heart-disease-diagnostic-analysis

October 12, 2024

1 Heart Disease Diagnostic Analysis

2 Introduction:

[1]:

```
# This project focuses on analyzing heart disease data using Python for␣
 ↪visualization and SQL for querying.
# Heart disease risk factors like age, cholesterol, and blood pressure are␣
 ↪explored through data-driven methods.
# SQL queries efficiently retrieve insights, while Python visualizations␣
 ↪provide clear, actionable patterns.
# The analysis aims to identify trends and relationships within heart disease␣
 ↪data for early diagnosis.
# Python and SQL tools empower the project to deliver meaningful health␣
 ↪insights and recommendations.
```

3 Importing Libraries:

[2]:

```
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import mysql.connector
import numpy as np

db = mysql.connector.connect(host = "localhost",
                             username = "root",
                             password = "1012",
                             database = "heart")
cur = db.cursor()
```

4 Importing Dataset:

[3]:

```
data = pd.read_csv("C:/Users/ASUS/Desktop/Power BI Practice/Heart Disease.csv")
data.head(10)
# After Cleaning in SQL
```

```
[3]:    Age     Sex ChestPainType  RestingBloodPressure  SerumCholesterol  \
     0   52  Female        Angina                   125               212
     1   53  Female        Angina                   140               203
     2   70  Female        Angina                   145               174
     3   61  Female        Angina                   148               203
     4   62    Male        Angina                   138               294
     5   58    Male        Angina                   100               248
     6   58  Female        Angina                   114               318
     7   55  Female        Angina                   160               289
     8   46  Female        Angina                   120               249
     9   54  Female        Angina                   122               286

       FastingBloodSugar RestingECGResults  MaxHeartRateAchieved  \
     0            Normal          Abnormal                   168
     1              High            Normal                   155
     2            Normal          Abnormal                   125
     3            Normal          Abnormal                   161
     4              High          Abnormal                   106
     5            Normal            Normal                   122
     6            Normal          Probable                   140
     7            Normal            Normal                   145
     8            Normal            Normal                   144
     9            Normal            Normal                   116

       ExerciseInducedAngina  Oldpeak SlopeOfPeakExerciseSTSegment  \
     0                    No      1.0                 Pathological
     1                   Yes      3.1                    Upsloping
     2                   Yes      2.6                    Upsloping
     3                    No      0.0                 Pathological
     4                    No      1.9                  Downsloping
     5                    No      1.0                  Downsloping
     6                    No      4.4                    Upsloping
     7                   Yes      0.8                  Downsloping
     8                    No      0.8                 Pathological
     9                   Yes      3.2                  Downsloping

                  MajorVessels  ThalassemiaStatus HeartDiseaseStatus
     0     50% to 75% Blockage  Reversable defect             Normal
     1             No Blockage  Reversable defect             Normal
     2             No Blockage  Reversable defect             Normal
     3  Less than 50% Blockage  Reversable defect             Normal
     4  More than 75% Blockage       Fixed defect             Normal
     5             No Blockage       Fixed defect           Evidence
     6  More than 75% Blockage             Normal             Normal
     7  Less than 50% Blockage  Reversable defect             Normal
     8             No Blockage  Reversable defect             Normal
     9     50% to 75% Blockage       Fixed defect             Normal
```

5 About Dataset:

[5]:

```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1025 entries, 0 to 1024
Data columns (total 14 columns):
 #   Column                        Non-Null Count  Dtype
---  ------                        --------------  -----
 0   Age                           1025 non-null   int64
 1   Sex                           1025 non-null   object
 2   ChestPainType                 1025 non-null   object
 3   RestingBloodPressure          1025 non-null   int64
 4   SerumCholesterol              1025 non-null   int64
 5   FastingBloodSugar             1025 non-null   object
 6   RestingECGResults             1025 non-null   object
 7   MaxHeartRateAchieved          1025 non-null   int64
 8   ExerciseInducedAngina         1025 non-null   object
 9   Oldpeak                       1025 non-null   float64
 10  SlopeOfPeakExerciseSTSegment  1025 non-null   object
 11  MajorVessels                  1025 non-null   object
 12  ThalassemiaStatus             1025 non-null   object
 13  HeartDiseaseStatus            1025 non-null   object
dtypes: float64(1), int64(4), object(9)
memory usage: 112.2+ KB
```

6 Distribution of Heart Disease by Age Group.

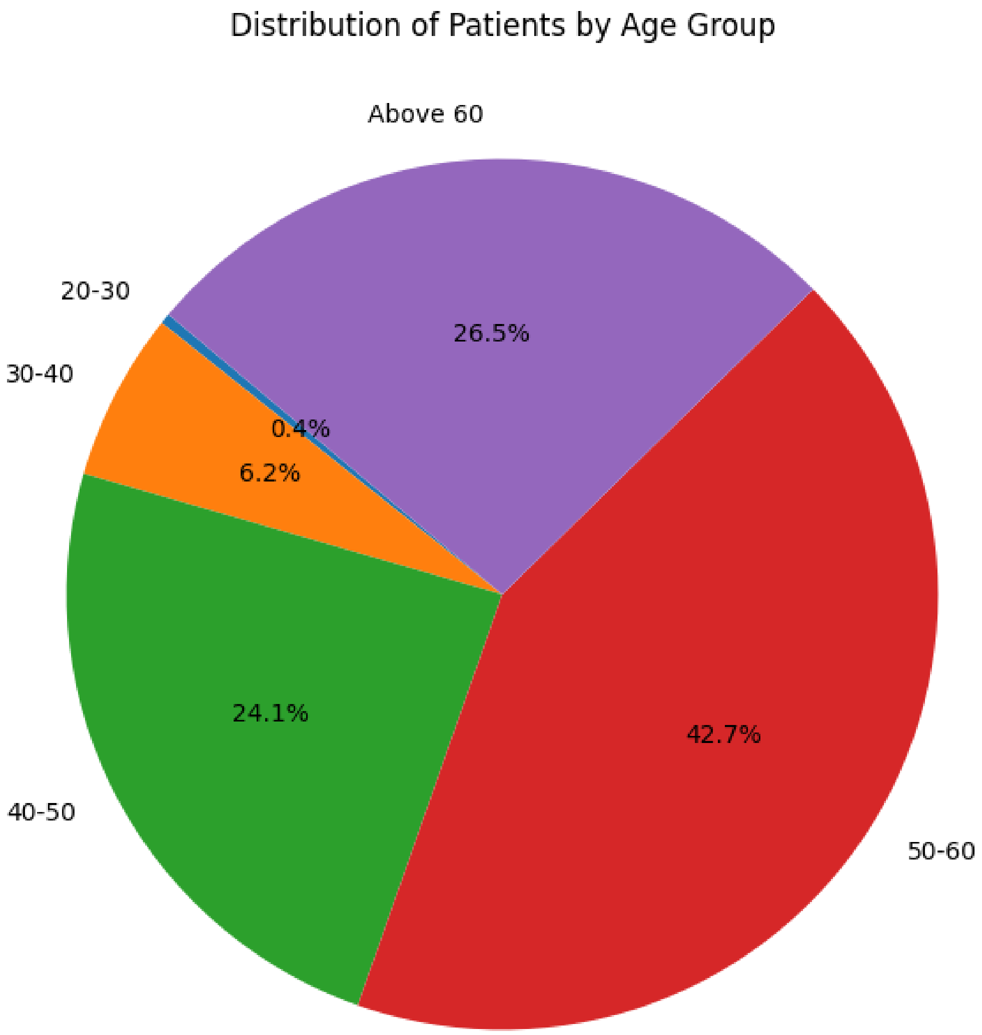
[6]:

```
query = """SELECT
    CASE
        WHEN Age BETWEEN 20 AND 30 THEN '20-30'
        WHEN Age BETWEEN 31 AND 40 THEN '30-40'
        WHEN Age BETWEEN 41 AND 50 THEN '40-50'
        WHEN Age BETWEEN 51 AND 60 THEN '50-60'
        WHEN Age > 60 THEN 'Above 60'
    END AS AgeGroup,
    COUNT(*) AS PatientCount,
    SUM(CASE
        WHEN HeartDiseaseStatus = 'Evidence' THEN 1
        ELSE 0
    END) AS 'Heart Disease Count',
    ROUND(AVG(CASE
                WHEN HeartDiseaseStatus = 'Evidence' THEN 1.0
                ELSE 0
            END) * 100,
            2) AS 'Heart Disease Percentage'
FROM
```

```
    heart.`heart disease`
GROUP BY AgeGroup
ORDER BY AgeGroup"""
cur.execute(query)
data = cur.fetchall()
df = pd.DataFrame(data, columns = ["Age Group","Patient Count","Heart Disease␣
  ↪Count","Heart Disease Percent"])
df
```

```
[6]:   Age Group  Patient Count Heart Disease Count Heart Disease Percent
     0     20-30              4                   4                100.00
     1     30-40             64                  41                 64.06
     2     40-50            247                 166                 67.21
     3     50-60            438                 204                 46.58
     4  Above 60            272                 111                 40.81
```

```
[7]: plt.figure(figsize=(8, 8))
     plt.pie(df['Patient Count'], labels=df['Age Group'], autopct='%1.1f%%',␣
       ↪startangle=140)
     plt.title('Distribution of Patients by Age Group')
     plt.show()
```



