LHS 610 FINAL PROJECT

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Introduction

How does the number of major vessels colored by fluoroscopy (0-3) relate to the presence of coronary heart disease? Is there a linear relationship, or is the risk of heart disease disproportionately higher for patients with a specific number of major vessels?

Population: Patients in the UCI Heart Disease Data

Exposure: Number of major vessels colored by fluoroscopy (0-3)

Comparison group: Patients with different numbers of major vessels colored by fluoroscopy

Outcome: Presence of heart disease

The relationship between the number of major vessels colored by fluoroscopy (0-3) and heart disease presence has been investigated in various studies. However, complexities and influencing factors warrant further exploration.

Bartel et al.'s study revealed a relationship between coronary calcification detected by fluoroscopy and coronary artery disease presence. Among patients with coronary calcification, 97% had significant coronary disease angiographically. Coronary calcification prevalence increased with age and disease severity, but no significant difference was found between males and females. The study concluded that cardiac fluoroscopy is a valuable, non-invasive procedure for detecting significant coronary artery disease.[1] Gianrossi et al.'s meta-analytic review examined the diagnostic accuracy of cardiac fluoroscopy for coronary artery disease (CAD). The overall sensitivity and specificity were 67% and 87%, respectively, with higher sensitivity for multivessel disease. This highlights fluoroscopy's utility as a diagnostic tool for CAD.[2] Loecker et al.'s study assessed the fluoroscopic detection of coronary artery calcification in asymptomatic young men. The presence of calcification was significantly associated with an increased risk of CAD events.[4] This suggests that fluoroscopic detection can be useful for identifying individuals at higher risk. However, knowledge gaps remain regarding optimal screening strategies for different age groups, genders, and risk profiles. Incorporating these findings can help illustrate the potential association between coronary calcification detected by fluoroscopy, including the number of major vessels colored, and coronary artery disease presence. These studies strengthen the rationale for further investigation into this relationship to better understand and predict CAD presence and severity.

Investigating the relationship between the number of major vessels colored by fluoroscopy (0-3) and heart disease presence aligns with the "Triple Aim" of healthcare: improving health, enhancing care experience, and reducing costs.[4] Understanding this relationship can improve health outcomes by identifying risk factors, leading to targeted prevention, early detection, and tailored treatments for at-risk patients. This knowledge enables more effective interventions, ultimately benefiting population health. Examining it can enhance patient care experiences by informing personalized care plans and guidance, resulting in patients feeling more supported in managing their condition. Lastly, this investigation can reduce healthcare costs by identifying high-risk patients early, enabling appropriate preventive measures, and reducing the need for costly treatments and hospitalizations. Efficient resource allocation contributes to a more sustainable healthcare system.

Methods

Name: UCI Heart Disease Data

Description: The dataset comprises of 920 record instances and 14 relevant attributes that contain information about various factors related to heart disease for patients from multiple clinical centers such as the Hungarian Institute of Cardiology, University Hospital, Zurich & Basil, Switzerland, V.A. Medical Center, Long Beach, and Cleveland Clinic Foundation.

Access: The dataset can be downloaded or accessed from the University of California, Irvine Archives website. (https://archive.ics.uci.edu/ml/datasets/heart+disease).

The primary use case of the dataset is to develop predictive models and provide insights into factors contributing to heart disease. Analyzing patient attributes helps researchers and healthcare professionals understand the complex relationships between these factors and heart disease. This knowledge can be used to create predictive models, identify individuals at risk, and allow for early intervention. The dataset can also serve as a resource for experimental tasks, exploratory analyses, and evaluating intervention effectiveness.

Strengths of this dataset include its relatively large sample size and comprehensive relevant attributes, covering various aspects of heart disease. Obtained through a multivariate experimental study design, the dataset allows for complex analyses and insights into relationships between different attributes and heart disease. It's wide recognition and use in the machine learning field lend credibility to findings derived from its analysis. However, there are weaknesses associated with the dataset. Missing or incomplete data for some patients can limit the dataset's usefulness in answering specific research questions. The data has been collected from specific institutions, potentially making it unrepresentative of the broader population. Consequently, findings derived from this dataset may not be universally applicable and should be interpreted with caution. The data collection from specific institutions could introduce bias, as patients may have unique characteristics or be subject to specific environmental factors, potentially skewing conclusions drawn from the data.

