In [ ]:
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# DSC 530
# Gracie Inman
# Final Project
# 08/12/23
```

In [49]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import scipy.stats as stats
import statsmodels.api as sm

NUM_BINS = 20
# Step 1: Load the dataset
def load_dataset(filename):
    return pd.read_csv(filename)

# Step 2: Describe the 5 variables
# Heart rate is the patient's heart rate.
## Sleep duration is how long the patient slept
## Sleep quality quantifies the quality of the sleep
## Physical activity level quantifies how active the patient is.
## Age is how old the subject is.
## Stress Level is how stressed the subject feels quantified.

# Step 3: Create histograms and identify outliers (Chapter 2)
def plot_histogram_with_outliers(data, column):
    plt.figure(figsize=(8, 6))
    plt.hist(data[column], bins=NUM_BINS, edgecolor='k', alpha=0.7)
    plt.xlabel(column)
    plt.ylabel('Frequency')
    plt.title(f'Histogram of {column}')
    plt.grid(True)
    plt.show()

# Plot histograms for each variable and identify outliers
variables = ['Gender', 'Age', 'Sleep Duration', 'Quality of Sleep', 'Physical A
for var in variables:
    plot_histogram_with_outliers(data, var)

# Step 4: Calculate descriptive characteristics (Chapter 2)
def calculate_descriptive_stats(data, column):
    mean = data[column].mean()
    mode = data[column].mode()[0]
    spread = data[column].std()
    tails = data[column].skew()
    return mean, mode, spread, tails

# Step 5: Compare scenarios using PMF (Chapter 3)
def plot_pmf(data, column, scenario_column, scenario_value):
    filtered_data = data[data[scenario_column] == scenario_value]
    pmf = filtered_data[column].value_counts(normalize=True).sort_index()

    plt.bar(pmf.index, pmf.values)
    plt.xlabel(column)
    plt.ylabel('PMF')
    plt.title(f'PMF of {column} for {scenario_column} = {scenario_value}')
    plt.grid(True)
    plt.show()
```

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# Step 6: Create a CDF (Chapter 4)
def plot_cdf(data, column):
    plt.figure(figsize=(8, 6))
    sorted_data = np.sort(data[column])
    cdf = np.arange(1, len(sorted_data) + 1) / len(sorted_data)
    plt.plot(sorted_data, cdf)
    plt.xlabel(column)
    plt.ylabel('CDF')
    plt.title(f'CDF of {column}')
    plt.grid(True)
    plt.show()

# Step 7: Plot an analytical distribution and provide analysis (Chapter 5)
def plot_analytical_distribution(data, column, distribution=stats.norm):
    plt.figure(figsize=(8, 6))

    # Plot the histogram or KDE of the data
    plt.hist(data[column], bins=20, density=True, alpha=0.7, label='Data')

    # Plot the analytical distribution
    xmin, xmax = plt.xlim()
    x = np.linspace(xmin, xmax, 100)
    params = distribution.fit(data[column])
    pdf = distribution.pdf(x, *params)
    plt.plot(x, pdf, 'r', label='Analytical Distribution')

    plt.xlabel(column)
    plt.ylabel('Density')
    plt.title(f'Analytical Distribution vs. Data Distribution of {column}')
    plt.legend()
    plt.grid(True)

    # Adjust y-axis limits for better visibility
    plt.ylim([0, max(pdf) * 1.0])

    plt.show()

# Step 8: Create scatter plots and analyze correlation and causation (Chapter 7
def plot_scatter(data, x_column, y_column):
    plt.figure(figsize=(8, 6))
    plt.scatter(data[x_column], data[y_column], alpha=0.5)
    plt.xlabel(x_column)
    plt.ylabel(y_column)
    plt.title(f'Scatter Plot of {x_column} vs {y_column}')
    plt.grid(True)
    plt.show()



# Step 9: Conduct a hypothesis test (Chapter 9)
def conduct_hypothesis_test(data, variable1, variable2):
    group1 = data[data[variable2] == 'Male'][variable1]
    group2 = data[data[variable2] == 'Female'][variable1]

    # Perform a hypothesis test (t-test)
    t_stat, p_value = stats.ttest_ind(group1, group2)

    # Provide interpretation of results
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    if p_value < 0.05:
        result = "Reject null hypothesis: There is a significant difference bet
    else:
        result = "Fail to reject null hypothesis: There is no significant diffe

    print(f"T-Stat: {t_stat}")
    print(f"P-Value: {p_value}")
    print(result)
# ...

# Step 10: Conduct a regression analysis (Chapter 10 & 11)
def conduct_regression_analysis(data, dependent_variable, explanatory_variables
    X = sm.add_constant(data[explanatory_variables])
    y = data[dependent_variable]
    model = sm.OLS(y, X).fit()

    # Print regression summary and interpret results
    print(model.summary())

def analyze_variable(column_data):
    if column_data.dtype.kind in "biufc":
        # If the data is numerical, perform statistical analysis
        stats = {
            "Mean": column_data.mean(),
            "Median": column_data.median(),
            "Standard Deviation": column_data.std(),
            "Minimum": column_data.min(),
            "Maximum": column_data.max(),
        }
    else:
        # If the data is non-numerical, count occurrences of each value
        counts = column_data.value_counts()
        stats = {value: count for value, count in counts.items()}
    return stats

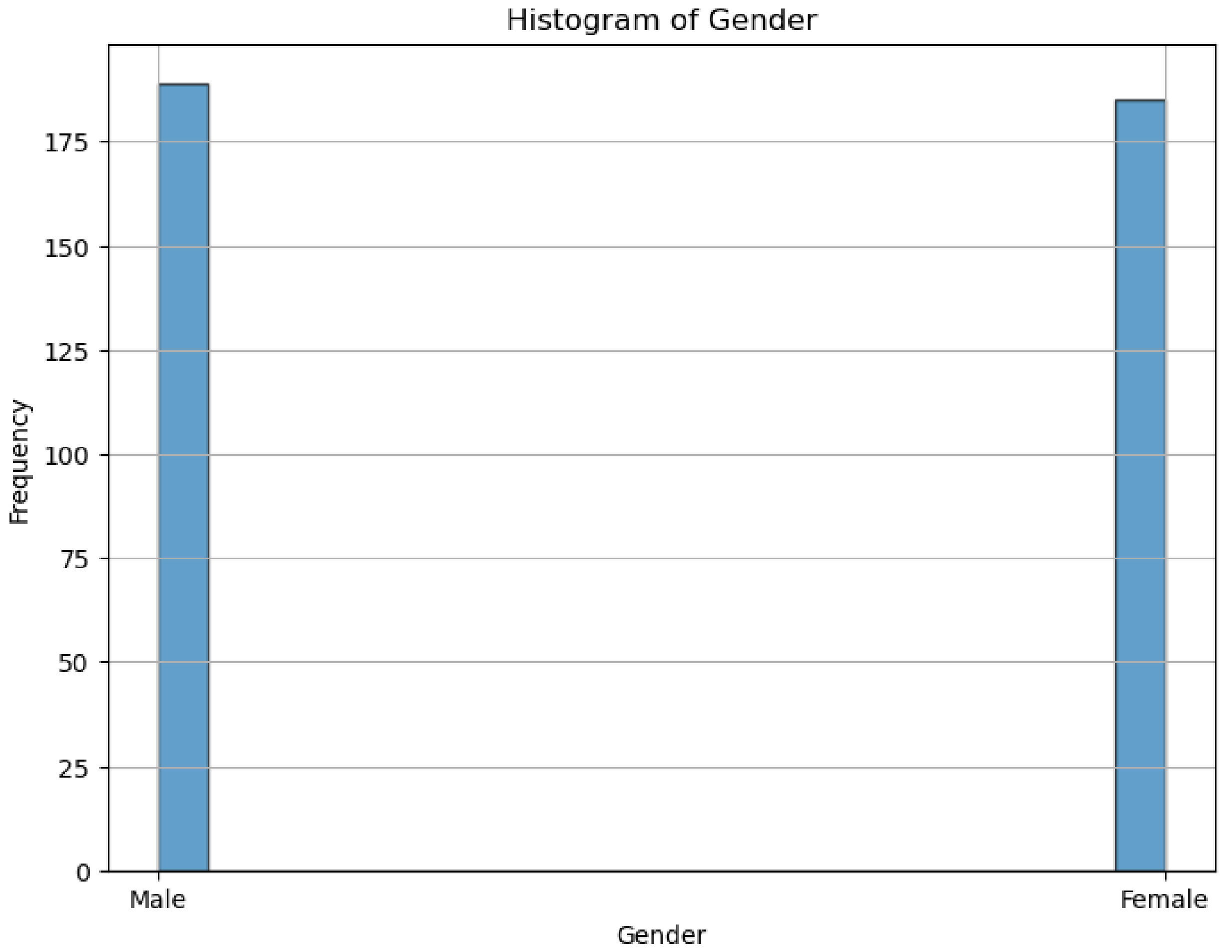
def correlation_matrix(data_frame):
    correlation_matrix = data_frame.corr()
    return correlation_matrix

