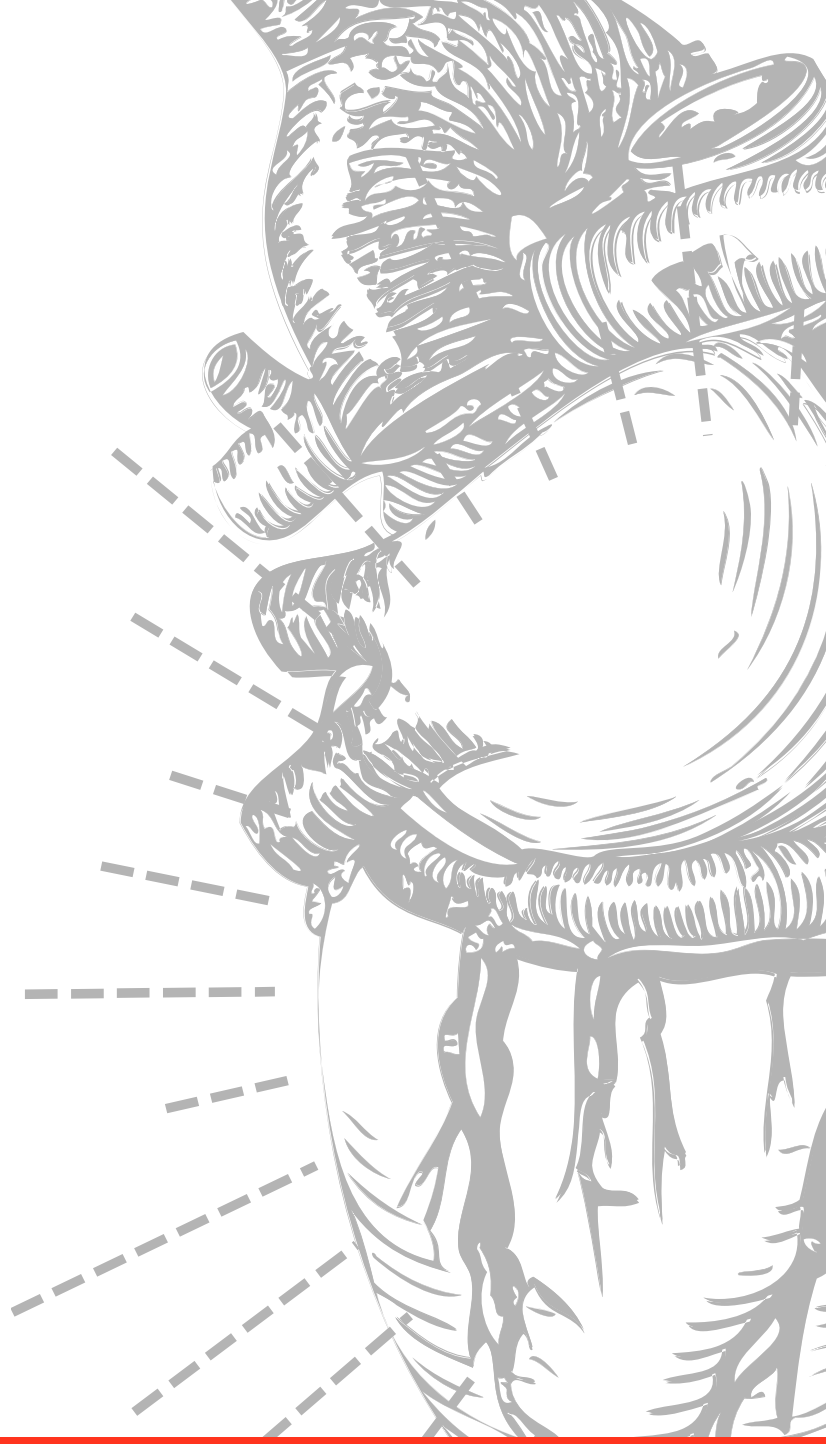
HEALING THE HEART AND MIND

# A Data-Driven Approach to Understanding Heart Disease Health Indicators and Mental Health

**Group 5 - Austin, Justin, Walt**

# WHAT WE'LL DISCUSS TODAY





# RESEARCH OBJECTIVES

Investigate the relationship between mental health and heart disease

Develop a predictive model that would determine risk of heart disease

Create action plans for policy makers and healthcare institutions

# METHODOLOGY

2021 BRFSS Data

Data Processing

Exploratory Data Analysis

Modeling

Conclusion

## *Tools Used*

pandas

matplotlib


## *Dataset*

*n = 220,411*

# 2021 BRFSS DATA

The **Behavioral Risk Factor Surveillance System** (BRFSS) is a survey conducted in the U.S. to understand health-related risk behaviors and chronic health conditions of residents in the US.

**Surveyor:**

- Centers for Disease Control and Prevention

**Method:**

- Telephone Survey

# DATA PROCESSING

**REMOVED INVALID DATA**

- Dropped missing values
- Removed duplicate data

**MAPPED VARIABLES TO STANDARDIZED VALUES**

- Converted "Yes" to 1 and "No" to 0
- Converted integers to strings for better visualization

**ONE-HOT-ENCODED NON-BINARY CATEGORICAL VARIABLES**

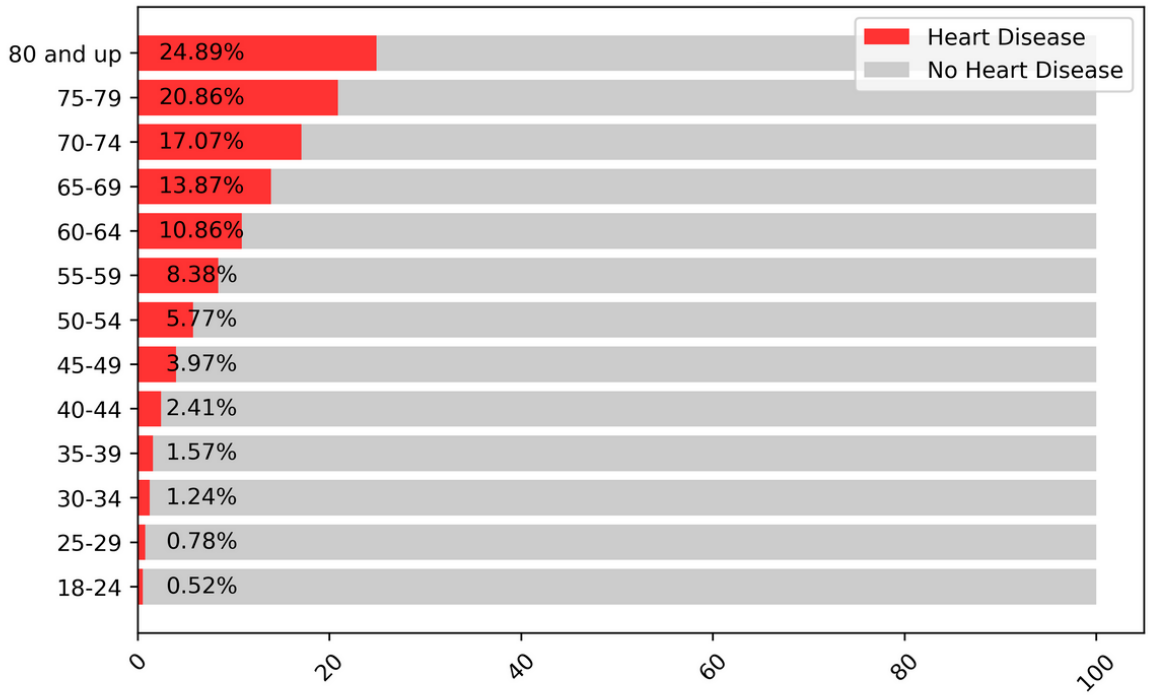
BMI, Diabetes, General Health, Mental Health Status, Age, Education, Income

# EDA

**Did you know?**

The incidence rate of heart disease for an 80-year old is **50 times (!)** that of an 18-year-old!

# AGE GROUP

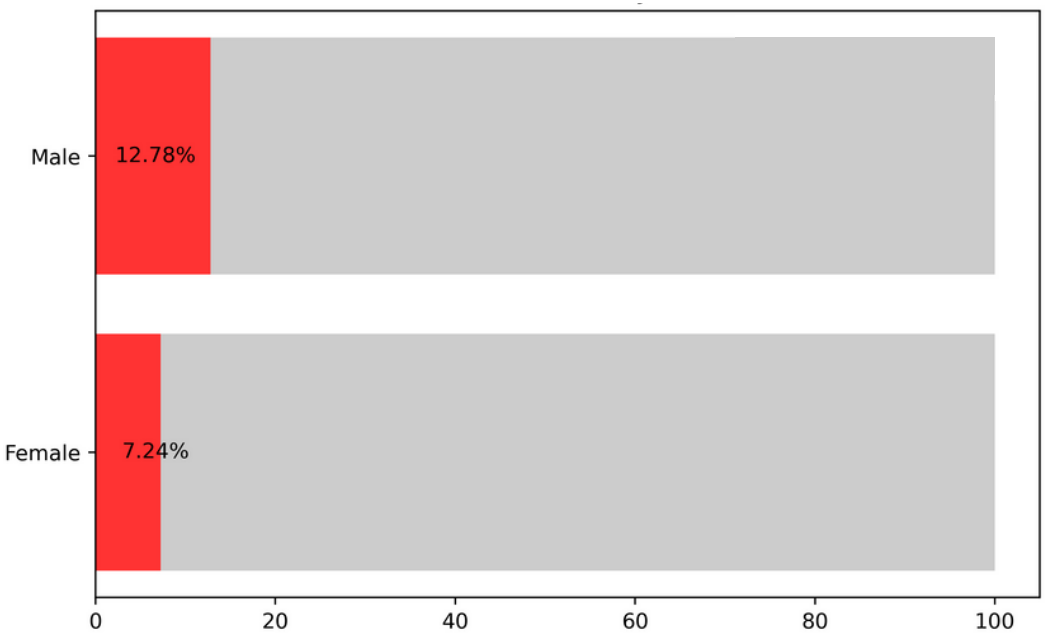



The older you get, the more likely you are to be afflicted by heart disease. Here's why:

As people age, the heart and blood vessels undergo various changes such as **thickening and stiffening of the arteries, reduced elasticity of blood vessels, and decreased pumping ability of the heart,** contributing to the likelihood of heart disease.

*Source: American Heart Association. (2021). Aging and heart disease. Retrieved from https://www.heart.org/en/health-topics/heart-attack/understand-your-risks-to-prevent-a-heart-attack/aging-and-heart-disease.*

# BIOLOGICAL SEX

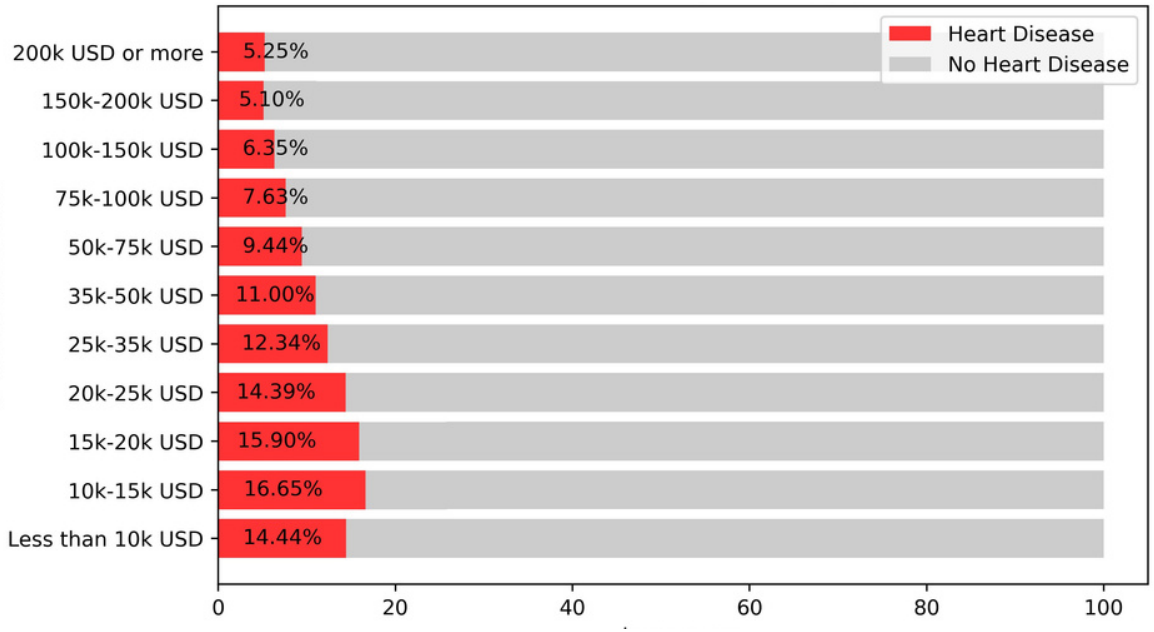



Our dataset shows that **males are about 50% more likely than females** to be afflicted by heart disease. This is likely due to:

1. **Lifestyle factors**. Men are more likely to engage in certain lifestyle behaviors that increase the risk of heart disease, such as **smoking and excessive alcohol consumption**.
2. **Hormonal differences.** Estrogen, a female sex hormone, helps to keep blood vessels flexible and can reduce the buildup of plaque in the arteries. **As women go through menopause, their estrogen levels decrease, which can increase the risk of heart disease.**

*Source: Mendelsohn, M. E., & Karas, R. H. (2005). The protective effects of estrogen on the cardiovascular system. New England Journal of Medicine, 340(23), 1801-1811.*

# INCOME LEVELS

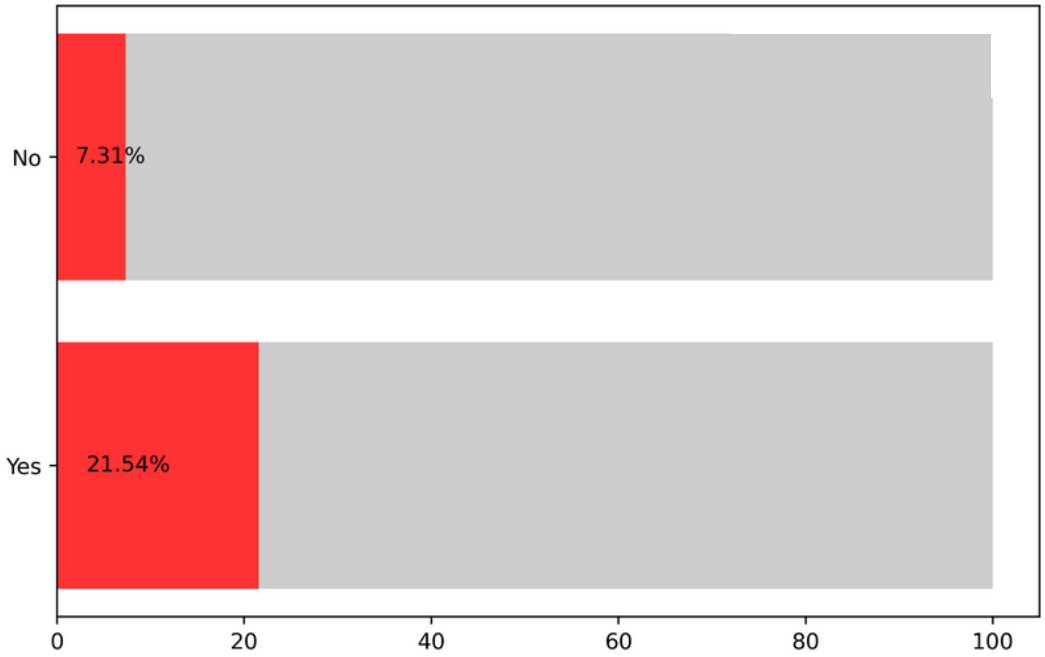



Generally, the richer you are, the less likely you are to be afflicted by heart disease. Here's why:

1. **Access to healthcare.** Wealthier individuals are more likely to have access to quality healthcare, improving their chances of receiving timely treatment for heart disease risk factors.
2. **Less occupational exposure.** Wealthier individuals are less likely to be occupationally exposed to hazardous pollutants or chemicals, which can increase the risk of heart disease.

*Source: Mackenbach, J. P., Stirbu, I., Roskam, A. J., Schaap, M. M., Menvielle, G., Leinsalu, M., ... & Kunst, A. E. (2008). Socioeconomic inequalities in health in 22 European countries. New England Journal of Medicine, 358(23), 2468-2481.*

# DIFFICULTY WALKING

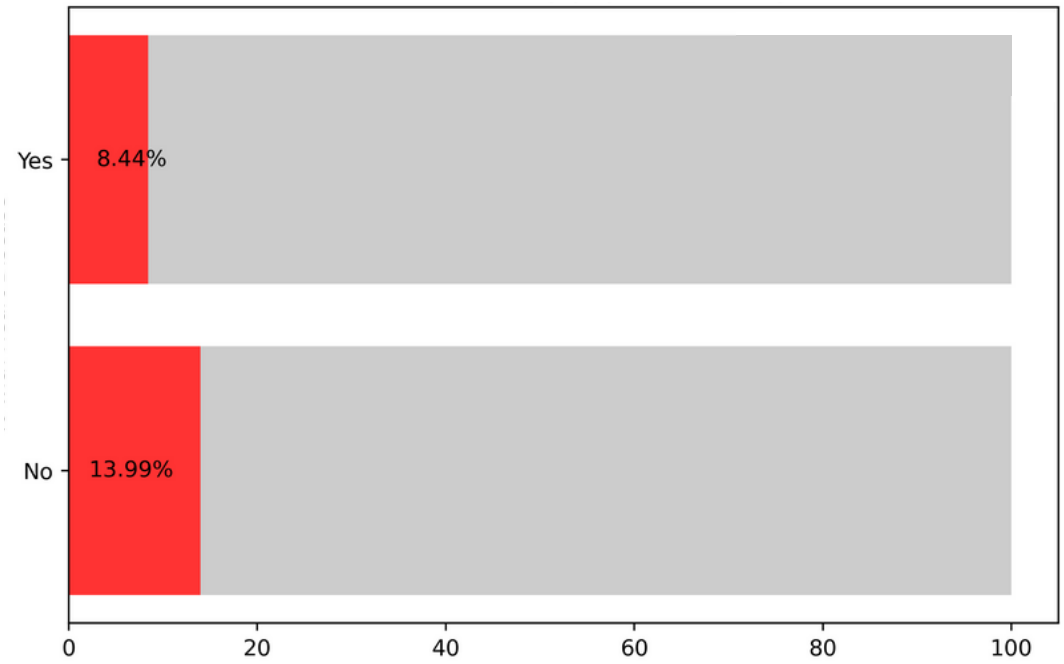



Interestingly, those with difficulty walking are **thrice as likely** to be afflicted by heart disease than those who don't. Key possible reasons are:

1. **Higher rates of obesity.** Difficulty walking contributes to obesity, which in turn increases the risk of **high blood pressure**, and other cardiovascular risk factors.
2. **Higher rates of diabetes.** Those with difficulty walking are more likely diabetic, which itself is a major risk factor for heart disease, as it can **damage blood vessels and increase the risk of atherosclerosis.**

