sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"])
# Mean Systolic Blood Pressure of Vulnerable Patients
mu_v <- mean(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Vulnera
ble'])
mu_v
# Mean Systolic Blood Pressure of Immune Patients
mu_i <- mean(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Immune'
])
mu_i
# Null Hypothesis
mu_0 <- 0
# Variance of Systolic Blood Pressure of Vulnerable Patients
var_v <- var(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Vulnera
ble'])
var_v
# Variance of Systolic Blood Pressure of Vulnerable Patients
var_i <- var(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Immune'
])
var_i
# Sample Size of Systolic Blood Pressure of Vulnerable Patients
n_v <- length(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Vulner
able'])
n_v
# Sample Size of Systolic Blood Pressure of Vulnerable Patients
n_i <- length(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == 'Immun
e'])
n_i
# t-value (test statistic)
t <- (mu_v - mu_i - mu_0)/sqrt(var_v/n_v + var_i/n_i)
```

```
t
# p-value for 2 sided t-test
p_value <- pt(q = t, df = min(n_v, n_i) - 1, lower.tail = FALSE)*2
p_value
# Lower Boundary of Confidence Interval
lowerBound <- mu_v - mu_i + qt(0.05, min(n_v, n_i) - 1)*sqrt(var_v/n_v + var_i/n_i)
lowerBound
# Upper Boundary of Confidence Interval
upperBound <- mu_v - mu_i + qt(0.95, min(n_v, n_i) - 1)*sqrt(var_v/n_v + var_i/n_i)
upperBound
set.seed(0)
num_sims <- 10000
# A vector to store my results
results <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 mean_immune <- mean(sample(x = sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeart
Disease == 'Immune'],
 size = 300,
 replace = TRUE))
 mean_vulnerable <- mean(sample(x = sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryH
eartDisease == 'Vulnerable'],
 size = 300,
 replace = TRUE))
 results[i] <- mean_vulnerable - mean_immune
}
# Finally plot the results
hist(results, freq = FALSE, main='Sampling Distribution of the Sample Mean', xlab = 'Average Dif
ference Systolic Blood Pressure', ylab = 'Density')
lines(x = seq(9, 21, .01), dnorm(seq(9, 21, .01), mean = mean(results), sd = sd(results)))
# Bootstrap one-sided CI
c(quantile(results, c(.025, .975)))
t.test(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"],
sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"])$conf.int
set.seed(0)
transform(sampleData,Group=sample(TenYearCoronaryHeartDisease))
set.seed(0)
num_sims <- 10000
# A vector to store my results
results_given_H0_true <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 # idea here is if there is no relationshipm we should be able to shuffle the groups
  shuffled_groups <- transform(sampleData,Group=sample(TenYearCoronaryHeartDisease))
  mean_immune <- mean(shuffled_groups$SystolicBloodPressure[shuffled_groups$Group=="Immune"])
  mean_vulnerable <- mean(shuffled_groups$SystolicBloodPressure[shuffled_groups$Group=="Vulnerab
le"])
  results_given_H0_true[i] <- mean_vulnerable - mean_immune
}
# Finally plot the results
hist(results_given_H0_true, freq = FALSE, main='Dist. of the Diff in Sample Means Under Null', x
lab = 'Average Difference Systolic Blood Pressure under Null', ylab = 'Density')
diff_in_sample_means <- mean(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDis
ease=="Vulnerable"]) - mean(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDise
```

```
ase=="Immune"])
low_end_extreme <- mean(results_given_H0_true) + (mean(results_given_H0_true) - diff_in_sample_m
eans)
lines(x = seq(-6, 6, .01), dnorm(seq(-6, 6, .01), mean = mean(results_given_H0_true), sd = sd(re
sults_given_H0_true)))
abline(v=diff_in_sample_means, col = "blue")
abline(v=abs(diff_in_sample_means), col = "red")
# counts of values more extreme than the test statistic in our original sample, given H0 is true
# two sided given the alternate hypothesis
count_of_more_extreme_lower_tail <- sum(results_given_H0_true <= low_end_extreme)
count_of_more_extreme_upper_tail <- sum(results_given_H0_true >= diff_in_sample_means)
bootstrap_pvalue <- (count_of_more_extreme_lower_tail + count_of_more_extreme_upper_tail)/num_si
ms
cat("Bootstrap p-value")
bootstrap_pvalue
cat("t-test p-value")
t.test(sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Vulnerable"],
sampleData$SystolicBloodPressure[sampleData$TenYearCoronaryHeartDisease == "Immune"])$p.value
# the parts of the test statistic
# sample props
p_hat_M <- length(data$Gender[data$Gender == "Male" & data$TenYearCoronaryHeartDisease == "Vulne
rable"])/length(data$Gender[data$Gender == "Male"])
p_hat_F <- length(data$Gender[data$Gender == "Female" & data$TenYearCoronaryHeartDisease == "Vul
nerable"])/length(data$Gender[data$Gender == "Female"])
# null hypothesized population prop difference between the two groups
p_0 <- 0
# sample size
n_M <- length(data$Gender[data$Gender == "Male"])
n_F <- length(data$Gender[data$Gender == "Female"])
# sample variances
den_p_M <- (p_hat_M*(1-p_hat_M))/n_M
den_p_F <- (p_hat_F*(1-p_hat_F))/n_F
# z-test test statistic
z <- (p_hat_M - p_hat_F - p_0)/sqrt(den_p_M + den_p_F)
z
# two sided p-value
two_sided_diff_prop_pval <- pnorm(q = z, lower.tail = FALSE)*2
two_sided_diff_prop_pval
# lower bound
(p_hat_M - p_hat_F)+(qnorm(0.025)*sqrt(den_p_M + den_p_F))
# upper bound
(p_hat_M - p_hat_F)+(qnorm(0.975)*sqrt(den_p_M + den_p_F))
# Make the data
male <- rep(c(1, 0), c(length(data$Gender[data$Gender == "Male" & data$TenYearCoronaryHeartDisea
se == "Vulnerable"]), n_M - length(data$Gender[data$Gender == "Male" & data$TenYearCoronaryHeart
Disease == "Vulnerable"])))
female <- rep(c(1,0), c(length(data$Gender[data$Gender == "Female" & data$TenYearCoronaryHeartDi
sease == "Vulnerable"]), n_F - length(data$Gender[data$Gender == "Female" & data$TenYearCoronary
HeartDisease == "Vulnerable"])))
num_sims <- 10000
# A vector to store my results
results <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
```

```
 prop_M <- mean(sample(male,
 size = n_M,
 replace = TRUE))
 prop_F <- mean(sample(x = female,
 size = n_F,
 replace = TRUE))
 results[i] <- prop_M - prop_F
}
# Finally plot the results
hist(results, freq = FALSE, main='Dist. of the Diff in Prop', xlab = 'Difference in Prop. of Pat
ients Vulnerable to Heart Disease', ylab = 'Density')
lines(x = seq(0.01, 0.13, .001), dnorm(seq(0.01, 0.13, .001), mean = mean(results), sd = sd(resu
lts)))
cat("Bootstrap")
c(quantile(results, c(.025, .975)))
cat("Normal Approximation")
c((p_hat_M - p_hat_F)+(qnorm(0.025)*sqrt(den_p_M + den_p_F)), (p_hat_M - p_hat_F)+(qnorm(0.975)*
sqrt(den_p_M + den_p_F)))
# Make the data
df_combined <- data.frame("vulnerable_patients" = c(male, female), "gender" = rep(c("male", "fem
ale"), c(n_M, n_F)))
# Sanity checks
summary(df_combined$gender)
mean(df_combined$vulnerable_patients[df_combined$gender=="male"]) == p_hat_M
mean(df_combined$vulnerable_patients[df_combined$gender=="female"]) == p_hat_F
num_sims <- 1000
# A vector to store my results
results_given_H0_true <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 # idea here is if there is no relationshipm we should be able to shuffle the groups
 shuffled_groups <- transform(df_combined, gender=sample(gender))
 prop_M <- mean(shuffled_groups$vulnerable_patients[shuffled_groups$gender=="male"
])
 prop_F <- mean(shuffled_groups$vulnerable_patients[shuffled_groups$gender=="female"
])
 results_given_H0_true[i] <- prop_M - prop_F
}
# Finally plot the results
hist(results_given_H0_true, freq = FALSE,
 main='Dist. of the Diff in Sample Sample Props Under Null',
 xlab = 'Average Difference in Prop. Vulnerable Patients under Null',
 ylab = 'Density')
diff_in_sample_props <- p_hat_M - p_hat_F
lines(x = seq(-0.05, 0.05, .001), dnorm(seq(-0.05, 0.05, .001), mean = mean(results_given_H0_tru
e), sd = sd(results_given_H0_true)))
abline(v=diff_in_sample_props, col = "blue")
abline(v=-diff_in_sample_props, col = "red")
# counts of values more extreme than the test statistic in our original sample, given H0 is true
# two sided given the alternate hypothesis
count_of_more_extreme_lower_tail <- sum(results_given_H0_true <= -diff_in_sample_props)
count_of_more_extreme_upper_tail <- sum(results_given_H0_true >= diff_in_sample_props)
bootstrap_pvalue <- (count_of_more_extreme_lower_tail + count_of_more_extreme_upper_tail)/num_si
ms
```

```
cat("Bootstrap p-value")
bootstrap_pvalue
cat("Normal Approx p-value")
two_sided_diff_prop_pval
chiData <- data$Education
head(chiData)
table(chiData)
prop.table(table(chiData))
n <- 3658
r <- 4
npi <- 914.5
tchi <- sum(((table(chiData) - npi)^2)/npi)
tchi
p_value <- pchisq(tchi, df = r-1, lower.tail = FALSE)
p_value
# Create our data under the assumption that H_0 is true
solutions_under_H_0 <- rep(c("C", "GED", "HS", "VS"), npi)
# Sanity Check
table(solutions_under_H_0)
num_sims <- 10000
# A vector to store my results
chisq_stats_under_H0 <- rep(NA, num_sims)
# A loop for completing the simulation
for(i in 1:num_sims){
 new_samp <- sample(solutions_under_H_0, n, replace = T)
 chisq_stats_under_H0[i] <- sum(((table(new_samp) - npi)^2)/npi)
}
hist(chisq_stats_under_H0, freq = FALSE,
 main='Dist. of the Chi-Square Statistic Under Null',
 xlab = 'Chi-Square Stat under Null',
 ylab = 'Density')
abline(v=sum(((table(chiData) - npi)^2)/npi), col="red")
#The randomization p-value
sum(chisq_stats_under_H0 >= sum(((table(chiData) - npi)^2)/npi))/num_sims
```