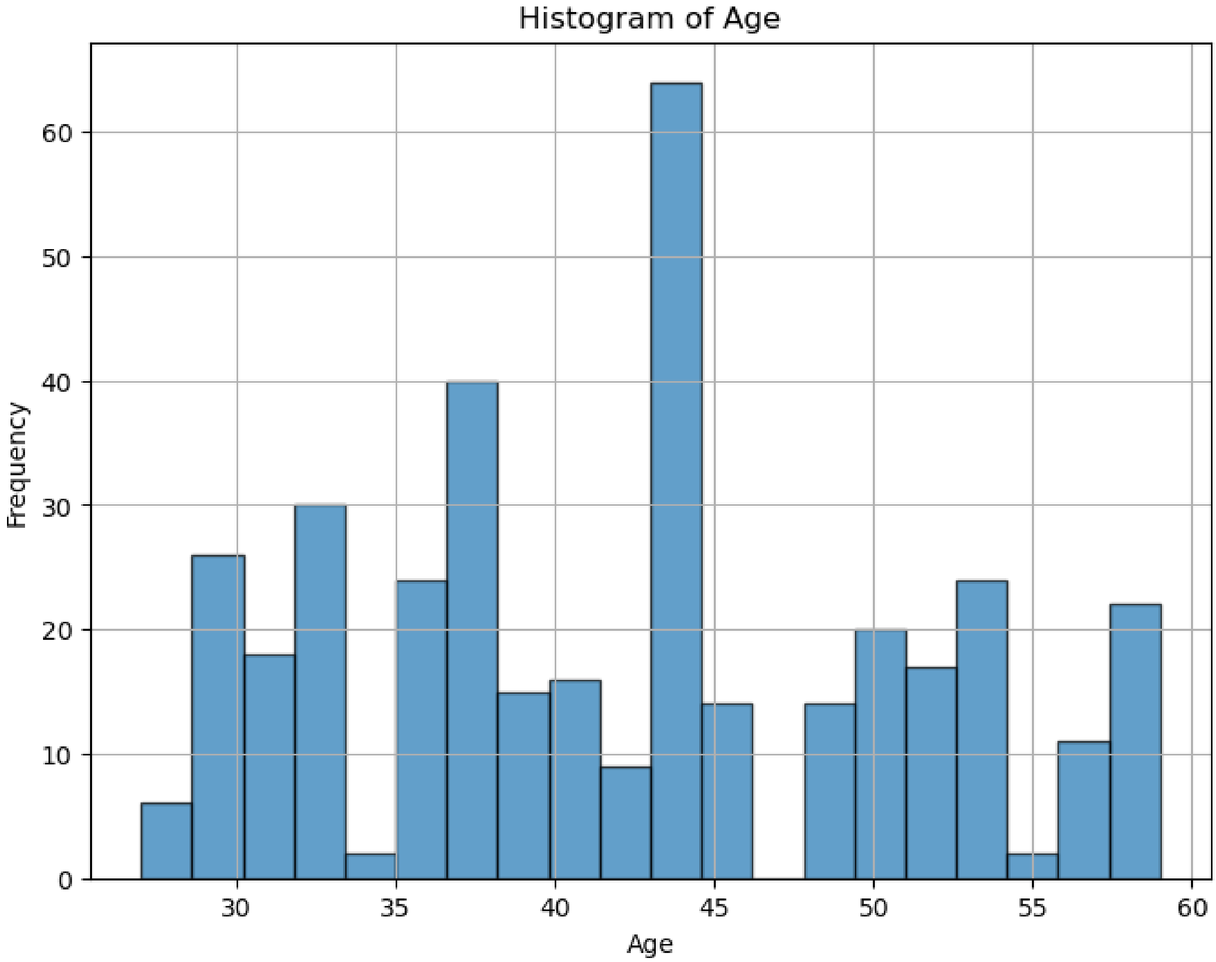
def main():
    # Call the functions to perform the analyses
    data = load_dataset('Sleep_health_and_lifestyle_dataset.csv')