*Source: Guralnik, J. M., Ferrucci, L., Simonsick, E. M., Salive, M. E., & Wallace, R. B. (1995). Lower-extremity function in persons over the age of 70 years as a predictor of subsequent disability. New England Journal of Medicine, 332(9), 556-561.*

# PHYSICAL ACTIVITY

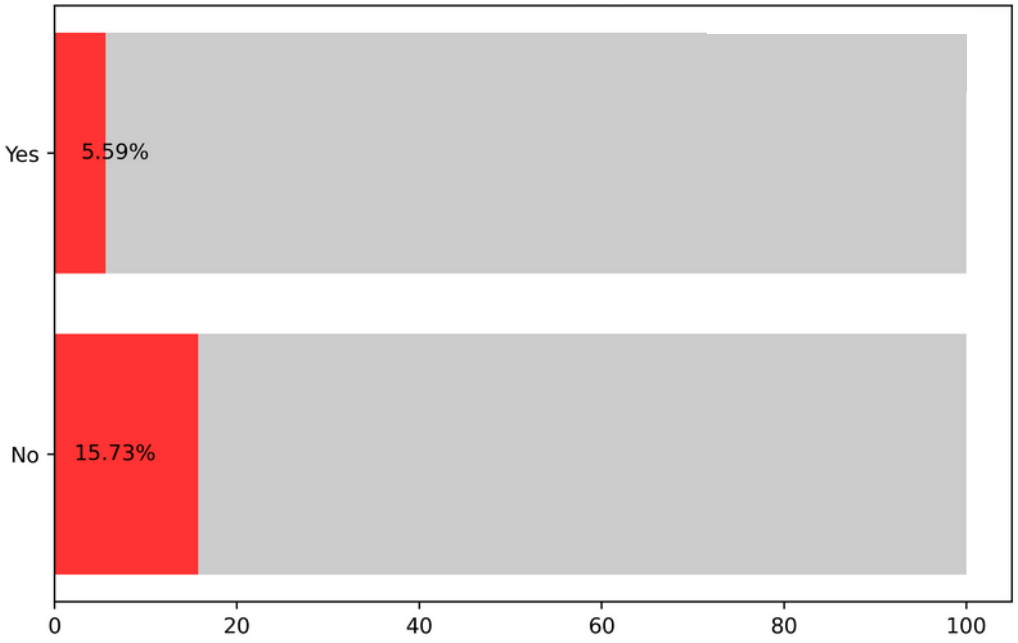



People who engage in physical activity are almost **less than twice as likely to have heart disease** compared to people who don't.

This is unsurprising as physical activity contributes to **improved cardiovascular health,** strengthening the heart and blood vessels, improving blood flow, and reducing inflammation.

*Source: American Heart Association. (2021). Physical Activity Improves Quality of Life. Retrieved from https://www.heart.org/en/healthy-living/fitness/fitness-basics/aha-recs-for-physical-activity-in-adults.*

# CHOLESTEROL LEVELS



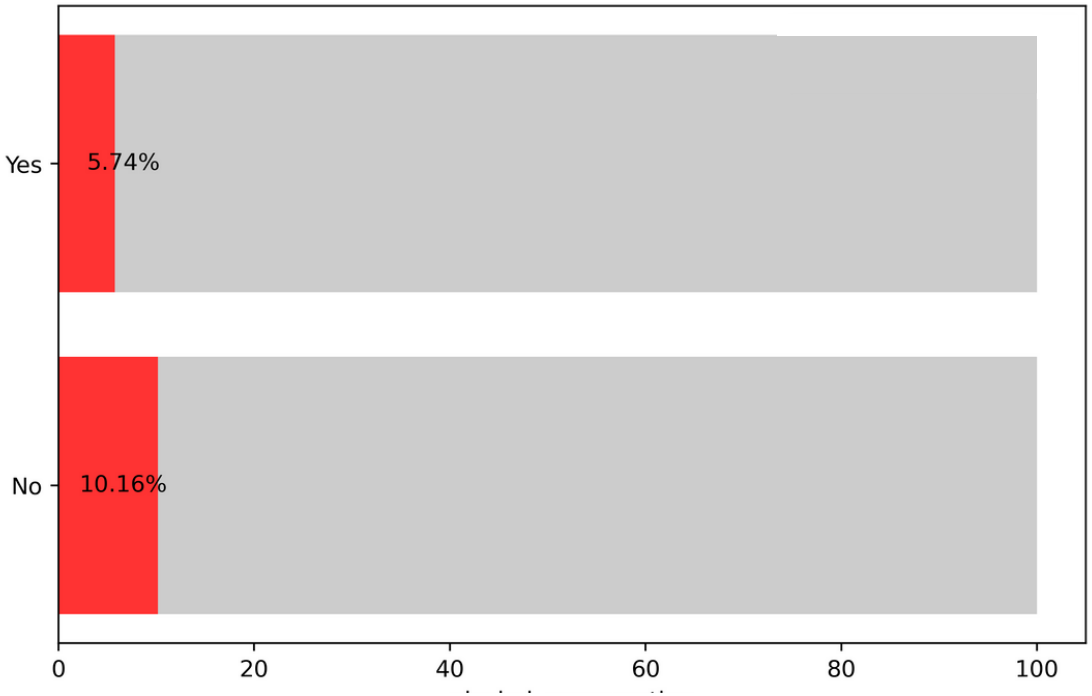

While our dataset shows that those without high cholesterol are more likely to be afflicted by heart disease, this is contrary to the scientific evidence on the same subject.

This is likely due to the fact that **cases of high cholesterol are often underreported**.

A JAMA Cardiology study in 2013 found that a **significant proportion of established heart disease patients with high cholesterol were not aware of their condition** and were not receiving treatment, highlighting the need for improved efforts to identify high cholesterol.

*Source: Coutinho, T., Goel, K., Correa de Sa, D., Carter, R. E., Hodge, D. O., Kragelund, C., ... & Lopez-Jimenez, F. (2013). Combining body mass index with measures of central obesity in the assessment of mortality in subjects with coronary disease: role of "normal weight central obesity". JAMA cardiology, 148(7), 717-727.*

# ALCOHOL CONSUMPTION




This is a particularly interesting result, where those who **consume alcohol are almost less than twice as likely to contract heart disease than teetotalers.**

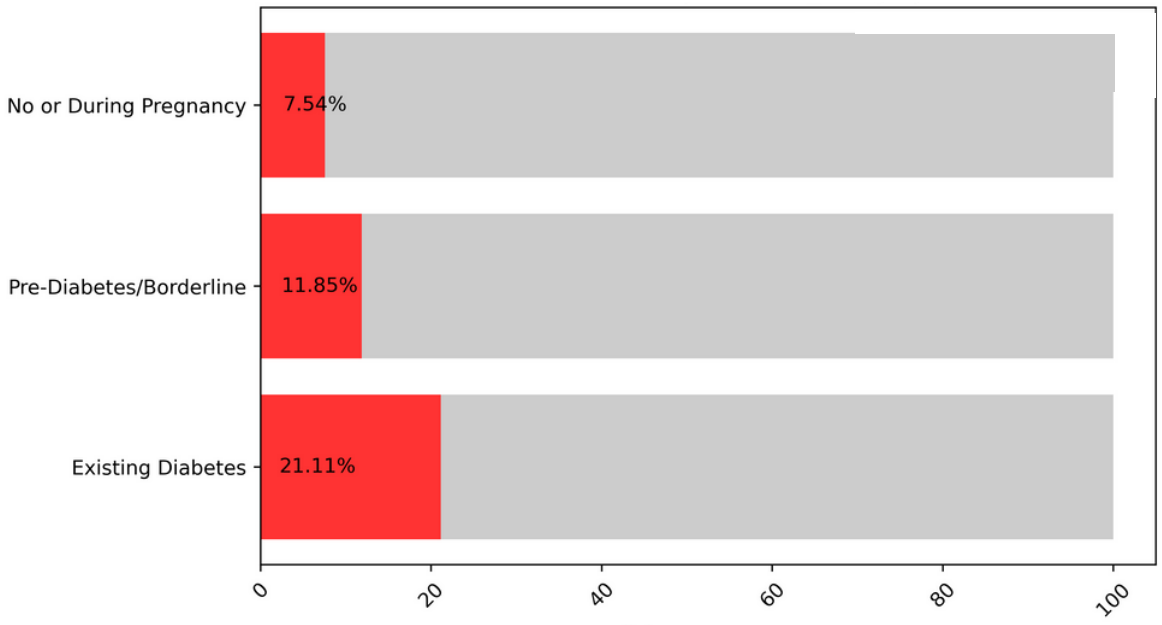
There is some evidence to suggest that **moderate alcohol consumption can lower the risk of heart disease.**

One possible theory is that alcohol consumption improves insulin sensitivity, which can help to **lower the risk of type 2 diabetes**.

Diabetes is a known risk factor for heart disease, as we see on the next slide.

