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The Association Between Increasing Age Among Males/Females & The Causes of Coronary Heart Disease: Cholesterol, Blood Pressure, & BMI

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Abstract

Background: Cardiovascular diseases (CVDs) are the leading global cause of mortality, with coronary heart disease (CHD) being a major contributor. CHD results from atherosclerosis, the buildup of fatty plaques in blood vessels. Modifiable risk factors include hypertension, high cholesterol, obesity, and inactivity, while non-modifiable factors like age, sex, and ethnicity also influence CHD risk. **Method:** This prospective cohort study, utilizing data from the Framingham Heart Study, investigates the impact of age, gender, BMI, and cholesterol levels on CHD risk. It also explores disparities by gender and race. The dataset includes 699 participants without prior CVD symptoms. Statistical methods such as linear regression, t-tests, and survival analysis were used. **Results:** Men showed a higher risk of developing CHD than women. Women generally had higher body fat percentages and were more consistent with medical follow-ups. Rising cholesterol levels increased CHD risk and correlated with higher BMI categories. **Discussion:** The findings emphasize the importance of early detection and prevention, particularly in older males. While women have a lower overall CHD risk, increasing cholesterol and pulse pressure with age pose significant risks. Managing cholesterol is critical to reducing CHD risk, particularly in women with higher mean cholesterol levels linked to body fat. Strengths of the study include its comprehensive variable assessment and longitudinal design, though its generalizability is limited due to the single-city setting.

Keywords: Health, education, attitude, perception, challenge

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Introduction

Coronary heart disease (CHD) is a leading cause of mortality worldwide (National Library of Medicine, 2023). Globally, the rise of CHD represents a growing public health concern, with an estimated prevalence of 250 million people and approximately nine million deaths each year (British Heart Foundation, 2023). Various modifiable and non-modifiable factors contribute to CHD risk, including age, sex, BMI, and blood pressure (U.S. National Library of Medicine, 2023). CHD results from the narrowing of the coronary arteries due to plaque buildup, which makes blood flow to the heart hard (National Heart, Lung, and Blood Institute, 2023).

A key risk factor for CHD is elevated low-density lipoprotein (LDL) cholesterol. Numerous studies show that high cholesterol levels significantly increase the likelihood of developing CHD (Peters et al., 2016). Hypercholesterolemia, or high cholesterol, makes arterial narrowing and can lead to severe cardiovascular complications such as CHD. Familial hypercholesterolemia, a genetic condition, further elevates an individual's risk of developing CHD (News-Medical, 2019).

Gender differences also play a significant role in CHD risk. Men are at a higher risk for CHD compared to women (Jousilahti et al., 1999). This difference is attributed in part to the protective effects of estrogen in women, which helps maintain arterial health (British Heart Foundation, 2023). Despite this, men continue to have a higher incidence of CHD, while women may have increased stroke risk with age. In the U.S., stroke mortality is notably higher among women, especially as they age (Siasos et al., 2016).

Differences in CHD risk also exist across racial and ethnic groups. For instance, in the U.S., around 60% of Black adults have hypertension, a significant risk factor for CHD. Black adults, particularly Black women, are more likely to experience complications like hypertension during pregnancy, and they face a higher risk of fatal outcomes from heart attacks compared to white adults (Cleveland Clinic, 2022).

Cardiovascular diseases (CVDs), including CHD, are a significant global health burden, responsible for more than 20 million deaths annually (Di Cesare et al., 2024). Public health efforts aim to mitigate these risks through education and awareness campaigns, yet the prevalence of CVD continues to rise. Therefore, engaging health educators is essential for promoting risk factor awareness, disease management, and encouraging healthier behaviors

This study aims to explore the association between CHD and various risk factors such as age, sex, cholesterol, BMI, and blood pressure. It will investigate how these factors contribute to CHD risk in both males and females as they age, and how modifiable factors, particularly cholesterol levels and BMI, influence the development of CHD.

Methods

Data Source

The Framingham study is a cohort study that began in 1948 and aimed to identify the key factors that contribute to cardiovascular disease and its associated complications. It is a longitudinal design and includes over 14,000 participants spanning three generations, all aged between 30 and 62 years. The study involves conducting thorough physical exams and interviews to identify common patterns related to the development of CVD. The dataset used in this study is a random sample of 699 subjects who were initially free of CVD.