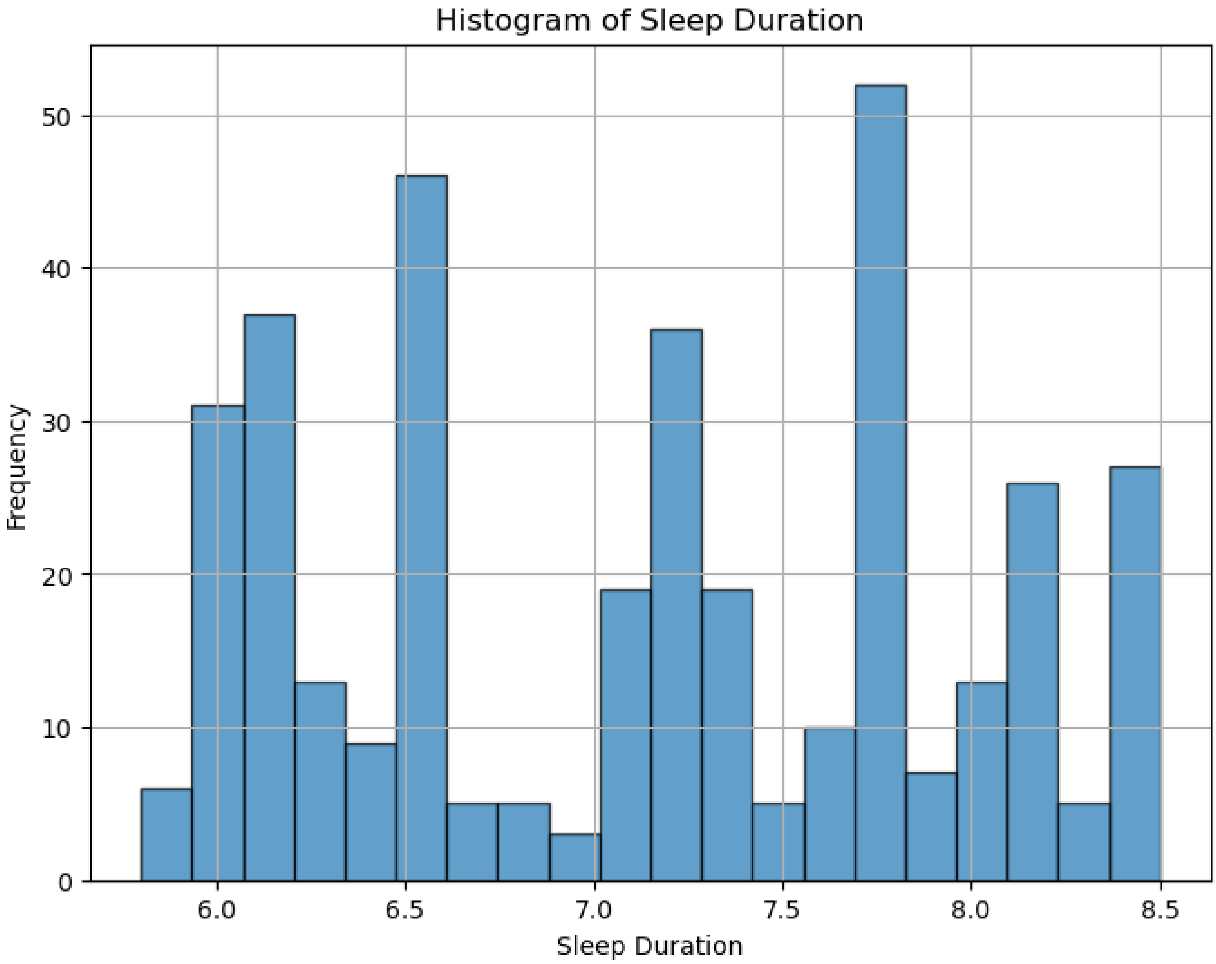
    # Calculate and display descriptive statistics
    variables_to_analyze = ['Age', 'Sleep Duration', 'Quality of Sleep', 'Heart
    for variable in variables_to_analyze:
        stats = calculate_descriptive_stats(data, variable)
        print(f"Descriptive Statistics for {variable}:")
        print(f"  Mean: {stats[0]:.2f}")
        print(f"  Mode: {stats[1]:.2f}")
        print(f"  Standard Deviation: {stats[2]:.2f}")
        print(f"  Skewness: {stats[3]:.2f}")
        print()
    plot_analytical_distribution(data, 'Quality of Sleep')
    plot_histogram_with_outliers(data, 'Physical Activity Level')
    plot_pmf(data, 'Sleep Duration', 'Gender', 'Male')
    plot_cdf(data, 'Quality of Sleep')
    plot_analytical_distribution(data, 'Physical Activity Level')
    plot_scatter(data, 'Heart Rate', 'Age')
    plot_scatter(data, 'Quality of Sleep', 'Heart Rate')
```

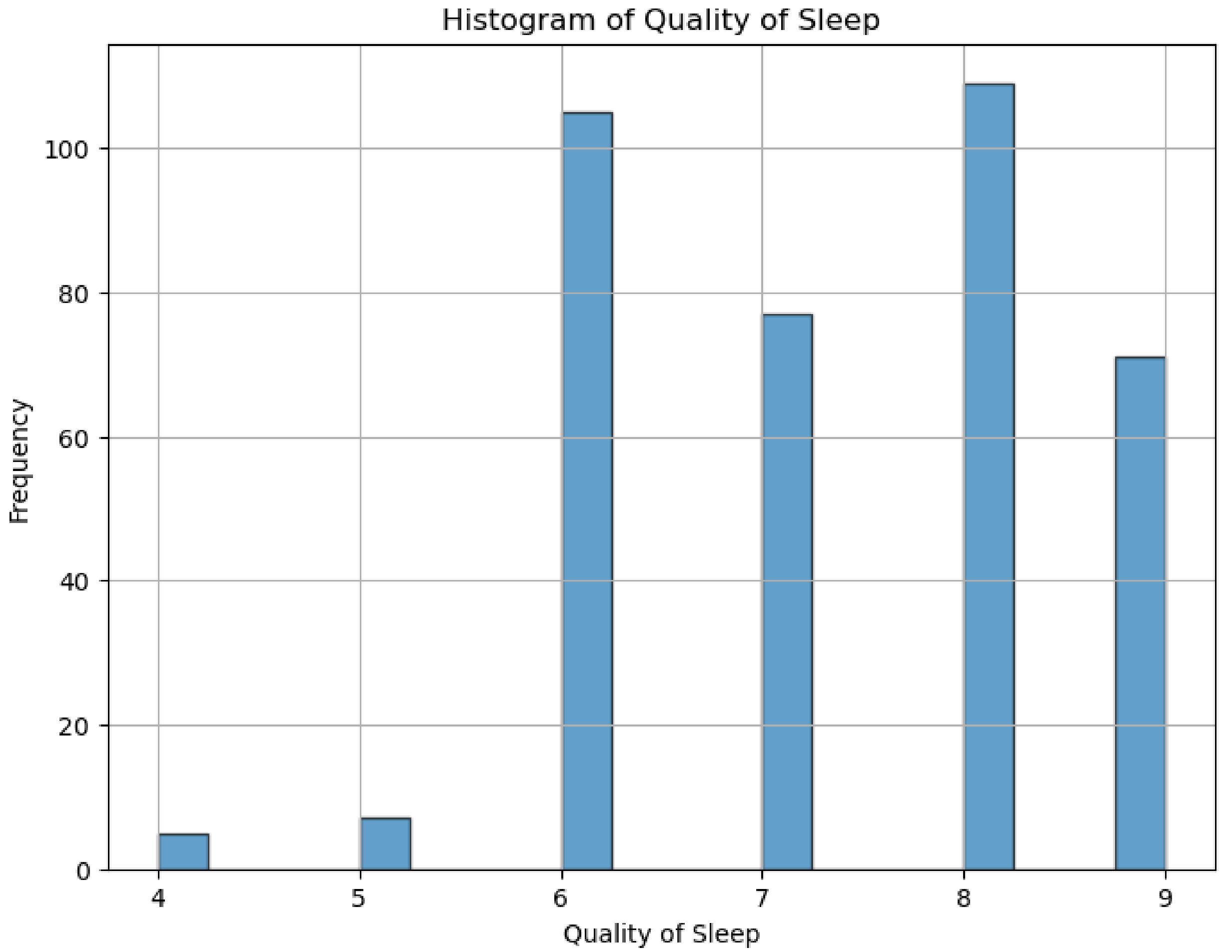
```
    conduct_hypothesis_test(data, 'Quality of Sleep', 'Gender')
    conduct_regression_analysis(data, 'Heart Rate', ['Sleep Duration', 'Age'])

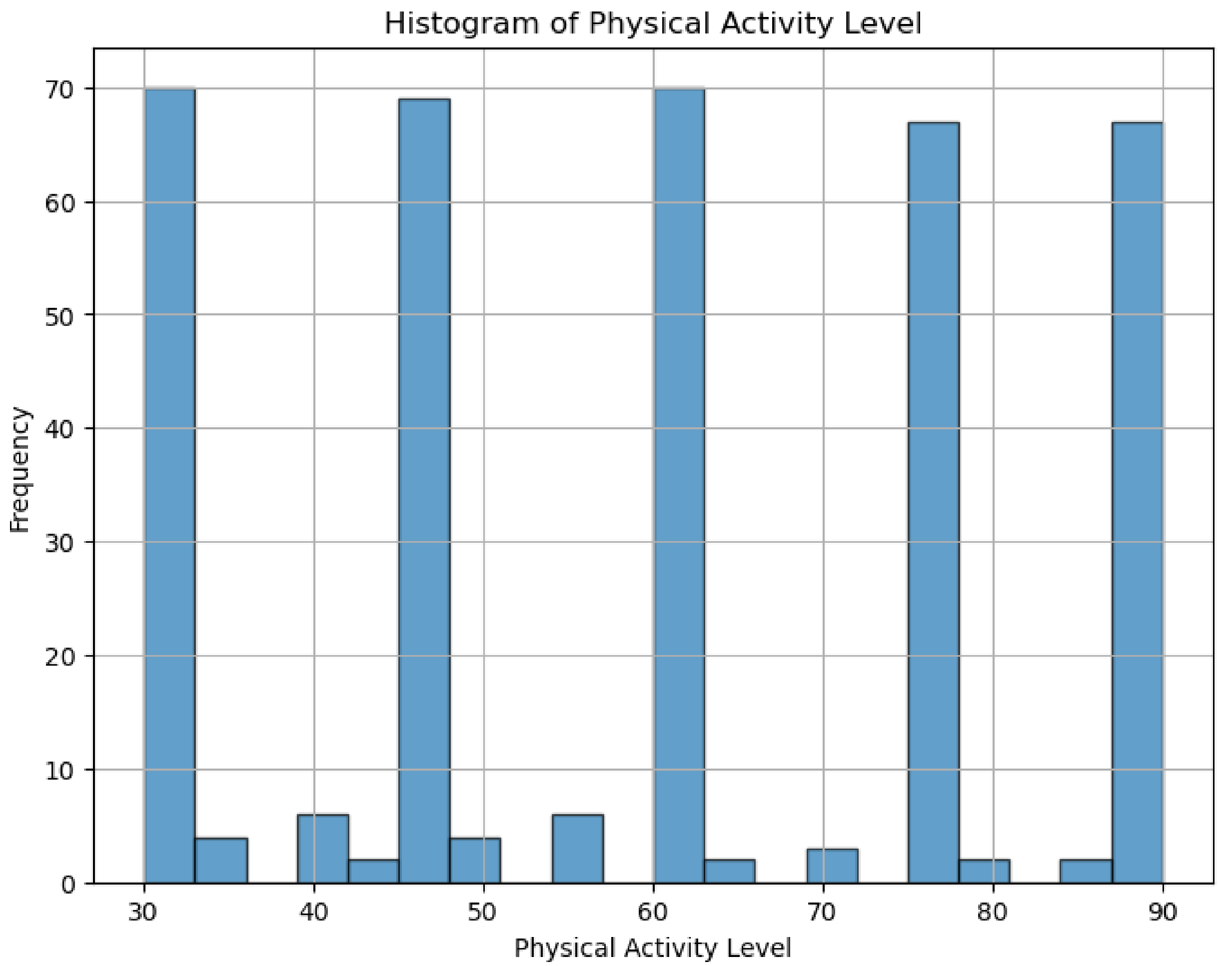
if __name__ == "__main__":
    main()
```

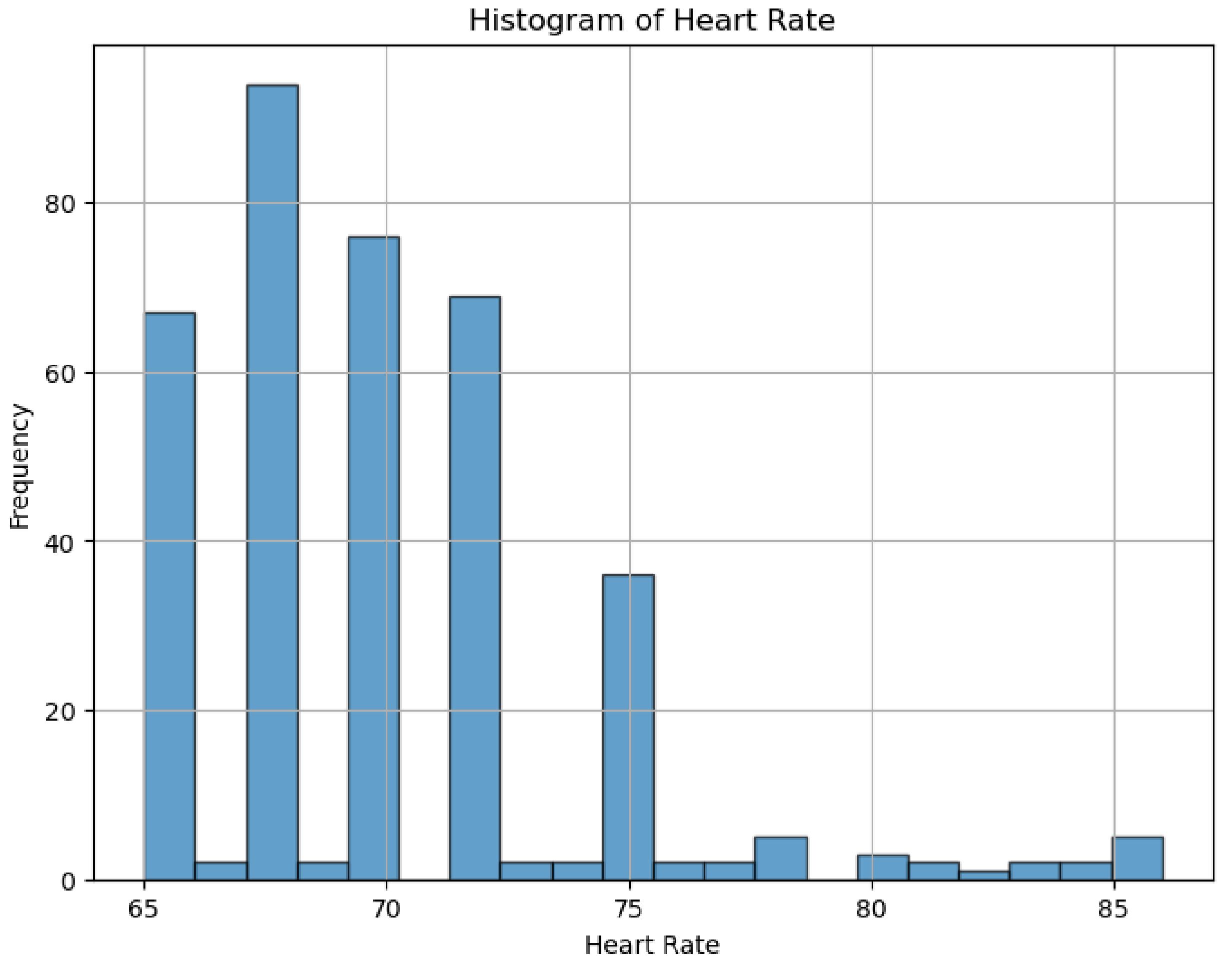



Histogram of Age
Frequency
Age
0
10
20
30
40
50
60
30
35
40
45
50
55
60


Histogram of Sleep Duration
Frequency
Sleep Duration
0
10
20
30
40
50
6.0
6.5
7.0
7.5
8.0
8.5


Histogram of Quality of Sleep
Frequency
0
20
40
60
80
100
4
5
6
7
8
9
Quality of Sleep


Histogram of Physical Activity Level
Frequency
Physical Activity Level
0
10
20
30
40
50
60
70
30
40
50
60
70
80
90


Histogram of Heart Rate
Frequency
Heart Rate
0
20
40
60
80
65
70
75
80
85

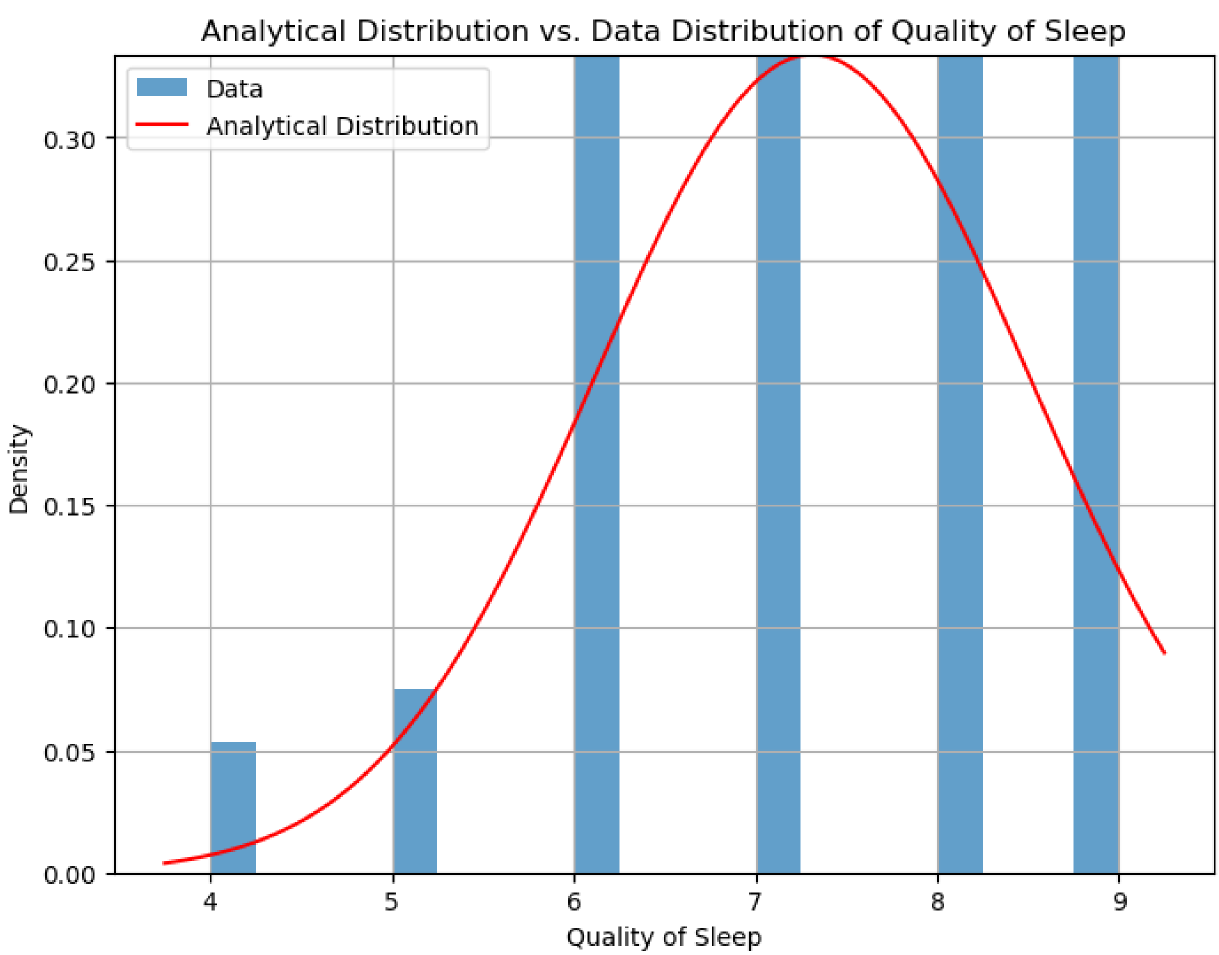
```
Descriptive Statistics for Age:
  Mean: 42.18
  Mode: 43.00
  Standard Deviation: 8.67
  Skewness: 0.26

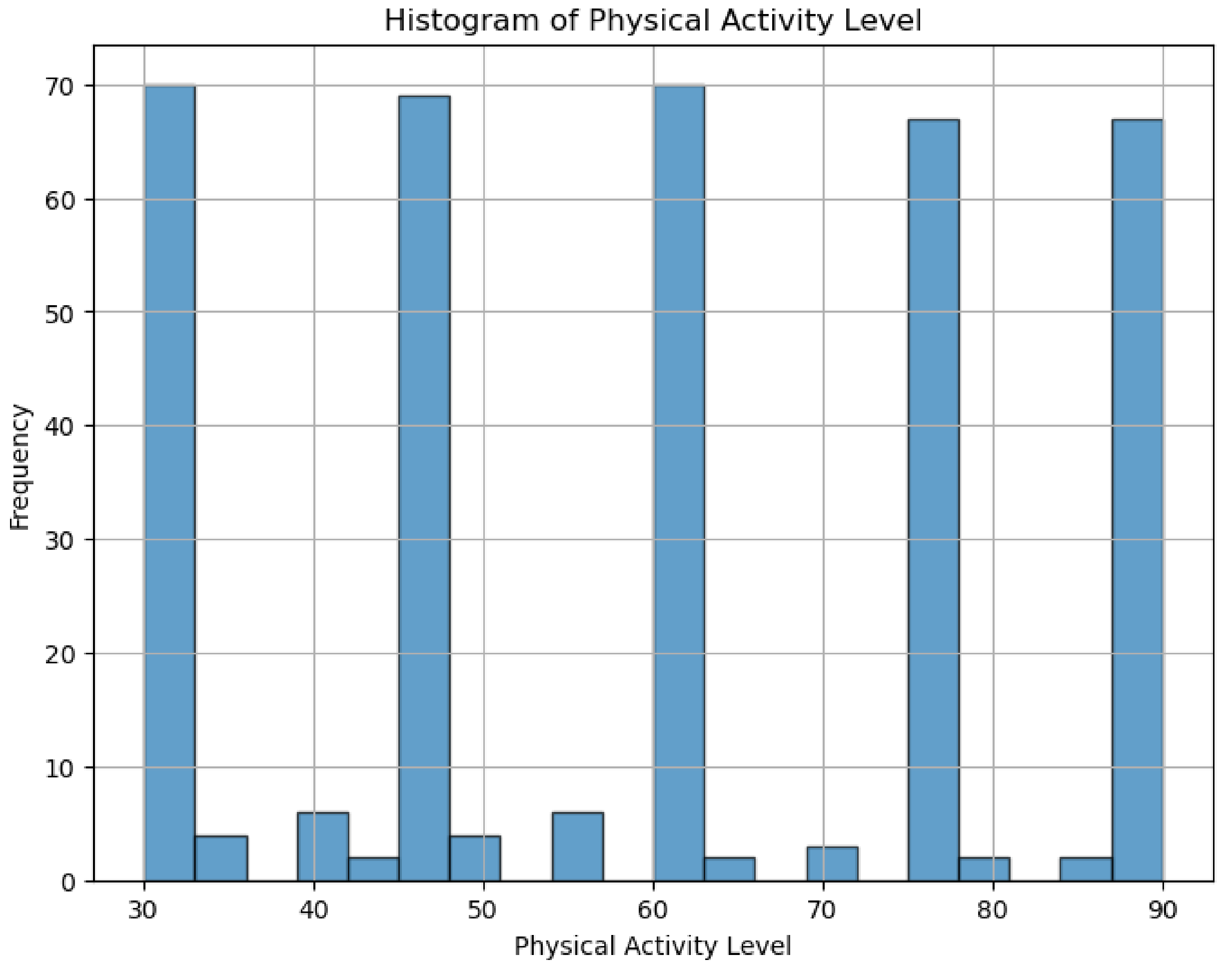
Descriptive Statistics for Sleep Duration:
  Mean: 7.13
  Mode: 7.20
  Standard Deviation: 0.80
  Skewness: 0.04

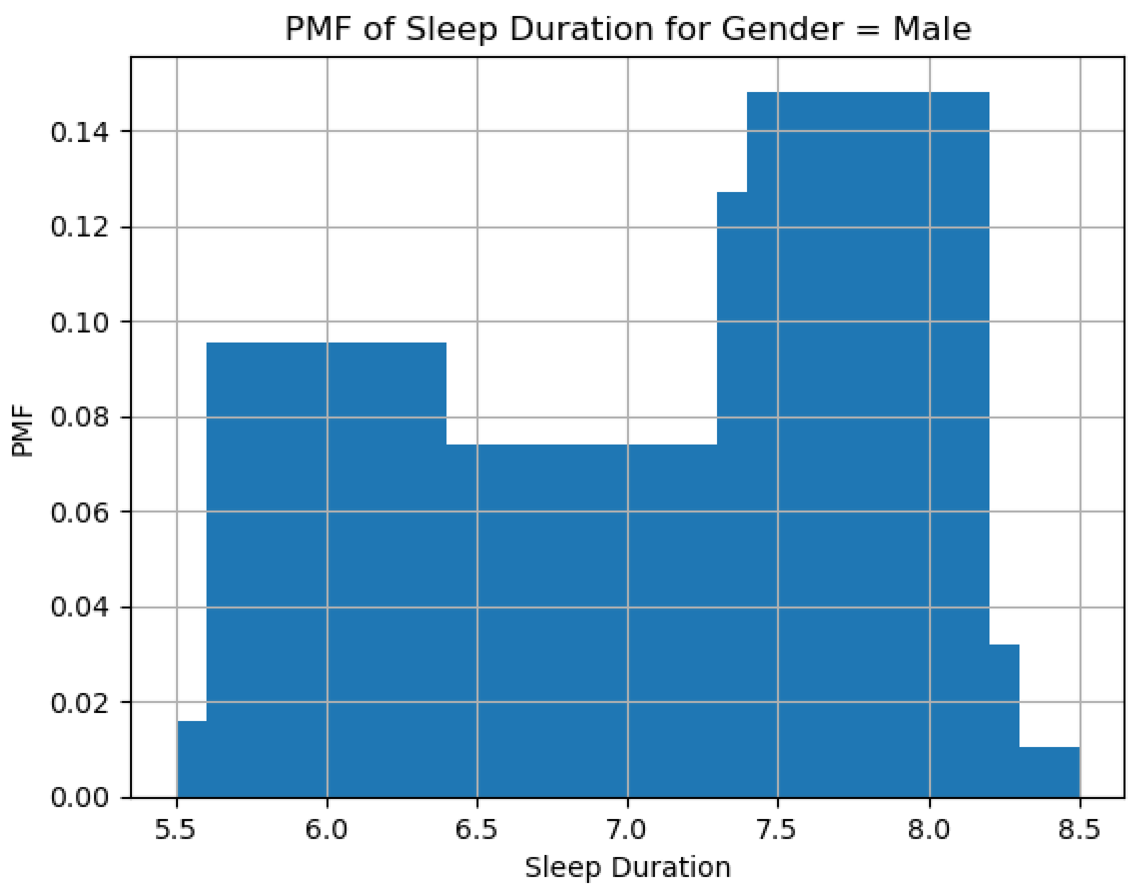
Descriptive Statistics for Quality of Sleep:
  Mean: 7.31
  Mode: 8.00
  Standard Deviation: 1.20
  Skewness: -0.21

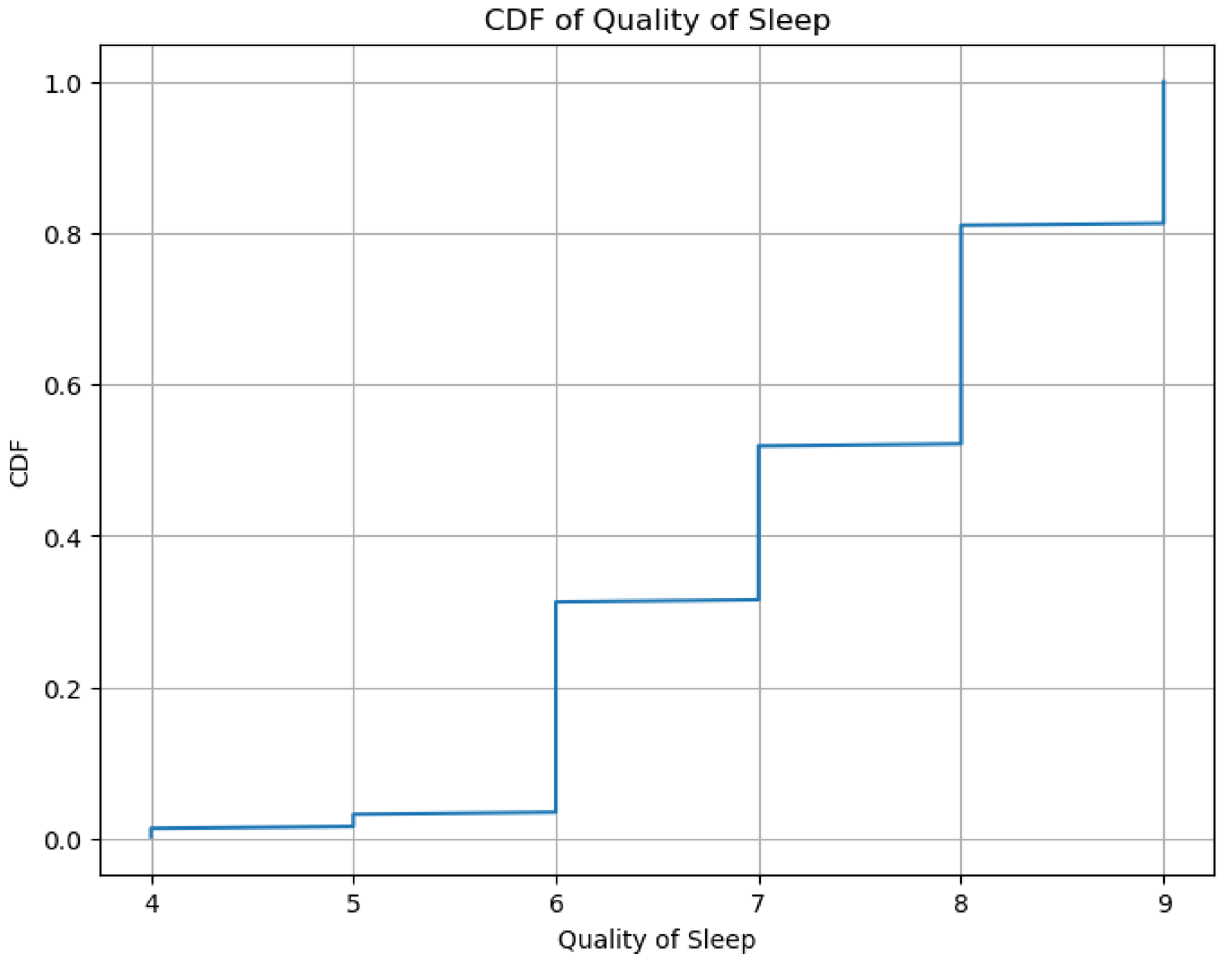
Descriptive Statistics for Heart Rate:
  Mean: 70.17
  Mode: 68.00
  Standard Deviation: 4.14
  Skewness: 1.22

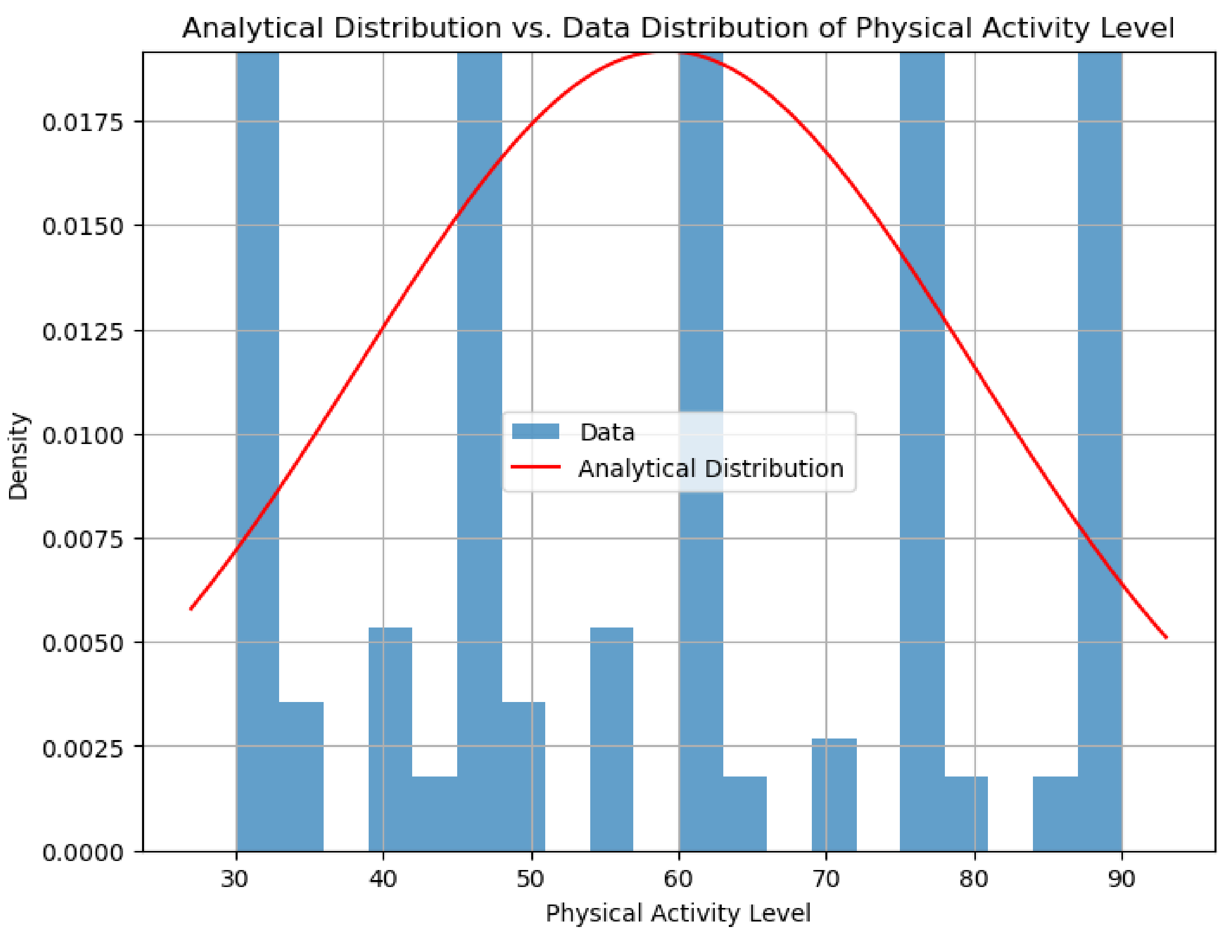
Descriptive Statistics for Physical Activity Level:
  Mean: 59.17
  Mode: 60.00
  Standard Deviation: 20.83
  Skewness: 0.07
```

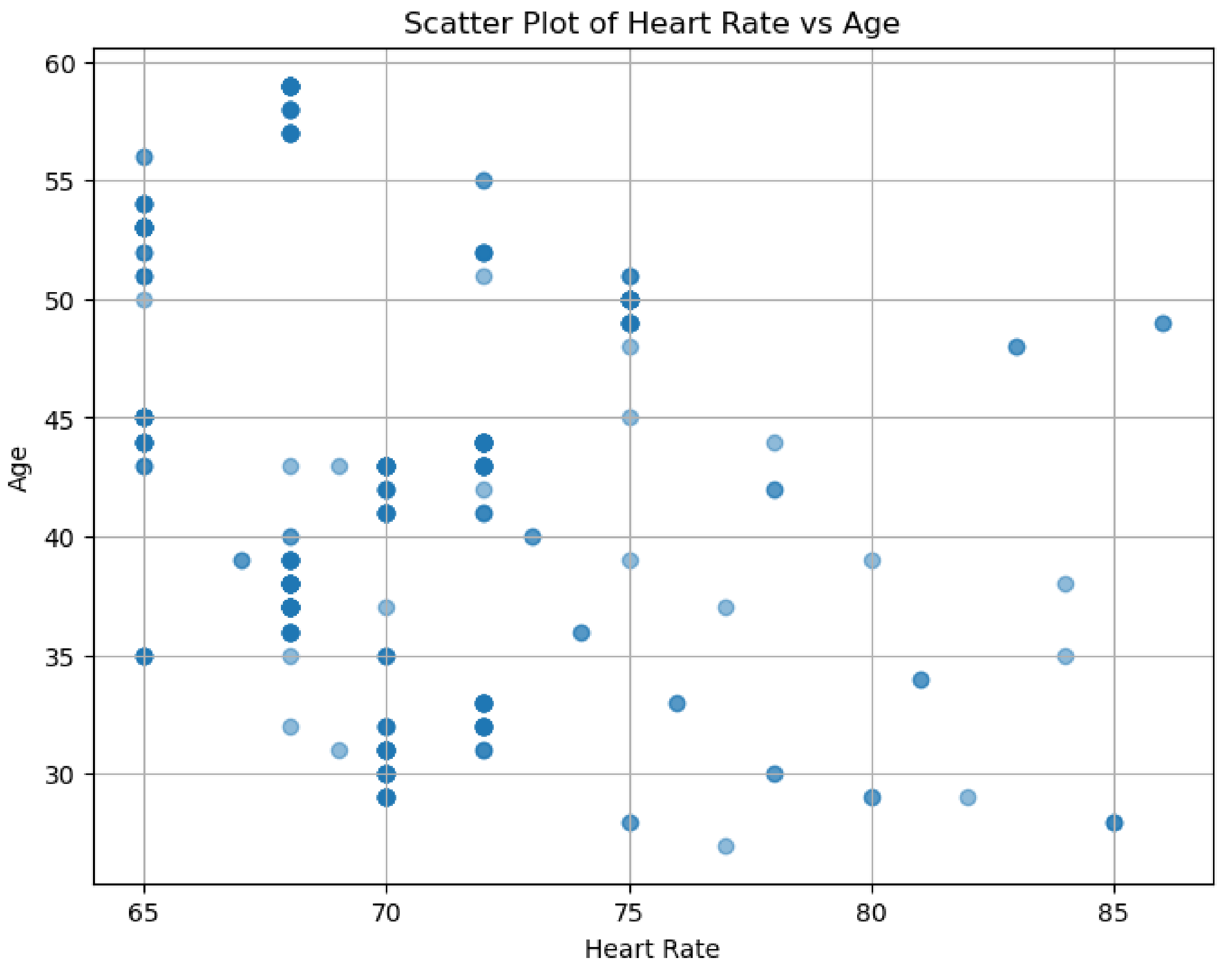


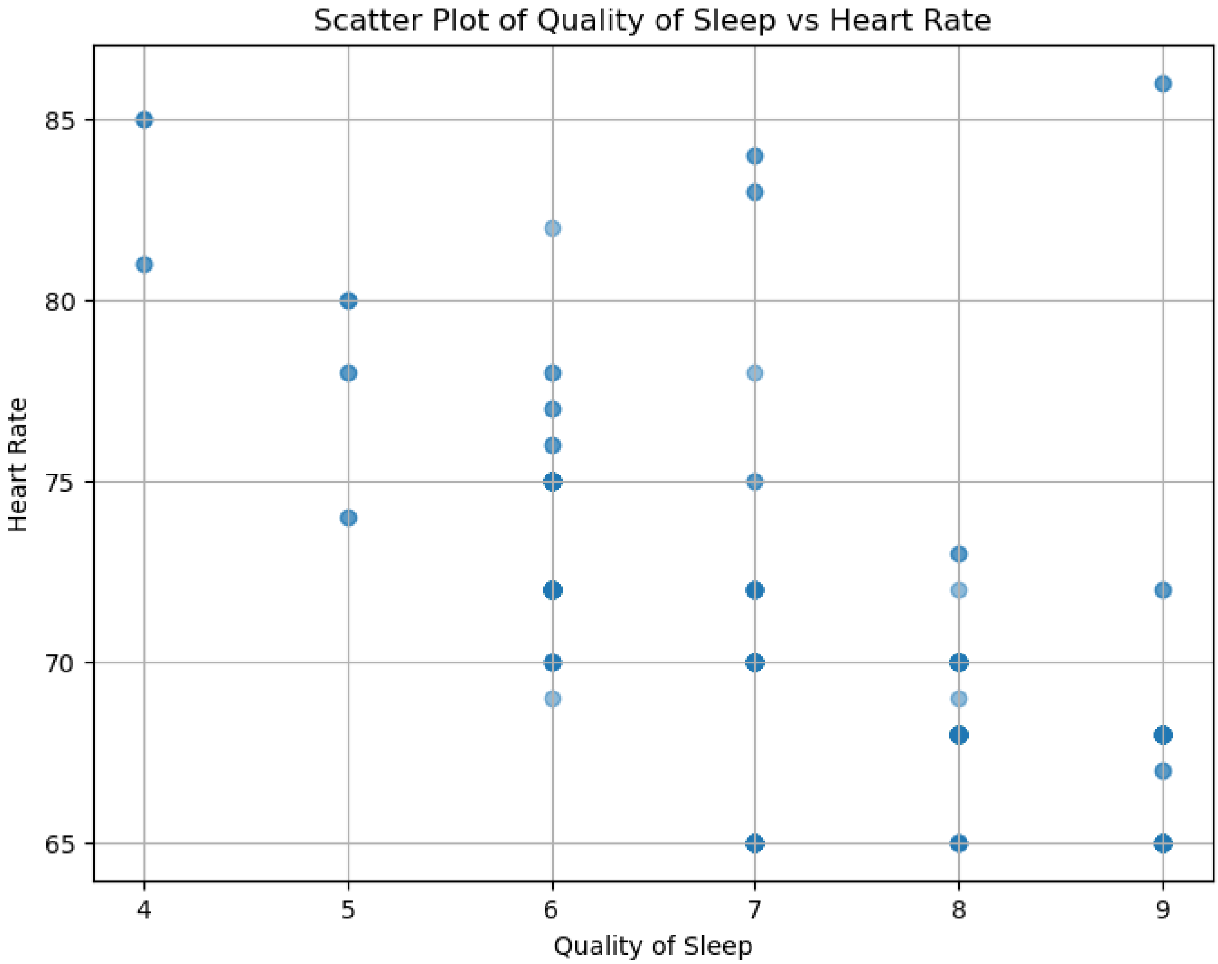

Histogram of Physical Activity Level
Frequency
Physical Activity Level
0
10
20
30
40
50
60
70
30
40
50
60
70
80
90


PMF of Sleep Duration for Gender = Male
PMF
Sleep Duration
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
5.5
6.0
6.5
7.0
7.5
8.0
8.5


CDF of Quality of Sleep
CDF
1.0
0.8
0.6
0.4
0.2
0.0
4
5
6
7
8
9
Quality of Sleep


Analytical Distribution vs. Data Distribution of Physical Activity Level
Density
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
Data
Analytical Distribution
30
40
50
60
70
80
90
Physical Activity Level


Scatter Plot of Heart Rate vs Age
Age
60
55
50
45
40
35
30
65
70
75
80
85
Heart Rate


Scatter Plot of Quality of Sleep vs Heart Rate
Heart Rate
85
80
75
70
65
4
5
6
7
8
9
Quality of Sleep

```
T-Stat: -5.874547760454642
P-Value: 9.416446532689304e-09
Reject null hypothesis: There is a significant difference between the groups.
                            OLS Regression Results
==============================================================================
Dep. Variable:             Heart Rate   R-squared:                       0.269
Model:                            OLS   Adj. R-squared:                  0.265
Method:                 Least Squares   F-statistic:                     68.36
Date:                Sat, 12 Aug 2023   Prob (F-statistic):           5.30e-26
Time:                        20:13:07   Log-Likelihood:                -1002.5
No. Observations:                 374   AIC:                             2011.
Df Residuals:                     371   BIC:                             2023.
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
====
                     coef    std err          t      P>|t|      [0.025      0.
975]
------------------------------------------------------------------------------
----
const             89.7075      1.691     53.039      0.000      86.382      9
3.033
Sleep Duration    -2.5877      0.246    -10.530      0.000      -3.071      -
2.104
Age               -0.0257      0.023     -1.142      0.254      -0.070
0.019
==============================================================================
Omnibus:                      136.960   Durbin-Watson:                   1.076
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              706.619
Skew:                           1.473   Prob(JB):                    3.63e-154
Kurtosis:                       9.055   Cond. No.                         406.
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correct
ly specified.
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In [ ]: