# Heart at Rest: Identifying Risk Factors for Cardiovascular Disease

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## ABSTRACT

The goal of this project was to use descriptive analytics to identify variables influencing resting heart rate. This study, known as the Framingham Heart Study, evaluated 5,209 people to identify risk factors for cardiovascular disease and its development over time. A one-way analysis of variance (ANOVA) model was used to determine whether resting heart changes in response to a female's smoking and hypertension status. A regression was also used to predict which variables have a significant impact on resting heart rate. Resting heart rate is lower, on average, for females who do not smoke and do not have hypertension. Uncontrolled Diabetes has a significant impact on resting heart rate. Future research is warranted to examine methods to decrease resting heart rate and prevent cardiovascular disease.

## INTRODUCTION

Resting heart rate, defined as the number of beats per minute at which the heart pumps blood while a person is at rest, is a significant indicator of overall physical health. A normal resting heart rate falls within the range of 60-100 beats per minute. A higher resting heart rate has been associated with increased risk of complications, including heart attacks and strokes. Conversely, a lower resting heart rate is typically indicative of better cardiac health and overall wellbeing. Hypertension, or high blood pressure, and smoking are commonly recognized as potential factors that can raise resting heart rate, thereby increasing the risk of fatal complications. Therefore, the purpose of this study is to investigate the association between resting heart rate and other variables.

## METHODS

Participants were followed over the course of multiple generations. A total of 5,209 individual patients were identified. The following 11 variables have been selected for the study: (1) Total Cholesterol, (2) Age (years), (3) Systolic Blood Pressure (mmHg), (4) Diastolic Blood Pressure (mmHg), (5) Current Smokers, (6) BMI, (7) Diabetes Status, (8) Hypertension Status, (9) Glucose Level, (10) Gender, (11) Resting Heart Rate (bpm).

**Building the Best Model**
1.) Creating New Variables:
- "CURSMOKE_HYPERTEN_CHECK": combines smoking status and hypertension status into categories: both smoker and hypertension, neither, smoker and no hypertension, non-smoker and has hypertension.
- "rest_hr_clean": dummy variable changing categorical variables of smoking status and hypertension status to quantitative variables

2.) Outliers were identified and removed
3.) Uncontrolled diabetes added as a variable to the regression
**ANOVA:** conditions were met through Q-Q normality plots and homogeneity
**Regression model:** Indicates statistical significance of variables
**Correlation Heatmap:** Indicates correlation between variables

## SELECTED PYTHON PACKAGES

- Pandas: Import data and create dummy variables
- Numpy: Select values and create new columns based on conditions
- Scipy.stats: Satistical analysis
- Matplotlip.pyplot: Create Q-Q plots
- Seaborn: Create boxplot
- Statsmodels.api: Create Regression

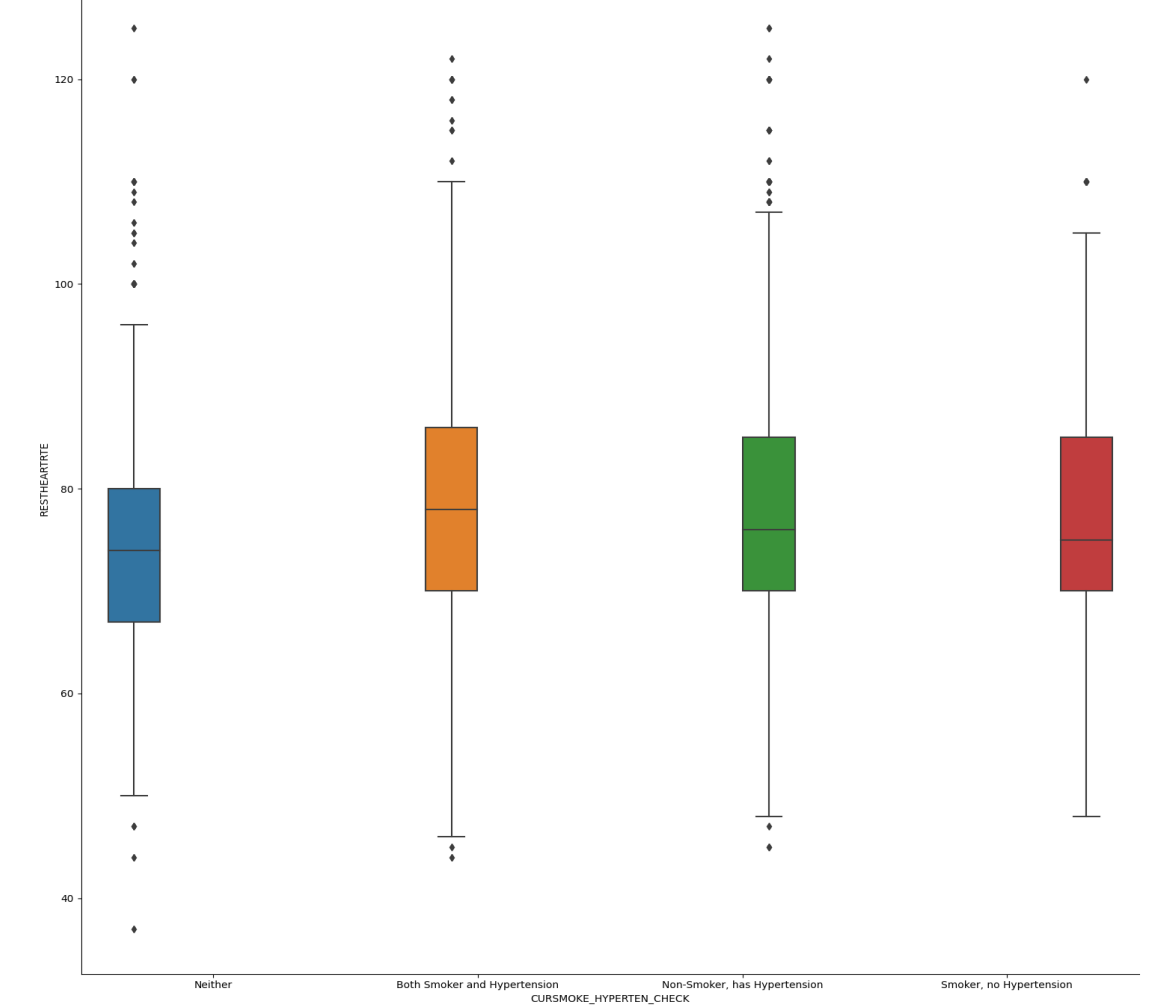**Figure 1:** Resting Heart Rate by Smoking and Hypertension Status
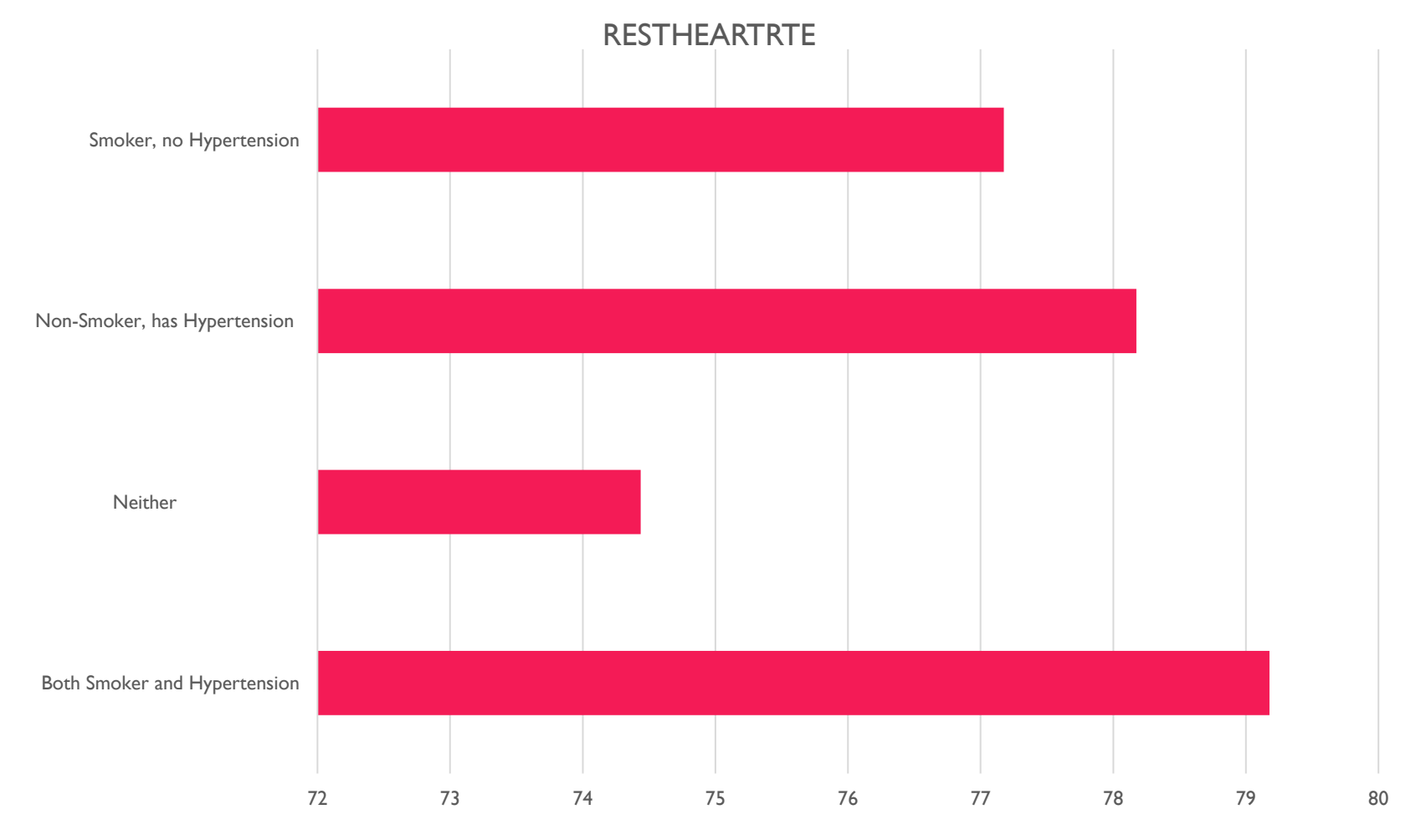


**Figure 2:** Means of Resting Heart Rate



**Figure 3:** Regression Table

| Variable | coef | std | t | P>|t| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| const | 41.7683 | 2.348 | 17.789 | 0 | 37.166 | 46.371 |
| TOTCHOLESTEROL | 0.0127 | 0.003 | 4.952 | 0 | 0.008 | 0.018 |
| AGE | -0.0162 | 0.014 | -1.154 | 0.248 | -0.044 | 0.011 |
| SYSBP | 0.0184 | 0.008 | 2.206 | 0.027 | 0.002 | 0.035 |
| DIABP | 0.1597 | 0.015 | 10.712 | 0 | 0.13 | 0.189 |
| BMI | 0.0011 | 0.03 | 0.037 | 0.97 | -0.057 | 0.059 |
| DIABETES | -0.0527 | 0.639 | -0.082 | 0.934 | -1.306 | 1.2 |
| GLUCOSE | 0.0961 | 0.007 | 13.936 | 0 | 0.083 | 0.11 |
| uncontrolled_diabetes | 8.6988 | 1.636 | 5.318 | 0 | 5.492 | 11.905 |
| CURSMOKE_Yes | 2.6867 | 0.238 | 11.3 | 0 | 2.221 | 3.153 |
| HYPERTEN_Yes | 0.5693 | 0.295 | 1.928 | 0.054 | -0.01 | 1.148 |
| GENDER_Male | -2.8751 | 0.234 | -12.312 | 0 | -3.333 | -2.417 |
| category_2 | 0.5717 | 0.269 | 2.121 | 0.034 | 0.043 | 1.1 |
| category_3 | -0.0063 | 0.332 | -0.019 | 0.985 | -0.658 | 0.645 |
| category_4 | -1.7011 | 0.376 | -4.529 | 0 | -2.437 | -0.965 |

**Figure 4:** Correlation Heatmap
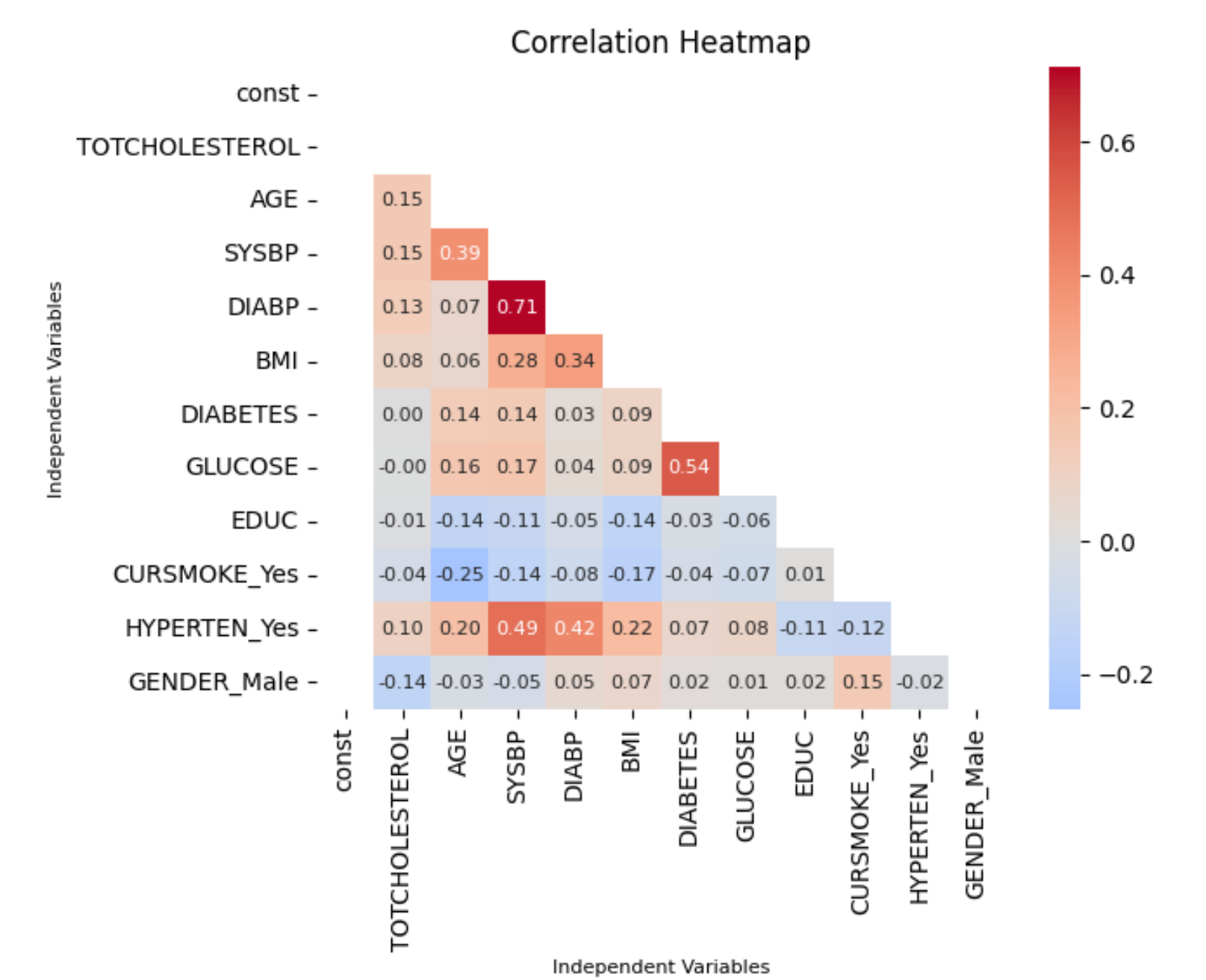


**Figure 5:** ANOVA

| Source of Variation | SS | df | MS | F | P-value | F crit |
|---|---|---|---|---|---|---|
| Between Groups | 13484.967903 | 3 | 4494.989301 | 30.920434 | 0.0 | 3.118108 |
| Within Groups | 958588.070139 | 6594 | 145.372774 | | | |
| Total | 972073.038042 | 6597 | 147.350771 | | | |

## RESULTS

**Uncontrolled Diabetes:** for every 1mg/dl increase in blood glucose, resting heart rate increased by 8.6988 beats per minute. This association is statistically significant.
**Total Cholesterol:** For every 1mg increase in total cholesterol, heart rate increased by 0.127 beats per minute. This shows a statistically significant relationship.
**Age:** was not a significant predictor for resting heart rate.
**Systolic Blood Pressure:** for every 1mmhg increase in blood pressure, resting heart rate increased by 0.184 beats per minute. This relationship is statistically significant.
**Diastolic Blood Pressure:** for every 1 mmHg increase in diastolic blood pressure, resting heart rate increased by 0.1597 beats per minute. This is statistically significant.
**BMI:** Body mass index was not a significant predictor of resting heart rate.
**Diabetes:** Diabetes was not a significant predictor of resting heart rate.
**Glucose:** for every 1 mg/dl increase in blood glucose, resting heart rate increases by 0.961 beats per minute.
**Smokers:** Those that smoke tend to have resting heart rates 2.6867 times higher than those that do not. This is statistically significant.
**Has Hypertension:** Those with hypertension have resting heart rates 0.5693 times higher than those that do not. This is statistically significant.
**Male:** Males tend to have resting heart rates 2.871 times lower than females. This is statistically significant.
**Education2:** Those with this level of education have a 0.517 increase in resting heart rate. This is statistically significant.
**Education3:** This is not a significant predictor of resting heart rate.
**Education4:** Those with this level of education have a 1.7011 decrease in resting heart rate. This is statistically significant.

## CONCLUSIONS

- The mean resting heart rates for those with hypertension is higher than those without hypertension.
- Resting heart rate for females who do not smoke or have hypertension tends to be lower than those that do.
- There is a significant relationship between uncontrolled diabetes and resting heart rate.
- There is a statistically significant relationship between groups for resting heart rate.
- Future research should continue to examine methods to decrease resting heart rate to prevent cardiovascular disease and associated complications.

## DESCRIPTION

**RESTHEARTRTE:** A person's heart rate over one minute while at rest.
**CURSMOKE:** Smoking status, whether a person currently smokes or does not.
**HYPERTEN:** Elevated blood pressure, includes systolic and diastolic pressures.
**Uncontrolled Diabetes:** A diagnosis of diabetes with an average blood glucose level greater than 180. Or consistent hbA1C of greater then 6.5%
**Diabetes:** Chronic health condition that affects how your body creates insulin and stores glucose. A diagnosis is given when hbA1C is greater than 6.5%.
**Education:** Level of education.
**Total Cholesterol:** Sum of LDL and HDL, indicates total amount of cholesterol in the blood. It is associated with increased risk for cardiovascular disease.
**Glucose:** A simple sugar that provides energy for the body. High blood glucose can lead to serious complications.