

DSCI 2411 - Project Report:

*“How Does A Non-Diabetic Female’s  
Lifestyle Affect Her Chances of  
Contracting Coronary Diseases?”*

Omar Moustafa

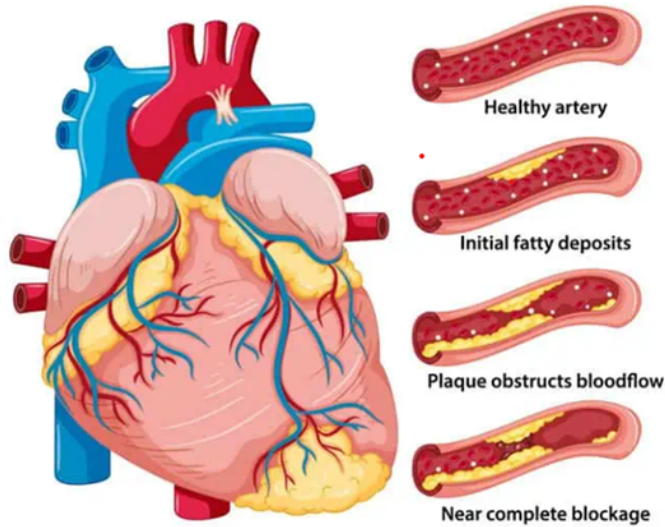
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## Introduction:

In our daily lives, our actions and decisions not only govern how our day goes but also affect our bodies' durability and health. So, this raised many questions in our minds, however, the most remarkable inquiry that interested us was how different aspects of our life could increase our chances of being diagnosed with a certain disease. The type of disease that we decided on was coronary disease which is considered extremely lethal and could be fatal as time passes. So, these initial ideas drove us to identify the research question that will motivate our research. How Does A Non-Diabetic Female's Lifestyle Affect Her Chances of Contracting Coronary Diseases?



According to the Oxford Languages website, the word coronary relates to the arteries supplying blood and/or surrounding the heart. Emphasizing the significance of this type of disease, a report done by the National Library of Medicine states that coronary artery disease (CAD) accounts for approximately 610,000 deaths annually (estimated 1 in 4 deaths) and is the leading cause of mortality in the United States[1].

The reason for our detailed research question is justified. Since we had numerous attributes in our dataset, we

tried to narrow down the number of factors increasing the risk for coronary diseases to intensify our focus on the issue in discussion. Therefore, it was necessary to utilize efficient sampling of the data. First, we focused on 7070 observations- about 20% of non-diabetic females, we had to determine the main dependent variable that would indicate an upcoming coronary disease case, so we went with BMI. Next, we had to locate the main independent variables affecting BMI that we wanted to include in our research. In our case, we chose fruits, smoking, physical activity, heavy alcohol consumption, income, and education. So, to nullify the effects of diabetes and gender we fixed our choice of sample to non-diabetic females. After analyzing the relationships between different lifestyle aspects and BMI, we thought that we needed a deeper set of relationships to enrich the research and find stronger factors than BMI – such as high cholesterol levels, blood pressure, stroke, and heart diseases/attack- to relate lifestyle adaptations to their chances of getting coronary diseases.

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[1] Brown, Jonathan C., et al. "Risk Factors for Coronary Artery Disease." *National Center for Biotechnology Information*, U.S. National Library of Medicine, 23 Jan. 2023, [pubmed.ncbi.nlm.nih.gov/32119297/](https://pubmed.ncbi.nlm.nih.gov/32119297/).

## What Problem Could This Dataset Help Address?

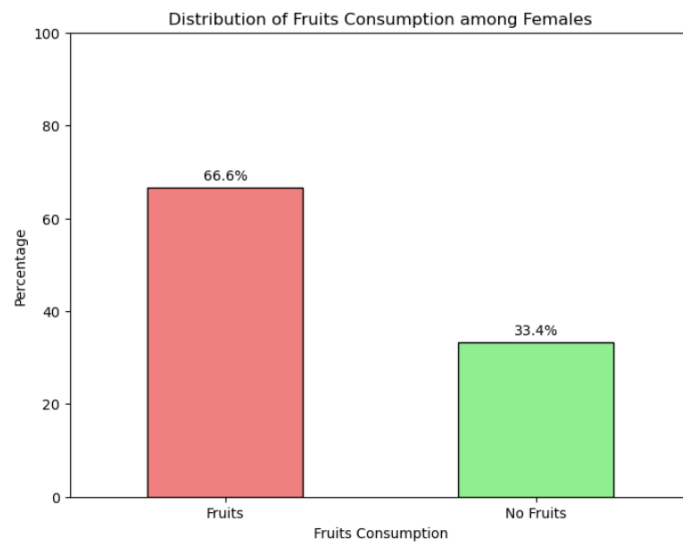
This dataset could help address the problem of what lifestyle factors contribute to a female's chances of contracting a coronary disease. With variables that represent dietary habits, unhealthy habits, physical activity levels, and financial status, trends and relationships that could clarify the factors that affect cardiovascular health can be determined from this dataset. The thorough analysis of this dataset can provide essential and valuable information and insights as to how such lifestyle elements can affect women's risk for coronary diseases. This particular dataset may also lead to a greater understanding and grasp of the complex nature of these several factors and even facilitate effective treatment plans to reduce the risk factors linked to coronary problems in women.

## Description of the Dataset:

The dataset includes multiple files with data about over 400,000 Americans who are on health-related risk behaviors, and chronic health conditions, and also tend to use inhibitive services. The data collection began in the year of 1984 and has been collected on an annual basis every year since then. The vast majority of the variables in this particular dataset are discrete with only a couple of the variables being continuous. The discrete variables correspond to the participants' diabetes level, whether or not they have high blood pressure or high cholesterol, whether they smoke or not, whether they consume alcohol to a heavy extent or not, and many more. The continuous variables in this dataset are the BMI values and ages of the participants. All in all, this dataset provokes attempts to analyze and visualize the relationships between the essential variables that play a role in trying to achieve a life that is as healthy and long-lasting as possible and keeping their chances of contracting coronary diseases as low as humanly possible.

## Data Summarization:

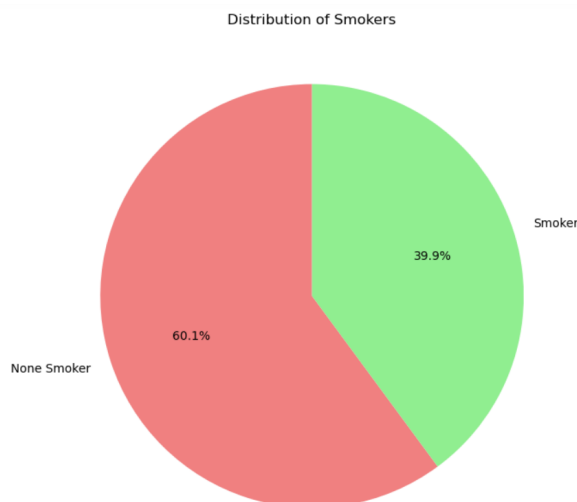
### Fruit Consumption Visualization & Summary:



In this dataset, fruit consumption is a discrete variable that takes the values of zero or one. To describe these values, one indicates that the participant consumes fruit at least once a day whereas zero indicates that the participant does not do so. This is a significant variable to consider and summarize as it is scientifically known and proven that consistently consuming fruits lowers one's likelihood of contracting coronary diseases. "An increase in fruit and vegetable consumption by one serving a day was associated with a 4% decrease in risk of CHD." (Dauchet, 2009)

From the bar chart above, the participants that were visualized were a sample of females who do not have diabetes and it can be seen that about two-thirds of these non-diabetic women consume fruits daily whereas the remaining third do not. This particular visualization highlights a positive trend in this sample's direction toward healthier eating practices.