Study Population and Variables

The study is located in Framingham, Massachusetts, U.S., and enlists participants with no history of heart attack or stroke to identify common elements related to cardiovascular disease. The subset data comprises 11 variables measured for 699 randomly selected people from the main study,

including ID, age, sex, BMI, BP (Systolic and diastolic blood pressure), pulse pressure, serum cholesterol, month of baseline exam, subject's follow-up, days since baseline, and CHD event at the end of follow-up.

Age and sex variables.

Among 699 participants, 312 were male while 387 were female, and they all had an age range of 31 to 66 years old, with a mean age of 46 for both genders. None of the participants had experienced at baseline any signs or symptoms of cardiovascular disease, heart attack, or stroke.

Primary outcome & Other outcomes

Our study's main outcome and focus will be on the incidence of Coronary Heart Disease (CHD)

Statistical Analysis

This data is descriptive epidemiology from the Framingham Heart Data. This paper focuses on the variable cholesterol and levels of increase and decrease and the outcome of interest, coronary health disease. A subset of 699 was taken from the original data, participants who had not yet developed symptoms of CVD or suffered neither stroke nor heart attack. The repeated-measure design was conducted to measure all levels of cholesterol, pp, and blood pressure. We have conducted different tests to see the correlation between variables and the outcome of CHD. Linear regression, t-test, and two-way scatter were performed during the analysis. We performed a linear regression to see the correlation between the increase in age and the chance of increasing cholesterol. We also ran multiple models to see the mean and median among all variables in order to understand the increase in these variables if age increases. We also generated multiple variables for BMI to see the correlation between each group of BMI. Moreover, we succeeded in testing the differences in mean pulse pressure and cholesterol between men and women. We also generated the amount of follow-up time and the difference between the shortest and the longest follow-up by generating a new variable called "Years.". A comparison between the mean of many variables among females and males was conducted to facilitate answering our research question and the chance of having CHD among males and females. Finally, we conducted a test to see as participants aged, does CHD increase, and how many had the outcome of interest. The outcome, we believe, is having more likelihood of developing Coronary Heart Disease (CHD) between men and women. The significance level for all analyses was set at 0.05. All statistical analyses were performed using Stata/BE 17.0.

Result

Cholesterol and Pulse Pressure by Age, Sex, and BMI

The data revealed that females tend to have higher levels of cholesterol and pulse pressure (PP) than males as they age. However, the overall means for age, cholesterol, and PP between males and females (Table 1) showed no significant differences across the entire dataset. Females in higher BMI categories had significantly higher cholesterol and PP levels than males (Table 2). For instance, in the obese category, females had a mean cholesterol level of 242.65 mg/dL compared to 222.42 mg/dL for males, highlighting a substantial difference. Additionally, as age increased, cholesterol and PP also increased for both sexes, with a significant positive correlation between cholesterol and PP (Tables 2 and 3).

Table 1: Descriptive Statistics and Mean Values by Sex

Variable	N (Total)	Overall Mean	Men (Mean)	Women (Mean)
PP	699	50.25	48.97	51.29
Age	699	46.4	46.52	46.3
Cholesterol	699	230.11	229.46	230.63

Key PP-Pulse Pressure

Table 2: BMI-Stratified Data on Age, Cholesterol, and Pulse Pressure

BMI Category	Mean Age	Mean Cholesterol (Men)	Mean Cholesterol (Women)	Mean Pulse Pressure
Normal Weight N=325	45.07	224.79	224.15	48.27

Overweight N=278	47.05	234.39	235.55	50.73
Obese N=96	48.97	222.42	242.65	55.59

Table 3: Blood Pressure and Cholesterol by BMI and Sex

BMI Category	Sex	Mean SBP	Mean DBP	Mean Cholesterol
Normal Weight	Men N=119	127.6	80.29	224.79
Normal Weight	Women N=206	127.29	78.46	224.15
Overweight	Men N=160	136.75	86.77	234.39
Overweight	Women N=118	134.9	83.14	235.55
Obese	Men N=33	139.94	89.82	222.42
Obese	Women N=63	146.95	88.49	242.65

Table 4: Logistic Regression Results for CHD Risk

Variable	Odds Ratio	Std. Error	P-Value	95 Lo
Age	1.035	0.01	0.001	1.(
Sex	0.586	0.096	0.001	0..
Constant	0.127	0.059	0.001	0.(

Cholesterol and BMI Trends

As BMI increased, cholesterol levels also rose across all participants (Table 2). However, females exhibited consistently higher cholesterol levels than males in both overweight and obese categories. While males in the normal weight category had a slightly higher mean cholesterol (224.79 mg/dL) compared to the overall normal weight mean, their cholesterol levels decreased in the obese category. In contrast, females in the obese category showed the highest mean cholesterol levels. These trends underscore the critical role of BMI in influencing cholesterol levels, particularly for females.

Blood Pressure by BMI and Sex

Mean systolic blood pressure (SBP) and diastolic blood pressure (DBP) increased with BMI for both sexes (Table 3). Notably, obese females exhibited a higher mean SBP (146.95 mmHg) than obese males (139.94 mmHg), which may be attributed to the larger sample size of obese females. Men generally had higher DBP values across BMI categories, though the gap narrowed in the obese group.

Risk of CHD by Age and Sex

The logistic regression analysis (Table 4) revealed that females had a 58% lower risk of developing CHD compared to males ($p = 0.001$), with an odds ratio of 0.586. Additionally, the odds of developing CHD increased by 3.5% with each additional year of age ($p < 0.001$). This finding aligns with the overall observation that age and BMI significantly influence cholesterol and cardiovascular risk factors (Tables 2 and 3).

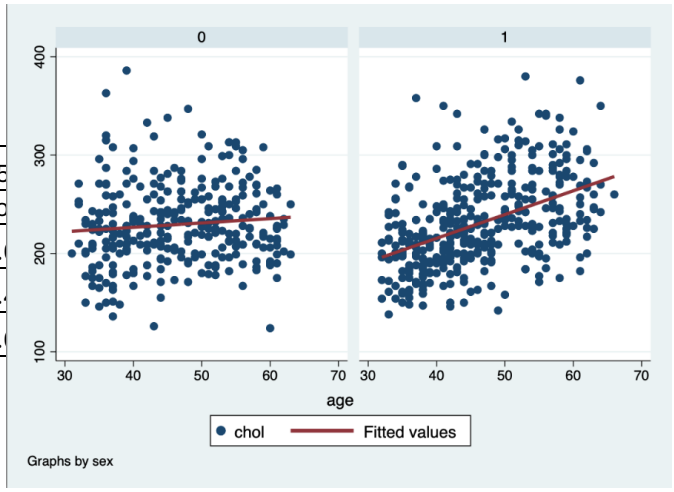

Figure 1: Mean Cholesterol Levels by Sex

The results highlight key disparities in cardiovascular risk factors. While females generally have lower CHD risk, their higher cholesterol and PP levels in certain BMI categories may elevate their risk over time. Managing BMI and cholesterol is crucial, especially in females with higher body fat percentages.

Figure 2: Mean Pulse Pressure by Sex

Additionally, age remains a significant predictor of CHD risk, emphasizing the importance of early prevention strategies for both sexes. These findings underscore the need for targeted interventions based on sex and BMI to mitigate cardiovascular risk effectively.

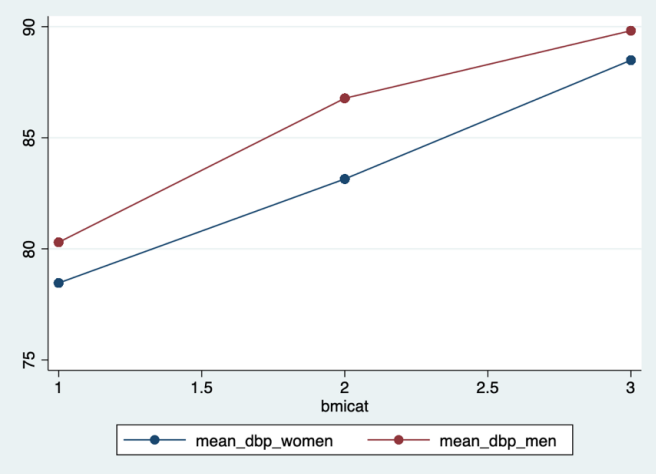

Figure 3: Mean Systolic Blood Pressure (SBP) by Sex

Discussion

In this population-based study, we observed that females have more than 50% lower risk of developing the outcome of interest CHD. Two of the key indicators of Coronary heart disease health are cholesterol levels and pulse pressure. Our findings showed that as females age, their cholesterol and pulse pressure tend to increase, which can lead to an increased risk of coronary heart disease.

Furthermore, there is a correlation between pulse pressure and cholesterol levels. Our findings have found that as cholesterol levels increase, so does pulse pressure. This correlation is believed to be due to the fact that high levels of cholesterol can cause stiffening of the arterial walls, which can increase pulse pressure. Our study has revealed a significant association between age and cholesterol levels in our sample population. Specifically, our findings showed that for every one-year increase in age, there was an average increase of 1.39 mg/dL in cholesterol levels. This result underscores the importance of monitoring cholesterol levels in individuals as they age and taking appropriate measures to manage elevated levels in order to reduce the risk of Coronary heart disease.

Our study has identified a significant gender difference in the association between BMI category and cholesterol levels. Specifically, our findings showed that among individuals classified as obese or overweight based on BMI, females had higher mean cholesterol levels than males. This result highlights the importance of considering both gender and BMI when assessing Coronary heart disease risk factors such as cholesterol levels. It also suggests that targeted interventions aimed at managing cholesterol levels may need to take into account gender-specific differences in BMI and associated health outcomes. It is not uncommon for there to be a higher proportion of females than males in certain BMI categories, such as overweight and obese. This perhaps is because females tend to have a higher percentage of body fat than males, which can result in a higher BMI despite having a similar body weight.

It is possible for the number of obese participants to not be equal between males and females in our study. This could be due to differences in the prevalence of obesity between males and females in the population being studied, differences in recruitment methods for males and females, or differences in willingness to participate in the study. Our study has revealed a significant gender difference in blood pressure levels, with males having higher blood pressure than females in our sample population.

This result highlights the importance of considering both gender and blood pressure when assessing Coronary Heart disease risk factors. Our study has observed a gender difference in the follow-up rates, with females tending to follow up more frequently than males in our sample population.

According to our findings, while age may not be the direct cause of Coronary heart disease, it can significantly impact the disease's development. In fact, our findings suggest that age can play a crucial role in the onset and progression of coronary heart disease. We came across a table during our investigation which clearly shows that as a person's age increases, the occurrence of coronary heart disease (CHD) does not necessarily increase in proportion. This implies that while age may not be the sole factor contributing to the development of CHD, it is certainly a contributing factor. The relationship between age and CHD is complex and may involve other factors that work in conjunction with age to increase the risk of developing this disease.

Limitations

This research has some limitations related to the data. Firstly, there were varying numbers of subjects in the BMI categories across different groups, which could introduce a bias to our result, as we observed in the BMI tables. It is important to note that there may be a potential bias as males in both normal and obese BMI categories had higher incidence rates than females. This could potentially lead to different and statistically significant results regarding the correlation between BMI and either the outcome or level of cholesterol. Secondly, if a study sample is not representative of the larger population of interest, then the findings may not be applicable to other situations or populations beyond the study.

The ability to generalize epidemiological data depends on how well the study sample represents the larger population of interest. In this case, since the study was conducted only in one city, the generalizability of the findings may be limited. The characteristics of one city's population may differ significantly from another city or region, meaning that the results of a study in one city may not be relevant to other populations in different cities and countries.

Implications for Future Research

The implications for future research based on the findings of this study are multifaceted. Firstly, given that our results indicate that males are more prone to developing CHD than females, further research could investigate whether other factors, such as genetic, lifestyle, or environmental factors, may play a more significant role in the development or progression of the outcomes. Additionally, our study suggests that age may not have a significant impact on the occurrence of the outcomes. However, it is important to note that this conclusion is based on our specific dataset and may not necessarily apply to other populations or outcomes. Therefore, further research could investigate the impact of age on the outcomes in different populations or in the context of different comorbidities. Additionally, studies that investigate the long-term impact of the outcomes could provide valuable insights into the clinical implications of these conditions.

Overall, our study provides a foundation for future research on the topics of sex and age in the context of the outcomes studied, and further research could expand upon these findings to improve our understanding and treatment of these conditions. Finally, the study indicates that there are some gender differences in the likelihood of developing CHD, but the differences are not significant, except for the obese category, where males have a substantially lower mean cholesterol level than females. Despite the popular belief that coronary heart disease mainly affects older individuals, age alone is not a definitive predictor of its risk. Coronary heart disease can occur at any stage of life, and its incidence is not solely based on age.

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