Heart Disease Diagnostic Analysis using Python

Importing Libraries for Data Analysis and Visualization

In [1]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

In [2]:

```
import pandas as pd
```

Reading CSV Data into Pandas DataFrame

In [3]:

```
df=pd.read_csv("Heart Disease data.csv")
```

In [4]:

```
df.head()
```

Out[4]:

	age	sex	cp	trestbps	chol	fbs	restecg	thalach	exang	oldpeak	slope	ca	thal
0	52	1	0	125	212	0	1	168	0	1.0	2	2	3
1	53	1	0	140	203	1	0	155	1	3.1	0	0	3
2	70	1	0	145	174	0	1	125	1	2.6	0	0	3
3	61	1	0	148	203	0	1	161	0	0.0	2	1	3
4	62	0	0	138	294	1	1	106	0	1.9	1	3	2

checking for missing Values

In [5]:

```
missing_values = df.isnull().sum()
missing_values
```

Out[5]:

```
age         0
sex         0
cp          0
trestbps    0
chol        0
fbs         0
restecg     0
thalach     0
exang       0
oldpeak     0
slope       0
ca          0
thal        0
target      0
dtype: int64
```

```
In [6]: df.columns
```

```
Out[6]: Index(['age', 'sex', 'cp', 'trestbps', 'chol', 'fbs', 'restecg', 'thalach',
               'exang', 'oldpeak', 'slope', 'ca', 'thal', 'target'],
              dtype='object')
```

Attributes:

```
age: Age of the patient.
sex: Gender of the patient (0 = female, 1 = male).
cp: Chest pain type (1 = typical angina, 2 = atypical angina, 3
= non-anginal pain, 4 = asymptomatic).
trestbps: Resting blood pressure (in mm Hg).
chol: Serum cholesterol in mg/dl.
fbs: Fasting blood sugar > 120 mg/dl (1 = true, 0 = false).
restecg: Resting electrocardiographic results (0 = normal, 1 =
having ST-T wave abnormality, 2 = showing     probable or
definite left ventricular hypertrophy).
thalach: Maximum heart rate achieved.
exang: Exercise induced angina (1 = yes, 0 = no).
oldpeak: ST depression induced by exercise relative to rest.
slope: Slope of the peak exercise ST segment (1 = upsloping, 2 =
flat, 3 = downsloping).
ca: Number of major vessels (0-3) colored by flourosopy.
thal: Thalassemia (0 = normal, 1 = fixed defect, 2 = reversible
defect).
target: Presence of heart disease (1 = yes, 0 = no).
```

Changing headers name to make it more understandable

```
In [7]: new_headers=["age","sex","chest_pain_type","resting_blood_pressure","cholestoral
        df.columns=new_headers
        df.columns
```

```
Out[7]: Index(['age', 'sex', 'chest_pain_type', 'resting_blood_pressure',
               'cholestoral', 'blood_sugar', 'electrocardiographic',
               'maximum_heart_rate', 'exercise_induced_angina', 'oldpeak', 'slope',
               'number_of_major_vessels', 'Thalassemia', 'target'],
              dtype='object')
```

Basic Statistics

Computing summary statistics (mean, median, standard deviation,min and max) for numerical attributes like age, blood pressure, cholesterol, and heart rate.

```
In [13]: summary_stats=df.describe()
         attributes=['age','resting_blood_pressure','cholestoral','maximum_heart_rate']
         selected_stats=summary_stats.loc[['mean','50%','std',"max","min"],attributes]
         print("\nsummary statics:")
         print(selected_stats)
```

```
summary statics:
            age  resting_blood_pressure  cholestoral  maximum_heart_rate
mean  54.434146              131.611707    246.00000          149.114146
50%   56.000000              130.000000    240.00000          152.000000
std    9.072290               17.516718     51.59251           23.005724
max   77.000000              200.000000    564.00000          202.000000
min   29.000000               94.000000    126.00000           71.000000
```

Heart Disease Rates

1. overall prevalence of heart disease in the dataset

In [15]:

```
prevalence=df["target"].mean()*100
print(f'Prevalence of Heart Disease in the Dataset:{prevalence:.2f}%')
```

```
Prevalence of Heart Disease in the Dataset:51.32%
```

2. Distribution of heart disease presence across different categories

2A. Gender: Male vs. Female.

In [53]:

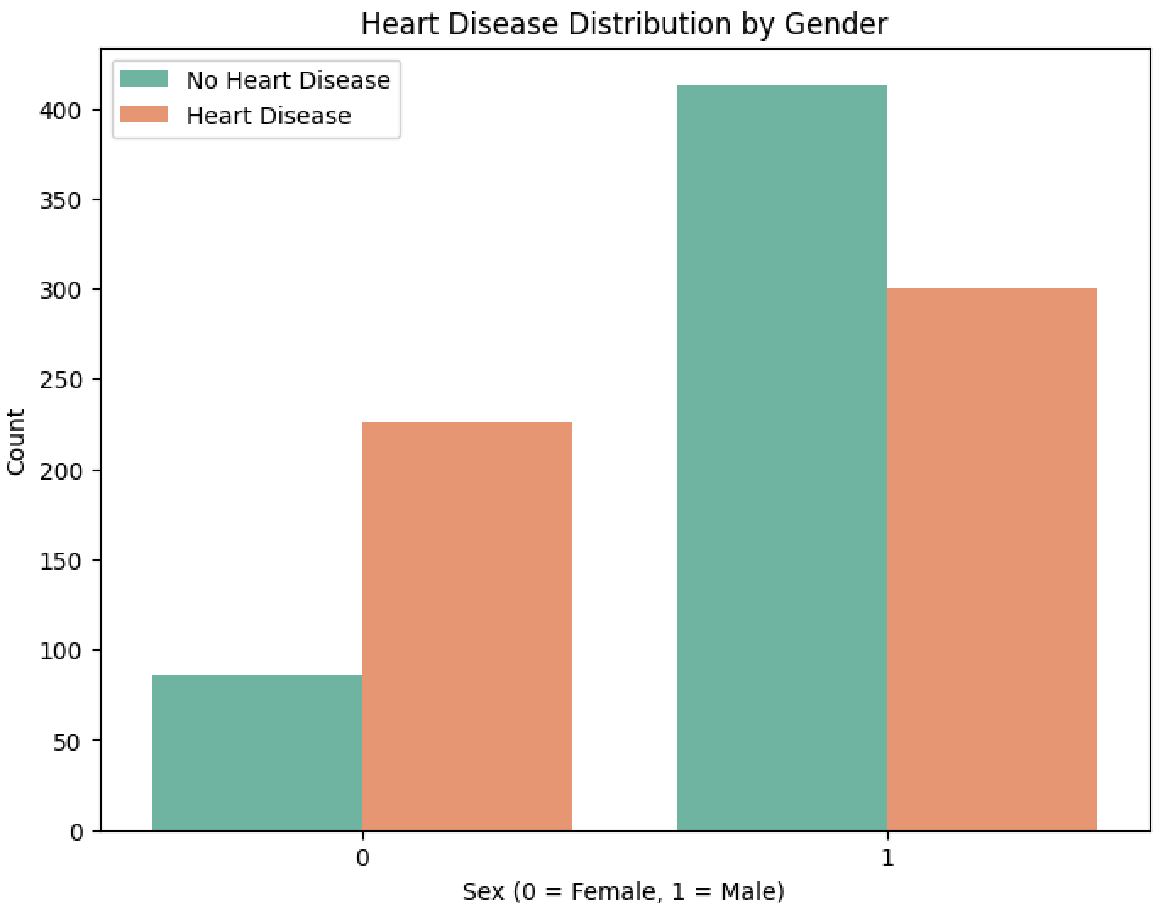
```
males = df['sex'].sum()
males
```

Out[53]:

```
713
```

In [16]:

```
plt.figure(figsize=(8, 6))
sns.countplot(x='sex', hue='target', data=df, palette='Set2')
plt.title('Heart Disease Distribution by Gender')
plt.xlabel('Sex (0 = Female, 1 = Male)')
plt.ylabel('Count')
plt.legend(['No Heart Disease', 'Heart Disease'])
plt.show()
```

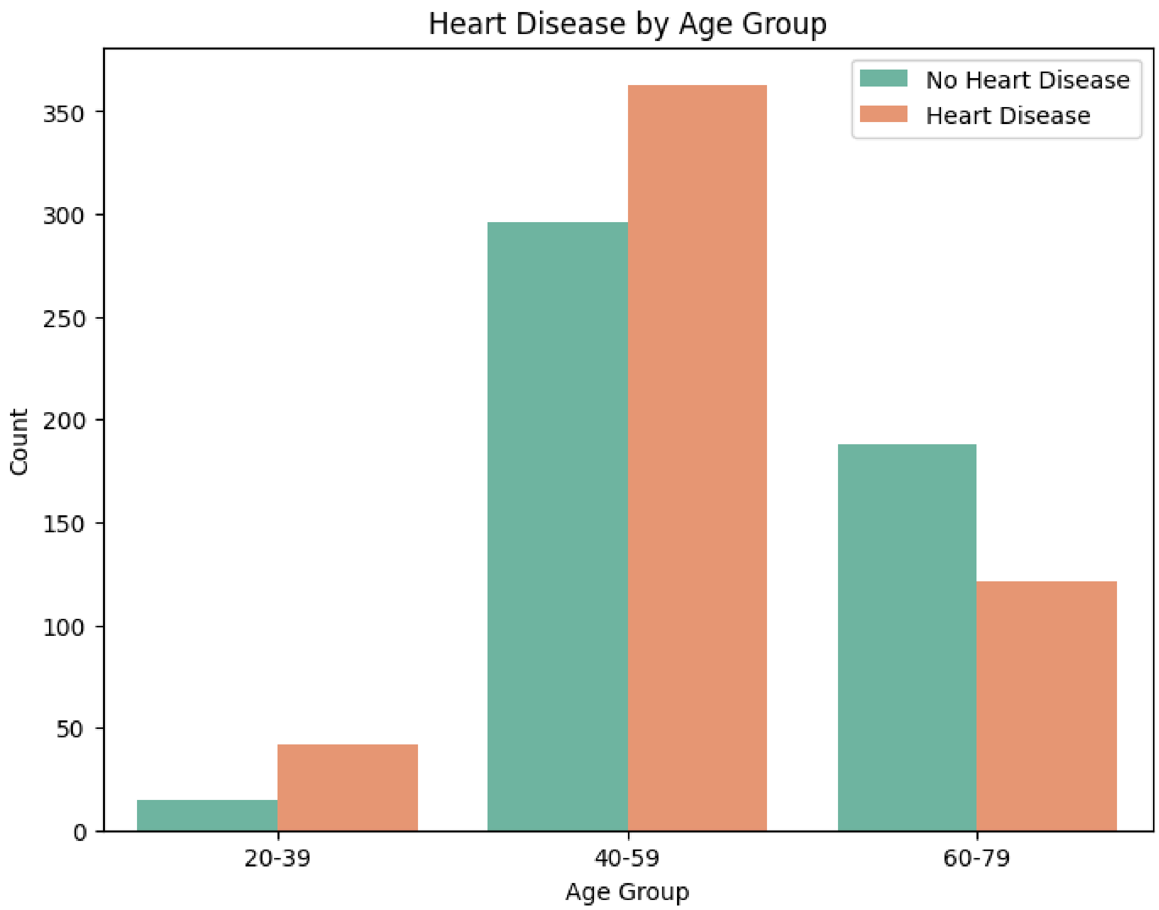


2B. Age Groups: Different age ranges (e.g., '20-39', '40-59', '60-79').

In [17]:
```
age_bins = [20, 40, 60, 80]
age_labels = ['20-39', '40-59', '60-79']
df['age_group'] = pd.cut(df['age'], bins=age_bins, labels=age_labels, right=Fals
df['age_group']
```

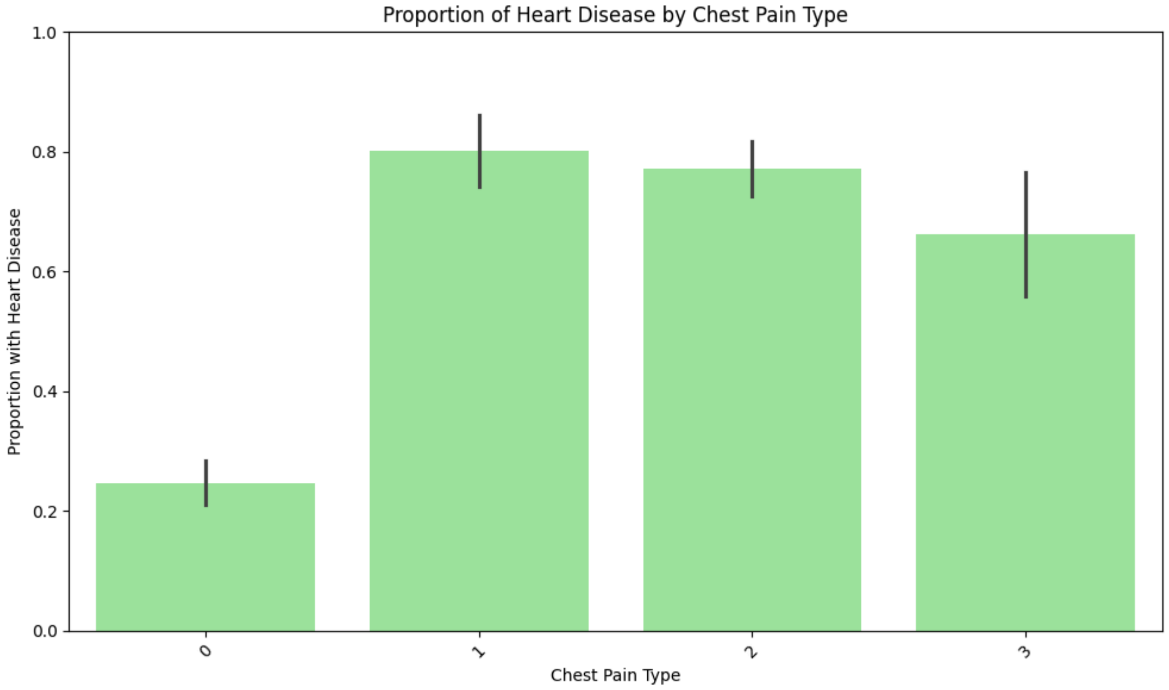
Out[17]:
```
0       40-59
1       40-59
2       60-79
3       60-79
4       60-79
        ...
1020    40-59
1021    60-79
1022    40-59
1023    40-59
1024    40-59
Name: age_group, Length: 1025, dtype: category
Categories (3, object): ['20-39' < '40-59' < '60-79']
```

In [18]:
```
plt.figure(figsize=(8, 6))
sns.countplot(x='age_group', hue='target', data=df, palette='Set2')
plt.title('Heart Disease by Age Group')
plt.xlabel('Age Group')
plt.ylabel('Count')
plt.legend(['No Heart Disease', 'Heart Disease'])
plt.show()
```



2C. Chest pain Type and proportion with heart disese

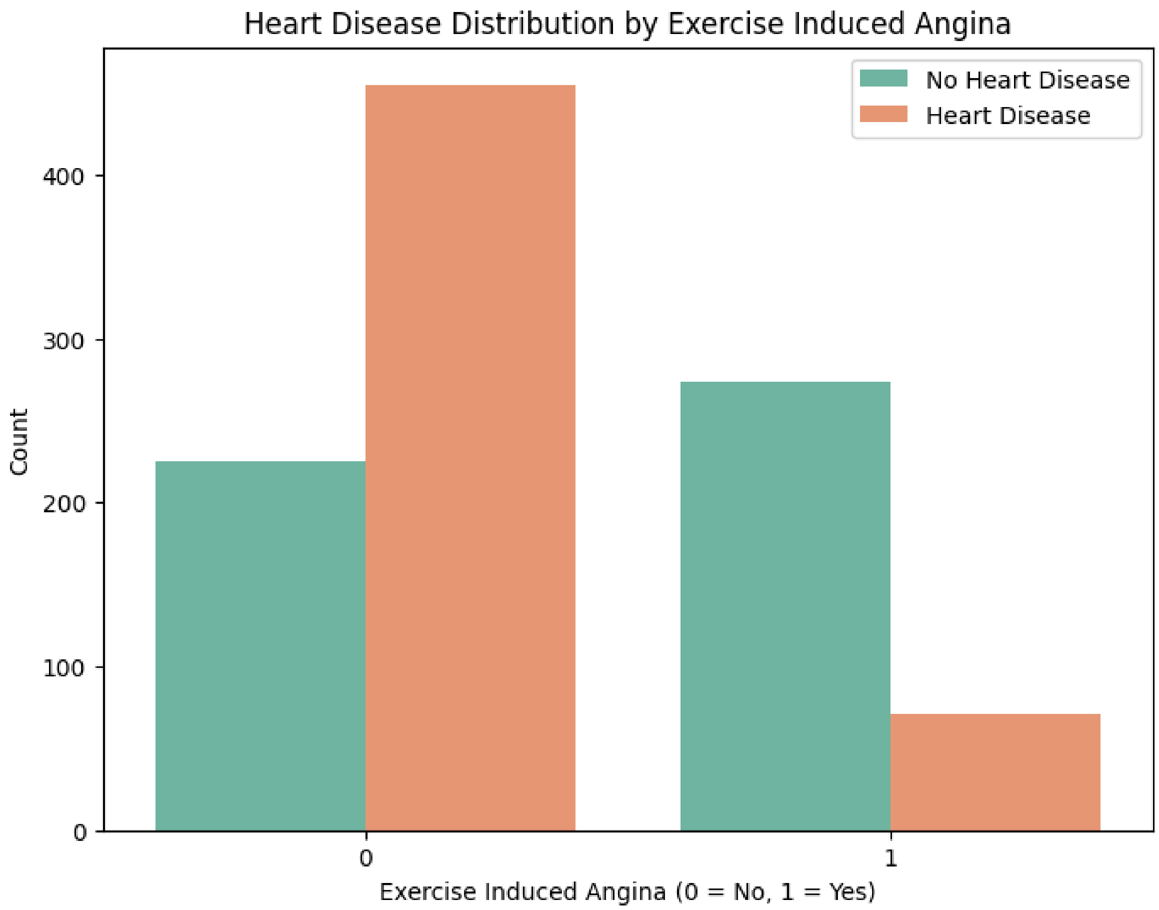
```
In [22]: plt.figure(figsize=(10, 6))
         sns.barplot(x='chest_pain_type', y='target', data=df, color='lightgreen')
         plt.xlabel('Chest Pain Type')
         plt.ylabel('Proportion with Heart Disease')
         plt.title('Proportion of Heart Disease by Chest Pain Type')
         plt.ylim(0, 1)
         plt.xticks(rotation=45)
         plt.tight_layout()
         plt.show()
```



2.D Excercise induce agina vs heart disease

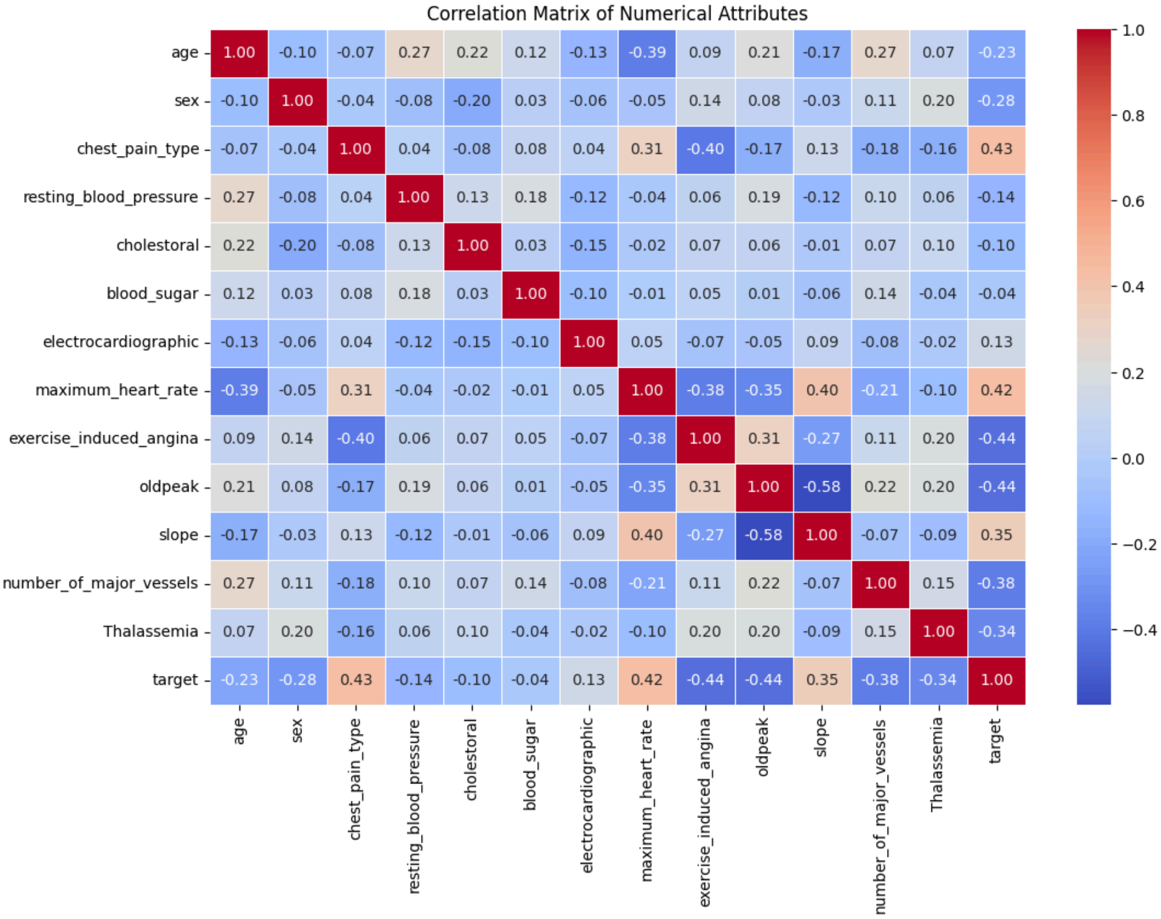
In [27]:

```
plt.figure(figsize=(8, 6))
sns.countplot(x='exercise_induced_angina', hue='target', data=df, palette='Set2'
plt.title('Heart Disease Distribution by Exercise Induced Angina')
plt.xlabel('Exercise Induced Angina (0 = No, 1 = Yes)')
plt.ylabel('Count')
plt.legend(['No Heart Disease', 'Heart Disease'])
plt.show()
```



3. Correlation Analysis

In [28]:
```
correlation_matrix = df.corr()
plt.figure(figsize=(12, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt='.2f', linewidt
plt.title('Correlation Matrix of Numerical Attributes')
plt.show()
```

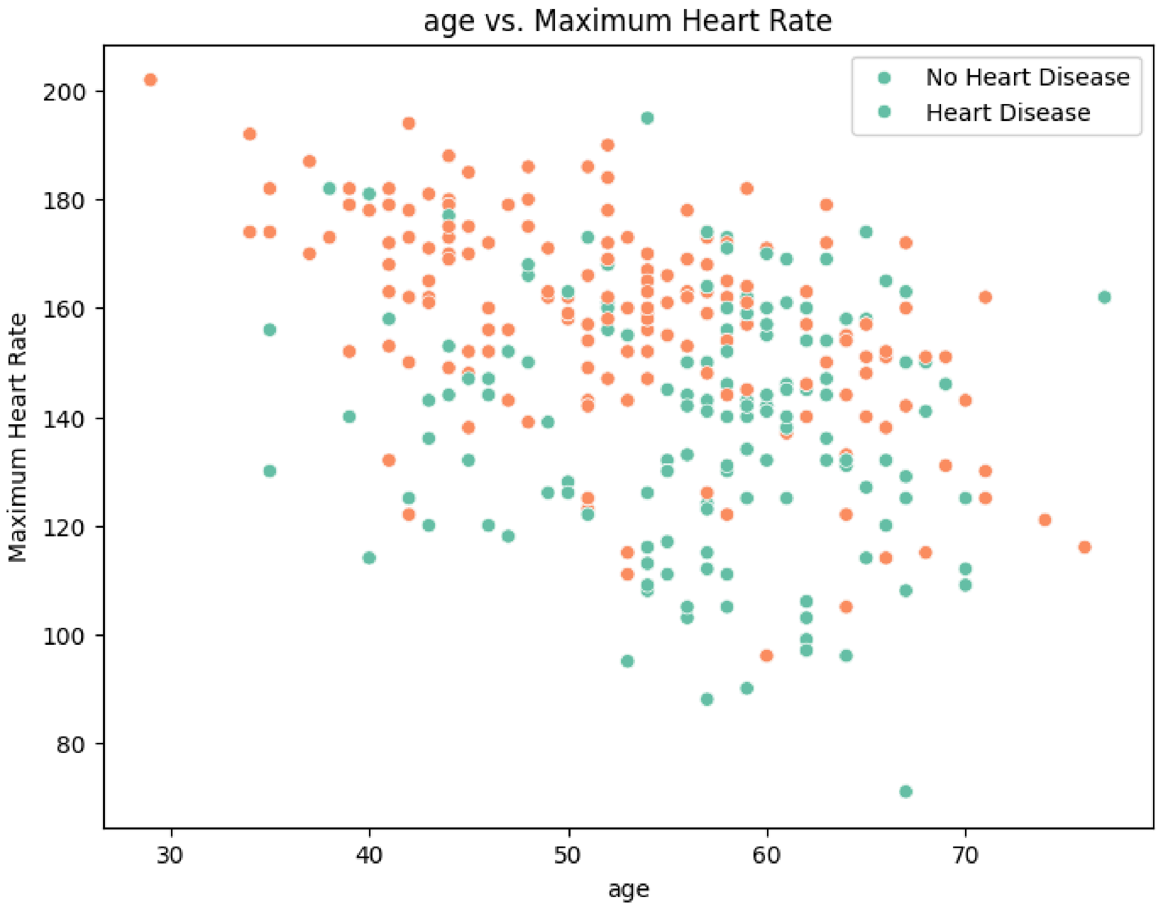


4. Relationship between different Attributes

4A. Age vs. Maximum Heart Rate

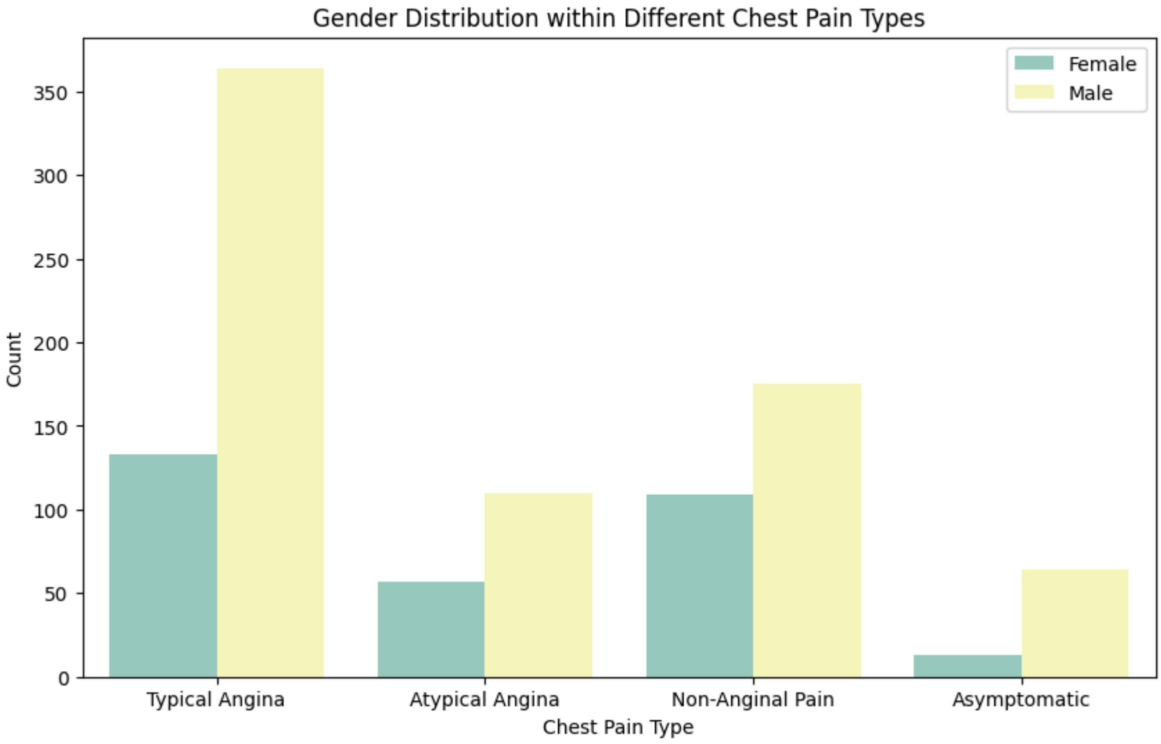
In [34]:

```
plt.figure(figsize=(8, 6))
sns.scatterplot(x='age', y='maximum_heart_rate', data=df, hue='target', palette=
plt.title('age vs. Maximum Heart Rate')
plt.xlabel('age')
plt.ylabel('Maximum Heart Rate')
plt.legend(['No Heart Disease', 'Heart Disease'])
plt.show()
```



4B. Chest pain Type vs Gender

In [36]:
```
plt.figure(figsize=(10, 6))
sns.countplot(x='chest_pain_type', hue='sex', data=df, palette='Set3')
plt.title('Gender Distribution within Different Chest Pain Types')
plt.xlabel('Chest Pain Type')
plt.ylabel('Count')
plt.xticks(ticks=[0, 1, 2, 3], labels=['Typical Angina', 'Atypical Angina', 'Non
plt.legend(['Female', 'Male'])
plt.show()
```

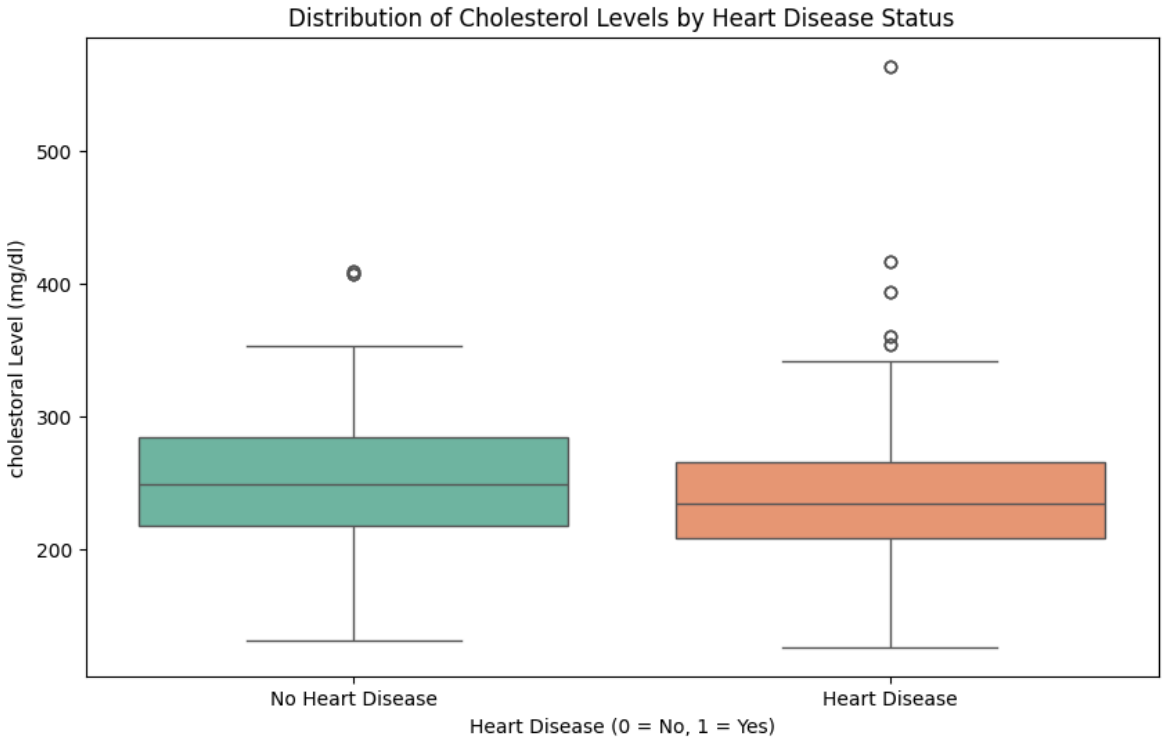


4C. Heart Disease vs Cholestrol

In [37]:

```
plt.figure(figsize=(10, 6))
sns.boxplot(x='target', y='cholestoral', data=df, palette='Set2')
plt.title('Distribution of Cholesterol Levels by Heart Disease Status')
plt.xlabel('Heart Disease (0 = No, 1 = Yes)')
plt.ylabel('cholestoral Level (mg/dl)')
plt.xticks(ticks=[0, 1], labels=['No Heart Disease', 'Heart Disease'])
plt.show()
```

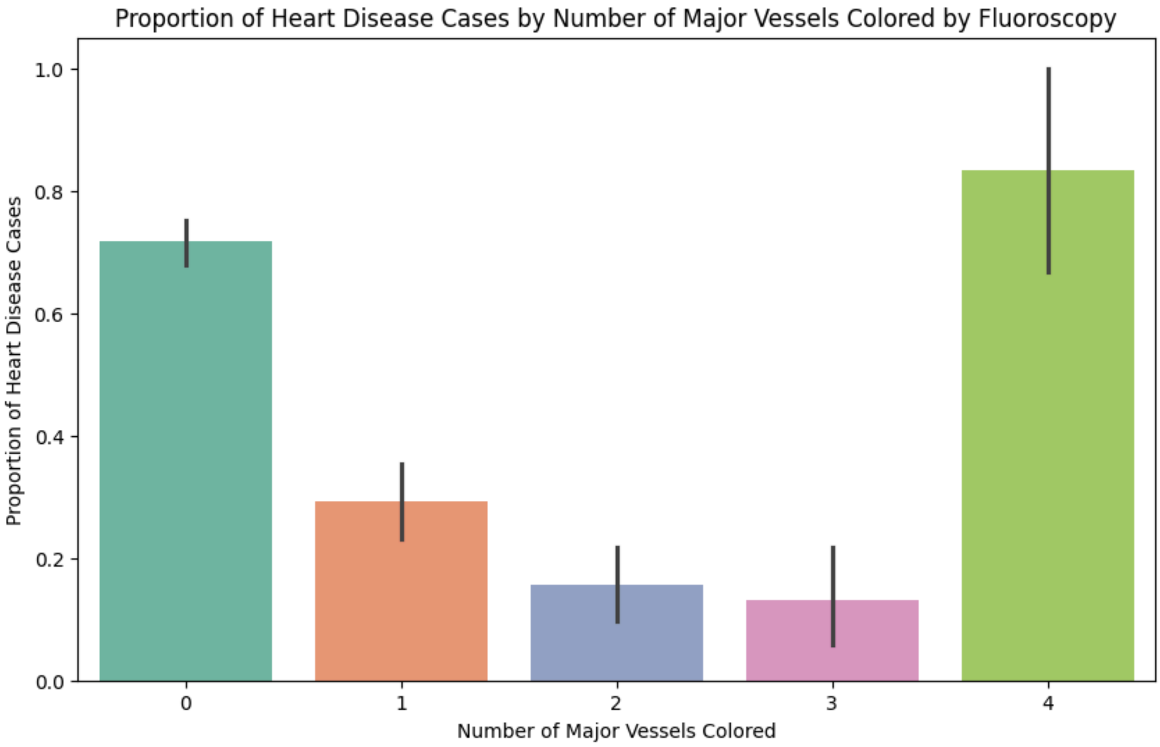
```
C:\Users\israr mohammed\AppData\Local\Temp\ipykernel_15396\668127005.py:2: Future
Warning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v
0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same effe
ct.

  sns.boxplot(x='target', y='cholestoral', data=df, palette='Set2')
```



4 D. Major vessel colored by Fluoroscopy vs heart disease

In [39]:
```
plt.figure(figsize=(10, 6))
sns.barplot(x='number_of_major_vessels', y='target', data=df, palette='Set2')
plt.title('Proportion of Heart Disease Cases by Number of Major Vessels Colored
plt.xlabel('Number of Major Vessels Colored')
plt.ylabel('Proportion of Heart Disease Cases')
plt.xticks(rotation=0)

plt.show()
```

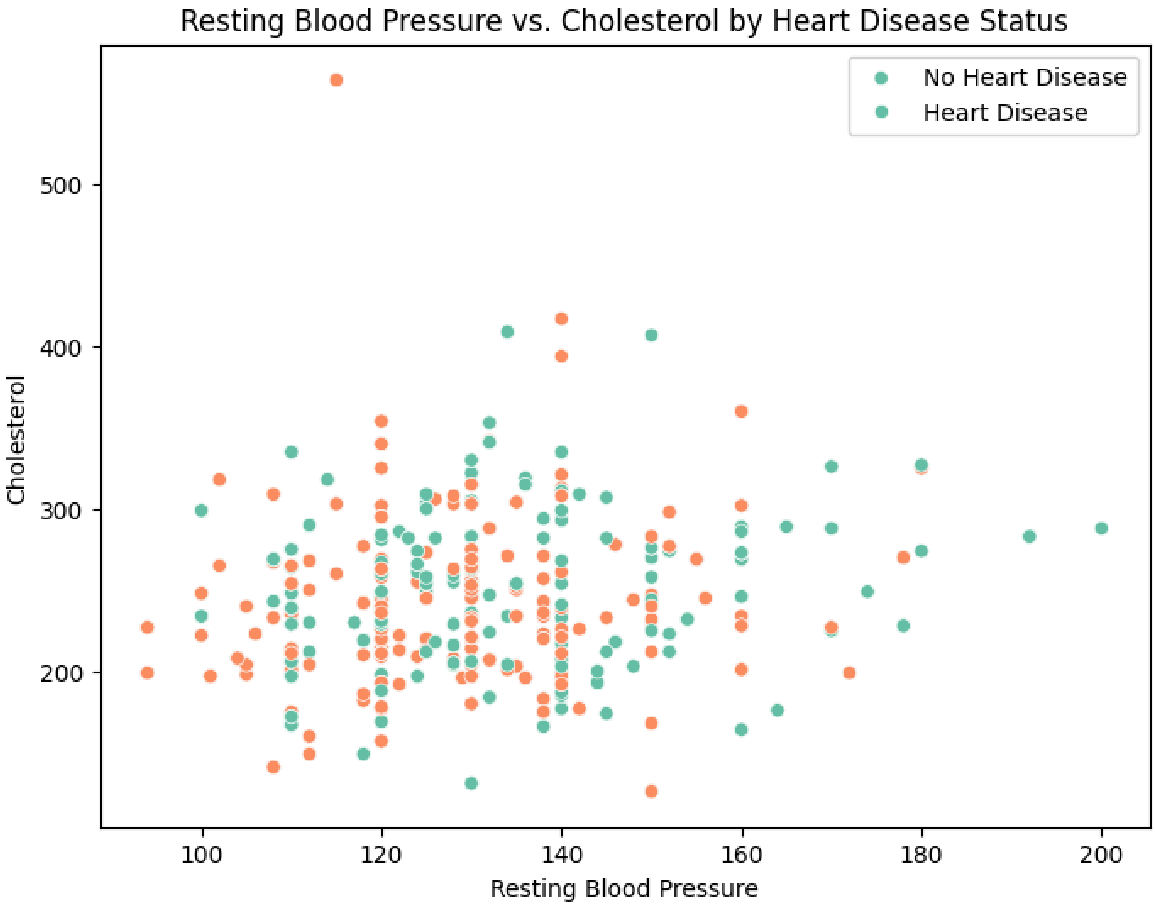
```
C:\Users\israr mohammed\AppData\Local\Temp\ipykernel_15396\2859506839.py:2: Futur
eWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v
0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same effe
ct.

  sns.barplot(x='number_of_major_vessels', y='target', data=df, palette='Set2')
```



4E. Cholestrol vs Blood Pressure

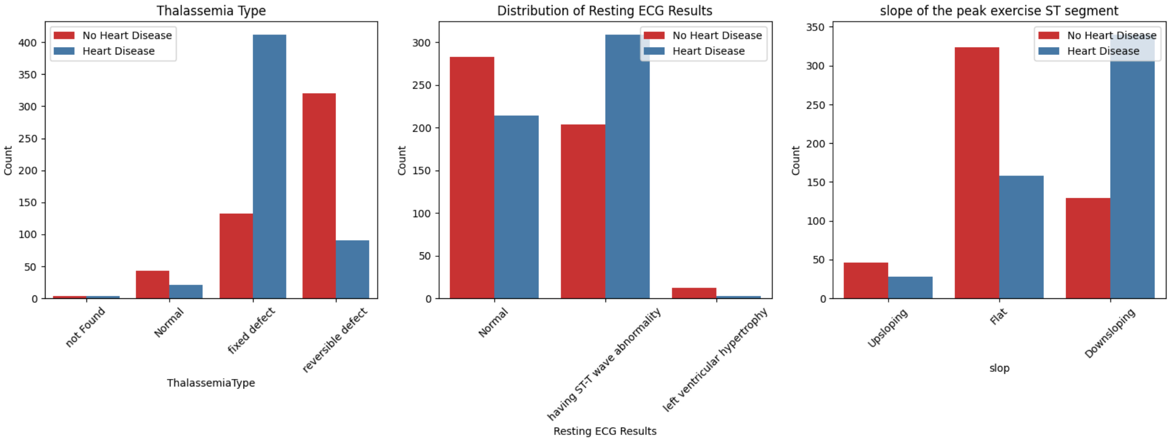
In [40]:

```
plt.figure(figsize=(8, 6))
sns.scatterplot(x='resting_blood_pressure', y='cholestoral', hue='target', data=
plt.title('Resting Blood Pressure vs. Cholesterol by Heart Disease Status')
plt.xlabel('Resting Blood Pressure')
plt.ylabel('Cholesterol')
plt.legend(['No Heart Disease', 'Heart Disease'])
plt.show()
```



4F. Remainig Analysis using sub plots

In [52]:
```
plt.figure(figsize=(16, 10))

plt.subplot(2, 3, 1)
sns.countplot(x='Thalassemia', hue='target', data=df, palette='Set1')
plt.title('Thalassemia Type')
plt.xlabel('ThalassemiaType')
plt.xticks(ticks=[0,1, 2, 3], labels=['not Found','Normal', 'fixed defect', 'rev
plt.xticks(rotation=45)

plt.legend(['No Heart Disease', 'Heart Disease'])
plt.ylabel('Count')

plt.subplot(2, 3, 2)
sns.countplot(x='electrocardiographic', hue='target', data=df, palette='Set1')
plt.title('Distribution of Resting ECG Results')
plt.xlabel('Resting ECG Results')
plt.xticks(ticks=[0, 1, 2], labels=['Normal', 'having ST-T wave abnormality', 'l
plt.xticks(rotation=45)
plt.ylabel('Count')
plt.legend(['No Heart Disease', 'Heart Disease'])


plt.subplot(2, 3, 3)
sns.countplot(x='slope', hue='target', data=df, palette='Set1')
plt.title('slope of the peak exercise ST segment')
plt.xlabel('slop')
plt.xticks(ticks=[0, 1, 2], labels=['Upsloping', 'Flat', 'Downsloping'])
plt.xticks(rotation=45)
plt.ylabel('Count')
plt.legend(['No Heart Disease', 'Heart Disease'])

plt.tight_layout()
plt.show()
```



Findings

The average age is 54.4 years, ranging from 29 to 77 years.

```
covering typical age ranges associated with cardiovascular risk.
```

Resting blood pressure averages 131.6 mmHg, ranging from 94 to 200 mmHg.

```
he average of 131.6 mmHg suggests slightly elevated blood
pressure compared to the normal range of less than 120/80 mmHg.
```

Average cholesterol level is 246 mg/dL, ranging from 126 to 564 mg/dL.

```
The average cholesterol level of 246 mg/dL is higher than the
healthy range (below 200 mg/dL), indicating potential elevated
cardiovascular risk.
```

Maximum heart rate averages 149.1 bpm, ranging from 71 to 202 bpm.

```
The average maximum heart rate of 149.1 bpm is slightly lower
than expected for individuals of similar age, which could
reflect varying fitness levels or health conditions.
```

Prevalence of Heart Disease in the Dataset:51.32%

```
which indiates more then half of thetest samples are having
heart disease.
```

Based on Gender

```
-Among those with heart disease, there are fewer males compared
to females, indicating a lower prevalence of heart disease among
males in the sample.
-Conversely, among those without heart disease, the opposite
trend is observed: there are more males than females.
```

Age Groups and Heart Disease:

- Individuals aged 40-59 years have the highest prevalence of heart disease within the sample.
- The age group 20-39 years has a lower prevalence of heart disease compared to the 40-59 age group.
- The age group 60-79 years has the lowest prevalence of heart disease among the groups considered.
- The sample data suggests that individuals aged 40-59 years are not only most likely to have heart disease but also represent the largest segment of the sample overall. This age group exhibits a significant concentration of both heart disease and non-heart disease cases within the dataset.

More Insights

1. **Thalassemia Type**:
   - Individuals with 'reversible defect' or 'fixed defect' thalassemia types are more likely to have heart disease.
   - 'Normal' thalassemia type individuals show a lower incidence of heart disease.
   - Those where thalassemia was 'not found' have a mixed but generally lower prevalence of heart disease.
2. **Resting ECG Results**:
   - Individuals with 'left ventricular hypertrophy' on resting ECG tend to have a higher prevalence of heart disease.
   - Both 'Normal' and 'having ST-T wave abnormality' categories show varying prevalence of heart disease, with 'Normal' typically lower.
3. **Slope of the Peak Exercise ST Segment**:
   - The 'downsloping' slope of the peak exercise ST segment is associated with a higher prevalence of heart disease.
   - 'Flat' and 'upsloping' slopes show varying prevalence, with 'upsloping' generally having a lower association with heart disease.

4. **Correlation Matrix**:
   - Age, maximum heart rate, and possibly cholesterol levels show significant correlations with heart disease ('target'), suggesting they may be important predictors.
5. **Scatter Plot: Age vs. Maximum Heart Rate**:

  - Individuals with heart disease tend to have lower maximum heart rates as they age compared to those without heart disease.

6. **Gender Distribution within Different Chest Pain Types**:

   - The distribution of chest pain types varies between males and females, highlighting gender differences in how chest pain is reported or perceived.

7. **Box Plot: Cholesterol Levels by Heart Disease Status**:

   - Median cholesterol levels are higher in individuals with heart disease compared to those without, indicating cholesterol levels may influence heart disease risk.

8. **Bar Plot: Proportion of Heart Disease Cases by Number of Major Vessels Colored by Fluoroscopy**:

   - As the number of major vessels colored by fluoroscopy increases, there is generally a higher proportion of heart disease cases, suggesting a potential diagnostic significance of this feature.

In [ ]: