Final Report

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10/31/21

```
## Warning in system("timedatectl", intern = TRUE): running command 'timedatectl'
## had status 1
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.1 --
```

```
## v ggplot2 3.3.5     v purrr   0.3.4
## v tibble  3.1.5     v dplyr   1.0.7
## v tidyr   1.1.4     v stringr 1.4.0
## v readr   2.0.2     v forcats 0.5.1
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
##
## Attaching package: 'janitor'
```

```
## The following objects are masked from 'package:stats':
##
##     chisq.test, fisher.test
```

```
## Registered S3 method overwritten by 'tune':
##   method                    from
##   required_pkgs.model_spec parsnip
```

```
## -- Attaching packages --------------------------------------- tidymodels 0.1.4 --
```

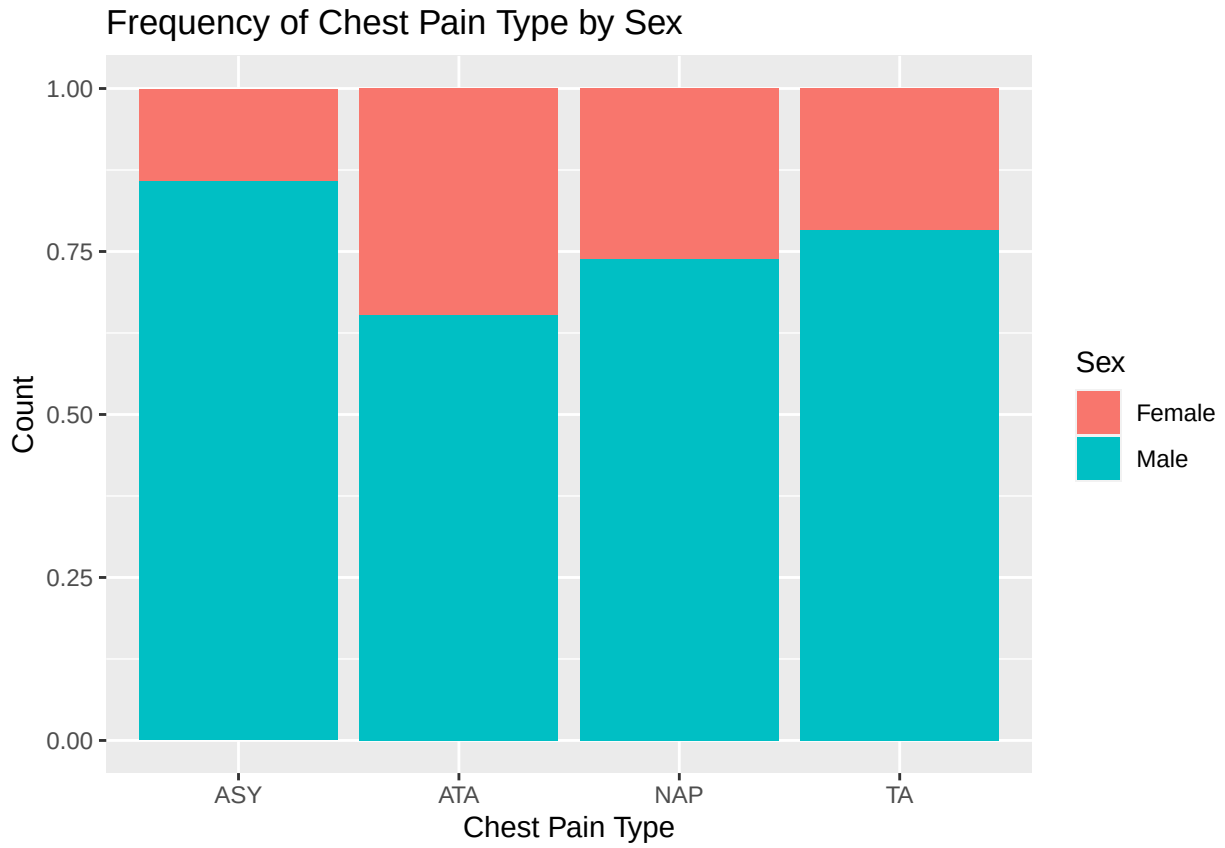
```
## v broom        0.7.9      v rsample      0.1.0
## v dials        0.0.10     v tune         0.1.6
## v infer        1.0.0      v workflows    0.2.4
## v modeldata    0.1.1      v workflowsets 0.1.0
## v parsnip      0.1.7      v yardstick    0.0.8
## v recipes      0.1.17
```

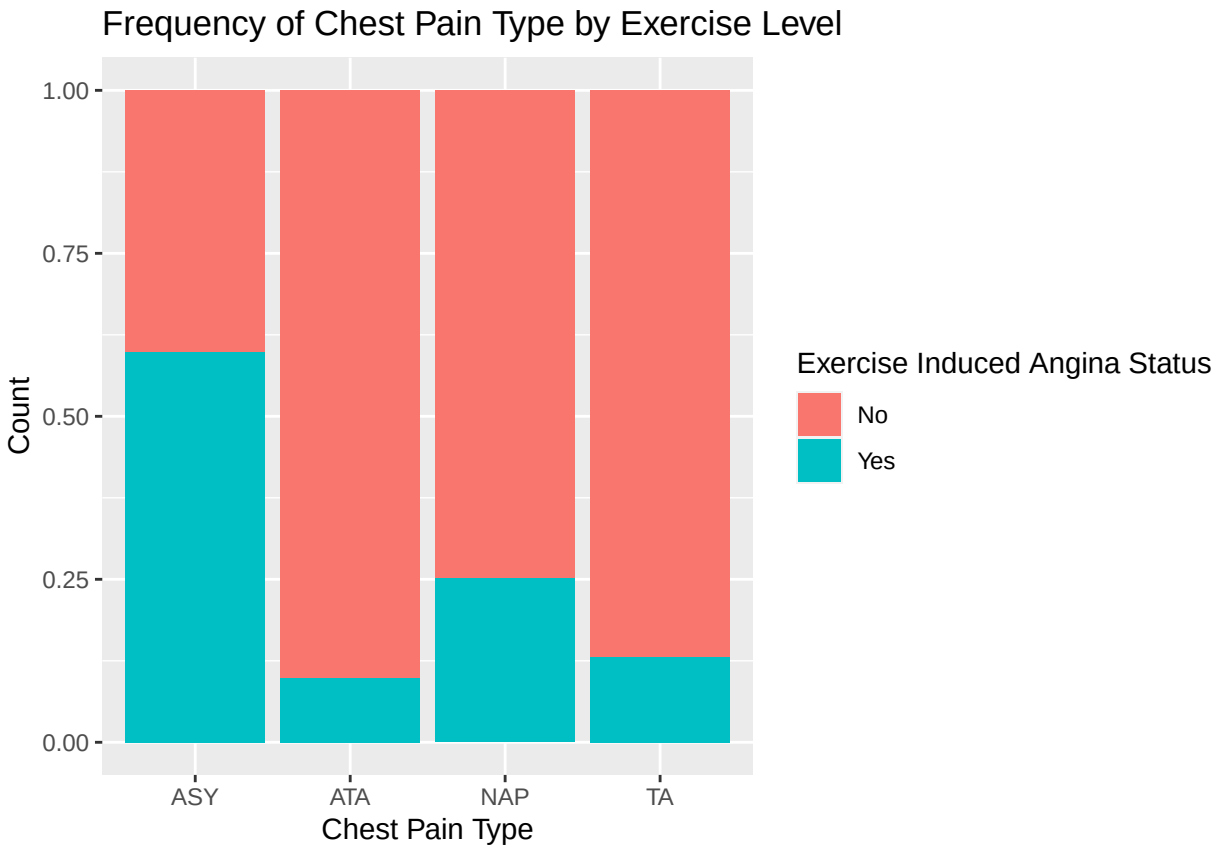
```
## -- Conflicts ------------------------------------------ tidymodels_conflicts() --
## x scales::discard() masks purrr::discard()
## x dplyr::filter()   masks stats::filter()
## x recipes::fixed()  masks stringr::fixed()
## x dplyr::lag()      masks stats::lag()
## x yardstick::spec() masks readr::spec()
## x recipes::step()   masks stats::step()
## * Learn how to get started at https://www.tidymodels.org/start/
```

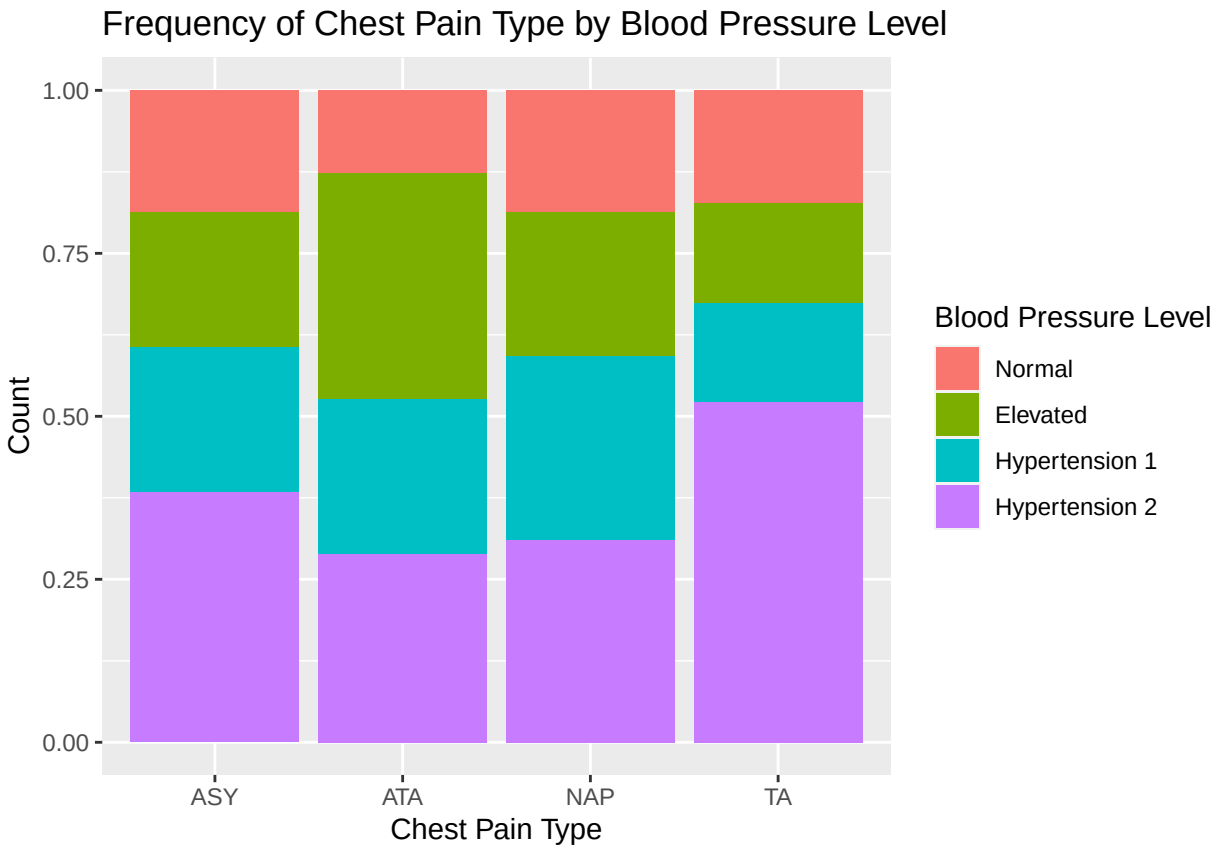
Abstract

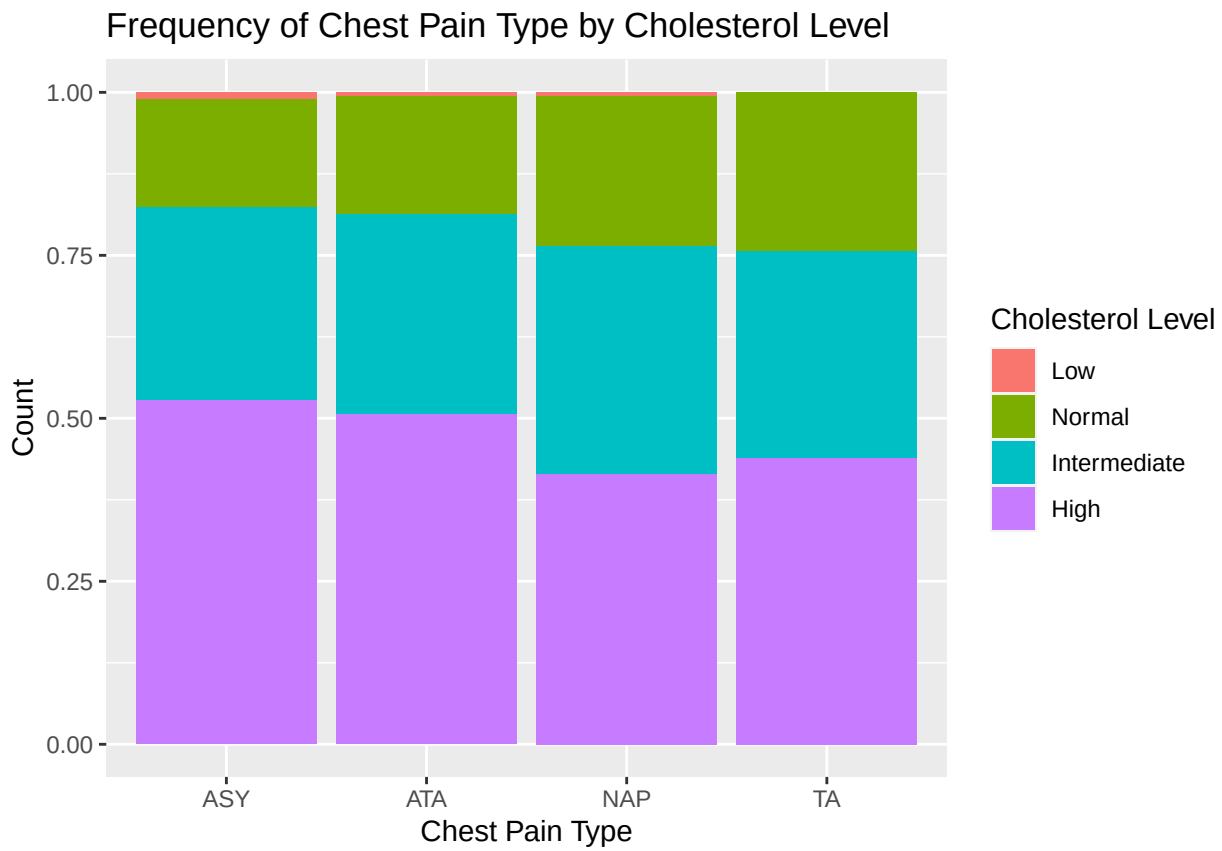
Introduction

For this data visualization, chest pain types and their relation to other physiological factors were analyzed to search for an association between factors, such as blood pressure, cholesterol, and exercise, and the type of chest pain a patient experiences. The dataset being analyzed is the Heart Failure Prediction Dataset, retrieved from Kaggle, and compiled from five sets with common variables. These sources are the Hungarian Institute of Cardiology. Budapest, University Hospital, Zurich, Switzerland, University Hospital, Basel, Switzerland, the V.A. Medical Center, Long Beach, and the Cleveland Clinic Foundation. The variables of interest include gender, resting blood pressure (mm Hg), serum cholesterol (mm/d), whether or not the angina was exercise induced, and whether or not the patient was diagnosed with heart disease (**diagnosis before or after the angina??). To allow for the use of statistical tests, each variable was transformed into a categorical variable.




Frequency of Chest Pain Type by Exercise Level
1.00
0.75
0.50
0.25
0.00
Count
ASY
ATA
NAP
TA
Chest Pain Type
Exercise Induced Angina Status
No
Yes


Frequency of Chest Pain Type by Blood Pressure Level
1.00
0.75
0.50
0.25
0.00
Count
ASY
ATA
NAP
TA
Chest Pain Type
Blood Pressure Level
Normal
Elevated
Hypertension 1
Hypertension 2



Statistical Tests

```
##
##  Pearson's Chi-squared test
##
## data:  sex_table
## X-squared = 36.879, df = 3, p-value = 4.88e-08
```

```
##
##  Pearson's Chi-squared test
##
## data:  exer_table
## X-squared = 179.27, df = 3, p-value < 2.2e-16
```

```
##
##  Pearson's Chi-squared test
##
## data:  chol_table
## X-squared = 8.6117, df = 9, p-value = 0.4739
```

```
##
##  Pearson's Chi-squared test
##
## data:  RBP_table
## X-squared = 26.829, df = 9, p-value = 0.001493
```

```
##
```

```
##  Pearson's Chi-squared test
##
## data:  disease_table
## X-squared = 268.07, df = 3, p-value < 2.2e-16
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  sex_step
## p-value = 2.369e-08
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.2031800 0.4733313
## sample estimates:
## odds ratio
##  0.3100921
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  sex_step2
## p-value = 0.0002766
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.3054468 0.7119609
## sample estimates:
## odds ratio
##  0.4656136
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  sex_step3
## p-value = 0.1896
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.2722762 1.4001345
## sample estimates:
## odds ratio
##  0.5922146
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  sex_step4
## p-value = 0.07251
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.9418551 2.3984968
## sample estimates:
## odds ratio
##   1.501076
```

```
##
##  Fisher's Exact Test for Count Data
##
```

```
## data:  sex_step5
## p-value = 0.1107
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.8524745 4.6148967
## sample estimates:
## odds ratio
##   1.906248
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  sex_step6
## p-value = 0.7073
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.5679163 3.0759273
## sample estimates:
## odds ratio
##   1.270772
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  exer_step
## p-value < 2.2e-16
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.04032086 0.12583163
## sample estimates:
## odds ratio
## 0.07331366
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  exer_step2
## p-value < 2.2e-16
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.1529646 0.3280057
## sample estimates:
## odds ratio
##  0.2253116
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  exer_step3
## p-value = 4.234e-10
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.03430591 0.24552456
## sample estimates:
## odds ratio
##   0.100903
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  exer_step4
## p-value = 0.0001411
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  1.656297 5.935882
## sample estimates:
## odds ratio
##   3.070166
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  exer_step5
## p-value = 0.5883
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.4161352 3.9597702
## sample estimates:
## odds ratio
##   1.374316
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  exer_step6
## p-value = 0.0836
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.1466831 1.1500616
## sample estimates:
## odds ratio
##  0.4483045
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  RBP_step
## p-value = 0.001125
## alternative hypothesis: two.sided
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  RBP_step2
## p-value = 0.2331
## alternative hypothesis: two.sided
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  RBP_step3
## p-value = 0.34
## alternative hypothesis: two.sided
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  RBP_step4
## p-value = 0.0436
## alternative hypothesis: two.sided

##
##  Fisher's Exact Test for Count Data
##
## data:  RBP_step5
## p-value = 0.006839
## alternative hypothesis: two.sided

##
##  Fisher's Exact Test for Count Data
##
## data:  RBP_step6
## p-value = 0.05117
## alternative hypothesis: two.sided

##
##  Fisher's Exact Test for Count Data
##
## data:  disease_step
## p-value < 2.2e-16
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.02532899 0.07052378
## sample estimates:
## odds ratio
## 0.04297732

##
##  Fisher's Exact Test for Count Data
##
## data:  disease_step2
## p-value < 2.2e-16
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.1001099 0.2122784
## sample estimates:
## odds ratio
##  0.1463117

##
##  Fisher's Exact Test for Count Data
##
## data:  disease_step3
## p-value = 6.656e-07
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.1039251 0.3983253
## sample estimates:
## odds ratio
##   0.204859
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  disease_step4
## p-value = 1.618e-06
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  1.984092 5.990659
## sample estimates:
## odds ratio
##   3.401259
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  disease_step5
## p-value = 3.929e-05
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##   2.15486 10.44700
## sample estimates:
## odds ratio
##    4.73165
```

```
##
##  Fisher's Exact Test for Count Data
##
## data:  disease_step
## p-value < 2.2e-16
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
##  0.02532899 0.07052378
## sample estimates:
## odds ratio
## 0.04297732
```

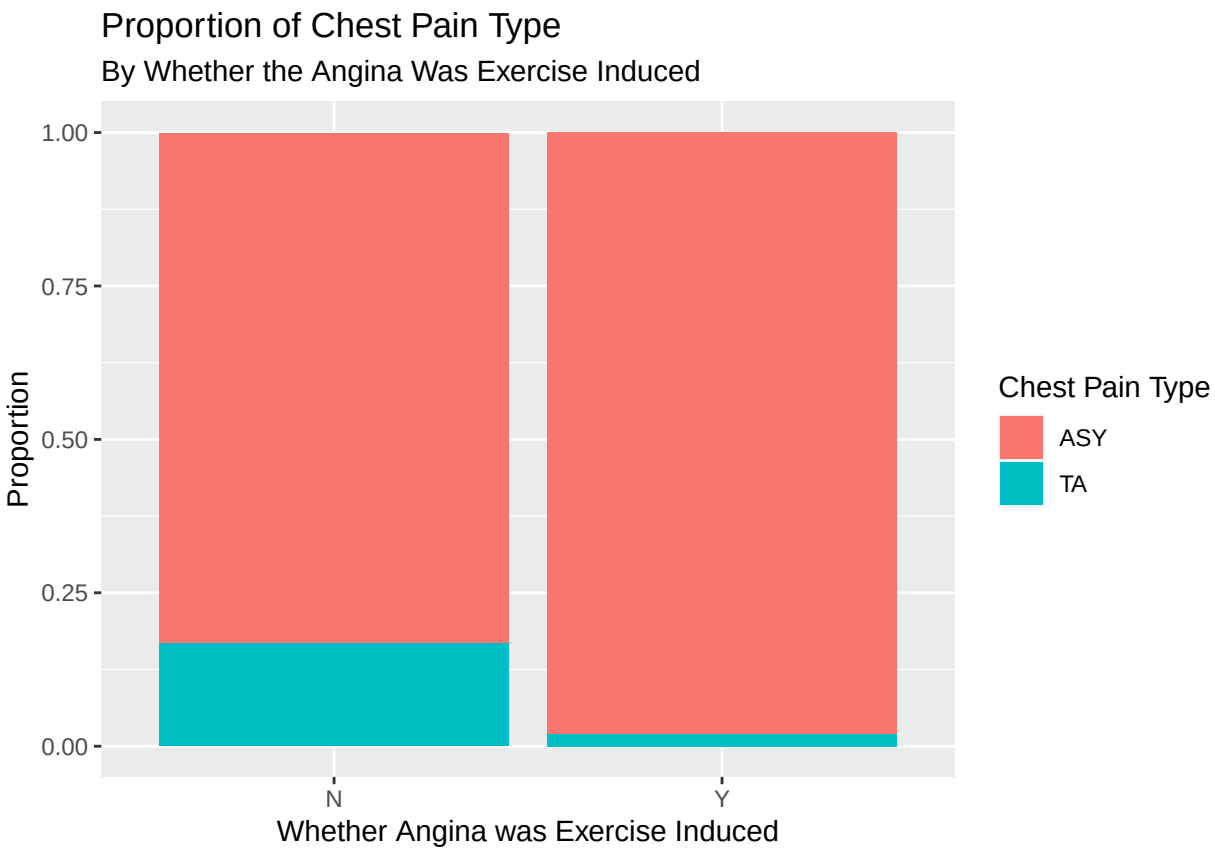
Results

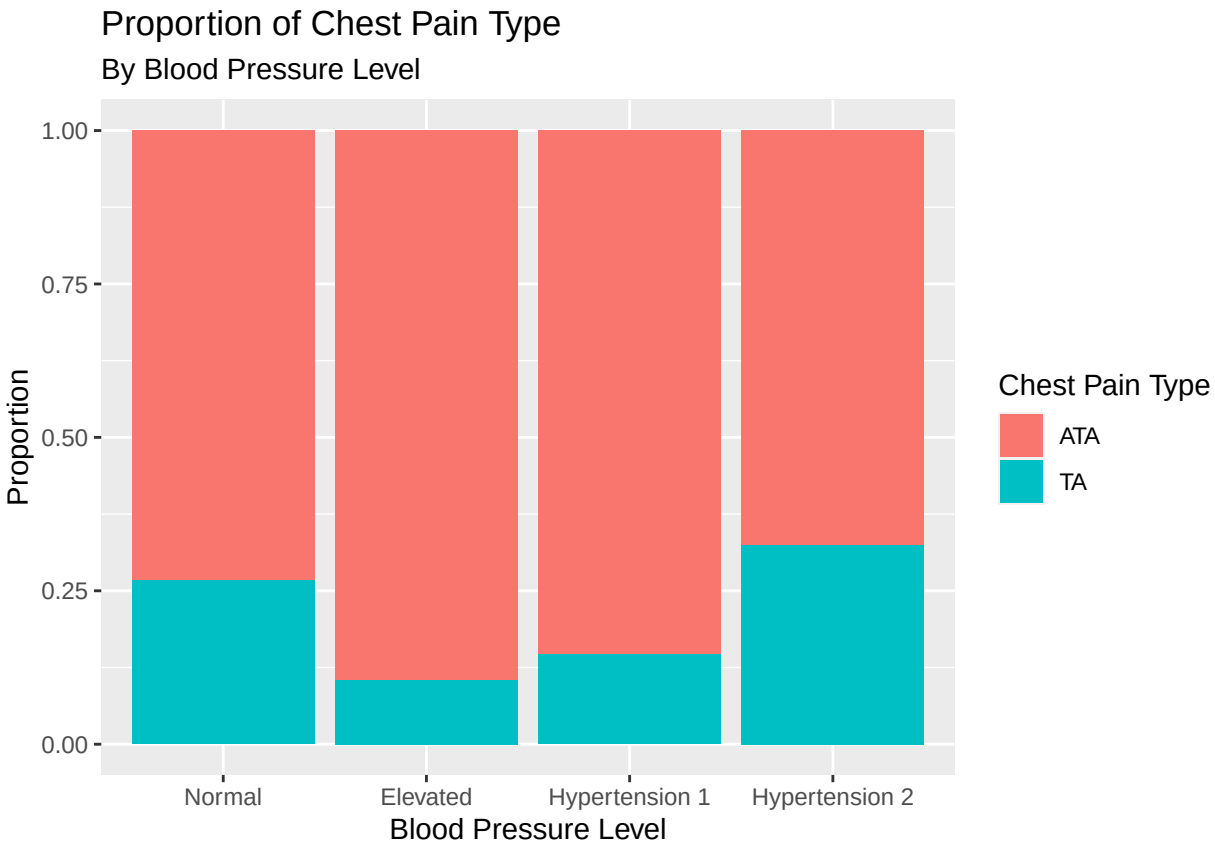
Table 1: X^2 Test Results - P Values for Preliminary X^2 Tests

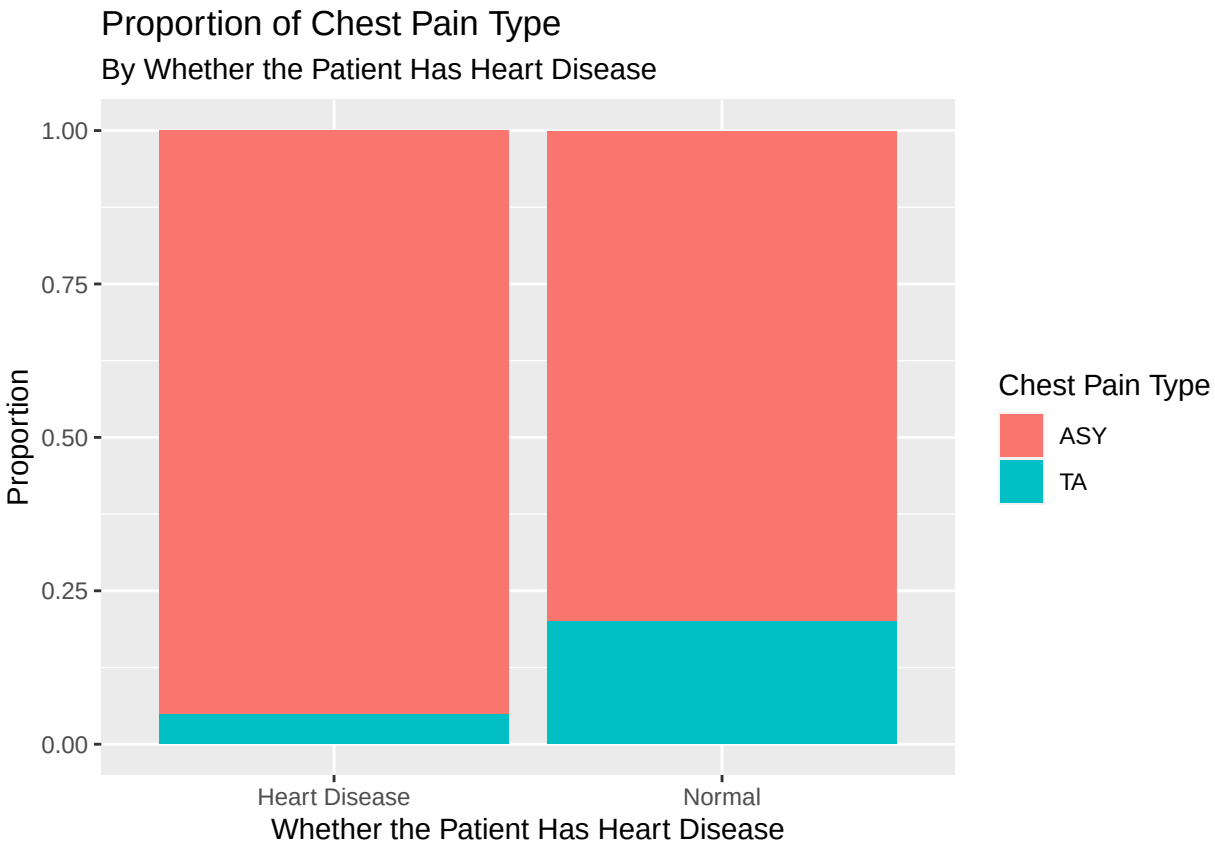
Predicting Variable	P Value for X^2 Statistic
Sex	4.88e-8
ExerciseAngina	<2.2e-16
chol_level	0.4738
press_level	0.001493
HeartDisease	<2.2e-16

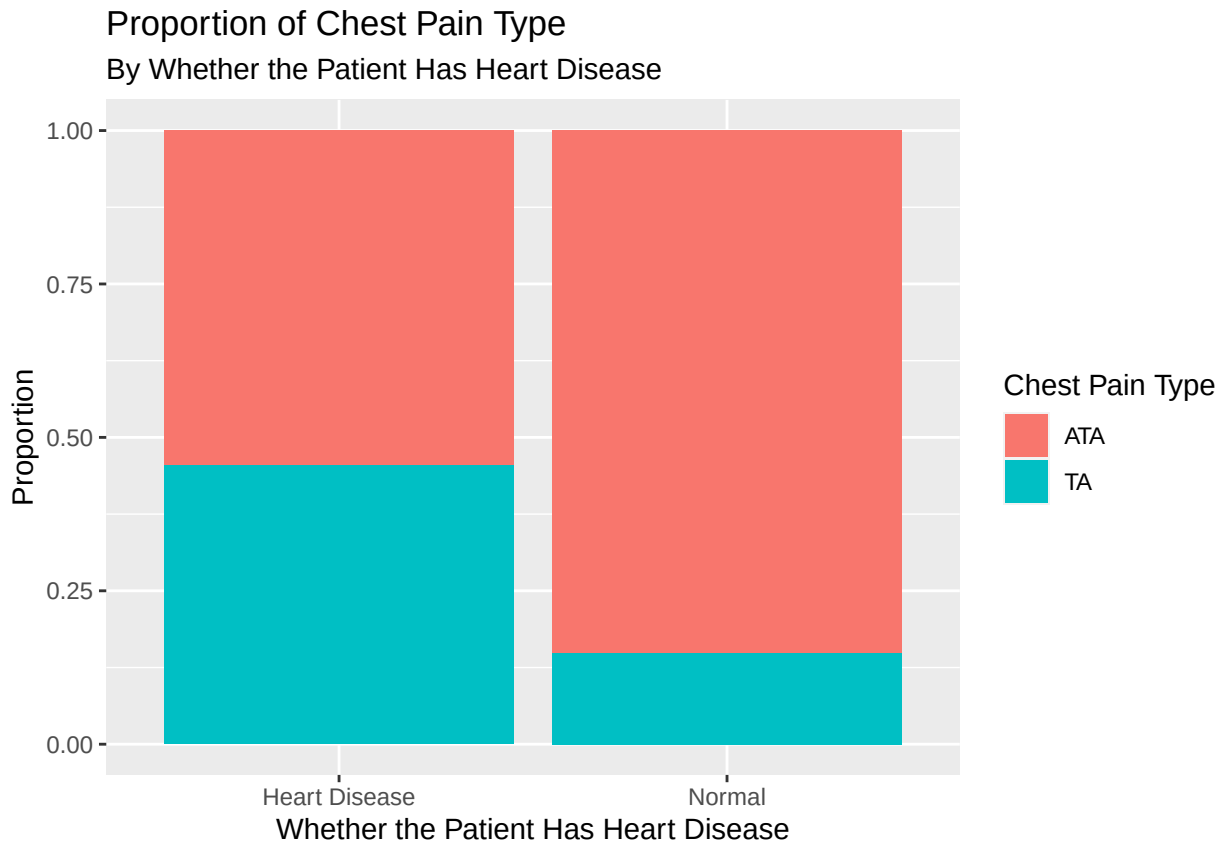
Table 2: Results From Fisher's Exact Step Down Tests

Predicting Variable	TA & ATA Outcome P Values	TA & ASY Outcome P Values
Sex	0.1107	0.1896
ExerciseAngina	0.5883	4.23e-10
press_level	0.006839	0.34
HeartDisease	3.929e-05	6.656e-07


Proportion of Chest Pain Type
By Whether the Angina Was Exercise Induced
1.00
0.75
0.50
0.25
0.00
Proportion
N
Y
Whether Angina was Exercise Induced
Chest Pain Type
ASY
TA


Proportion of Chest Pain Type
By Blood Pressure Level
1.00
0.75
0.50
0.25
0.00
Proportion
Normal
Elevated
Hypertension 1
Hypertension 2
Blood Pressure Level
Chest Pain Type
ATA
TA


Proportion of Chest Pain Type
By Whether the Patient Has Heart Disease
1.00
0.75
0.50
0.25
0.00
Proportion
Heart Disease
Normal
Whether the Patient Has Heart Disease
Chest Pain Type
ASY
TA




```
## # A tibble: 5 x 7
##   term                       estimate std.error statistic p.value conf.low conf.high
##   <chr>                         <dbl>     <dbl>     <dbl>   <dbl>    <dbl>     <dbl>
## 1 (Intercept)                   3.76      0.440     3.01  2.62e-3    1.66      9.51
## 2 press_levelElevated           3.38      0.597     2.04  4.15e-2    1.05     11.2
## 3 press_levelHypertension 1     2.27      0.605     1.35  1.76e-1    0.691     7.63
## 4 press_levelHypertension 2     0.889     0.506    -0.233 8.16e-1    0.317     2.35
## 5 HeartDisease                  0.219     0.384    -3.95  7.68e-5    0.102     0.464
```

```
## # A tibble: 3 x 7
##   term            estimate std.error statistic    p.value conf.low conf.high
##   <chr>              <dbl>     <dbl>     <dbl>      <dbl>    <dbl>     <dbl>
## 1 (Intercept)         2.99     0.227      4.82 0.00000144     1.94      4.75
## 2 ExerciseAnginaY     7.16     0.463      4.25 0.0000215      3.08     19.6
## 3 HeartDisease        2.72     0.335      2.99 0.00278        1.42      5.30
```

```
## # A tibble: 2 x 2
##   Sex   count
##   <chr> <int>
## 1 F        80
## 2 M       462
```

```
## # A tibble: 4 x 3
## # Groups:   Sex [2]
##   Sex   ChestPainType count
##   <chr> <chr>         <int>
## 1 F     ASY              70
## 2 F     TA               10
```

```
## 3 M     ASY             426
## 4 M     TA               36
```

```
## # A tibble: 2 x 2
##   Sex   count
##   <chr> <int>
## 1 F        70
## 2 M       149
```

```
## # A tibble: 4 x 3
## # Groups:   Sex [2]
##   Sex   ChestPainType count
##   <chr> <chr>         <int>
## 1 F     ATA              60
## 2 F     TA               10
## 3 M     ATA             113
## 4 M     TA               36
```

```
## # A tibble: 2 x 2
##   ExerciseAngina count
##   <chr>          <int>
## 1 N                239
## 2 Y                303
```

```
## # A tibble: 4 x 3
## # Groups:   ExerciseAngina [2]
##   ExerciseAngina ChestPainType count
##   <chr>          <chr>         <int>
## 1 N              ASY             199
## 2 N              TA               40
## 3 Y              ASY             297
## 4 Y              TA                6
```

```
## # A tibble: 2 x 2
##   ExerciseAngina count
##   <chr>          <int>
## 1 N                196
## 2 Y                 23
```

```
## # A tibble: 4 x 3
## # Groups:   ExerciseAngina [2]
##   ExerciseAngina ChestPainType count
##   <chr>          <chr>         <int>
## 1 N              ATA             156
## 2 N              TA               40
## 3 Y              ATA              17
## 4 Y              TA                6
```

```
## # A tibble: 16 x 3
## # Groups:   press_level [4]
##    press_level    ChestPainType count
##    <fct>          <chr>         <int>
##  1 Normal         ASY              93
##  2 Normal         ATA              22
##  3 Normal         NAP              38
##  4 Normal         TA                8
##  5 Elevated       ASY             102
```

```
##  6 Elevated       ATA              60
##  7 Elevated       NAP              45
##  8 Elevated       TA                7
##  9 Hypertension 1 ASY             111
## 10 Hypertension 1 ATA              41
## 11 Hypertension 1 NAP              57
## 12 Hypertension 1 TA                7
## 13 Hypertension 2 ASY             190
## 14 Hypertension 2 ATA              50
## 15 Hypertension 2 NAP              63
## 16 Hypertension 2 TA               24
```

```
## # A tibble: 8 x 3
## # Groups:   press_level [4]
##   press_level    ChestPainType count
##   <fct>          <chr>         <int>
## 1 Normal         ASY              93
## 2 Normal         TA                8
## 3 Elevated       ASY             102
## 4 Elevated       TA                7
## 5 Hypertension 1 ASY             111
## 6 Hypertension 1 TA                7
## 7 Hypertension 2 ASY             190
## 8 Hypertension 2 TA               24
```

```
## # A tibble: 8 x 3
## # Groups:   press_level [4]
##   press_level    ChestPainType count
##   <fct>          <chr>         <int>
## 1 Normal         ATA              22
## 2 Normal         TA                8
## 3 Elevated       ATA              60
## 4 Elevated       TA                7
## 5 Hypertension 1 ATA              41
## 6 Hypertension 1 TA                7
## 7 Hypertension 2 ATA              50
## 8 Hypertension 2 TA               24
```

knitr::include_graphics("IMG_6447.jpg")

Discussion