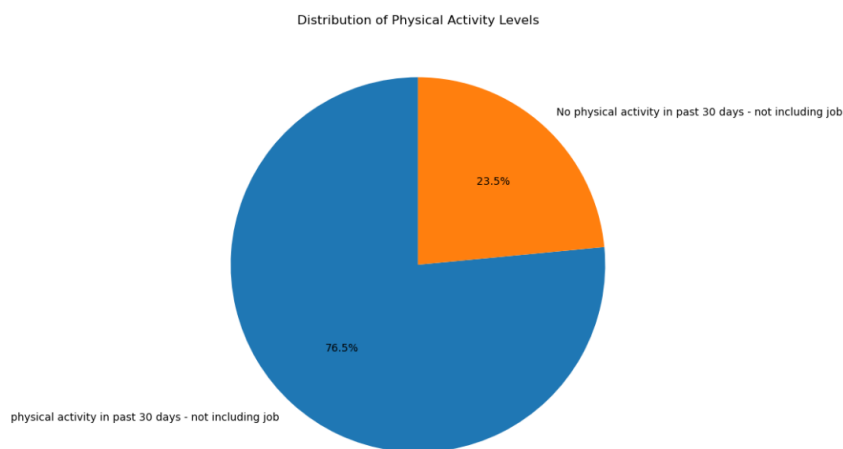
### Smokers Visualization & Summary:



In this dataset, smoking is also a discrete variable that takes the values of zero or one. To describe these values, one indicates someone is a smoker whereas zero indicates someone is not a smoker. This is another major variable to consider and summarize as it is scientifically known and proven that smoking increases one's chances of getting coronary diseases. "Chemicals in cigarette smoke cause the blood to thicken and form clots inside veins and arteries. Blockage from a clot can lead to a heart attack and sudden death." (SMOKING AND CARDIOVASCULAR DISEASE, 2014)

From the pie chart above, the participants that were visualized were a sample of females who do not have diabetes and it can be seen that about 60% of them are non-smokers and the remaining 40% of them are indeed smokers. Therefore, this shows that among this sample population, the trend is positive towards caring for their respiratory health and avoiding smoking.

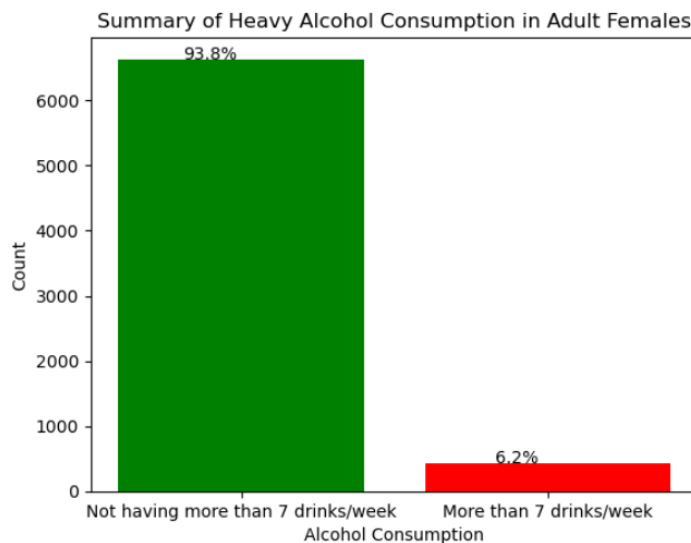
### **Physical Activity Visualization & Summary:**



In this dataset, physical activity is a discrete variable that takes the values of zero or one. To describe these values, one indicates that that person had indeed done physical activity in the past 30 days excluding their job whereas zero indicates that they did not do any sort of physical activity in the past month. This is another significant variable to consider and summarize as it is well-known that physical activity lowers one's chances of getting any coronary disease. "According to a review published in *Circulation*, people who engaged in 150 minutes of moderate-intensity leisure activity per week had a 14 percent lower risk of coronary heart disease than those who reported no exercise. The more you exercise, the lower your risk." (Krucik, 2017)

The pie chart above depicts the distribution of physical activity levels among women who do not have diabetes. According to this pie chart, 23.5% of women did not engage in any physical activity in the previous 30 days, excluding work. However, 76.5% of women had engaged in physical exercise in the previous 30 days, excluding work. Therefore, the majority of these females have put an initiative towards maintaining decent physical health by consistently working out to prevent themselves from contracting coronary disease as much as they can.

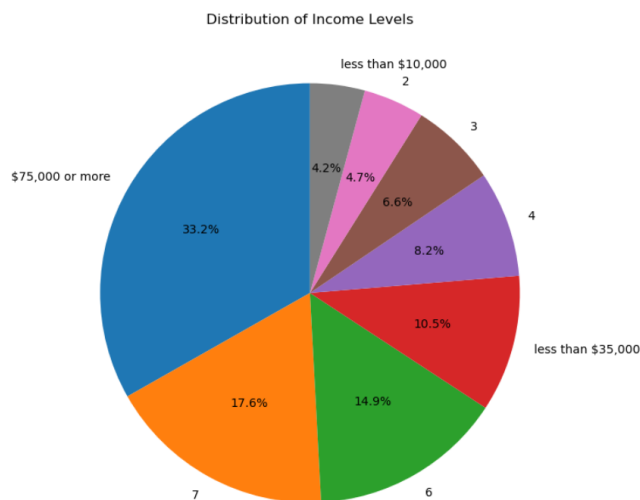
## Heavy Alcohol Consumption Visualization & Summary:



In this dataset, heavy alcohol consumption is another discrete variable that takes the values of zero or one. To describe these values, one indicates has more than 7 alcoholic drinks per week whereas zero indicates that does not do so. This is another significant variable to consider and summarize as it is scientifically known and proven that consuming alcohol heavily consistently can severely increase one's chances of getting coronary diseases. "Having more than 2 alcoholic drinks a day for women or more than 3 drinks a day for men may: Contribute to high blood pressure, which is a risk factor for coronary artery disease." (Rakesh, 2022)

The bar chart above depicts the distribution of heavy alcohol consumption among adult women who do not have diabetes where it can be seen that under 7% of them consume more than 7 drinks each week and about 94% of them avoid consuming alcohol to heavy extents. This is, therefore, consistent with the larger shift in society towards health-conscious choices and indicates that the vast majority of this particular group is aware of what needs to be done to avoid such negative health consequences.