*Source: Gaziano, J. M. (2021). Moderate alcohol intake and cardiovascular disease. Harvard Health Publishing. Retrieved from https://www.health.harvard.edu/blog/moderate-alcohol-intake-and-cardiovascular-disease-2021030522361.*

# DIABETES

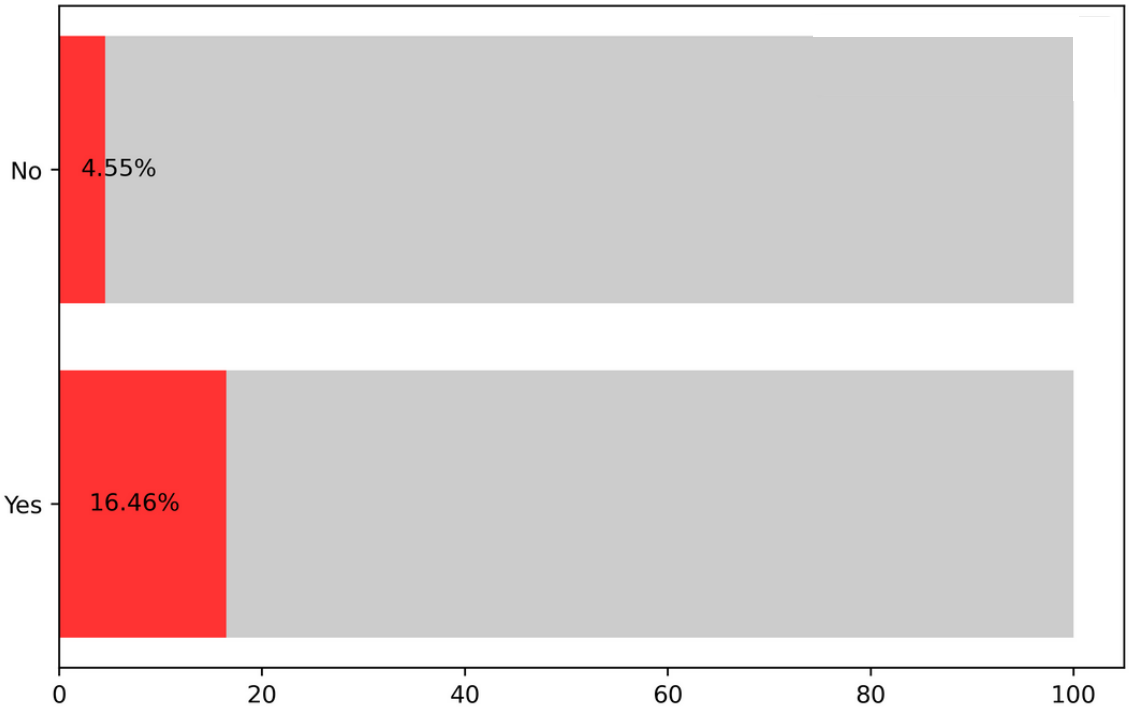



People with diabetes are **more than twice as likely to have heart disease** compared to people without diabetes. This could be because diabetes contributes to

1. **High blood glucose levels**, which can damage the blood vessels and lead to atherosclerosis (hardening and narrowing of the arteries)
2. **High blood pressure**, which is a major risk factor for heart disease, as we see on the next slide.

*Source: American Diabetes Association. (2021). Diabetes and Cardiovascular Disease. Retrieved from https://www.diabetes.org/diabetes/complications/cardiovascular-disease.*

# HIGH BLOOD PRESSURE

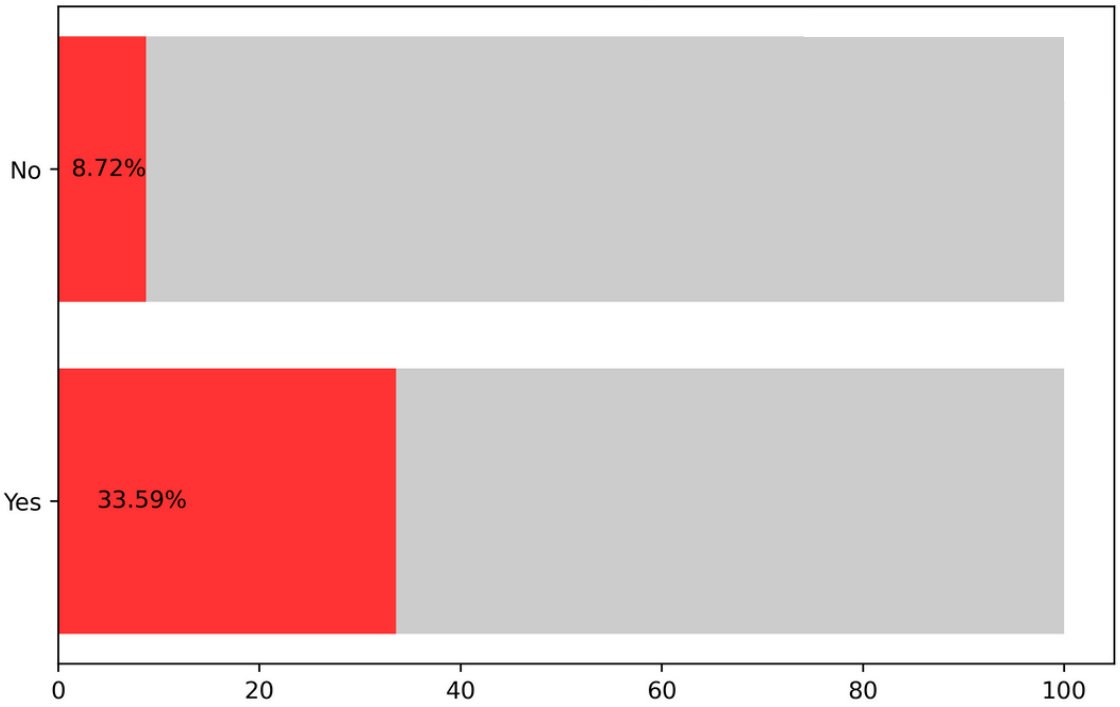



People with high blood pressure are **more than four times as likely to have heart disease** compared to people without high blood pressure. This could be due to

1. **Increased workload on the heart,** forcing the heart to work harder to pump blood leading to an enlarged heart, weakening of the heart muscle, and eventually heart failure.
2. **Increased risk of blood clots,** which can lead to heart attack or stroke, which itself is a likely indicator of heart disease.

*Source: Mayo Clinic Staff. (2021). High blood pressure (hypertension). Mayo Clinic. Retrieved from https://www.mayoclinic.org/diseases-conditions/high-blood-pressure/symptoms-causes/syc-20373410.*

# STROKE

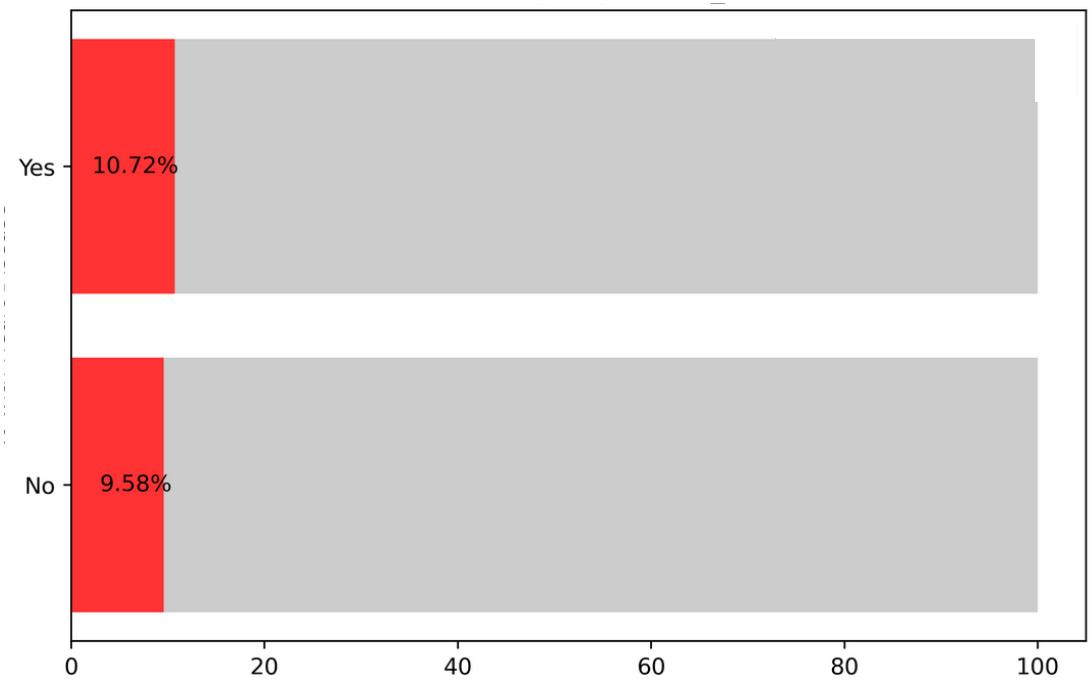



People with stroke are almost **more than four times as likely to have heart disease** compared to people without stroke. This could be due to

1. **Shared risk factors.** As we have seen so far, many of the risk factors for stroke and heart disease are the same, such as **high blood pressure, diabetes**, **and smoking.** Having one of these risk factors increases the risk of developing both stroke and heart disease.
2. Stroke can **damage the blood vessels** in the brain and body, increasing the risk of developing **atherosclerosis** (buildup of fatty deposits in arteries) and hence heart disease.

*Source: American Heart Association. (2021). Stroke and heart disease. Retrieved from https://www.heart.org/en/health-topics/consumer-healthcare/what-is-cardiovascular-disease/stroke-and-heart-disease.*

# DEPRESSIVE DISORDER

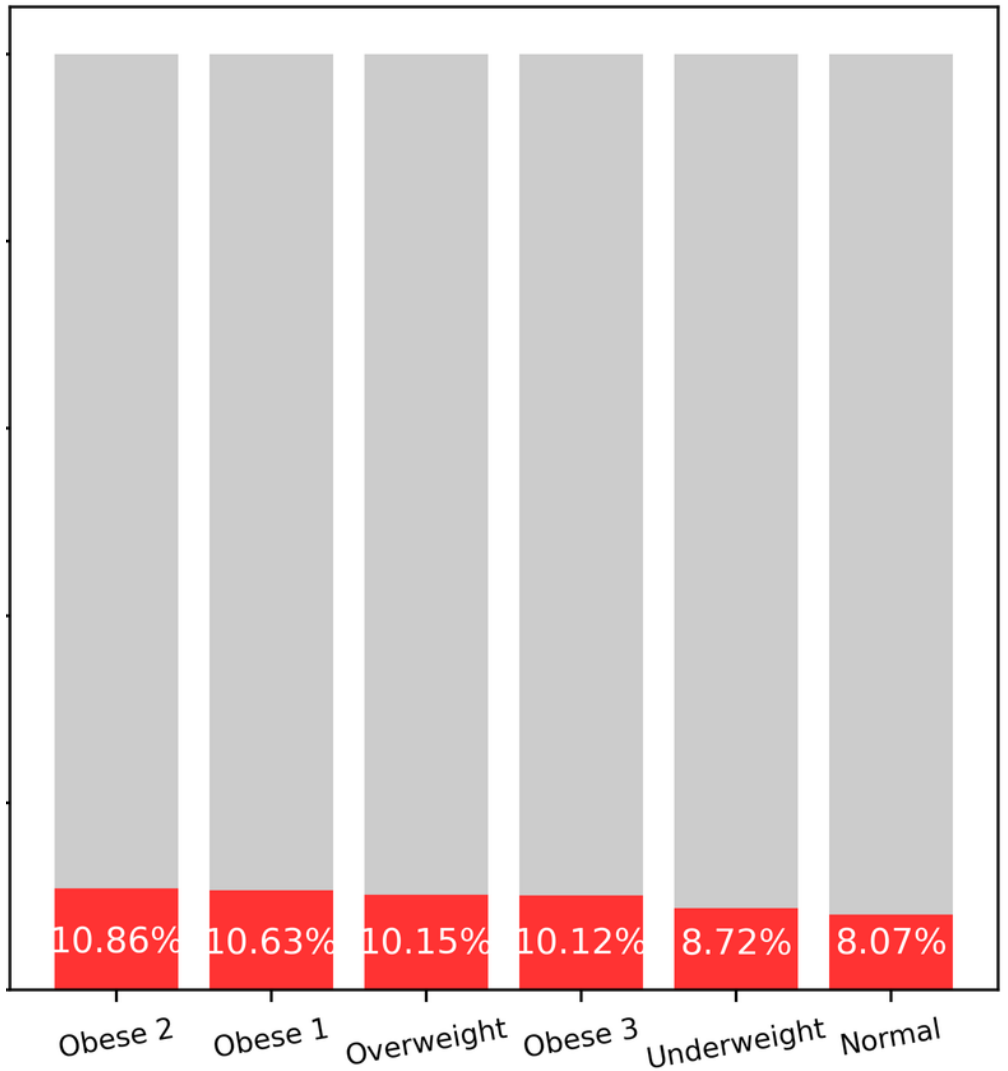



People experiencing **depression,** anxiety, stress, and even PTSD over a long period of time may experience certain physiologic effects on the body, such as increased cardiac reactivity reduced blood flow to the heart, and heightened levels of cortisol.

*Source: Center for Disease Control and Prevention (2020). Heart Disease and Mental Health Disorders. Retrieved from Heart Disease and Mental Health Disorders | cdc.gov.*

# 1 IN 10 PEOPLE WITH CLASS 2 OBESE EXPERIENCED HEART DISEASE

**The extra weight in obese people forces the heart to do more work. It can also cause problems by increasing the risk of developing many other factors that make heart disease more likely.**



# MODELING & INTERPRETABILITY

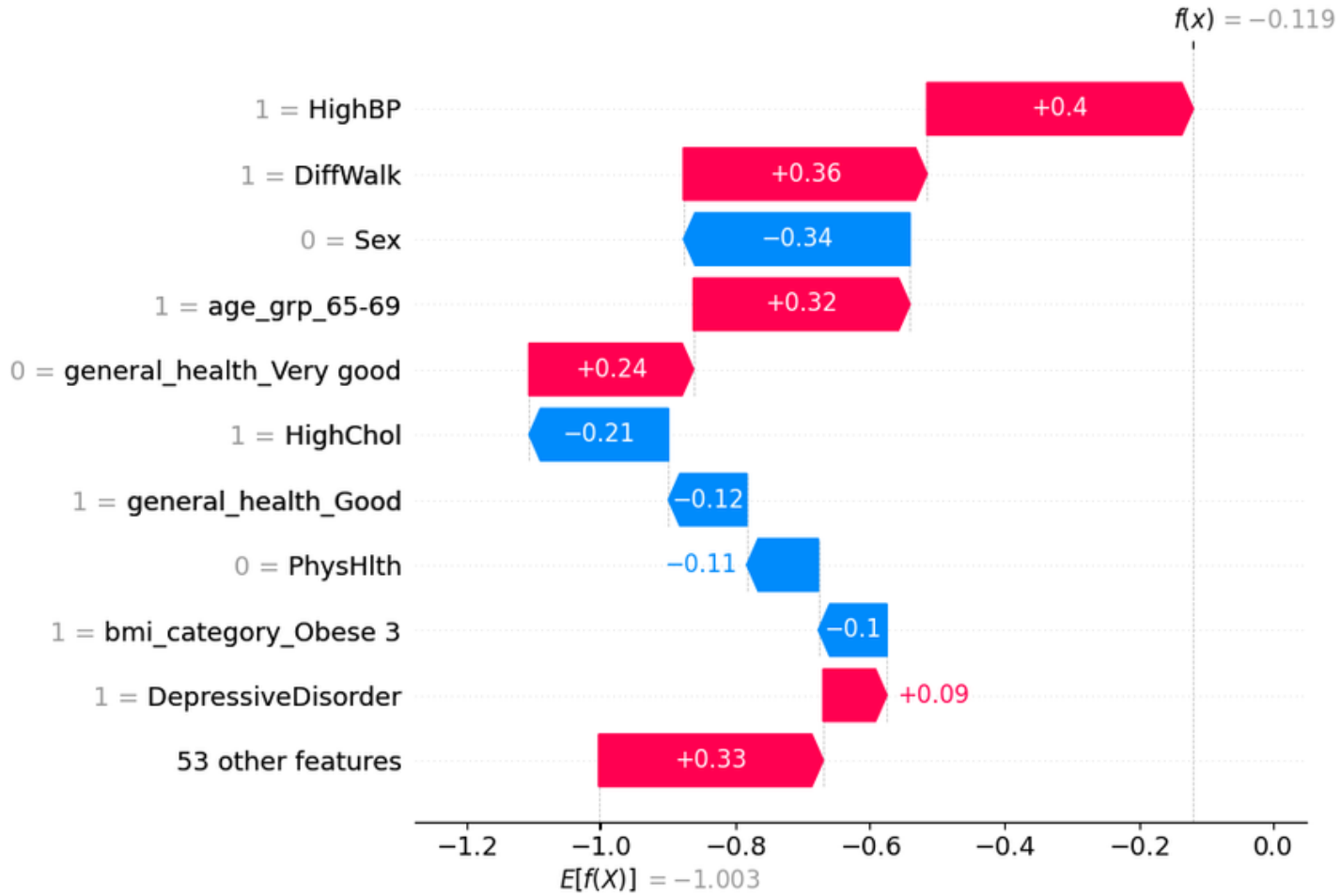
# MODELLING RESULTS

| ML Algorithm | Method | Train Recall | Val Recall | Holdout Recall | Train Accuracy | Val Accuracy | Holdout Accuracy |
|---|---|---|---|---|---|---|---|
| Logistic Regression | No Resampling | 10.30% | 10.11% | 9.33% | 90.99% | 90.99% | 90.84% |
| | ReSampling x HyperTune | **76.90%** | **76.78%** | **79.11%** | 74.11% | 74.09% | 74.06% |
| K Nearest Neighbors | No Resampling | 21.36% | 9.32% | 9.33% | 91.86% | 91.86% | 89.86% |
| | ReSampling x HyperTune | **60.88%** | **51.83%** | **60.86%** | 81.13% | 79.82% | 77.81% |
| Gradient Boosting | No Resampling | 9.41% | 9.16% | 8.52% | 91.05% | 91.05% | 90.86% |
| | ReSampling x HyperTune | **77.07%** | **76.04%** | **79.68%** | 71.61% | 71.42% | 73.69% |

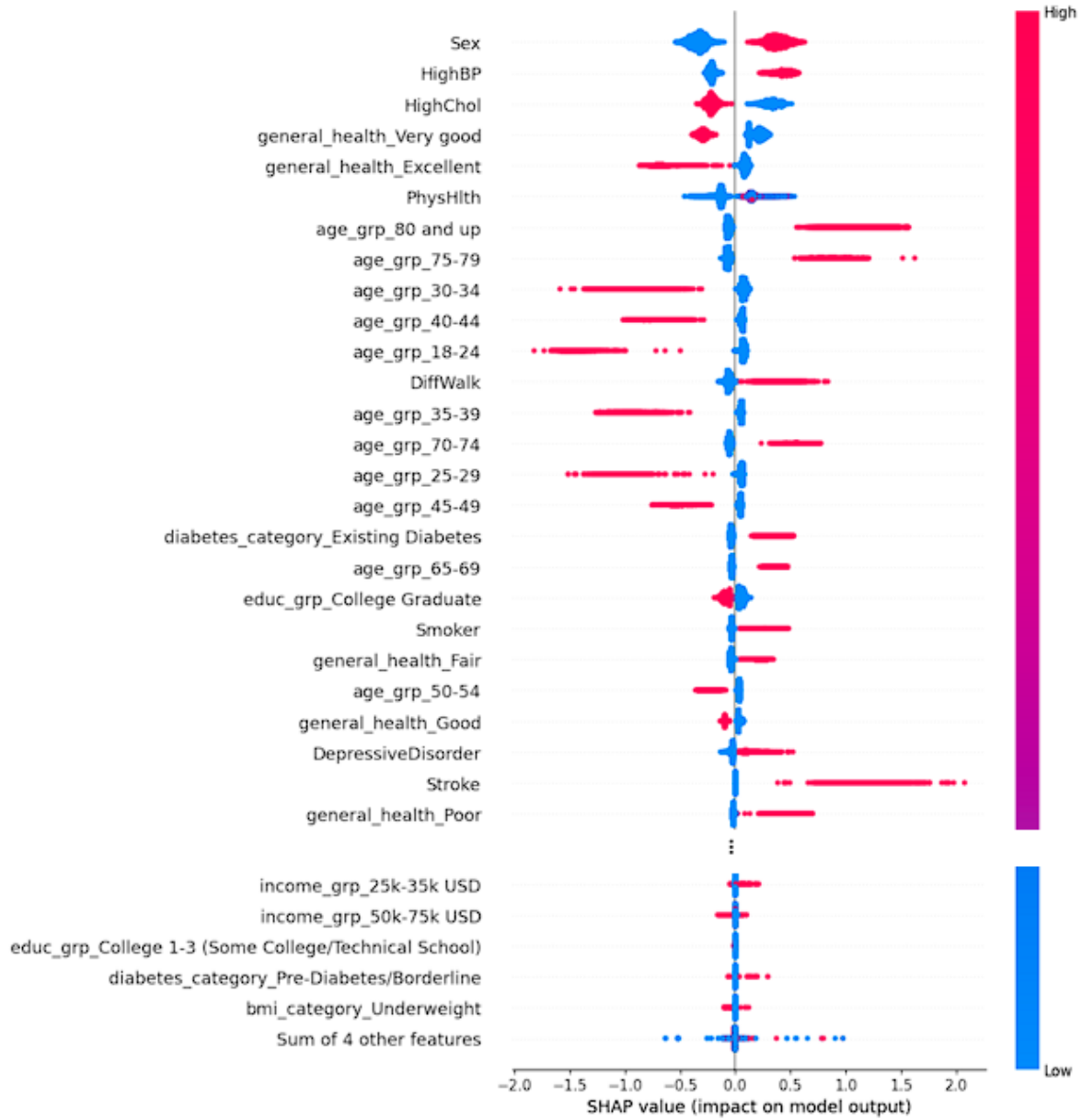
Three algorithms were considered in creating the predictive model, these are Logistic Regression, K Nearest Neighbors, and Gradient Boosting. To address the data imbalance, an under-sampling is performed using Random Under Sampler.

The table above shows recall and accuracy scores across train, validation, and holdout sets.

Amongst the three models, the one with the best recall scores was selected. This is because our target variable to predict is having heart disease and what we want is to create a model that would correctly identify those with heart disease.




Based on the SHAP waterfall plot, features such as **high blood pressure**, **difficulty walking**, **age 65-69,** and **very good general health** have notable contributions to the prediction score. Being female and being inactive in physical activities has negative contributions.




Based on the SHAP beeswarm plot, the features that have a high positive impact on the model output are **sex**, **high blood pressure**, and **age groups 80+**, and **75-79**. This means that having these feature values increases the risk of experiencing heart disease.

On the other hand, the features that have a negative impact on the model output are excellent general health, age groups 30-34, and 40-44. This means that having these feature values decreases the risk of experiencing heart disease.

Also, being diagnosed with a depressive disorder contributes to a higher risk of contracting heart disease.

# CONCLUSION

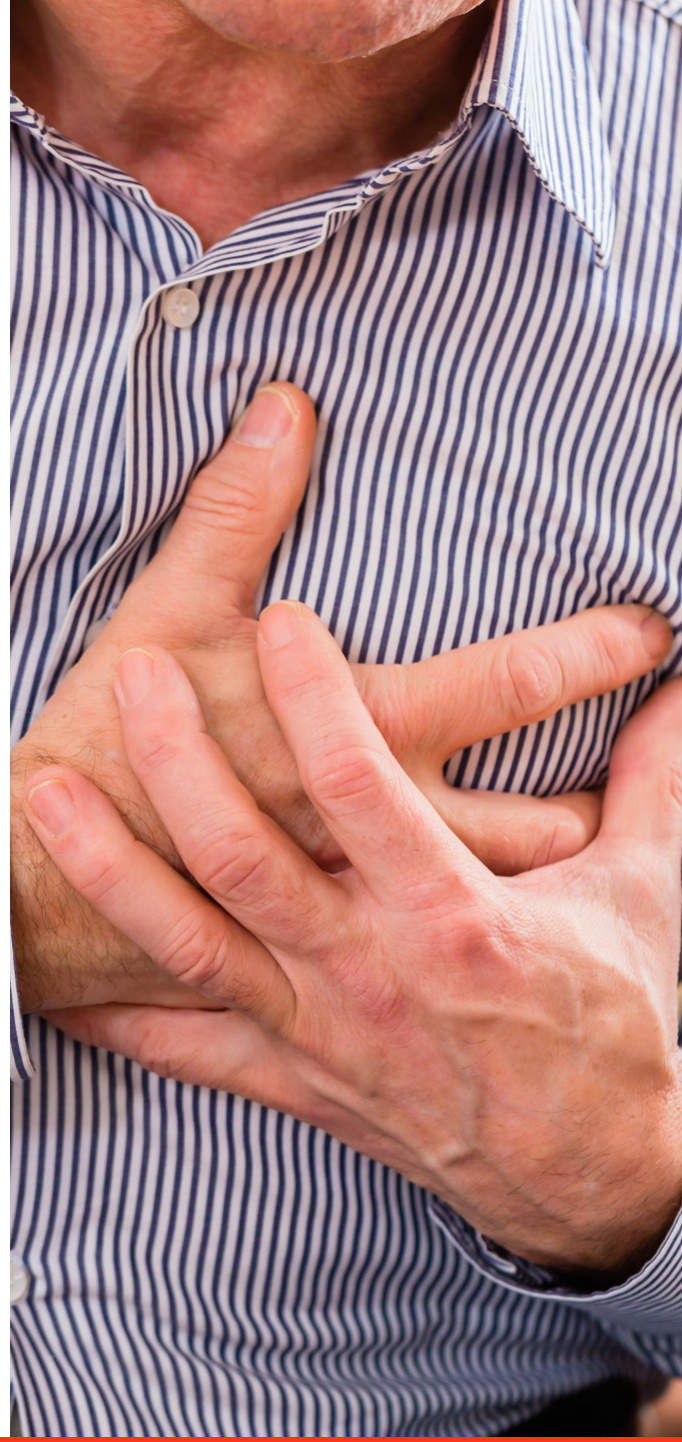
*Heart Disease and Mental Health*

**The study showed that men are more likely to experience heart disease as opposed to women. The factors that could increase the risk of heart disease are Age, High BP, History of Stroke, Smoking, History of Diabetes, and Difficulty walking.**

**Also, we saw that having been diagnosed with depressive disorder in fact could lead to experiencing heart disease as well.**

**From this, we see that it is important that each individual to take care of their health as most diseases are related to one another.**

**Moreover, as much as we take care of physical health and well-being, people should also be mindful of their mental health as this could lead to complications and manifest as a physical health disease.**



# RECOMMENDATION

*For Policy Makers*

**Policy makers across the globe can leverage on this study by creating certain policies that would address the threat of heart disease on the general population.**

**In the Philippines, the leading cause of death in 2021 is ischemic heart disease. In fact, this has been the highest cause of death since 2019.**

**Policy makers and the department of health could focus on**

- **information campaigns on the causes/factors of heart disease**
- **availability of medicine for hypertension and diabetes**
- **accessibility to mental health care i.e., free consultations and penetration in rural areas**

# RECOMMENDATION

*For Medical Institutions*

**Medical institutions across the globe can leverage on this study creating programs that would improve patient care.**

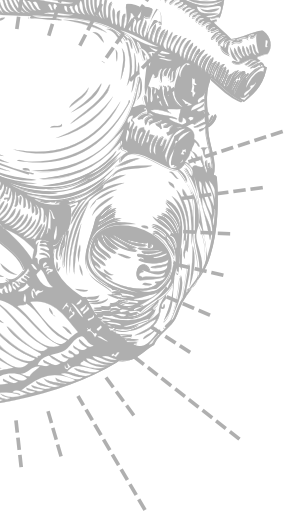
**These are things institutions can consider are:**

- **Develop a personalized risk assessment tool by profiling patient based on his/her history and experience. This allows development more targeted and effective treatment plans for each individual.**
- **Proper screening and documentation of Cholesterol levels of patients.**
- **Incorporate mental health services during checkups. This allows early detection of certain mental health problems.**
- **Implement a telemedicine program specifically for heart disease patients for monitoring and ease of access.**

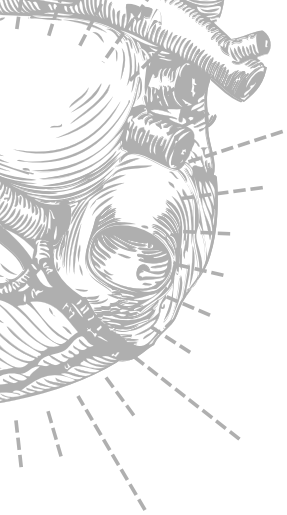
## HEALING THE HEART AND MIND

# REMEMBER, A HEALTHY MIND LEADS TO A HEALTHY HEART.

# PRIORITIZE YOUR PHYSICAL AND MENTAL WELL-BEING TO PREVENT HEART DISEASE AND LIVE A FULFILLING LIFE.



# APPENDIX

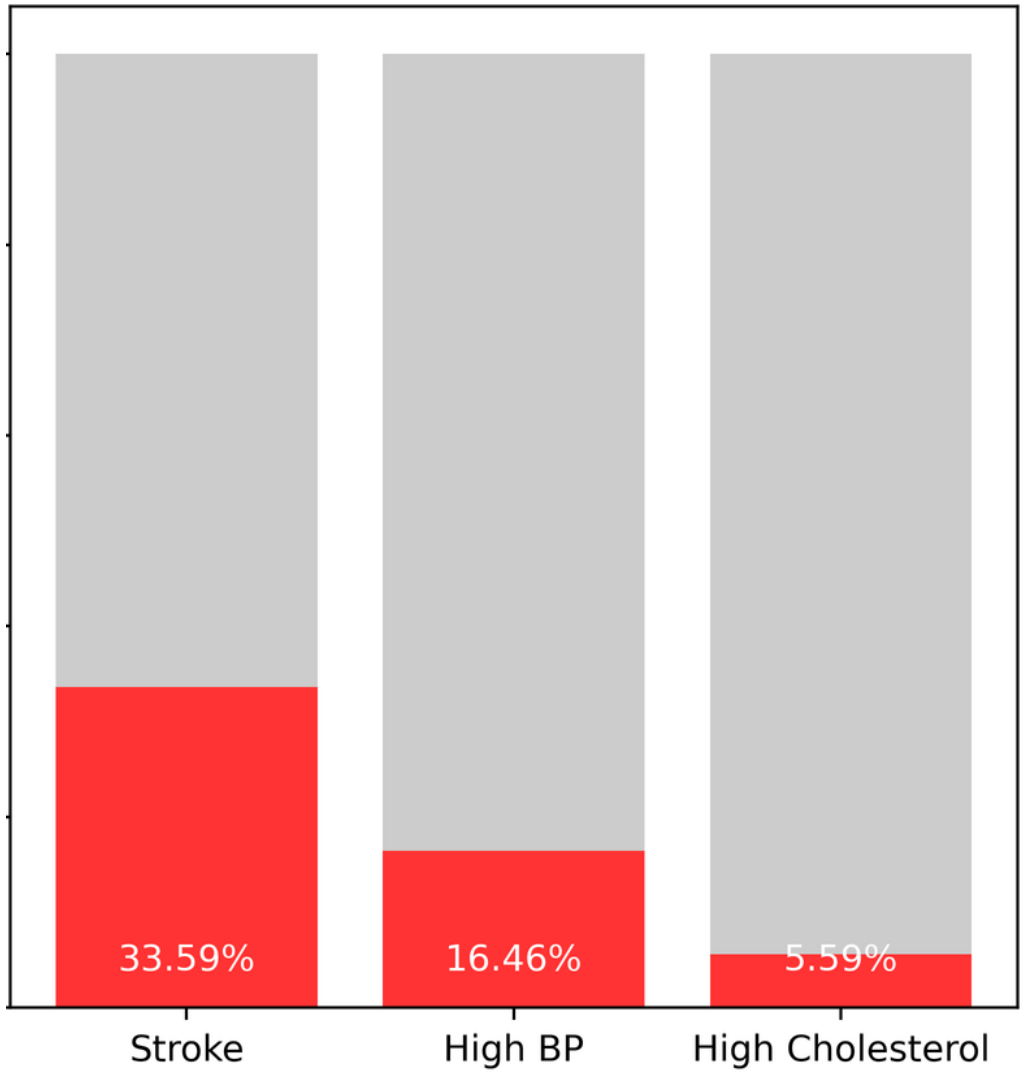


# DEPLOYMENT LINK

https://lockjaw-heart-disease-risk-prediction.streamlit.app/

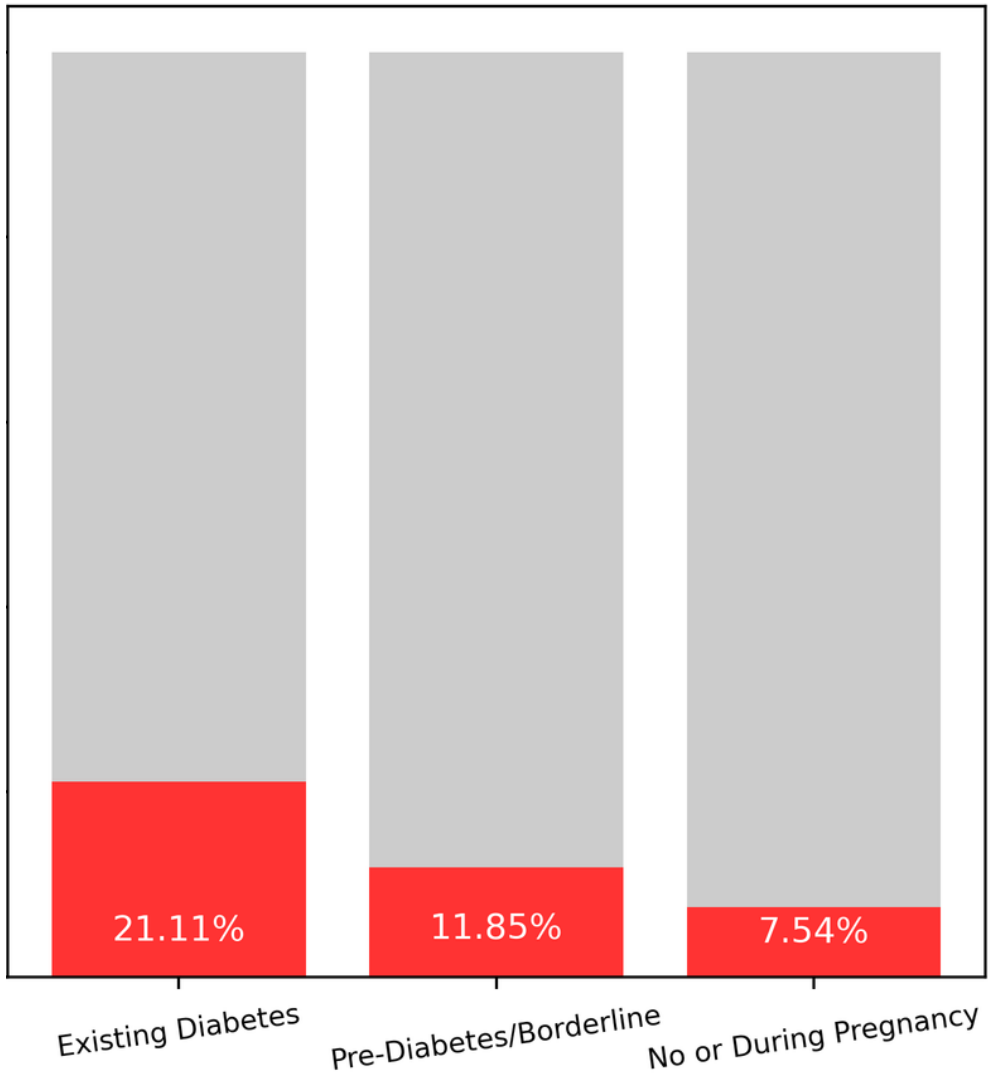
# STROKE IS THE LEADING RISK FACTOR FOR HEART DISEASE

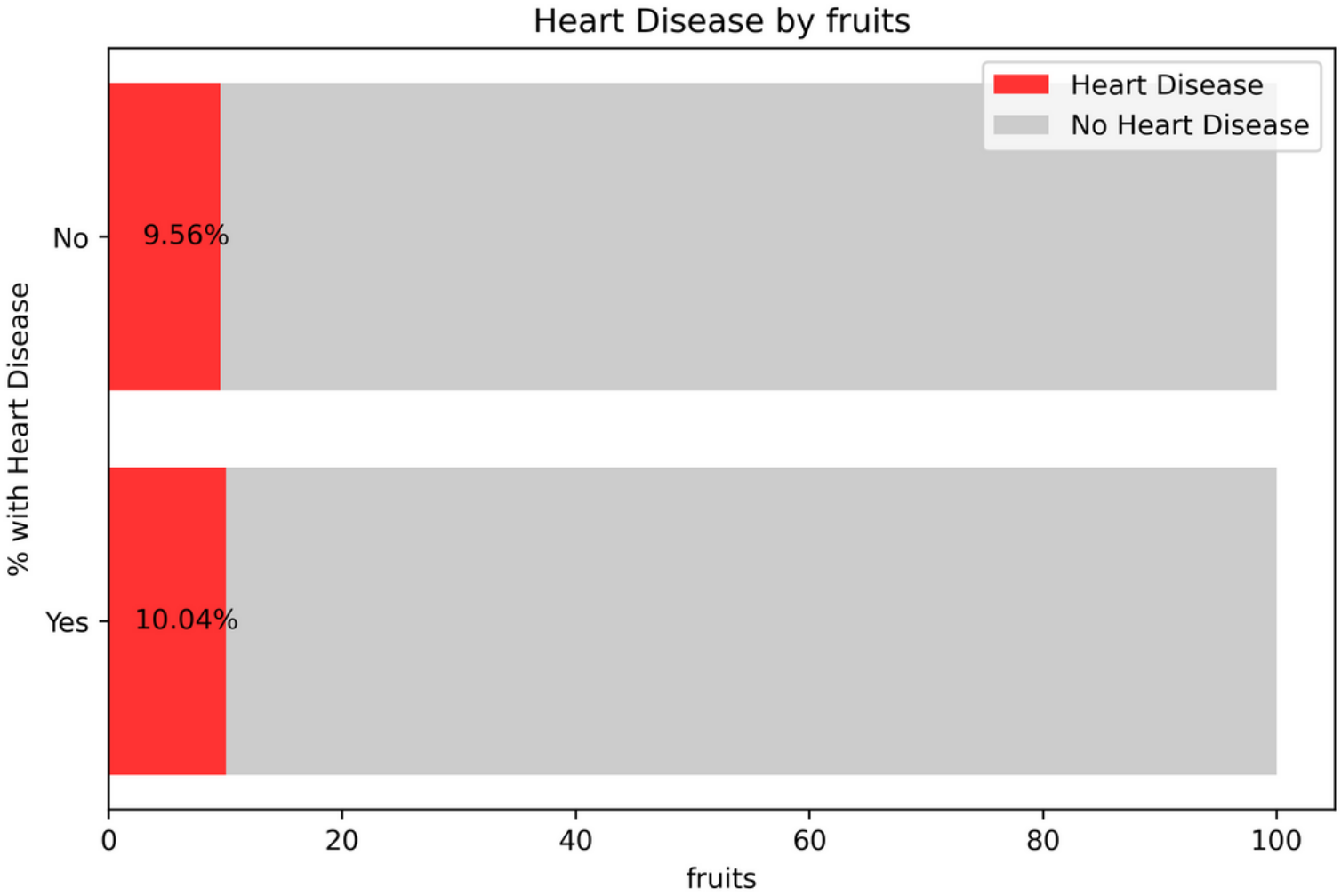
**Atherosclerosis, or the build-up of fatty plaque in the arteries, is the leading cause of heart attacks and strokes. It can prevent blood from reaching the heart and it contributes to the development of blood clots that can travel to the heart or brain.**

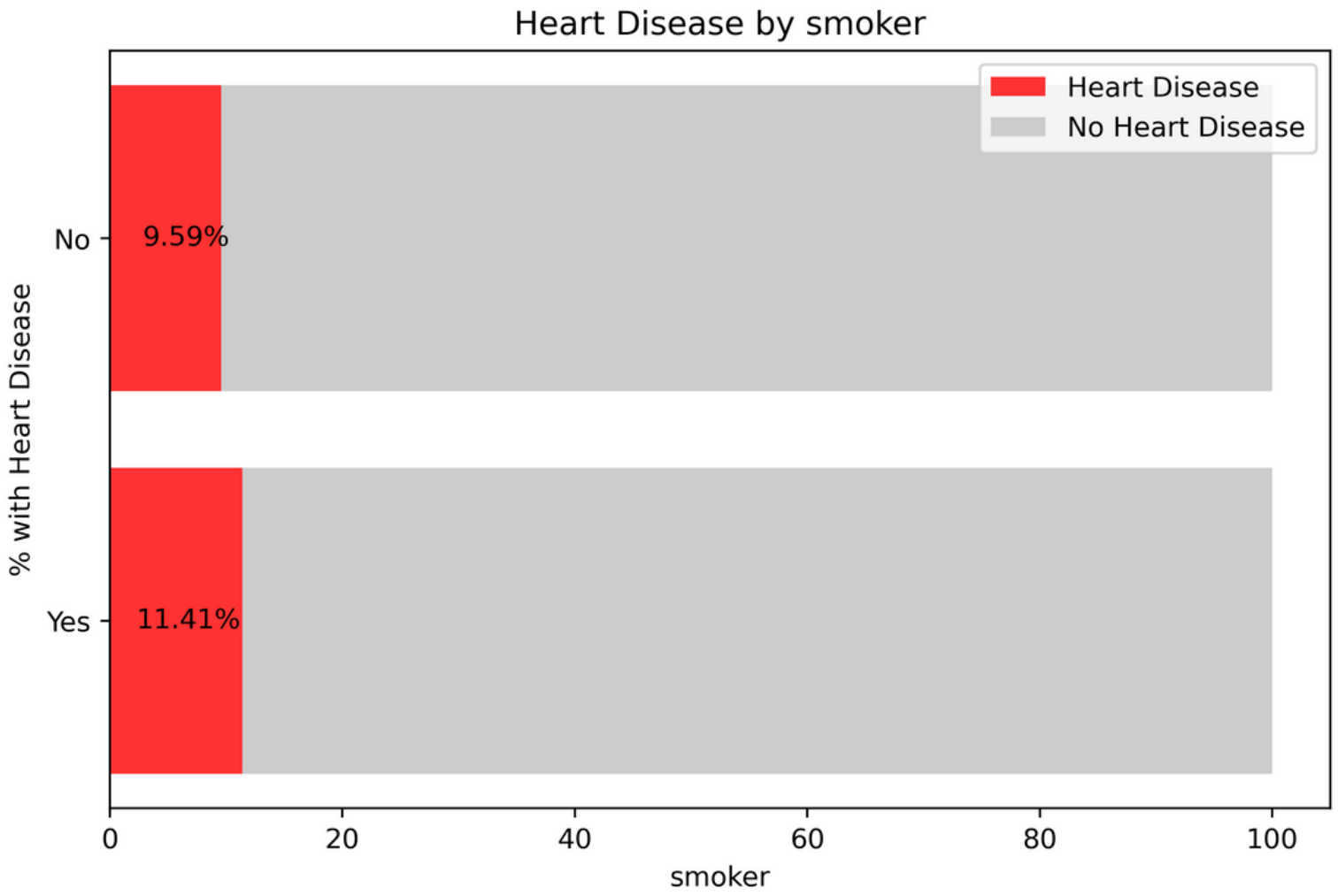


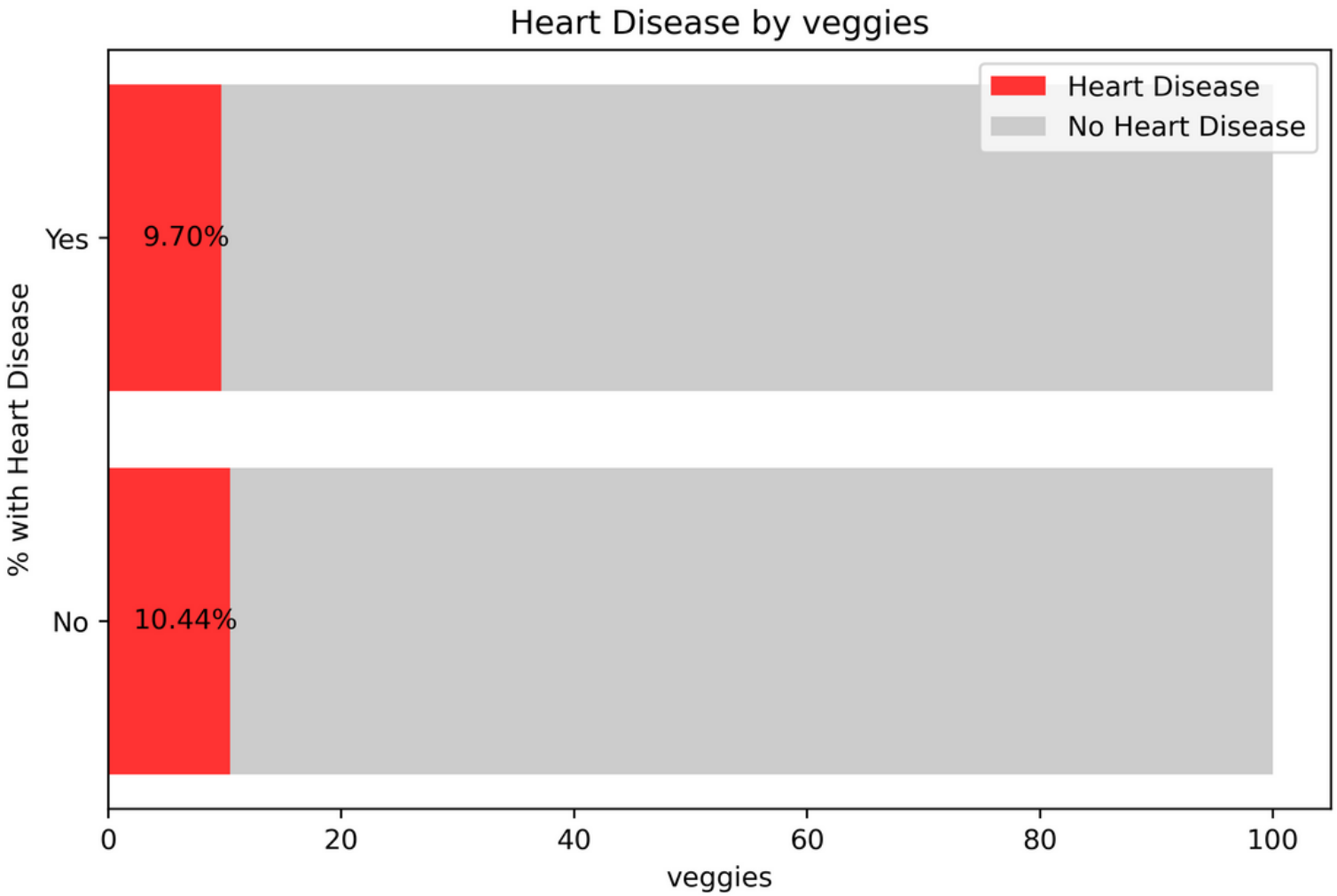
# 21 IN EVERY 100 PEOPLE WHO ARE DIAGNOSED WITH DIABETES EXPERIENCE HEART DISEASE

**High blood glucose from diabetes can damage the blood vessels and the nerves that control your heart and blood vessels. Over time, this damage can lead to heart disease.**




Heart Disease by fruits
Heart Disease
No Heart Disease
No
Yes
9.56%
10.04%
% with Heart Disease
0
20
40
60
80
100
fruits


Heart Disease by smoker
Heart Disease
No Heart Disease
% with Heart Disease
No
Yes
9.59%
11.41%
0
20
40
60
80
100
smoker


Heart Disease by veggies
Heart Disease
No Heart Disease
Yes
No
9.70%
10.44%
% with Heart Disease
0
20
40
60
80
100
veggies

# HYPER PARAMETERTUNING AND SAMPLING

**During the modelling exercises under sampling and hyperparameter tuning was done. The table below shows the best fitted parameters.**

| ML Algorithm | Hyperparameter tuned |
|---|---|
| Logistic Regression | C: 0.1 |
| | max_iterationjs: 100 |
| | Solver: lbfgs |
| K Nearest Neighbors | nearest neighbors: 18 |
| | |
| Gradient Boosting | learning rate: 0.1 |
| | n_estimators: 200 |