Exposure variable: The exposure variable is the number of major vessels colored by fluoroscopy (0-3) stored in the column [‘ca’]. These major vessels include the Right Coronary Artery (RCA), the Left Circumflex (LCX), and the Left Anterior Descending Artery (LAD). Fluoroscopy Angiograms are used to visualize the level of blockage in these major vessels. This raises the question of whether an increase in the number of major vessels colored by fluoroscopy is less likely to lead to the presence of heart disease.

Outcome variable: The outcome variable is the presence of heart disease. The dataset originally records heart diseases in the variable [‘num’] as [0=no heart disease; 1,2,3,4 = stages of heart disease]. I have modified this column into a new column called [has_heart_disease] that stores values as 0 = absence of heart disease and 1,2,3,4 = presence of heart disease to define the outcome variable and establish a better relationship more clearly.

Hypothesis: I expect a significant relationship between the number of major vessels colored by fluoroscopy and the presence of heart disease, as fluoroscopy can indicate blood flow obstruction in coronary arteries, a major risk factor for heart disease. I hypothesize that the risk of heart disease will not have a simple linear relationship with the number of major vessels colored but will be disproportionately higher for patients with a specific number of vessels affected, due to the complexity of heart disease influenced by various factors. By examining the data, I aim to identify trends and patterns, providing insights into the role of major vessels in heart disease development and progression. Additionally, I will explore attributes like age and sex to determine if they act as confounding factors influencing the relationship between the number of major vessels colored by fluoroscopy and heart disease, contributing to a better understanding of complex factors involved in heart disease.

Confounders: Age and sex are potential confounders present in the dataset, as both are associated with the exposure (number of major vessels colored by fluoroscopy) and the outcome (presence of heart disease). Age is a well-established risk factor for heart disease, increasing the likelihood of arterial plaque buildup and potentially affecting the number of major vessels colored by fluoroscopy. Controlling for age is essential to isolate the impact of the number of major vessels on heart disease risk. Sex is another potential confounder, as heart disease prevalence and risk factors differ between males and females. Males may have a higher risk of heart disease at an earlier age [5], while females' risk generally increases after menopause.[6] The number of major vessels colored by fluoroscopy may also differ between sexes due to biological and hormonal differences. Controlling for sex is crucial to avoid biased results in the relationship between the number of major vessels colored by fluoroscopy and heart disease presence.

Results

	attribute	description	type
1.	age	Age in years	int
2.	sex	Female or male	bin
3.	cp	Chest pain type (typical angina, atypical angina, non-angina, or asymptomatic angina)	cat
4.	trestbps	Resting blood pressure (mm Hg)	con
5.	chol	Serum cholesterol (mg/dl)	con
6.	fbs	Fasting blood sugar (< 120 mg/dl or > 120 mg/dl)	bin
7.	restecg	Resting electrocardiography results (normal, ST-T wave abnormality, or left ventricular hypertrophy)	cat
8.	thalach	Max. heart rate achieved during thalium stress test	con
9.	exang	Exercise induced angina (yes or no)	bin
10.	oldpeak	ST depression induced by exercise relative to rest	con
11.	slope	Slope of peak exercise ST segment (upsloping, flat, or downsloping)	cat
12.	ca	Number of major vessels colored by fluoroscopy	int
13.	thal	Thalium stress test result (normal, fixed defect, or reversible defect)	cat
14.	num	Heart disease status: number of major vessels with >50% narrowing (0,1,2,3, or 4)	int

Unstratified Analysis

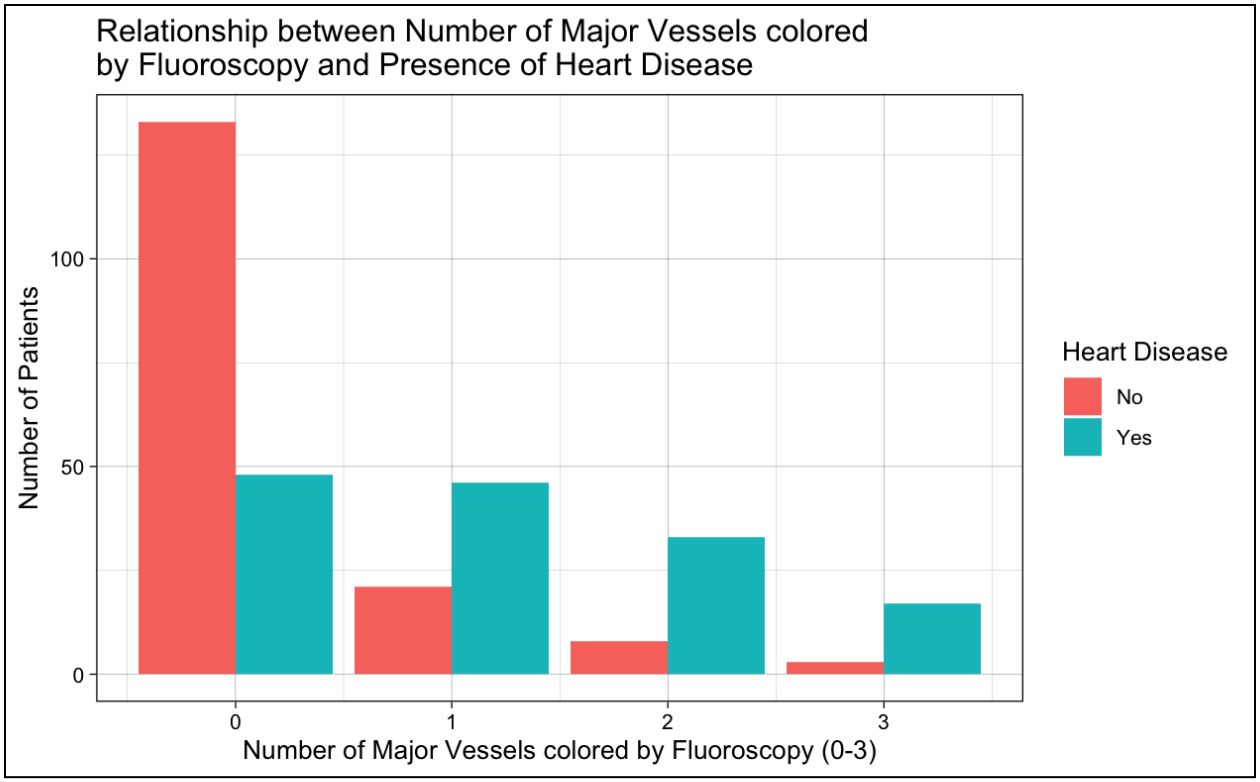

Figure 1

There are a significant number of patients with heart disease when there are no major vessels colored by fluoroscopy. But as the number of major vessels colored by fluoroscopy increases from 1-3, there is a steady decline seen in the number of patients with heart disease, which can potentially mean that there exists a relationship between the number of major vessels colored by fluoroscopy and coronary heart disease.

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Pearson's Chi-squared test


data:  table(dataset$ca, dataset$has_heart_disease)

X-squared = 73.2, df = 3, p-value = 8.806e-16
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The null hypothesis is that there is no relationship between the number of major vessels colored by fluoroscopy and the presence of heart disease. The p-value signifies that there is an extremely low chance of 8.806e-16 (which is very close to zero) that we would observe this data (or data more extreme than what we found) based on random chance alone. Therefore, it can be concluded that the result is statistically significant.

Stratified Analysis (Confounder 1):

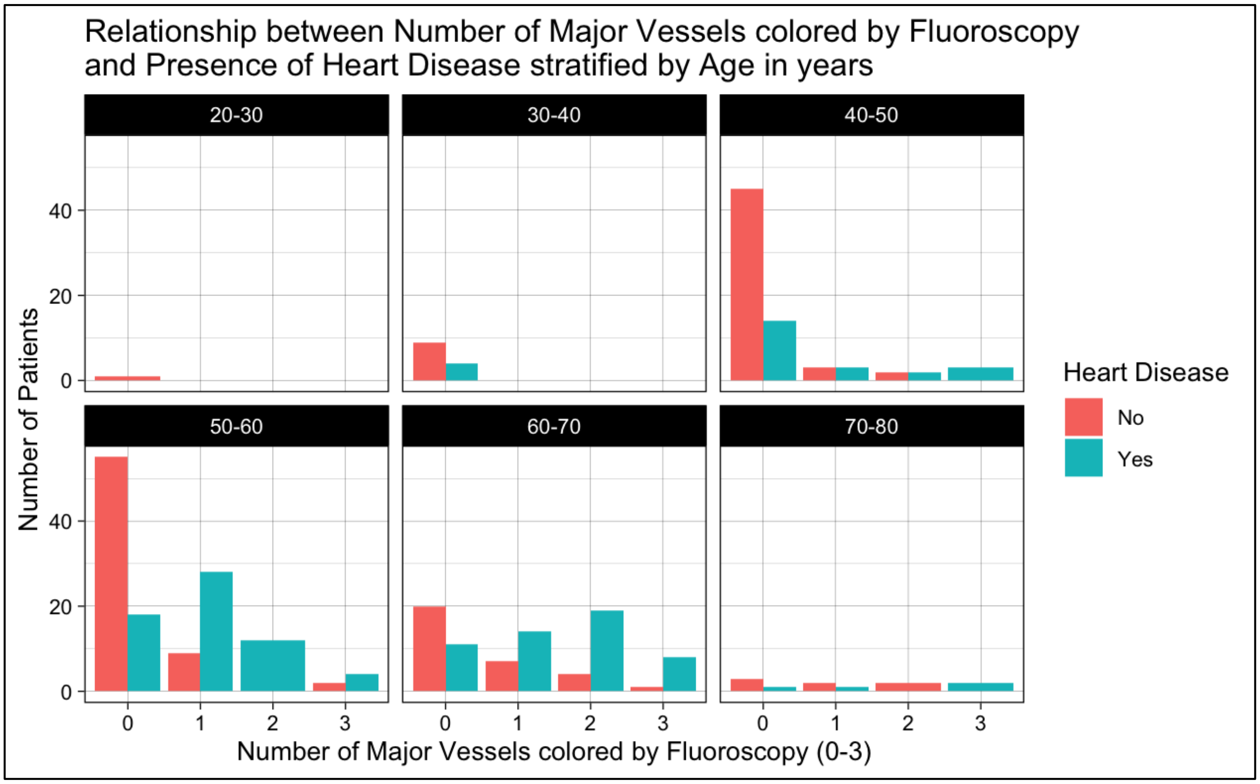

Figure 2

Stratifying the relationship by age gives us the picture that the greatest number of patients with heart disease are found to be in the age groups of 50-60 and 60-70 years. This can mean that age influences the patient's risk of developing heart disease. In age groups of 40-50 years, the same relationship is maintained as seen previously in Figure 1. But in these high-risk age groups (50-70 years), this relationship can no longer be appreciated. Age acts as a confounding variable influencing the relationship between the number of major vessels colored by fluoroscopy and the presence of heart disease. We can see that the number of patients with heart disease increases even as there are more major vessels visualized. This change is quite evident in the 60–70-year age group.

Stratified Analysis (Confounder 2):

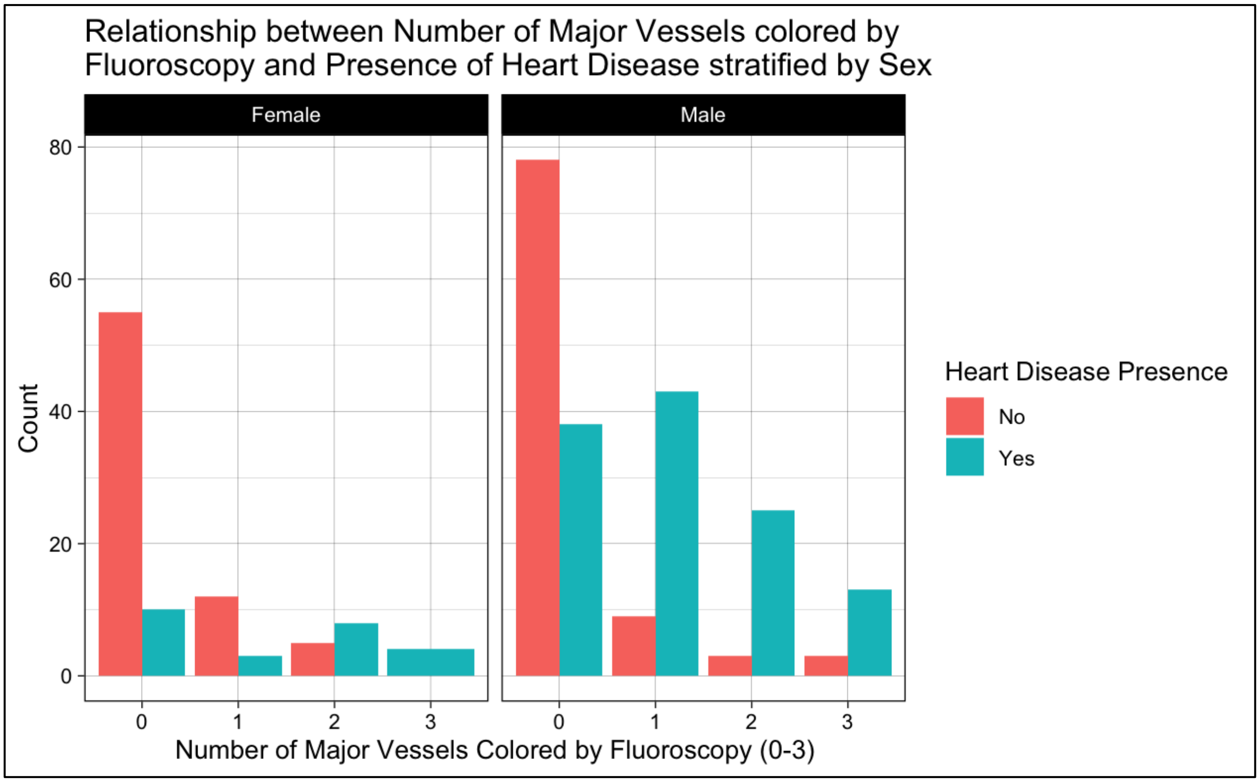

Figure 3

Stratifying the relationship by sex gives us a clear interpretation that there are a greater number of males with heart diseases than females. This can mean that sex influences the patient's risk of developing heart disease.[8] In these sex groups, it is evident that sex does act as a confounding variable affecting the relationship between heart disease and the number of major vessels colored by fluoroscopy as it is difficult to assess a relationship between the exposure and outcome variable as we did previously in Figure 1. A higher number of males show the presence of heart disease even as the number of major vessels increases from 0-1.

Discussion

In conclusion, the analysis revealed a significant relationship between the number of major vessels colored by fluoroscopy and the presence of heart disease, the chances of heart disease reduce as the number of major vessels colored on fluoroscopy increases. However, this relationship was influenced by confounding factors. Age was found to be a significant confounder, as the relationship between the exposure and outcome variables was no longer evident in high-risk age groups (50-70 years). Similarly, sex also acted as a confounding variable, as the number of males with heart disease increased even when the number of major vessels colored by fluoroscopy increased from 0 to 1.

The findings of this study help to highlight the complex relationships between various factors that contribute to heart disease and the importance of considering confounding factors when examining the relationship between specific risk factors. While the unstratified analysis suggested a relationship between the number of major vessels colored by fluoroscopy and heart disease, the stratified analysis revealed the importance of considering confounding variables such as age and sex.

The main limitations of the dataset include potential missing or incomplete data and the fact that it was collected from specific institutions, which may not be representative of the broader population. These factors can limit the generalizability of the findings and introduce biases. Additionally, the analysis did not account for other potential confounders or interactions between variables, which may also affect the observed relationships.

The implications of these findings are important for researchers, healthcare professionals, and policymakers involved in the prevention, management, and treatment of heart disease. Understanding the relationships between major vessels, age, sex, and heart disease can inform the development of more targeted prevention and intervention strategies. By considering the effects of confounding variables, predictive models can be improved, potentially leading to better identification of individuals at risk of heart disease and enabling earlier intervention.

Conclusion

Considering both the unstratified and stratified analyses, the relationship between the number of major vessels colored by fluoroscopy and the presence of heart disease appears to be influenced by age and sex as confounding factors. To accurately answer the specific health-related question, it is essential to account for these confounding variables in the analysis. This can be achieved by using multivariable regression models that adjust for age and sex, providing a clearer understanding of the true association between the number of major vessels colored by fluoroscopy and the presence of heart disease, independent of the effects of these confounders.

References

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