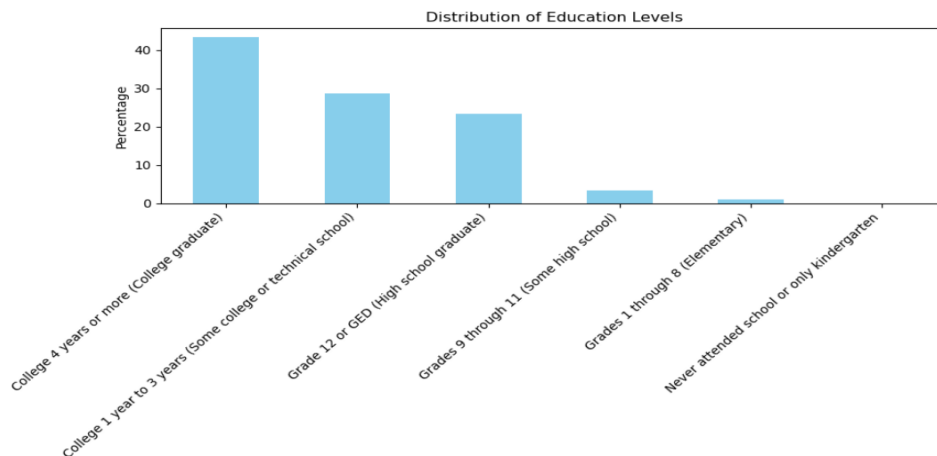
## Income Visualization & Summary:



In this dataset, income is once again a discrete variable that takes the values of either one, five, or eight. To describe these values, one indicates that that person makes less than \$10,000 annually, five indicates that that person makes between \$10,000 and \$35,000 per year, and eight indicates that that participant makes more than \$75,000 per year. This is an additional major variable to consider and summarize as income is also suggested and known to help one limit their chances of contracting a coronary disease as much as possible. “lower income was independently associated with higher odds of diabetes mellitus, hypertension, CAD, CHF, and stroke.” (Minhas, 2023)

The pie chart above represents the distribution of income levels among women who do not have diabetes. According to this pie chart, 4.2% of women earn less than \$10,000. 4.7%, 6.6%, and 8.2% of women earn between \$10,000 and \$35,000. However, 10.5% of women earn less than \$35,000 each year. 14.9% and 17.6% of women earn between \$35,000 and \$75,000, respectively. 33.2% of women earn more than \$75,000 per year.

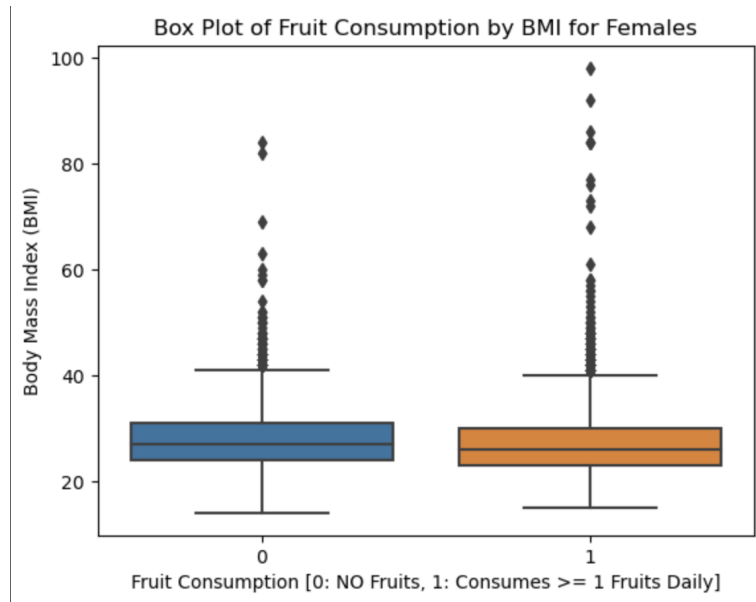
### **Education Visualization & Summary:**



In this dataset, education is a discrete variable that takes the values from one to six. To describe these values, one indicates that they either never attended school or only went to kindergarten, two indicates that up until only elementary school was attended, three indicates that up until only high school was attended but not finished, four indicates that they are a high school graduate, five indicates that up until only college was attended but not finished, and six indicates that they are indeed a college graduate. This is another significant variable to consider and summarize as it is well-known and suggested that being well-educated can help lower one’s chances of contracting coronary diseases. “Education is inversely associated with coronary heart disease (CHD).” (Epidemoil, 2012)

The count plot above shows the distribution of education levels among females who do not have diabetes. It shows that the majority of women have already graduated from college and the minority of women have not even attended school or only kindergarten. The academic dedication of those who reached as high of an education as possible truly lowers the possibility of them contracting a coronary disease to be as low as possible compared to those with less academic dedication.

## Identifying Relationships Between Attributes:



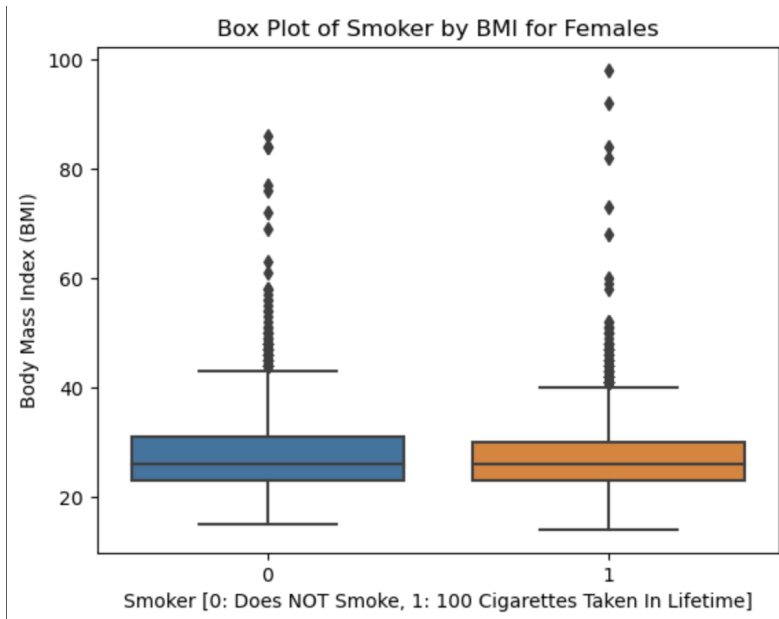
### Description & Analysis:

Scientifically speaking, eating fruits leads to lower BMI values as it is well known that fruit intake is inversely associated with obesity. Those who consume less amounts of fruits gain major weight compared to those who eat regularly. Because of their high vitamin, mineral, fiber, and antioxidant content, fruits are a vital part of a balanced diet. Including a range of fruits in a diet is well known to improve one's overall health and well-being where their weight is under control and their BMI value is as low as possible.

The box plot shown above shows that the participants who do not consume fruit have higher BMI values than those who consume fruits. Therefore, from this graph, the existing relationship between fruit consumption and BMI is that consuming fruits leads to lower BMI values, which indicates an inversely proportional relationship between these two variables. The more fruits that are consumed, the lower the BMI value is. This inverse relationship is further supported by the negative correlation coefficient between fruit consumption and BMI values calculated below. Additionally, this box plot matches the scientific expectation of the relationship between Fruit Consumption and BMI values.

```
fruit_bmi_correlation = df['Fruits'].corr(df['BMI'])
print(fruit_bmi_correlation)
-0.07913722692439368
```



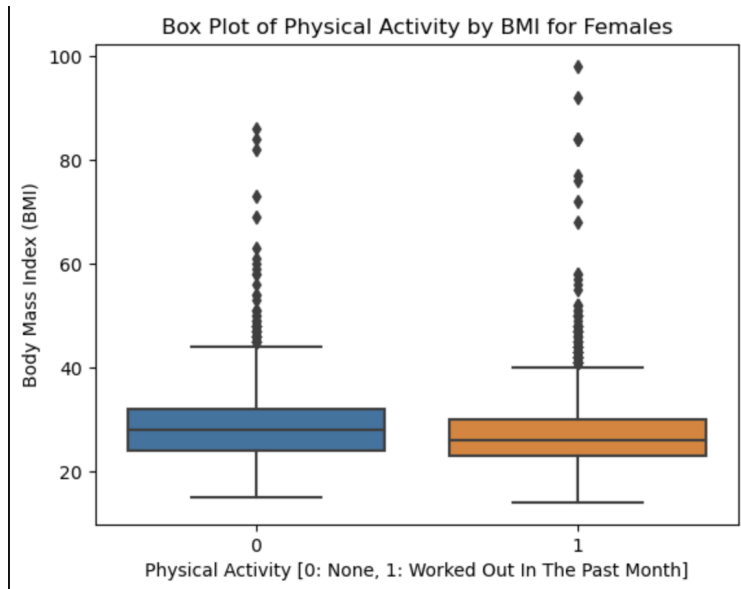


### **Description & Analysis:**

Scientifically speaking, females who smoke are expected to have lower BMI values than females who do not smoke. The main substance addictive in cigarettes, nicotine, is known to have metabolic effects that can lead to weight loss by increasing the metabolic rate and reducing feelings of hunger and therefore lowering one's BMI values. “On average, current smokers have lower BMIs than never smokers” (Piirtola, 2018)

The box plot shown above shows that the participants who do smoke have slightly lower BMI values than those who do not smoke. Therefore, from this graph, it can be stated that the existing relationship between smoking and BMI is that smoking leads to lower BMI values, which indicates an inversely proportional relationship between these two variables. The more that is smoked, the lower the BMI value is. This inverse relationship is further supported by the negative correlation coefficient between smoking and BMI values calculated below. Additionally, this box plot matches the scientific expectation of the relationship between Smoking and BMI values for females which is that the smokers have lower BMI values than those who have never smoked.

```
smoker_bmi_correlation = df['Smoker'].corr(df['BMI'])
print(smoker_bmi_correlation)
-0.005699920745745986
```

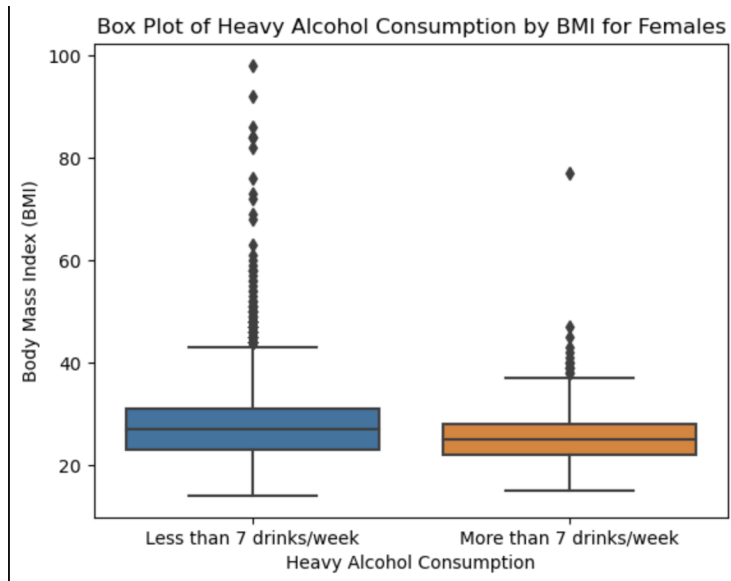


### **Description & Analysis:**

Scientifically speaking, doing physical activity consistently leads to having lower BMI values. This is achieved as the physical activity leads to lighter fat mass and greater lean muscle mass, both of which contribute to eventually having lower BMI values.

The box plot shown above shows that the participants who do not do any physical activity have greater BMI values than those who actually do physical activity. Therefore, from this graph, it can be stated that the existing relationship between physical activity and BMI is that physical activity leads to lower BMI values, which indicates an inversely proportional relationship between these two variables. The more physical activity that is done, the lower the BMI value is. This inverse relationship is further supported by the negative correlation coefficient between Physical Activity and BMI values calculated below. Additionally, this box plot matches the scientific expectation of the relationship between Physical Activity and BMI values.

```
physical_activity_bmi_correlation = df['PhysActivity'].corr(df['BMI'])
print(physical_activity_bmi_correlation)
-0.1509638442335407
```

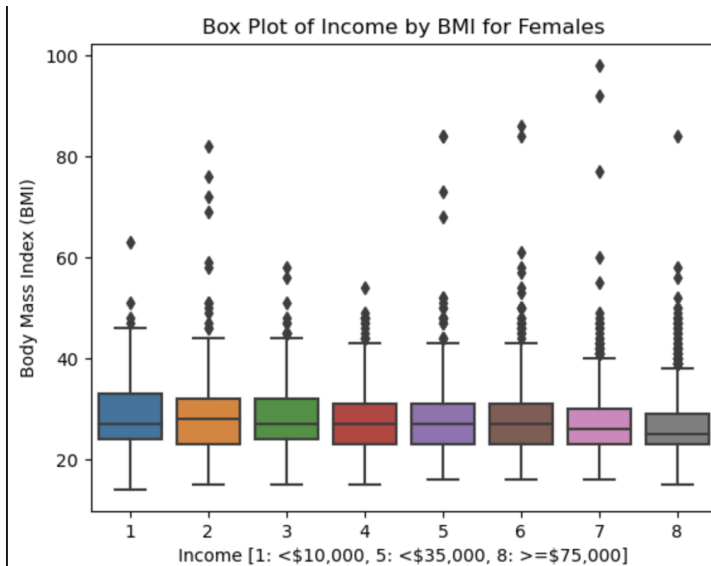


### **Description & Analysis:**

Scientifically speaking, consuming alcohol on an intense level is positively correlated with BMI values. Alcohol's side effects that lead to higher BMI values are that it can stop one's body from burning fats and it can increase one's feelings of hunger, specifically, it can lead to serious cravings for salty and greasy foods.

The box plot shown above shows that the participants who consume alcohol to a heavy extent have greater BMI values than those who do not drink alcohol. Therefore, from this graph, it can be stated that the existing relationship between Heavy Alcohol Consumption and BMI is that Heavy Alcohol Consumption leads to lower BMI values, which indicates an inversely proportional relationship between these two variables. The more the alcohol is drunk, the lower the BMI value is. This inverse relationship is further supported by the negative correlation coefficient between Heavy Alcohol Consumption and BMI values calculated below. So, the box plot above goes against the scientific expectation of how it was going to turn since it shows those who do not consume alcohol heavily are the ones with higher BMI values.

```
alcohol_bmi_correlation = df['HvyAlcoholConsump'].corr(df['BMI'])
print(alcohol_bmi_correlation)
-0.06925686848316162
```

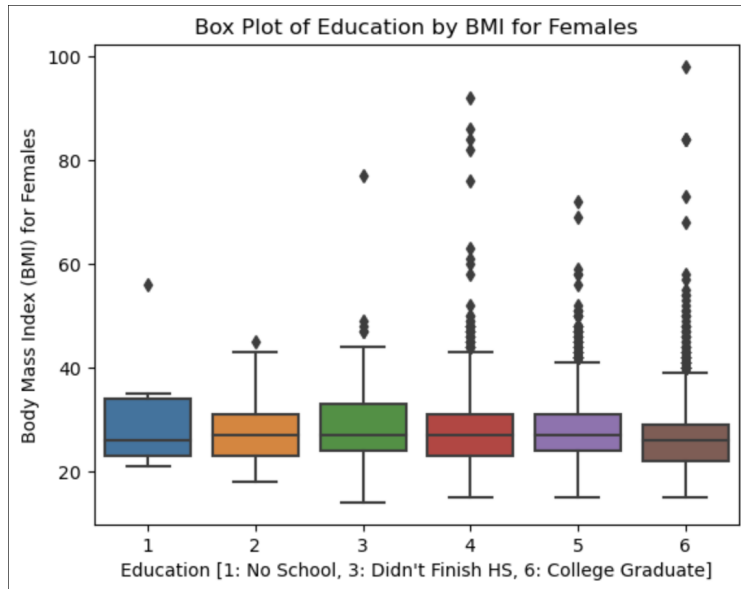


### Description & Analysis:

From a financial capability standpoint, those with larger incomes are expected to have lower BMI values than those who do not make as much money. This is mainly because those who make more money have the luxury of buying more healthy foods and taking care of their bodies better than those who do not make as much money where it would be expected that a more wealthy person has a lower BMI value than someone with a lower income.

The box plot shown above shows that the participants who have higher incomes have lower BMI values than those with lower incomes. Therefore, from this graph, it can be stated that the existing relationship between Income and BMI is that Income leads to lower BMI values, which indicates an existing inversely proportional relationship between these two variables. The greater the income, the lower the BMI value is. This inverse relationship is further supported by the negative correlation coefficient between Income and BMI values calculated below. Additionally, this box plot matches the economic expectation of the relationship between Income and BMI values.

```
income_bmi_correlation = df['Income'].corr(df['BMI'])
print(income_bmi_correlation)
-0.11848490057704697
```



### Description & Analysis:

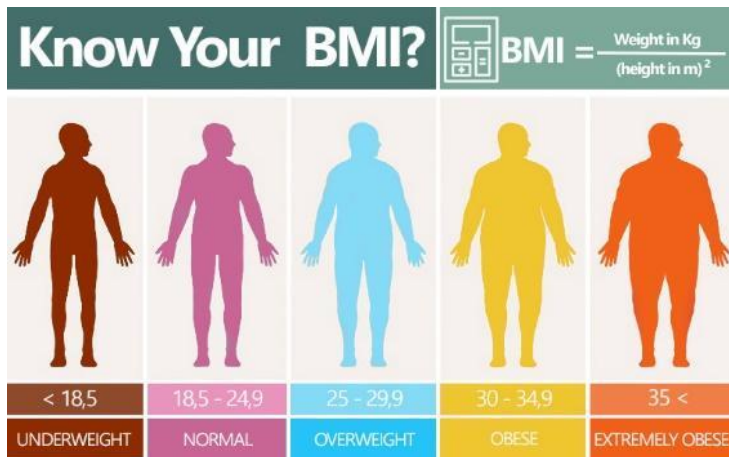
From an academic success and knowledgeable standpoint, it is heavily suggested that more educated people tend to have lower BMI values than those who are less educated or uneducated at all. This is mainly because educated people should learn how to take care of their bodies and know what unhealthy foods, habits, and substances to avoid. On the other hand, someone with lesser levels of education is less likely to know this same stuff as someone who is educated, making themselves more susceptible to getting into habits that hurt their body, and therefore would be expected to have a higher BMI value than a more well-educated person.

The box plot above shows that the participants who have higher levels of education have lower BMI values than those with lower education levels. Therefore, from this graph, it can be stated that the existing relationship between Education and BMI is that Education leads to lower BMI values, which indicates an existing inversely proportional relationship between these two variables. The higher the education level, the lower the BMI value is. This inverse relationship is further supported by the negative correlation coefficient between Education and BMI values calculated below. Additionally, this box plot matches the economic expectation that the ones who have reached higher levels of education are also the ones with lesser BMI values.

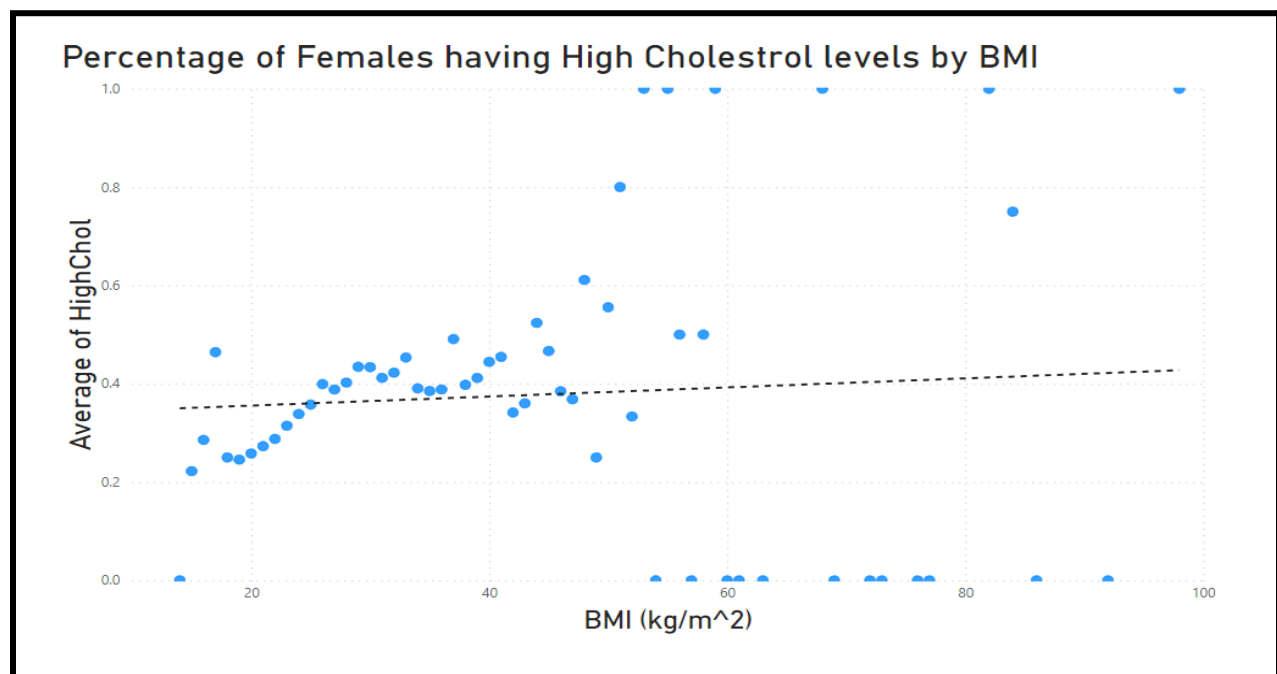
```
education_bmi_correlation = df['Education'].corr(df['BMI'])
print(education_bmi_correlation)
-0.10410764237989067
```

## Identifying More Sophisticated Relationships:

### BMI vs High Cholesterol Levels:



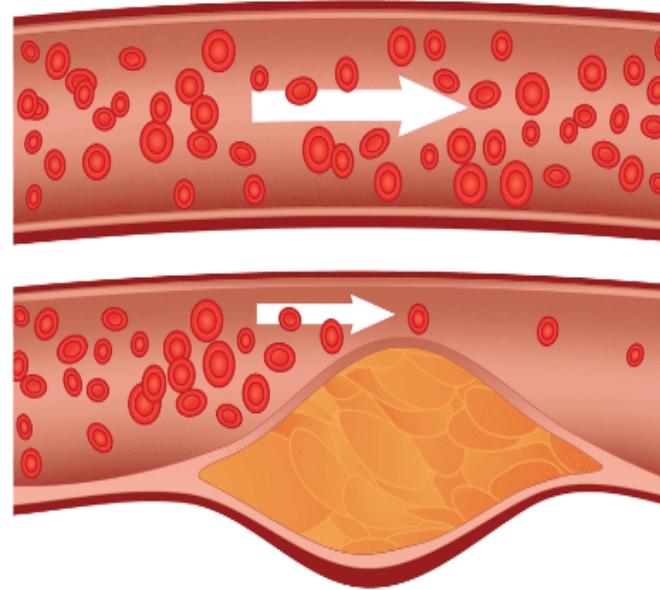
Usually, scientists have approximate cutoffs for Body Mass Indices (BMIs) that help identify the weight classification of a person. A person's BMI and weight have a positive relationship meaning that as one increases, the other also surges. Being in the overweight or obese range alters the body's process of producing and managing lipoproteins such as: cholesterol and triglycerides (Cooper, 2023). People lying in the overweight and obese range have a higher chance that their bodies will produce excess amounts of triglycerides and cholesterol. This occurs because having increased fat tissue "means higher amounts of free fatty acids are delivered to your liver" enabling the liver to transform these free fatty acids to more cholesterol and triglycerides (Cooper, 2023).



Since research utilized empirical data to draw connections between high BMI and high cholesterol levels (hypercholesterolemia), it is more likely that plotting BMI vs Chance of having High Cholesterol Levels for each BMI value in the dataset would yield a strong positive relationship between these two attributes. First, we had to derive the chance of getting diagnosed with hypercholesterolemia since we only had binary values either indicating certainty or impossibility of a hypercholesterolemia case for each female. This derivation processes included finding the average hypercholesterolemia cases for each BMI value from 12 to 98 (minimum and maximum values of BMI in the data) to represent the probability of a female having high cholesterol levels based on her BMI. Since this derivation turned the HighChol attribute to a continuous quantitative variable, it enabled us to produce a scatter plot with the data points corresponding to coordinates (BMI value, Chance of diagnosis with hypercholesterolemia). Despite confirming our estimation of a positive relationship between BMI and high cholesterol levels, the trend line's doesn't convey the expected strength of the relationship.

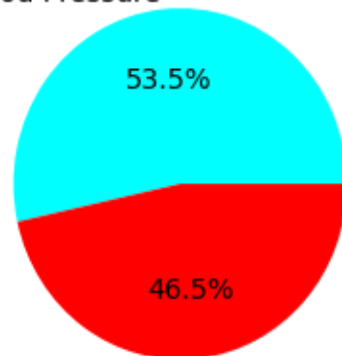
### High Cholesterol Levels vs High Blood Pressure:

Basically, high cholesterol (hypercholesterolemia) is a condition that occurs due to the presence of excess lipids in a person's blood (Cleveland Clinic, 2022). Even though lipids are a crucial element in moving and storing energy, absorbing vitamins and making hormones, extra lipids make the body unable to process them (Ahmed, 2023). Therefore, they start building up within a person's arteries and combining with other compounds in a person's blood, thus forming plaque in a process called Atherosclerosis (Mayo Foundation for Medical Education and Research, 2022). Therefore, the presence of plaque causes the arteries to stiffen and become narrow. Consequently, the heart has to exert more effort to pump blood through the clogged arteries. Since, our arteries cannot withstand constant high-pressure blood flow, they start to weaken, gradually tear (Story, 2020). Surprisingly, the process doesn't stop there, but the little tears in the artery provide more space for plaque to build up, thus narrowing arteries more and causing a bigger obstacle for smooth and normally-paced blood flow.



### Percentage of Females with high cholesterol having high blood pressure

High Cholesterol & Blood Pressure

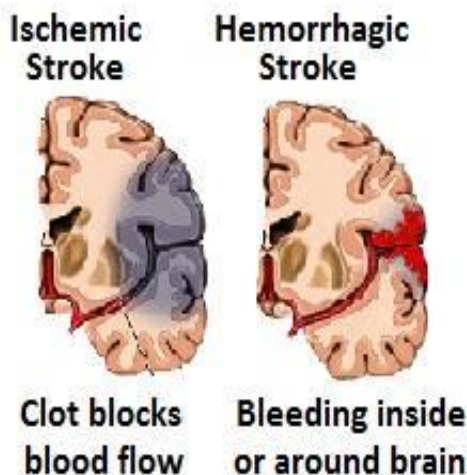


High Cholesterol Only

Based on the information above, we expected that there is a strong positive relationship between the presence of high cholesterol levels in females and the chances of being diagnosed with high blood pressure. So, we filtered out the total number of females who had high cholesterol levels. Then, we calculated the percentage of these females who also had high blood pressure (hypertension). The pie chart above highlights that 53.5% of females suffering from high cholesterol levels were also diagnosed with having high blood pressure, while only 46.5% of the females having high cholesterol and didn't have hypertension. Even though the percentage doesn't convey the expected strong positive relationship, it portrayed a weaker positive relationship that also shed light on our initial claim that having high cholesterol levels heightens the probability of suffering from high blood pressure. Since the chance of having high cholesterol levels increased with BMI that exceeded the healthy range, and the likelihood of hypertension disease surges with cholesterol levels, then an unhealthy lifestyle amplifies the probability of coronary artery diseases such as hypertension.



## Cholesterol vs Stroke & High Blood Pressure vs Stroke:



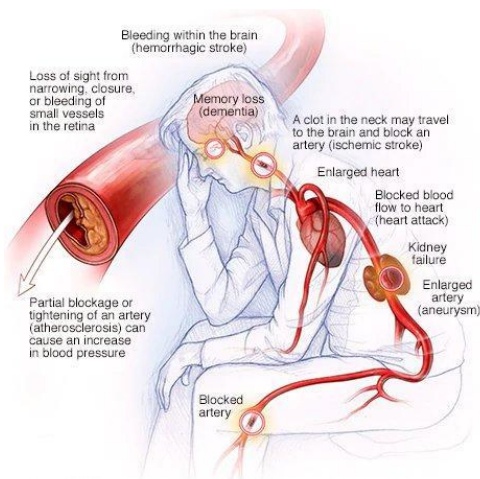
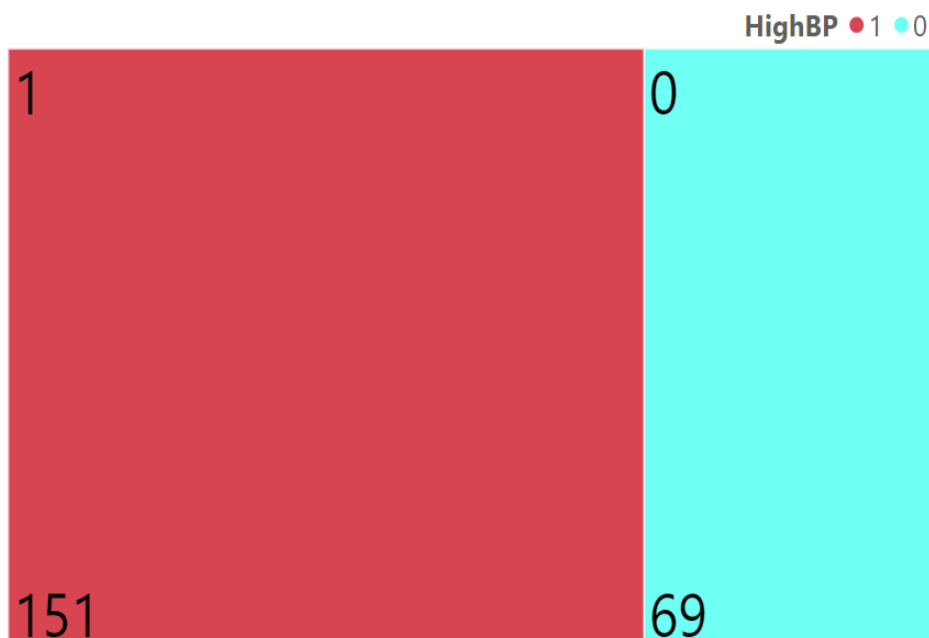
According to research, we expected that there is a strong positive relationship between the presence of high blood pressure in females and the chances of being diagnosed with a stroke. So, we filtered out the total number of females who had strokes. After calculating the ratio of these females who also had hypertension (along with a stroke), it turns out that for every 1 female without high blood pressure, there are approx. 2.2 females suffering from hypertension. Since the ratio was over double, it is evident that having high blood pressure is a major factor that surges females' proneness to suffer from a stroke in the future.

Moving on, high cholesterol levels heighten the chance of occurrence of another type of coronary disease: Ischemic stroke (which represents approximately 87% of all strokes (Laguipo, 2023.)). This stroke occurs when the accumulation of fatty deposits prevents blood flow to the brain through an artery. Since blood is the transporter of oxygen to the body, the obstruction of blood flow to the brain is lethal to the extent that the brain starts to shut down gradually, thus making the person unable to carry out basic activities such as taking, walking and breathing.

In addition, there is another type of stroke that occurs less frequently: Hemorrhagic stroke. Not only is high blood pressure an effect of high cholesterol levels, but it also increases the possibility that a more critical coronary disease such as the Hemorrhagic stroke. As opposed to the prevention of blood flow in Ischemic strokes, this type of stroke occurs due to the rupture of an artery in the brain because its wall wasn't strong enough to enable blood flow, as it was weakened by the high blood pressure.

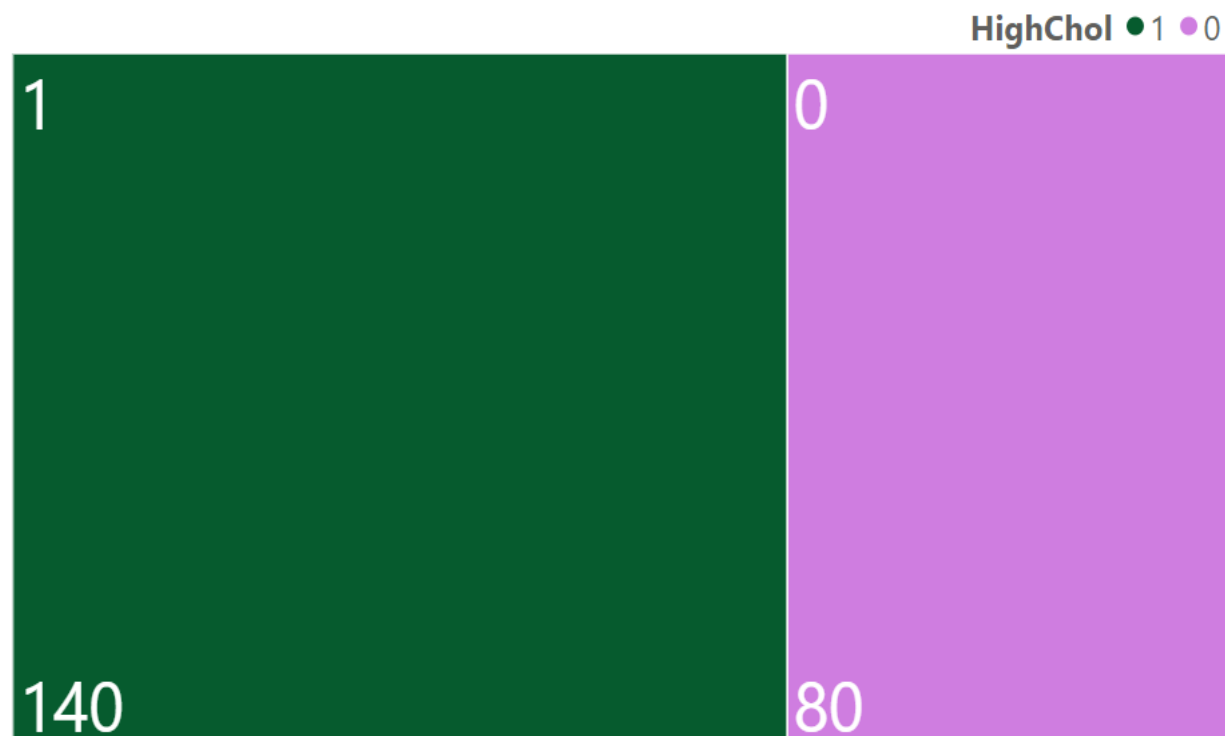
To highlight the seriousness of the matter, statistics highlight that more than 795000 Americans have a stroke every year (Centers for Disease Control and Prevention, 2023).

## Sum of Stroke by HighBP

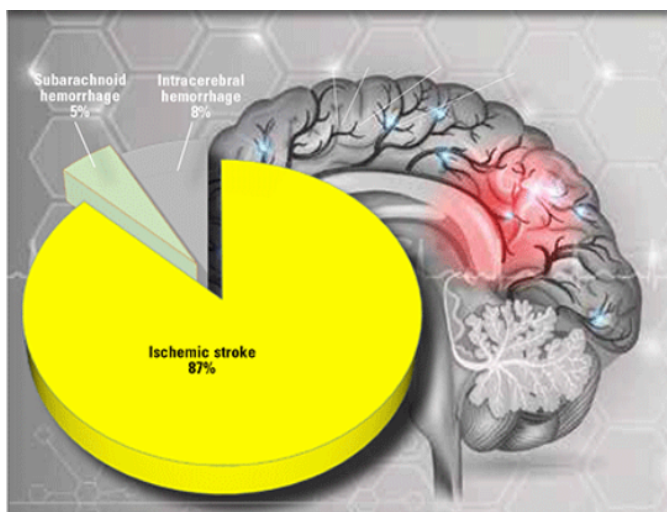




## Sum of Stroke by HighChol



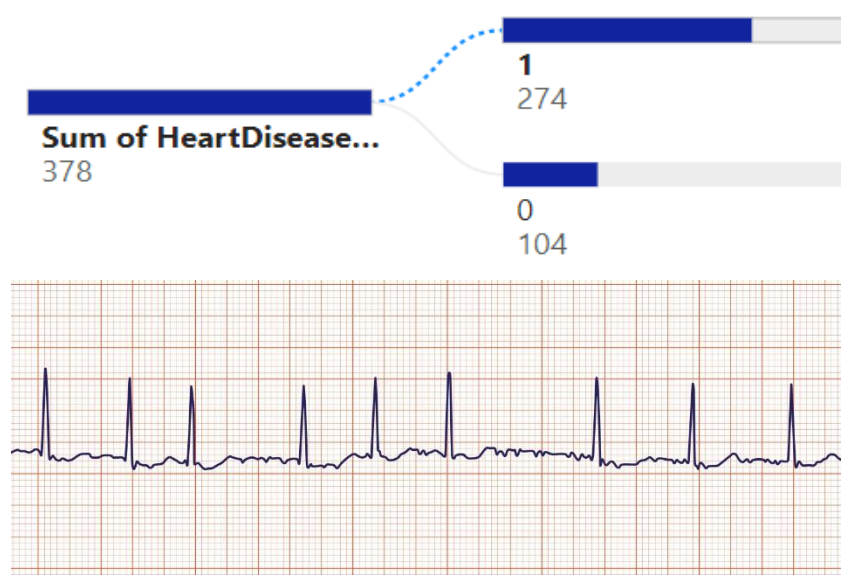
As for high cholesterol's effect on strokes, we expected that there is a strong positive relationship between the presence of high cholesterol in females and the chances of being diagnosed with a stroke because of scientists' claims that high cholesterol levels cause Ischemic strokes. So, we filtered out the total number of females who had strokes. After calculating the ratio of these females who also had high cholesterol (along with a stroke), it turns out that for every 1 female without high cholesterol levels, there are 1.75 females suffering from high cholesterol levels. Since the ratio was close to double, it is evident that having high cholesterol levels is a strong factor that surges females' proneness to suffer from a stroke in the future.



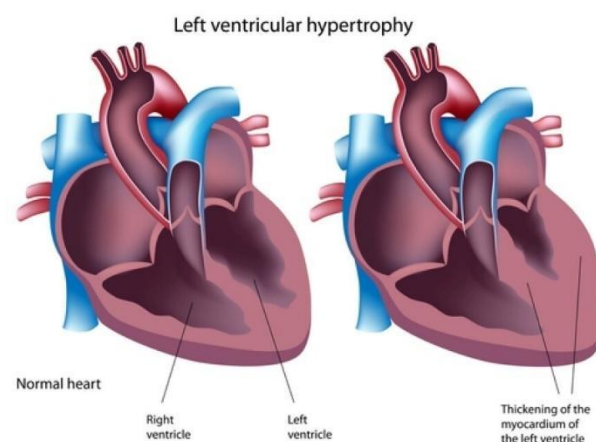
Even though the data confirms our findings in the scientific research about the major effects of hypercholesterolemia and hypertension on the chances of suffering from a stroke, there is one thing that contradicted with our findings. The ratio in the second tree map (stroke-diagnosed and normal to low cholesterol level females vs stroke and hypercholesterolemia-diagnosed females) is lower than the ratio in the first tree map (stroke-diagnosed and normal to low blood pressure level females vs stroke and hypertension-diagnosed females). This portrays that high blood pressure as a more influential factor in the increased risk of stroke, while in fact, high cholesterol level causes both hypertension and stroke so, it should have had a greater ratio.

## High Blood Pressure vs Heart Diseases/Attacks: Sum of Heart Diseases/Attack by HighBP

HighBP



From this decomposition tree, it is evident that out of the 378 cases of female heart disease/attack, 274 of them had hypertension. Therefore, it can be inferred from our data that a female heart disease/attack patient is more than approximately 3 times more likely to have had high blood pressure beforehand. Therefore, this decomposition tree highlights the strength of the positive relationship between a female being diagnosed with high blood pressure and having heart disease/attack.



According to a study made by the American Heart Association on the relationship between hypertension and heart diseases/attacks, hypertension is a main factor that increases the risk of heart diseases. In this research paper, Professors Flávio D. Fuchs and Paul K. Whelton addressed that “the attributable risk for BP equal or  $>115/75$  mm Hg was estimated to be 49% for CHD” (Coronary Heart Disease) (Fuchs and Whelton, 2019). In addition, the Blood Pressure UK Organization also emphasized the fact that high blood pressure puts an extra strain on blood vessels and the heart, which can not only damage blood vessels, but will also limit the blood flow back to the heart and from the heart to the rest of the body. Concerning the blood flow from the heart to the body to distribute oxygen, the heart could try to overcome the problem of high blood pressure by making the left ventricle work harder to pump blood. This extra effort enlarges the left ventricle (Left Ventricular Hypertrophy) and temporarily rescues the body. But as time passes, the left ventricle becomes so big and stiff to the extent that it can no longer efficiently pump blood to the body. Furthermore, high blood pressure can cause a coronary disease called Atrial Fibrillation where there is an irregular heartbeat (too fast or with an irregular rhythm) that often leads to strokes or blood clots in the future (The Blood Pressure UK Organization, 2021).

Due to the accumulation of one or more of these heart diseases over time, the heart finally collapses and stops pumping blood, causing a heart attack. Therefore, scientific research supports the decomposition tree figure in the sense that it shows how hypertension can heighten the chances of heart disease/attack in several different ways.

## **Conclusion:**

After conducting and summarizing the thorough research above, it can be concluded that maintaining a lifestyle that reduces a female's risk of coronary heart disease requires a multidimensional strategy. The daily consumption of fruits, which supply vital vitamins and minerals that are vital for one's heart health, is critical for this. At the same time, it is critical to avoid being a smoker and consuming alcohol heavily, as these particular behaviors are directly associated with cardiovascular problems. It is also important to consistently pursue physical activities as their consistent pursuit heavily strengthens the cardiovascular system and also improves one's general all-around health. Additionally, both being well-educated and having a reliable source of income are extremely important as they are also linked to staying in decent physical shape as they are well clear of being in danger concerning financial instability. Ultimately, women can actively protect their cardiovascular health and limit their chances of contracting coronary diseases as much as possible by genuinely implementing these beneficial habits into their regular lifestyle.

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