7 Heart Disease Frequency by Gender and Chest Pain Type.

```
[8]: query = """SELECT
         Sex,
         ChestPainType,
         COUNT(*) AS TotalPatient,
         SUM(CASE
             WHEN HeartDiseaseStatus = 'Evidence' THEN 1
             ELSE 0
         END) AS HeartDiseaseCount,
         ROUND(AVG(CASE
                     WHEN HeartDiseaseStatus = 'Evidence' THEN 1.0
                     ELSE 0
                 END) * 100,
                 2) AS HeartDiseasePercentage
     FROM
         heart.`heart disease`
     GROUP BY Sex , ChestPainType
     ORDER BY Sex , ChestPainType;"""
     cur.execute(query)
     data = cur.fetchall()
     df = pd.DataFrame(data, columns = ["Sex","Chest Pain Type","Total␣
      ↪Patient","Heart Disease Count","Heart Disease Percent"])
     df
```

[8]:

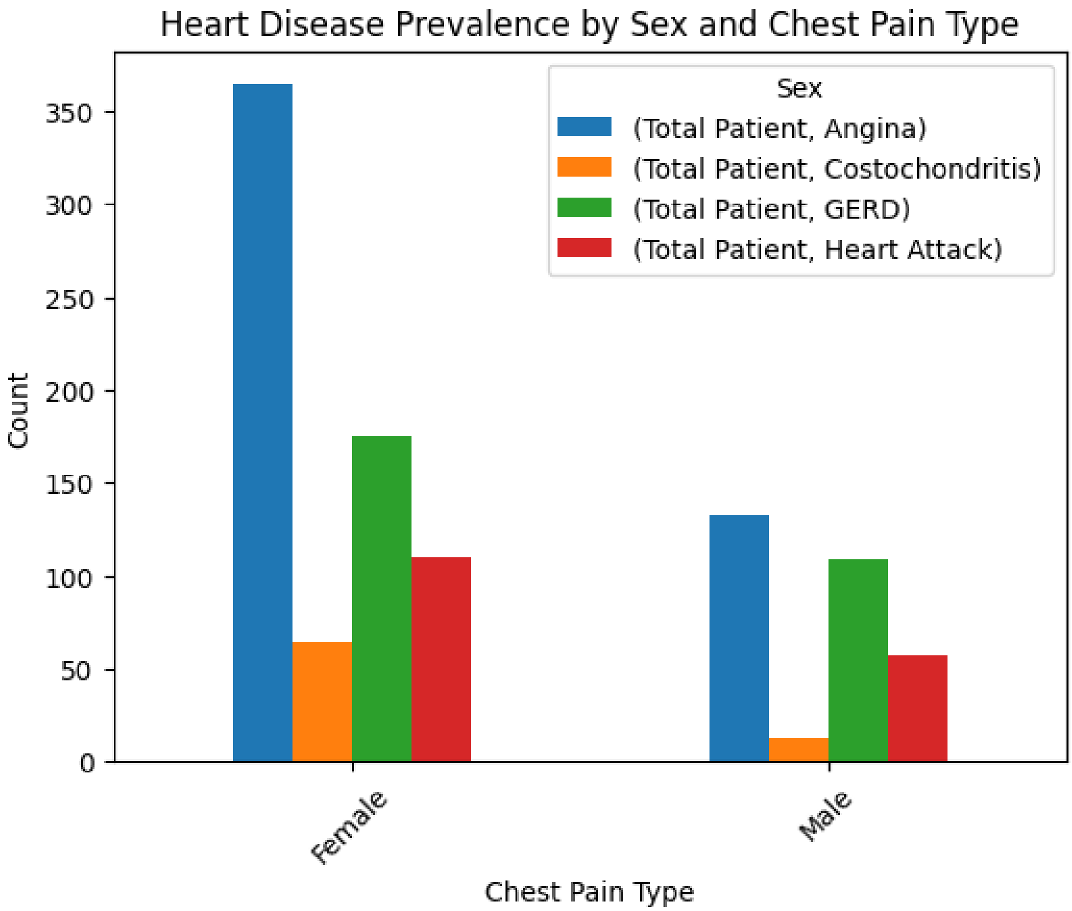
```
      Sex  Chest Pain Type  Total Patient Heart Disease Count  \
0  Female           Angina            364                  64
1  Female  Costochondritis             64                  38
2  Female             GERD            175                 114
3  Female     Heart Attack            110                  84
4    Male           Angina            133                  58
5    Male  Costochondritis             13                  13
6    Male             GERD            109                 105
7    Male     Heart Attack             57                  50

  Heart Disease Percent
0                 17.58
1                 59.38
2                 65.14
3                 76.36
4                 43.61
5                100.00
6                 96.33
7                 87.72
```

[9]:

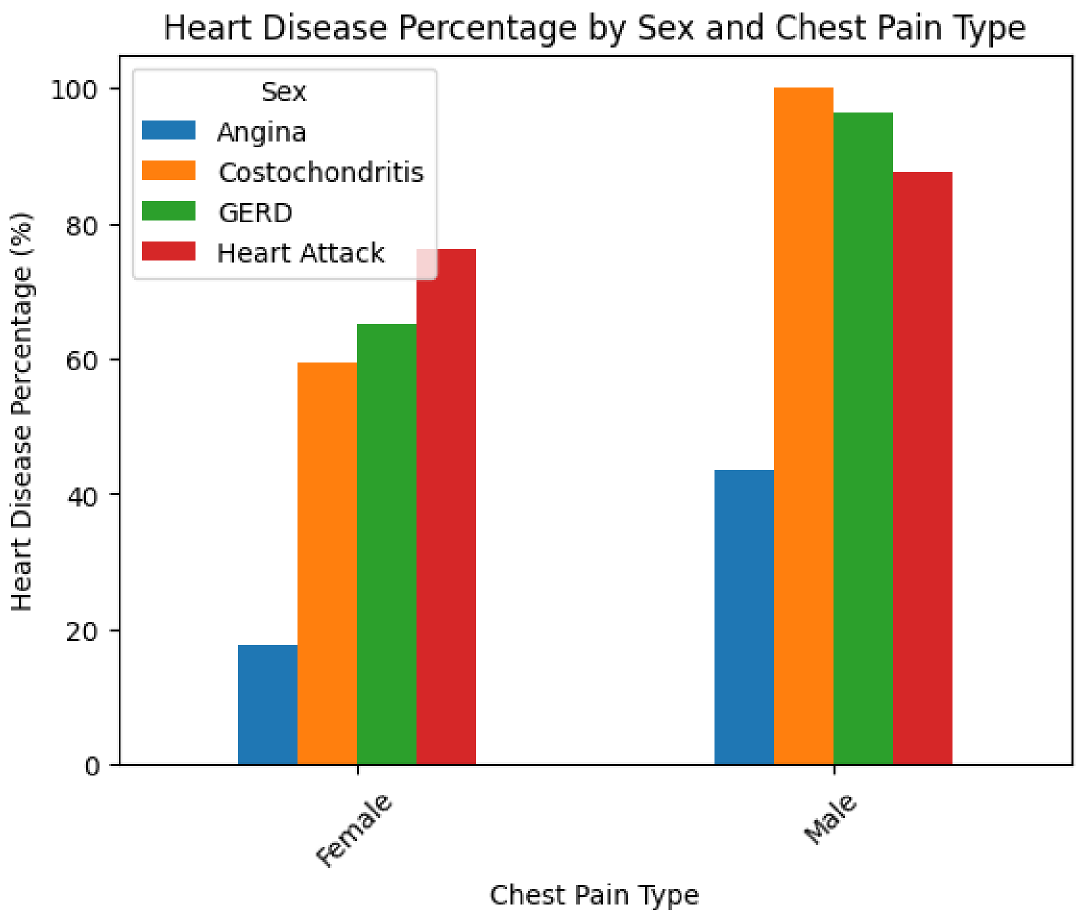
```
plt.figure(figsize=(8, 4))
df.groupby(['Sex', 'Chest Pain Type']).sum().unstack().plot(kind='bar')
plt.title('Heart Disease Prevalence by Sex and Chest Pain Type')
plt.xlabel('Chest Pain Type')
plt.ylabel('Count')
plt.legend(title='Sex')
plt.xticks(rotation=45)
plt.show()

df['Total Patients'] = df.groupby(['Sex', 'Chest Pain Type'])['Sex'].
 ↪transform('size')
pivot_df = df.pivot_table(index='Sex', columns='Chest Pain Type', values='Heart␣
 ↪Disease Percent')
```

```
plt.figure(figsize=(8, 4))
pivot_df.plot(kind='bar')
plt.title('Heart Disease Percentage by Sex and Chest Pain Type')
plt.xlabel('Chest Pain Type')
plt.ylabel('Heart Disease Percentage (%)')
plt.legend(title='Sex')
plt.xticks(rotation=45)
plt.show()
```

```
<Figure size 800x400 with 0 Axes>
```



```
<Figure size 800x400 with 0 Axes>
```



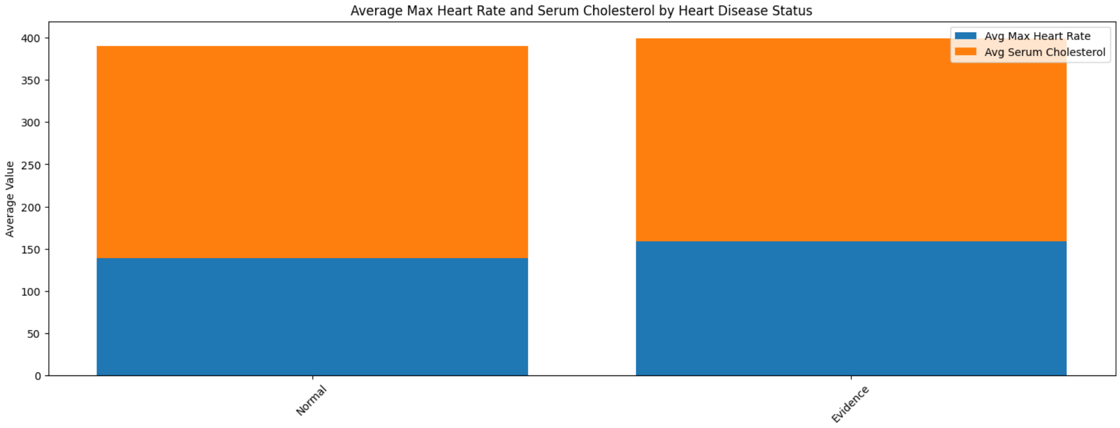
8 Average Max Heart Rate Achieved and Serum Cholesterol by Heart Disease Status.

[10]:

```
query = """SELECT
    HeartDiseaseStatus,
    AVG(MaxHeartRateAchieved) AS AvgMaxHeartRate,
    AVG(SerumCholesterol) AS AvgSerumCholesterol
FROM
    heart.`heart disease`
GROUP BY HeartDiseaseStatus"""
cur.execute(query)
data = cur.fetchall()
df = pd.DataFrame(data, columns = ["Heart Disease Status","Avg of Max Heart␣
 ↪Rate","Avg of Serum Cholesterol"])
df
```

```
[10]:   Heart Disease Status  Avg of Max Heart Rate  Avg of Serum Cholesterol
      0               Normal               139.1303                  251.2926
      1             Evidence               158.5856                  240.9791
```

```
[11]: plt.figure(figsize=(18, 6))
      x = df['Heart Disease Status']
      y1 = df['Avg of Max Heart Rate']
      y2 = df['Avg of Serum Cholesterol']
      plt.bar(x, y1, label='Avg Max Heart Rate')
      plt.bar(x, y2, label='Avg Serum Cholesterol', bottom=y1)
      plt.title('Average Max Heart Rate and Serum Cholesterol by Heart Disease␣
        ↪Status')
      plt.ylabel('Average Value')
      plt.xticks(rotation=45)
      plt.legend()
      plt.show()
```



9 Correlation Between Resting Blood Pressure and Age for Patients with Heart Disease.

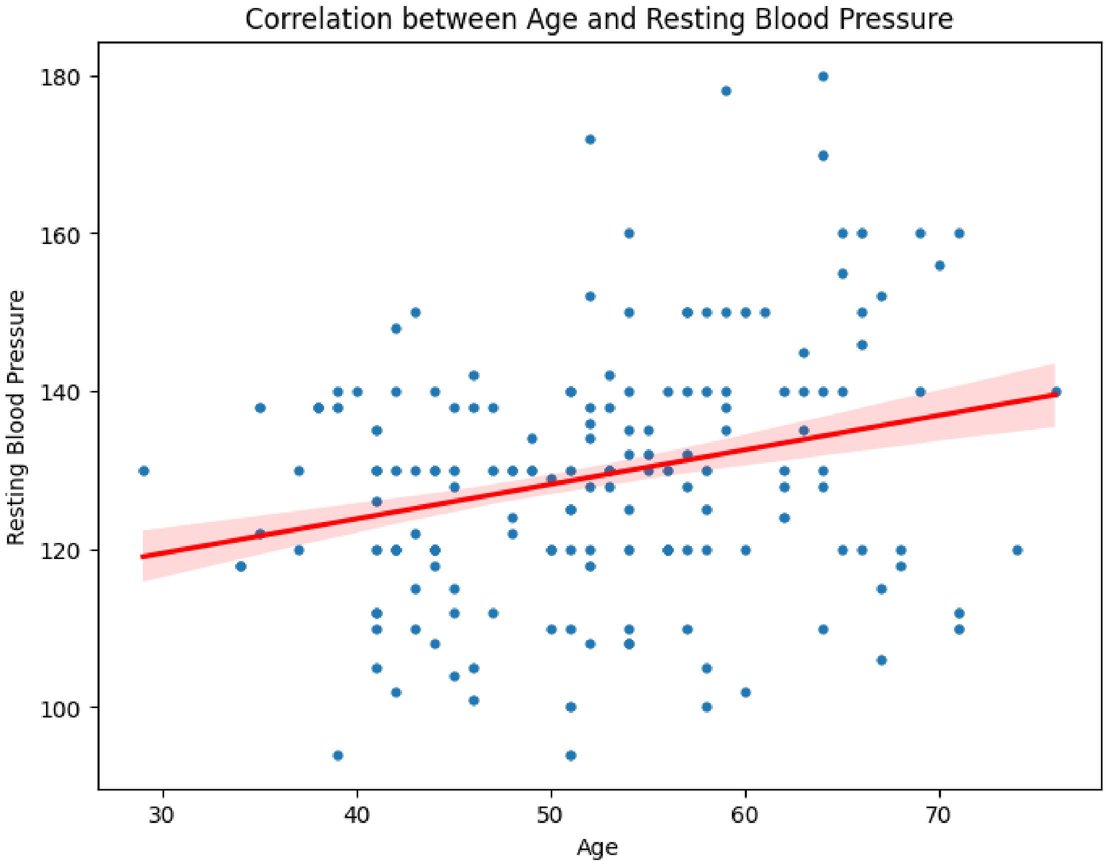
```
[12]: query = """SELECT
          Age,
          RestingBloodPressure
      FROM heart.`heart disease`
      WHERE HeartDiseaseStatus = 'Evidence'
      ORDER BY Age"""
      cur.execute(query)
      data = cur.fetchall()
      df = pd.DataFrame(data, columns = ["Age","Resting Blood Pressure"])
      df
```

[12]:

```
     Age  Resting Blood Pressure
0     29                     130
1     29                     130
2     29                     130
3     29                     130
4     34                     118
..   …                   …
521   74                     120
522   74                     120
523   76                     140
524   76                     140
525   76                     140

[526 rows x 2 columns]
```

[13]:

```
plt.figure(figsize=(8, 6))
sns.regplot(x='Age', y='Resting Blood Pressure', data=df, scatter_kws={'s':10},␣
 ↪line_kws={'color':'red'})
plt.title('Correlation between Age and Resting Blood Pressure')
plt.xlabel('Age')
plt.ylabel('Resting Blood Pressure')
plt.show()
```



10 Distribution of Heart Disease by Major Vessels and Thalassemia Status.

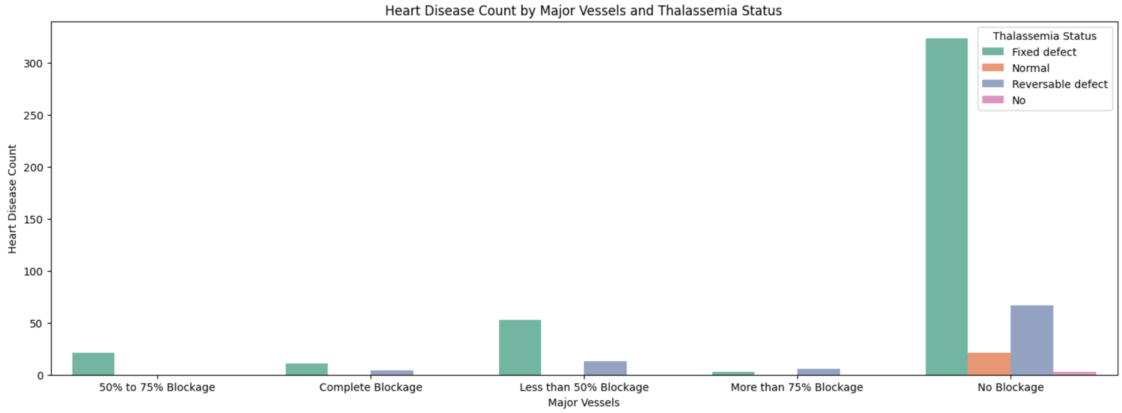
```
[14]: query = """SELECT
          MajorVessels,
          ThalassemiaStatus,
          COUNT(*) AS TotalPatients,
          SUM(CASE
              WHEN HeartDiseaseStatus = 'Evidence' THEN 1
              ELSE 0
          END) AS HeartDiseaseCount,
          ROUND(AVG(CASE
                      WHEN HeartDiseaseStatus = 'Evidence' THEN 1.0
                      ELSE 0
                  END) * 100,
                  2) AS HeartDiseasePercentage
      FROM
          heart.`heart disease`
      GROUP BY MajorVessels , ThalassemiaStatus
      ORDER BY MajorVessels , ThalassemiaStatus"""
      cur.execute(query)
      data = cur.fetchall()
      df = pd.DataFrame(data, columns = ["Major Vessels","Thalassemia Status","Total␣
        ↪Patient","Heart Disease Count","Heart Disease Percentage"])
      df
```

```
[14]:              Major Vessels Thalassemia Status  Total Patient  \
      0      50% to 75% Blockage       Fixed defect             48
      1      50% to 75% Blockage             Normal             13
      2      50% to 75% Blockage  Reversable defect             73
      3        Complete Blockage       Fixed defect             11
      4        Complete Blockage  Reversable defect              7
      5    Less than 50% Blockage       Fixed defect             98
      6    Less than 50% Blockage             Normal             15
      7    Less than 50% Blockage  Reversable defect            113
      8    More than 75% Blockage       Fixed defect             21
      9    More than 75% Blockage             Normal              7
      10   More than 75% Blockage  Reversable defect             41
      11             No Blockage       Fixed defect            366
      12             No Blockage                 No              7
      13             No Blockage             Normal             29
      14             No Blockage  Reversable defect            176
```

```
   Heart Disease Count  Heart Disease Percentage
0                   21                     43.75
1                    0                      0.00
2                    0                      0.00
3                   11                    100.00
4                    4                     57.14
5                   53                     54.08
6                    0                      0.00
7                   13                     11.50
8                    3                     14.29
9                    0                      0.00
10                   6                     14.63
11                 324                     88.52
12                   3                     42.86
13                  21                     72.41
14                  67                     38.07
```

[15]:

```
plt.figure(figsize=(18, 6))
sns.barplot(x='Major Vessels', y='Heart Disease Count', hue='Thalassemia␣
 ↪Status', data=df, palette='Set2')

plt.title('Heart Disease Count by Major Vessels and Thalassemia Status')
plt.xlabel('Major Vessels')
plt.ylabel('Heart Disease Count')
plt.legend(title='Thalassemia Status')
plt.show()
```



11 Effect of Fasting Blood Sugar on Heart Disease.

[16]:

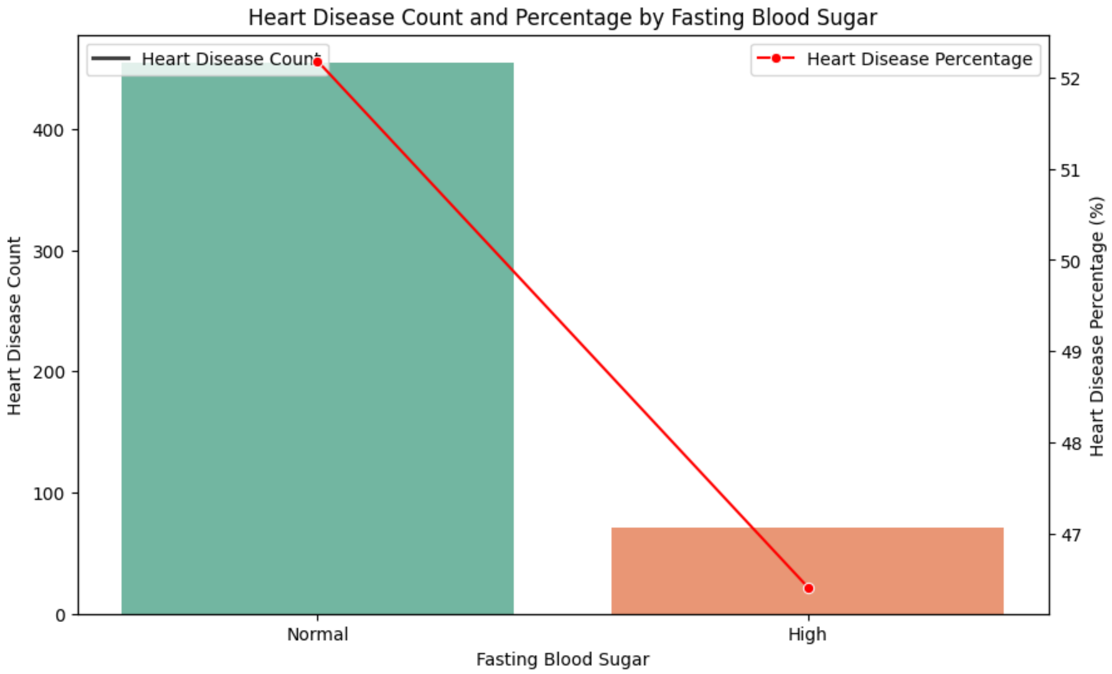
```
query = """SELECT
    FastingBloodSugar,
    COUNT(*) AS TotalPatients,
    SUM(CASE
        WHEN HeartDiseaseStatus = 'Evidence' THEN 1
        ELSE 0
    END) AS HeartDiseaseCount,
    ROUND(AVG(CASE
                WHEN HeartDiseaseStatus = 'Evidence' THEN 1.0
                ELSE 0
            END) * 100,
            2) AS HeartDiseasePercentage
FROM
    heart.`heart disease`
GROUP BY FastingBloodSugar"""
cur.execute(query)
data = cur.fetchall()
df = pd.DataFrame(data, columns = ["Fasting Blood Sugar","Total Patient","Heart␣
 ↪Disease Count","Heart Disease Percentage"])
df
```

[16]:

```
  Fasting Blood Sugar  Total Patient Heart Disease Count  \
0              Normal            872                 455
1                High            153                  71

  Heart Disease Percentage
0                    52.18
1                    46.41
```

[17]:

```
fig, ax1 = plt.subplots(figsize=(10, 6))
sns.barplot(x='Fasting Blood Sugar', y='Heart Disease Count',hue='Fasting Blood␣
 ↪Sugar', data=df, palette='Set2', ax=ax1)
ax1.set_ylabel('Heart Disease Count')
ax1.set_title('Heart Disease Count and Percentage by Fasting Blood Sugar')
ax2 = ax1.twinx()
sns.lineplot(x='Fasting Blood Sugar', y='Heart Disease Percentage', data=df,␣
 ↪color='r', marker='o', ax=ax2)
ax2.set_ylabel('Heart Disease Percentage (%)')
ax1.legend(['Heart Disease Count'], loc='upper left')
ax2.legend(['Heart Disease Percentage'], loc='upper right')
plt.show()
```



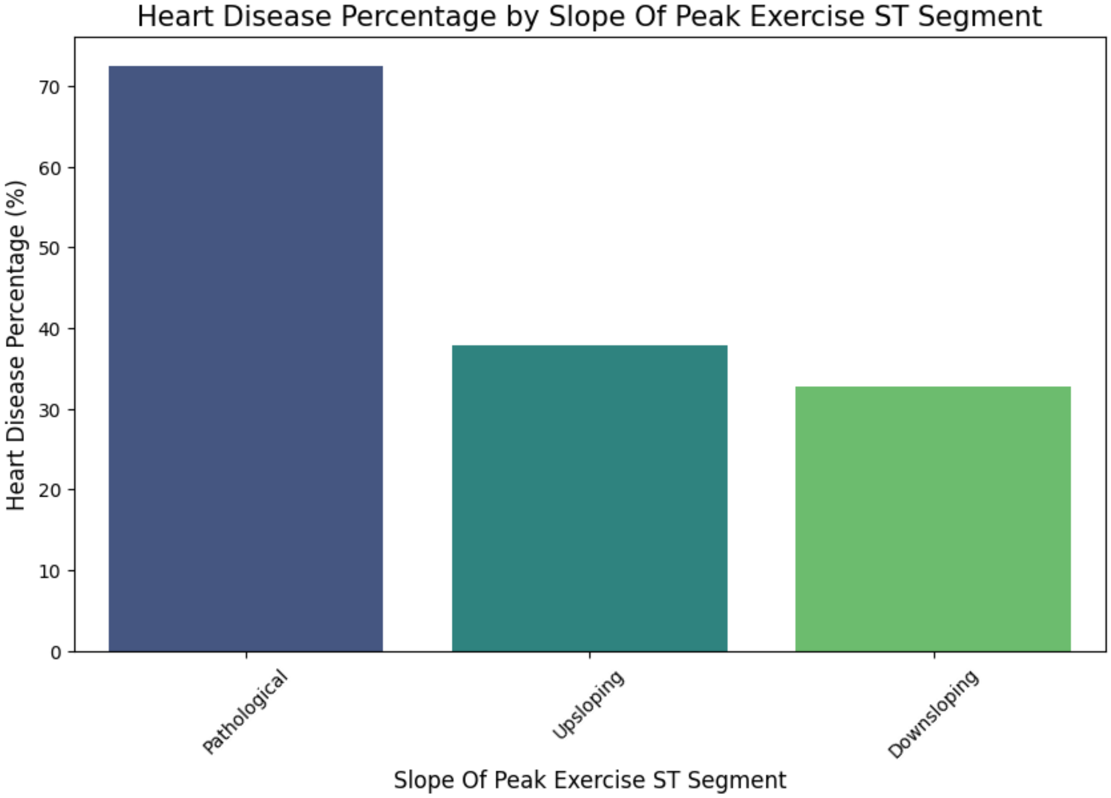
12 Slope of Peak Exercise ST Segment and Its Impact on Heart Disease.

[18]:
```
query = """SELECT
    SlopeOfPeakExerciseSTSegment,
    ROUND(AVG(Oldpeak), 3) AS Avg_Oldpeak,
    ROUND(AVG(CASE
                WHEN HeartDiseaseStatus = 'Evidence' THEN 1
                ELSE 0
            END) * 100,
            3) AS HeartDisease_Percentage
FROM
    heart.`heart disease`
GROUP BY SlopeOfPeakExerciseSTSegment
ORDER BY HeartDisease_Percentage DESC"""
cur.execute(query)
data = cur.fetchall()
df = pd.DataFrame(data, columns = ["Slope Of Peak Exercise ST Segment","AVG Old␣
 ↪Peak","Heart Disease Percentage"])
df
```

[18]:
```
  Slope Of Peak Exercise ST Segment  AVG Old Peak Heart Disease Percentage
0                      Pathological         0.421                   72.495
1                         Upsloping         2.728                   37.838
```

```
2                      Downsloping         1.450                 32.780
```

[19]:
```
plt.figure(figsize=(10, 6))
sns.barplot(
    x='Slope Of Peak Exercise ST Segment',
    y='Heart Disease Percentage', hue='Slope Of Peak Exercise ST Segment',␣
  ↪data=df,
    palette='viridis')
plt.xlabel('Slope Of Peak Exercise ST Segment', fontsize=12)
plt.ylabel('Heart Disease Percentage (%)', fontsize=12)
plt.title('Heart Disease Percentage by Slope Of Peak Exercise ST Segment',␣
  ↪fontsize=15)
plt.xticks(rotation=45)
plt.show()
```



13 Analysis of Thalassemia Status and Its Relationship to Heart Disease.

[20]:

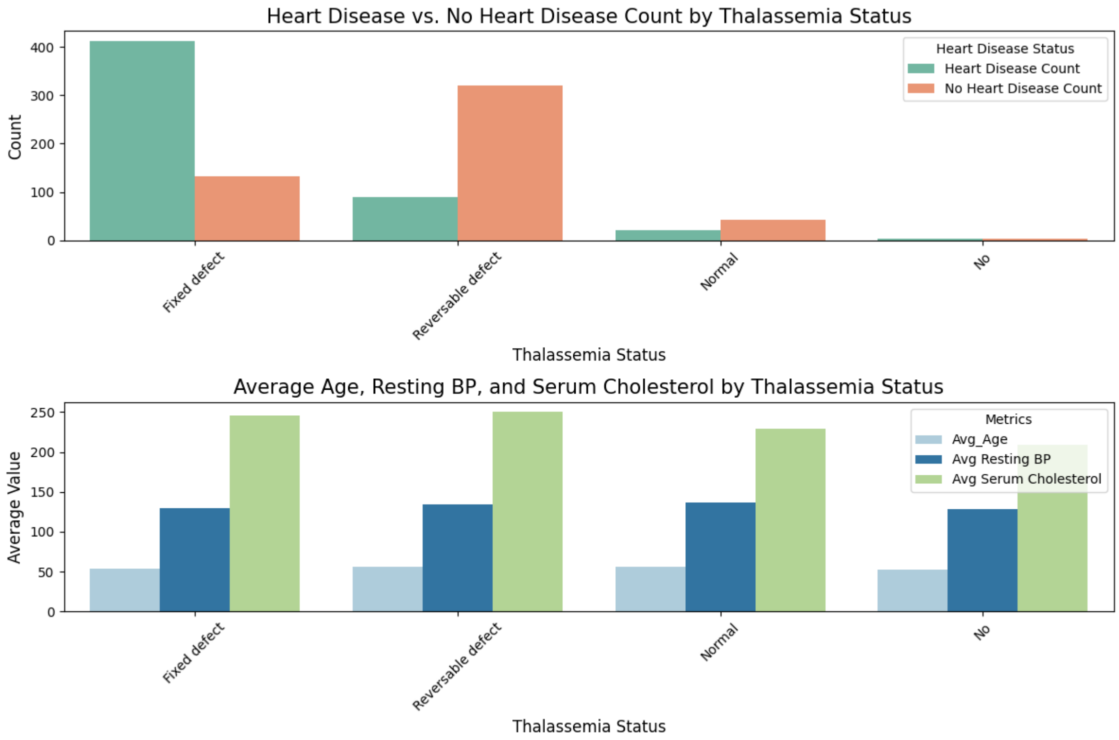
```
query = """SELECT
    ThalassemiaStatus,
    COUNT(CASE WHEN HeartDiseaseStatus = 'Evidence' THEN 1 ELSE NULL END) AS␣
  ↪HeartDisease_Count,
    COUNT(CASE WHEN HeartDiseaseStatus = 'Normal' THEN 1 ELSE NULL END) AS␣
  ↪NoHeartDisease_Count,
    AVG(Age) AS Avg_Age,
    AVG(RestingBloodPressure) AS Avg_RestingBloodPressure,
    AVG(SerumCholesterol) AS Avg_SerumCholesterol
FROM
    heart.`heart disease`
GROUP BY
    ThalassemiaStatus
ORDER BY
    HeartDisease_Count DESC"""
cur.execute(query)
data = cur.fetchall()
df = pd.DataFrame(data, columns = ["Thalassemia Status","Heart Disease␣
  ↪Count","No Heart Disease Count",
                                   "Avg_Age","Avg Resting BP","Avg Serum␣
  ↪Cholesterol"])
df
```

[20]:

```
  Thalassemia Status  Heart Disease Count  No Heart Disease Count  Avg_Age  \
0       Fixed defect                  412                     132  53.3438
1  Reversable defect                   90                     320  55.6488
2             Normal                   21                      43  56.1406
3                 No                    3                       4  52.4286

  Avg Resting BP Avg Serum Cholesterol
0       129.3217              245.3952
1       133.9049              250.0951
2       136.7813              228.9375
3       128.0000              209.1429
```

[21]:

```
plt.figure(figsize=(12, 8))
plt.subplot(2, 1, 1)
df_melted_counts = df.melt(id_vars='Thalassemia Status', value_vars=['Heart␣
  ↪Disease Count', 'No Heart Disease Count'],
                           var_name='Heart Disease Status', value_name='Count')
sns.barplot(
    x='Thalassemia Status',
    y='Count',
    hue='Heart Disease Status',
    data=df_melted_counts,
    palette='Set2')
plt.xlabel('Thalassemia Status', fontsize=12)
plt.ylabel('Count', fontsize=12)
plt.title('Heart Disease vs. No Heart Disease Count by Thalassemia Status',␣
 ↪fontsize=15)
plt.xticks(rotation=45)
plt.legend(title='Heart Disease Status')
plt.subplot(2, 1, 2)
df_melted_avgs = df.melt(id_vars='Thalassemia Status', value_vars=['Avg_Age',␣
 ↪'Avg Resting BP', 'Avg Serum Cholesterol'],
                         var_name='Metrics', value_name='Average')
sns.barplot(
    x='Thalassemia Status',
    y='Average',
    hue='Metrics',
    data=df_melted_avgs,
    palette='Paired')
plt.xlabel('Thalassemia Status', fontsize=12)
plt.ylabel('Average Value', fontsize=12)
plt.title('Average Age, Resting BP, and Serum Cholesterol by Thalassemia␣
 ↪Status', fontsize=15)
plt.xticks(rotation=45)
plt.legend(title='Metrics')
plt.tight_layout()
plt.show()
```



14 Max Heart Rate Achieved by Chest Pain Type and Heart Disease Status.

[22]:

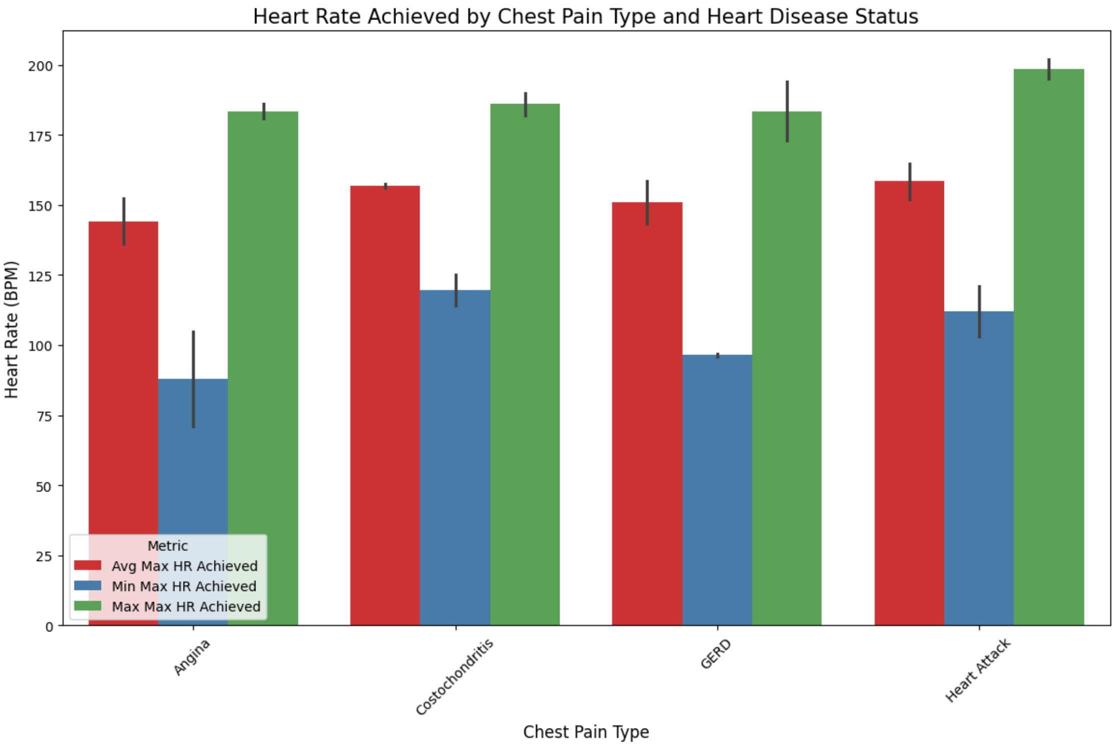
```
query = """SELECT
    ChestPainType,
    HeartDiseaseStatus,
    AVG(MaxHeartRateAchieved) AS Avg_MaxHeartRateAchieved,
    MIN(MaxHeartRateAchieved) AS Min_MaxHeartRateAchieved,
    MAX(MaxHeartRateAchieved) AS Max_MaxHeartRateAchieved
FROM
    heart.`heart disease`
GROUP BY
    ChestPainType, HeartDiseaseStatus
ORDER BY
    ChestPainType, HeartDiseaseStatus"""
cur.execute(query)
data = cur.fetchall()
df = pd.DataFrame(data, columns = ["Chest Pain Type","Heart Disease␣
  ↪Status","Avg Max HR Achieved",
                                   "Min Max HR Achieved","Max Max HR Achieved"])
df
```

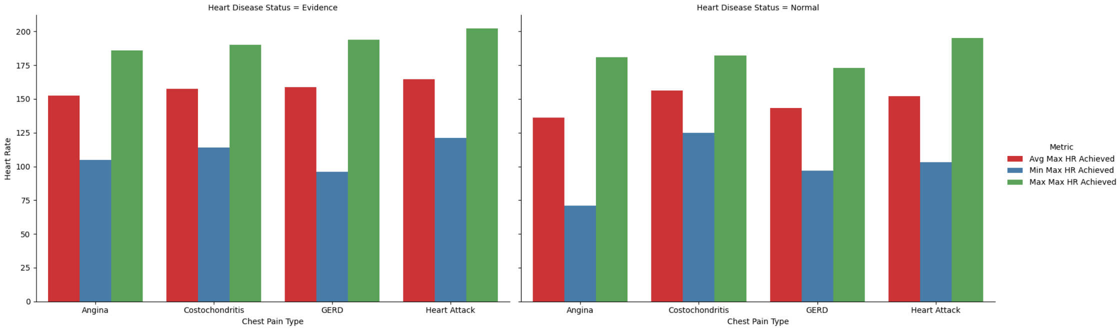
[22]:

```
   Chest Pain Type Heart Disease Status Avg Max HR Achieved  \
0           Angina             Evidence            152.2951
1           Angina               Normal            136.0693
2  Costochondritis             Evidence            157.6471
3  Costochondritis               Normal            156.1154
4             GERD             Evidence            158.5890
5             GERD               Normal            143.4154
6     Heart Attack             Evidence            164.6642
7     Heart Attack               Normal            152.0909

   Min Max HR Achieved  Max Max HR Achieved
0                  105                  186
1                   71                  181
2                  114                  190
3                  125                  182
4                   96                  194
5                   97                  173
6                  121                  202
7                  103                  195
```

[23]:

```
plt.figure(figsize=(14, 8))
df_melted = df.melt(id_vars=["Chest Pain Type", "Heart Disease Status"],
                    value_vars=["Avg Max HR Achieved", "Min Max HR Achieved",␣
 ↪"Max Max HR Achieved"],
                    var_name="Metric", value_name="Heart Rate")
hue_order = ["Avg Max HR Achieved", "Min Max HR Achieved", "Max Max HR␣
 ↪Achieved"]
sns.barplot(
    x="Chest Pain Type",
    y="Heart Rate",
    hue="Metric",
    data=df_melted,
    palette="Set1",
    hue_order=hue_order)
plt.xlabel('Chest Pain Type', fontsize=12)
plt.ylabel('Heart Rate (BPM)', fontsize=12)
plt.title('Heart Rate Achieved by Chest Pain Type and Heart Disease Status',␣
 ↪fontsize=15)
plt.legend(title='Metric')
plt.xticks(rotation=45)
g = sns.FacetGrid(df_melted, col="Heart Disease Status", height=6, aspect=1.5,␣
 ↪sharey=True)
g.map_dataframe(sns.barplot, x="Chest Pain Type", y="Heart Rate", hue="Metric",␣
 ↪hue_order=hue_order, palette="Set1")
g.add_legend(title="Metric")
plt.show()
```





15 Average Resting Blood Pressure by Age Group and Heart Disease Status.

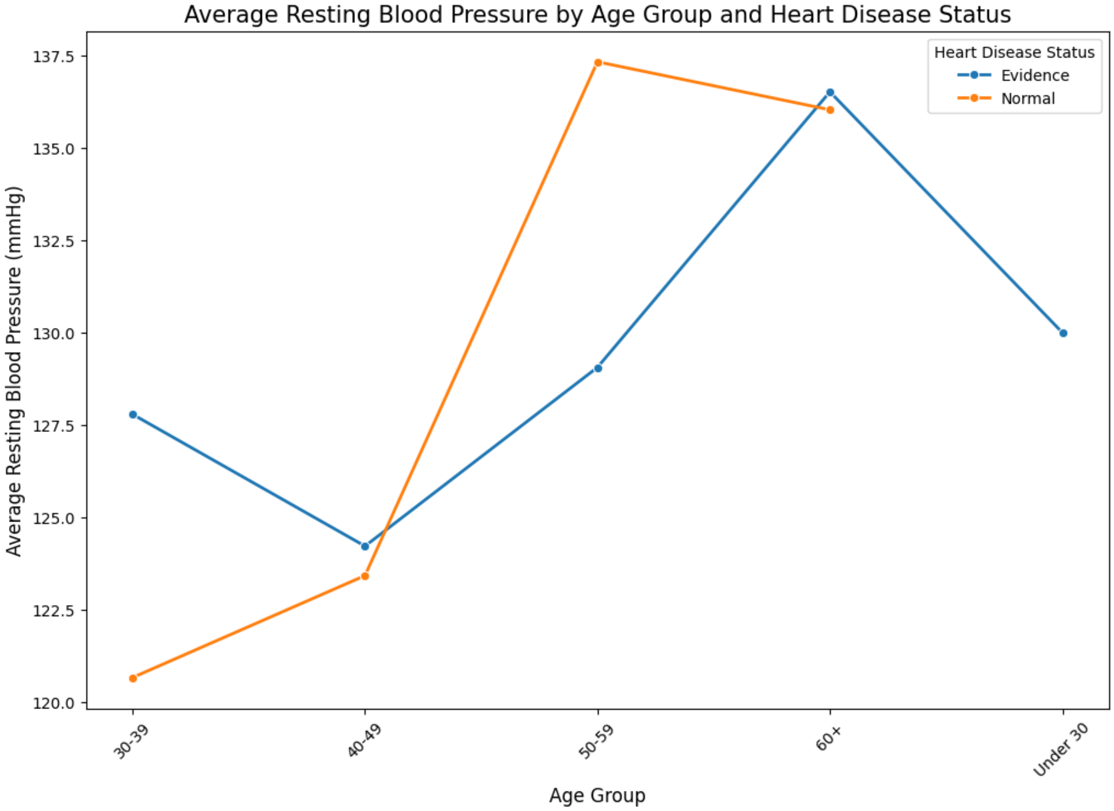
[24]:
```
query = """SELECT
    CASE
        WHEN Age < 30 THEN 'Under 30'
        WHEN Age BETWEEN 30 AND 39 THEN '30-39'
        WHEN Age BETWEEN 40 AND 49 THEN '40-49'
        WHEN Age BETWEEN 50 AND 59 THEN '50-59'
        WHEN Age >= 60 THEN '60+'
    END AS Age_Group,
    HeartDiseaseStatus,
    AVG(RestingBloodPressure) AS Avg_RestingBloodPressure
FROM
    heart.`heart disease`
GROUP BY
    Age_Group, HeartDiseaseStatus
ORDER BY
    Age_Group, HeartDiseaseStatus"""
cur.execute(query)
data = cur.fetchall()
df = pd.DataFrame(data, columns = ["Age Group","Heart Disease Status","Avg␣
 ↪Resting BP"])
df
```

[24]:

```
  Age Group Heart Disease Status Avg Resting BP
0     30-39             Evidence       127.7895
1     30-39               Normal       120.6667
2     40-49             Evidence       124.2229
3     40-49               Normal       123.4250
4     50-59             Evidence       129.0583
5     50-59               Normal       137.3241
6       60+             Evidence       136.5124
7       60+               Normal       136.0266
8  Under 30             Evidence       130.0000
```

[25]:

```
plt.figure(figsize=(12, 8))
sns.lineplot(
    x='Age Group',
    y='Avg Resting BP',
    hue='Heart Disease Status',
    data=df,
    palette='tab10',
    marker='o',
    linewidth=2)
plt.xlabel('Age Group', fontsize=12)
plt.ylabel('Average Resting Blood Pressure (mmHg)', fontsize=12)
plt.title('Average Resting Blood Pressure by Age Group and Heart Disease␣
 ↪Status', fontsize=15)
plt.legend(title='Heart Disease Status')
plt.xticks(rotation=45)
plt.show()
```

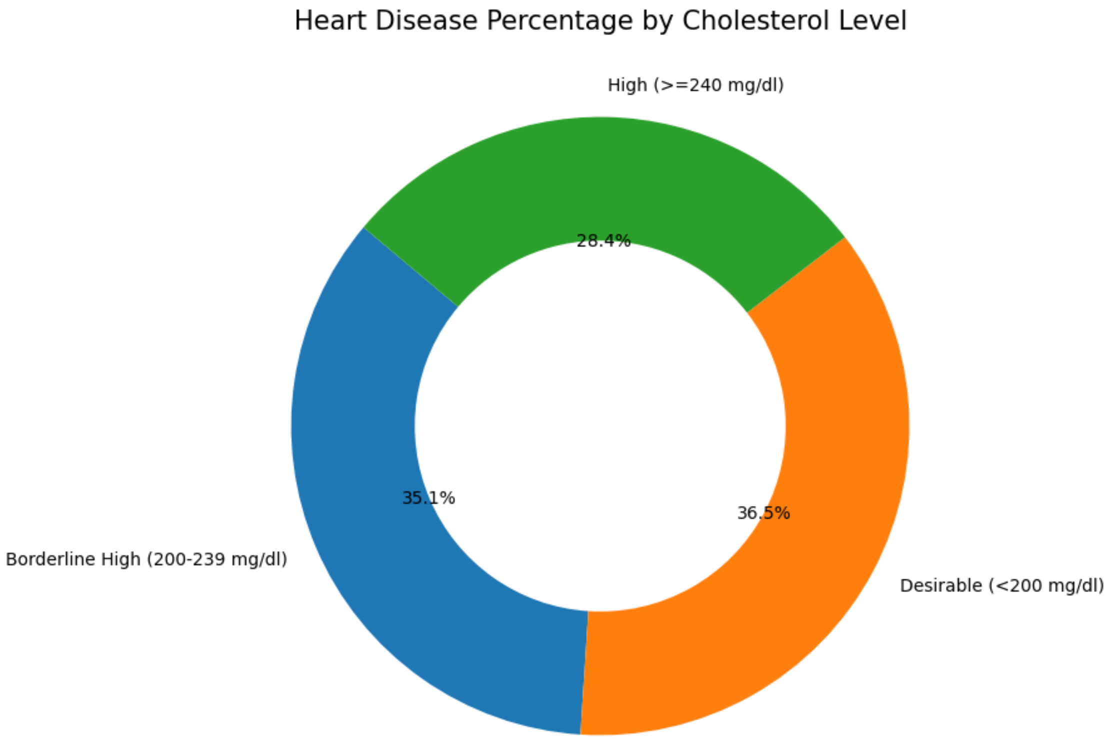


16 Impact of Serum Cholesterol on Heart Disease.

[26]:
```
query = """SELECT
    CASE
        WHEN SerumCholesterol < 200 THEN 'Desirable (<200 mg/dl)'
        WHEN SerumCholesterol BETWEEN 200 AND 239 THEN 'Borderline High␣
 ↪(200-239 mg/dl)'
        ELSE 'High (>=240 mg/dl)'
    END AS Cholesterol_Level,
    AVG(CASE WHEN HeartDiseaseStatus = 'Evidence' THEN 1 ELSE 0 END) * 100 AS␣
 ↪HeartDisease_Percentage
FROM
    heart.`heart disease`
GROUP BY
    Cholesterol_Level"""
cur.execute(query)
data = cur.fetchall()
df = pd.DataFrame(data, columns = ["Cholesterol Level","Heart Disease␣
 ↪Percentage"])
df
```

```
[26]:                    Cholesterol Level  Heart Disease Percentage
      0  Borderline High (200-239 mg/dl)                   56.3422
      1            Desirable (<200 mg/dl)                   58.5799
      2                High (>=240 mg/dl)                   45.6480
```

```
[27]: plt.figure(figsize=(8, 8))
      plt.pie(
          df['Heart Disease Percentage'],
          labels=df['Cholesterol Level'],
          autopct='%1.1f%%',
          colors=plt.get_cmap('tab10').colors,
          startangle=140,
          wedgeprops=dict(width=0.4))
      plt.title('Heart Disease Percentage by Cholesterol Level', fontsize=15)
      plt.show()
```



17 Conclusion:

[28]:

```
# Successful heart disease diagnostic analysis reveals key risk factors using Python and SQL techniques.
# SQL queries efficiently extracted insights from heart disease data for effective pattern recognition.
# Python visualizations enhanced understanding of age, cholesterol, and blood pressure's role in heart disease.
# Advanced analytics helped identify correlations between chest pain types and heart disease occurrence.
# Project enabled data-driven recommendations for early diagnosis and preventive measures against heart disease.
```

18 Presented By Kumar Siddharth.

19 Thank You.