Sleep Habits and Daily Productivity

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26-12-2023

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Probability & Statistics

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➢ Probability and Statistics:

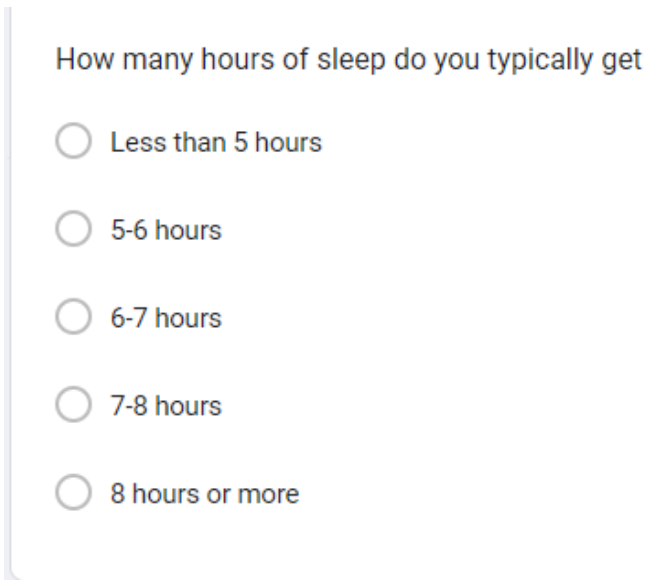
For our project, we were asked with conducting a survey that delves into the connection between sleep habits and daily productivity, analyzing the responses of 100 participants. The aim is to explore how people's sleep patterns relate to their overall daily performance and efficiency.

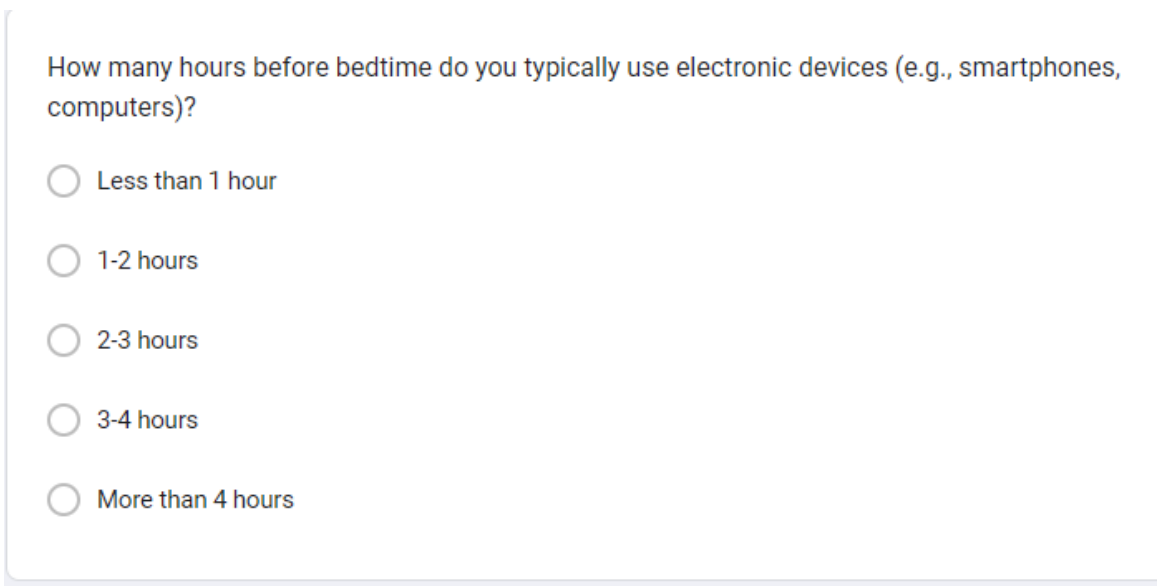
➢ Form Link:

https://forms.gle/9KGkAewQWDMg7qrC6

➢ Survey Snippets:

The initial and pivotal phase involved the creation of survey forms. During this process, meticulous attention was given to crafting questions that were concise, engaging, and directly pertinent to our chosen topic. The survey forms were distributed, and fortunately, we received an exceptionally positive response. In total, we managed to gather 100 valuable responses.
Here are some preview of the questions and responses.



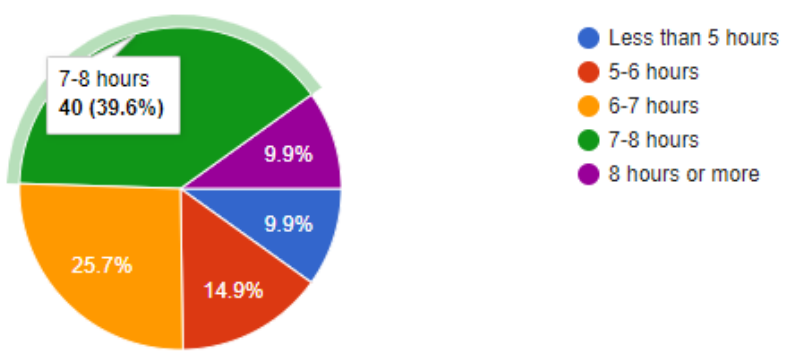


How often do you engage in physical exercise in a week? *

- ○ Never
- ○ 1-2 times
- ○ 3-4 times
- ○ 5-6 times
- ○ Every day

How many hours of sleep do you typically get per night?

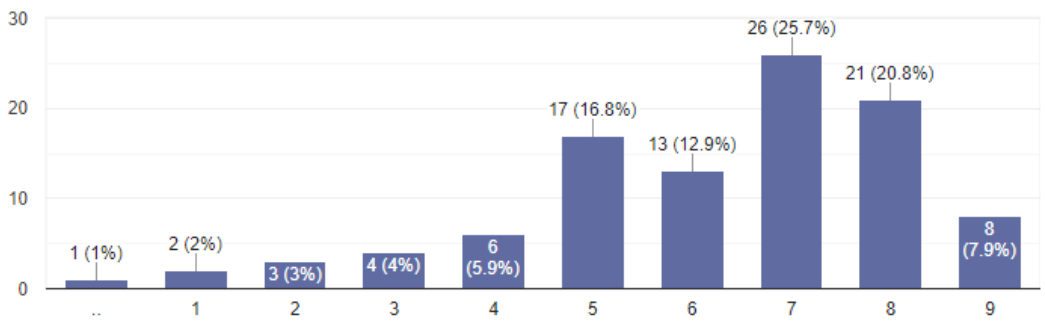
101 responses



On a scale from 1 to 10, rate your daily productivity?

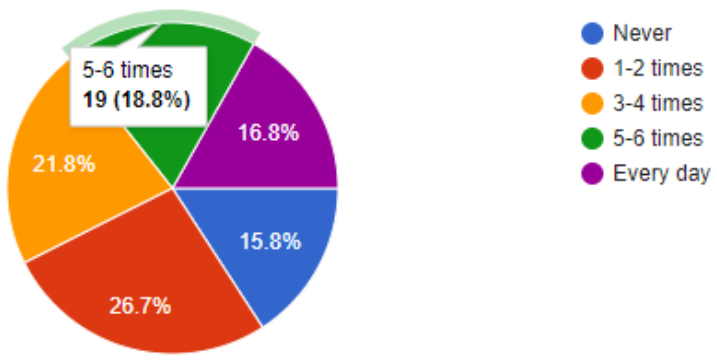
Copy

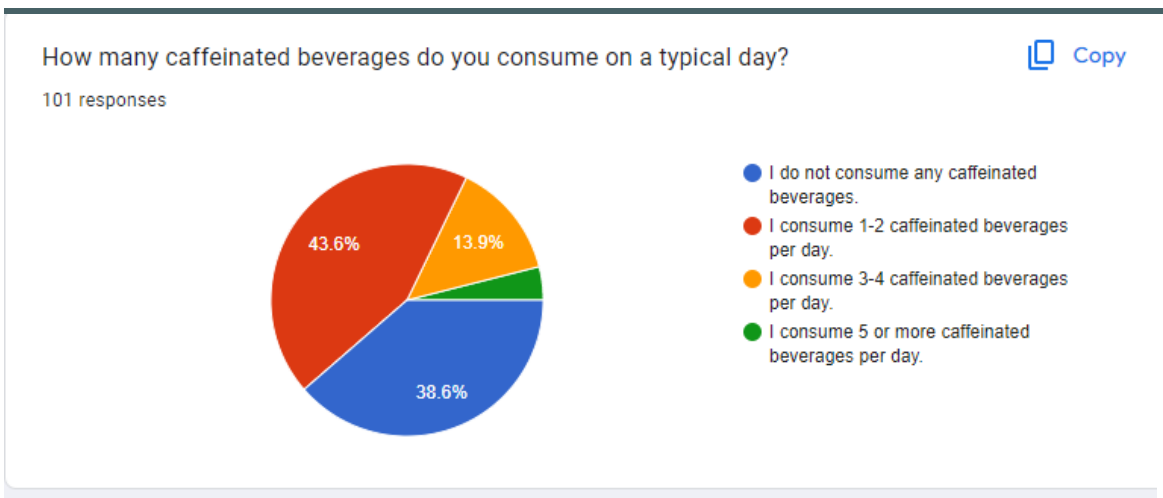
101 responses



How often do you engage in physical exercise in a week?

101 responses





❖Statistical Analysis:

After gathering the whole data, the next step was to perform the statistical analysis on the data for this we have chosen the Python IDE which is the best among all in terms of data analysis because of Panda, Matplotlib libraries so we prefer to choose python IDE.

➢ View of csv file in python:

- **Python code:**

```
# Load the DataFrame
df = pd.read_csv(r'C:/Users/Hp/OneDrive/Desktop/Python project/Sleep Habits and Daily.csv')
```

- **Csv view:**

```
PS C:\Users\Hp\OneDrive\Desktop\Python project> python -u "c:\Users\Hp\OneDrive\Desktop\Python project\project.py"
   How many hours of sleep do you typically get per night?  ...     How would you describe your bedtime routine?
0                                                7-8 hours  ...        Yes, I have a consistent bedtime routine.
1                                                6-7 hours  ...        Yes, I have a consistent bedtime routine.
2                                                5-6 hours  ...        Yes, I have a consistent bedtime routine.
3                                      Less than 5 hours    ...  No, I do not have a consistent bedtime routine.
4                                      Less than 5 hours    ...  No, I do not have a consistent bedtime routine.
..                                                   ...    ...                                              ...
95                                       8 hours or more    ...  No, I do not have a consistent bedtime routine.
96                                               7-8 hours  ...             Sometimes, I have a bedtime routine.
97                                               7-8 hours  ...  No, I do not have a consistent bedtime routine.
98                                     Less than 5 hours    ...             Sometimes, I have a bedtime routine.
99                                     Less than 5 hours    ...  No, I do not have a consistent bedtime routine.

[100 rows x 10 columns]
```

❖Shortening the column Names:

As for my Convenience we have shortened the name of every Column.

- **Python code:**

```python
new_c_names = {
    'How many hours of sleep do you typically get per night?': 'Sleep Hours',
    'On a scale from 1 to 10, rate your daily productivity?': 'Productivity Rating?',
    'How many hours before bedtime do you typically use electronic devices (e.g., smartphones, computers)?': 'Device Use Hrs Before Bed',
    'How often do you engage in physical exercise in a week?': 'Exercise Frequency',
    'How would you describe the stress levels you experience in your daily life?': 'Stress Level',
    'How many caffeinated beverages do you consume on a typical day?': 'Caffeine Intake per Day',
    'How often do you take naps during the day, if at all?': 'Nap Frequency',
    'At what time do you usually have your last meal before bedtime?': 'Last Meal Time Before Bed',
    'How would you describe the overall quality of your sleep?': 'Sleep Quality',
    'How would you describe your bedtime routine?': 'BedTime Routine Description'
}

# Renaming the column
df.rename(columns=new_c_names, inplace=True)
```

- **Result:**

```
DataFrame after renaming columns:
         Sleep Hours  Productivity Rating?  Device Use Hrs Before Bed  ...  Last Meal Time Before Bed  Sleep Quality                    BedTime Ro
0          7-8 hours                     8                 1-2 hours  ...                    7-8 PM      Excellent       Yes, I have a consistent
1          6-7 hours                     9                 1-2 hours  ...                   9-10 PM        Neutral       Yes, I have a consistent
2          5-6 hours                     9                 1-2 hours  ...                    8-9 PM        Neutral       Yes, I have a consistent
3   Less than 5 hours                    6         More than 4 hours  ...                   9-10 PM        Neutral  No, I do not have a consistent
4   Less than 5 hours                    5         More than 4 hours  ...                    8-9 PM           Good  No, I do not have a consistent
..                ...                  ...                       ...  ...                      ...            ...
95    8 hours or more                    4                 3-4 hours  ...              After 10 PM           Poor  No, I do not have a consistent
96         7-8 hours                     8                 2-3 hours  ...                    8-9 PM           Good            Sometimes, I have a
97         7-8 hours                     7                 2-3 hours  ...                   9-10 PM           Good  No, I do not have a consistent
98  Less than 5 hours                    5                 3-4 hours  ...                    8-9 PM        Neutral            Sometimes, I have a
99  Less than 5 hours                    5         More than 4 hours  ...                   9-10 PM           Poor  No, I do not have a consistent
```

❖ Statistical Trends:

To conduct statistical analysis, we required numerical data, but our existing dataset consisted of strings. To address this, we engaged in coding and developed scripts for various columns, such as the "sleep_quality" column. Through this coding process, a new column labeled "sleep_quality" was generated, representing the original column in numeric format. In the provided illustration, the numerical codes were assigned as follows: 1 for "very poor," 2 for "Poor," and 3 for "Neutral", 4 for "Good",5 for "Excellent".

- **Python code:**

```python
# Define code mappings for all questions
mappings = {
    'sleep_hours': {
        'Less than 5 hours': 1,
        '5-6 hours': 2,
        '6-7 hours': 3,
        '7-8 hours': 4,
        '8 hours or more': 5
    },
    'device_use_hrs_before_bed': {
        'Less than 1 hour': 1,
        '1-2 hours': 2,
        '2-3 hours': 3,
        '3-4 hours': 4,
        'More than 4 hours': 5
    },
    'exercise_frequency': {
        'Never': 1,
        '1-2 times': 2,
        '3-4 times': 3,
        '5-6 times': 4,
        'Every day': 5
    },
    'stress_level': {
        'I experience no stress.': 1,
        'I experience low stress.': 2,
        'I experience moderate stress.': 3,
        'I experience high stress.': 4,
        'I experience extreme stress': 5
    },
    'caffeine_intake_per_day': {
        'I do not consume any caffeinated beverages.': 1,
        'I consume 1-2 caffeinated beverages per day.': 2,
        'I consume 3-4 caffeinated beverages per day.': 3,
        'I consume 5 or more caffeinated beverages per day.': 4
    },
```

- **Output:**

```
DataFrame after mapping responses:
    Sleep Hours  Productivity Rating?  Device Use Hrs Before Bed  Exercise Frequency  Stress Level  Caffeine Intake per Day  Nap Frequency  Last Meal Time Before Bed  Sleep Quality  BedTime Routine Description
0             4                     8                          2                   5             1                        2              2                          2              5                            1
1             3                     9                          2                   3             2                        1              2                          4              3                            1
2             2                     9                          2                   2             3                        1              3                          3              3                            1
3             1                     6                          5                   4             5                        2              3                          4              3                            3
4             1                     5                          5                   2             5                        2              4                          3              4                            3
..          ...                   ...                        ...                 ...           ...                      ...            ...                        ...            ...                          ...
95            5                     4                          4                   2             4                        3              2                          5              2                            3
96            4                     8                          3                   4             2                        2              4                          3              4                            2
97            4                     7                          3                   4             2                        1              3                          4              4                            3
98            1                     5                          4                   3             4                        3              3                          3              3                            2
99            1                     5                          5                   1             4                        3              2                          4              2                            3

[100 rows x 10 columns]
```

➢ Variable Info:

In the provided code, variable.info () is used to display information about the data Frame called variable. This method provides a concise summary of the data Frame, including information about the data types of each column, the number of non-null values, and memory usage.

```
 #   Column                          Non-Null Count  Dtype
---  ------                          --------------  -----
 0   Sleep Hours                     100 non-null    int64
 1   Productivity Rating?            100 non-null    int64
 2   Device Use Hrs Before Bed       100 non-null    int64
 3   Exercise Frequency              100 non-null    int64
 4   Stress Level                    100 non-null    int64
 5   Caffeine Intake per Day         100 non-null    int64
 6   Nap Frequency                   100 non-null    int64
 7   Last Meal Time Before Bed       100 non-null    int64
 8   Sleep Quality                   100 non-null    int64
 9   BedTime Routine Description     100 non-null    int64
dtypes: int64(10)
memory usage: 7.9 KB
```

❖Descriptive Statistics:

The describe () function in pandas is used to generate descriptive statistics of a datagram or Series.

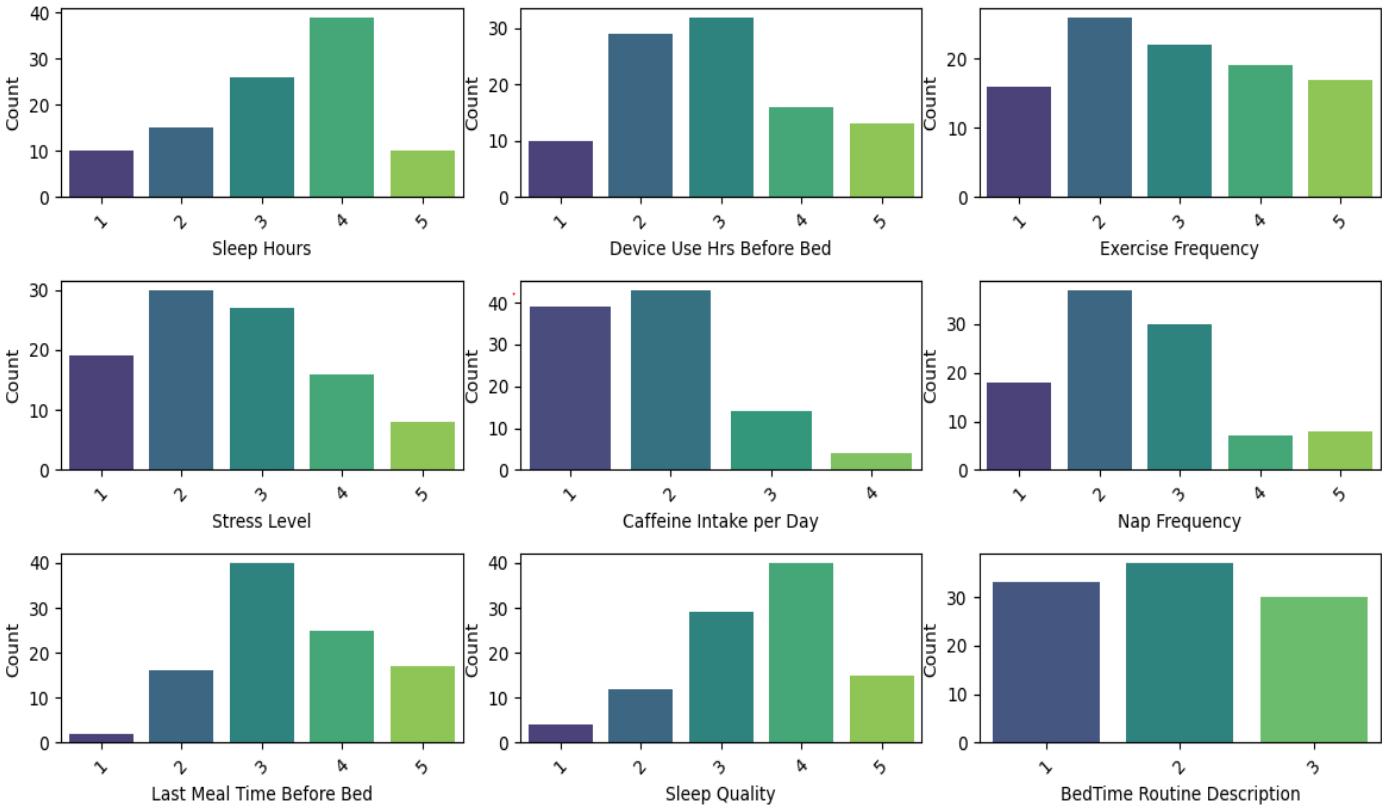
DataFrame Descriptive Statistics:

	Sleep Hours	Device Use Hrs Before Bed	Exercise Frequency	Stress Level	Caffeine Intake per Day	Nap Frequency	Last Meal Time Before Bed	Sleep Quality	BedTime Routine Description
count	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000	100.000000
mean	3.240000	2.930000	2.950000	2.640000	1.830000	2.500000	3.390000	3.500000	1.970000
std	1.138136	1.174261	1.336171	1.193586	0.817177	1.114641	1.013993	1.020002	0.797154
min	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
25%	2.750000	2.000000	2.000000	2.000000	1.000000	2.000000	3.000000	3.000000	1.000000
50%	3.000000	3.000000	3.000000	3.000000	2.000000	2.000000	3.000000	4.000000	2.000000
75%	4.000000	4.000000	4.000000	3.000000	2.000000	3.000000	4.000000	4.000000	3.000000
max	5.000000	5.000000	5.000000	5.000000	4.000000	5.000000	5.000000	5.000000	3.000000

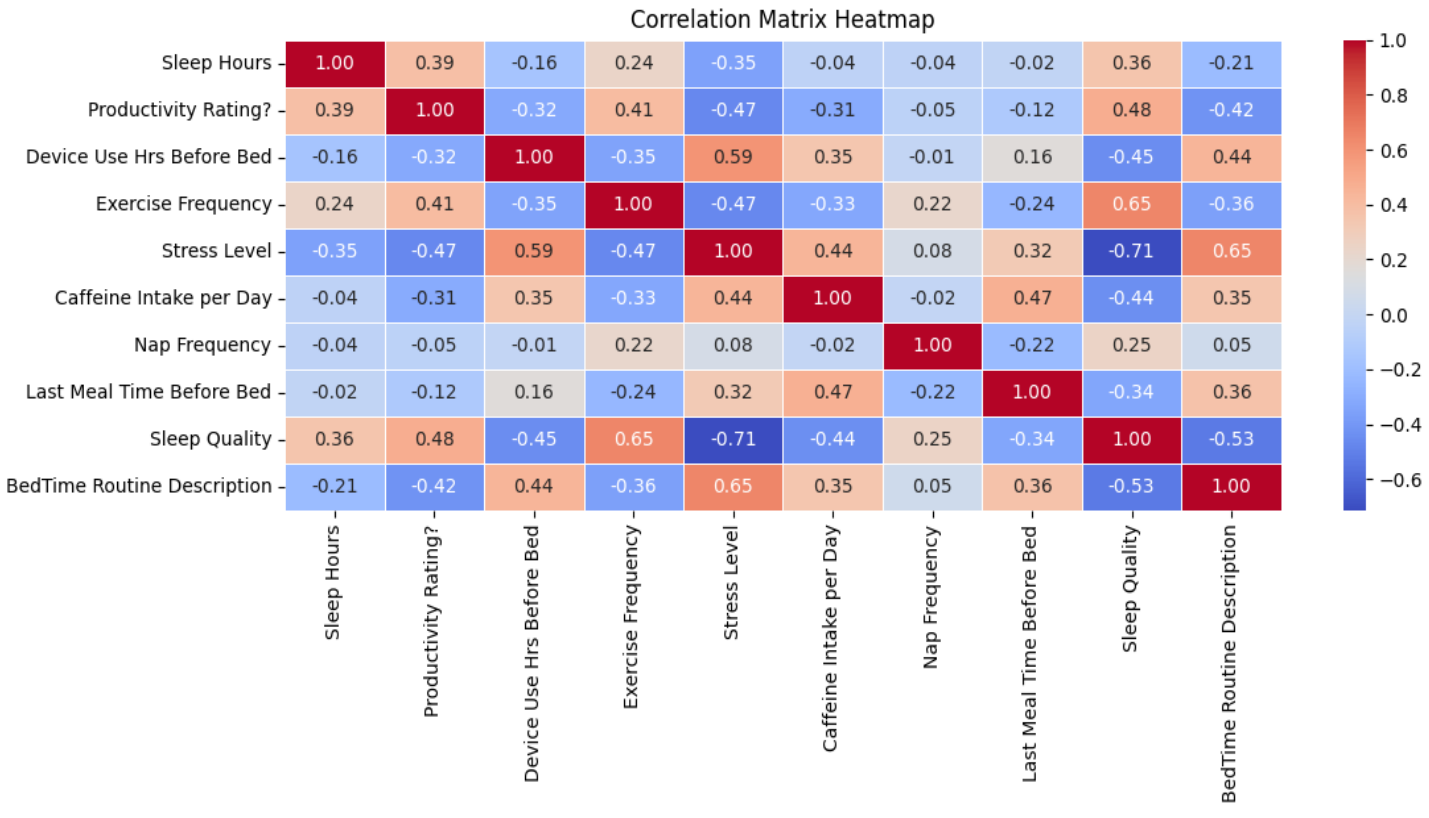
❖Statistical Graph:

➢ Bar Charts:

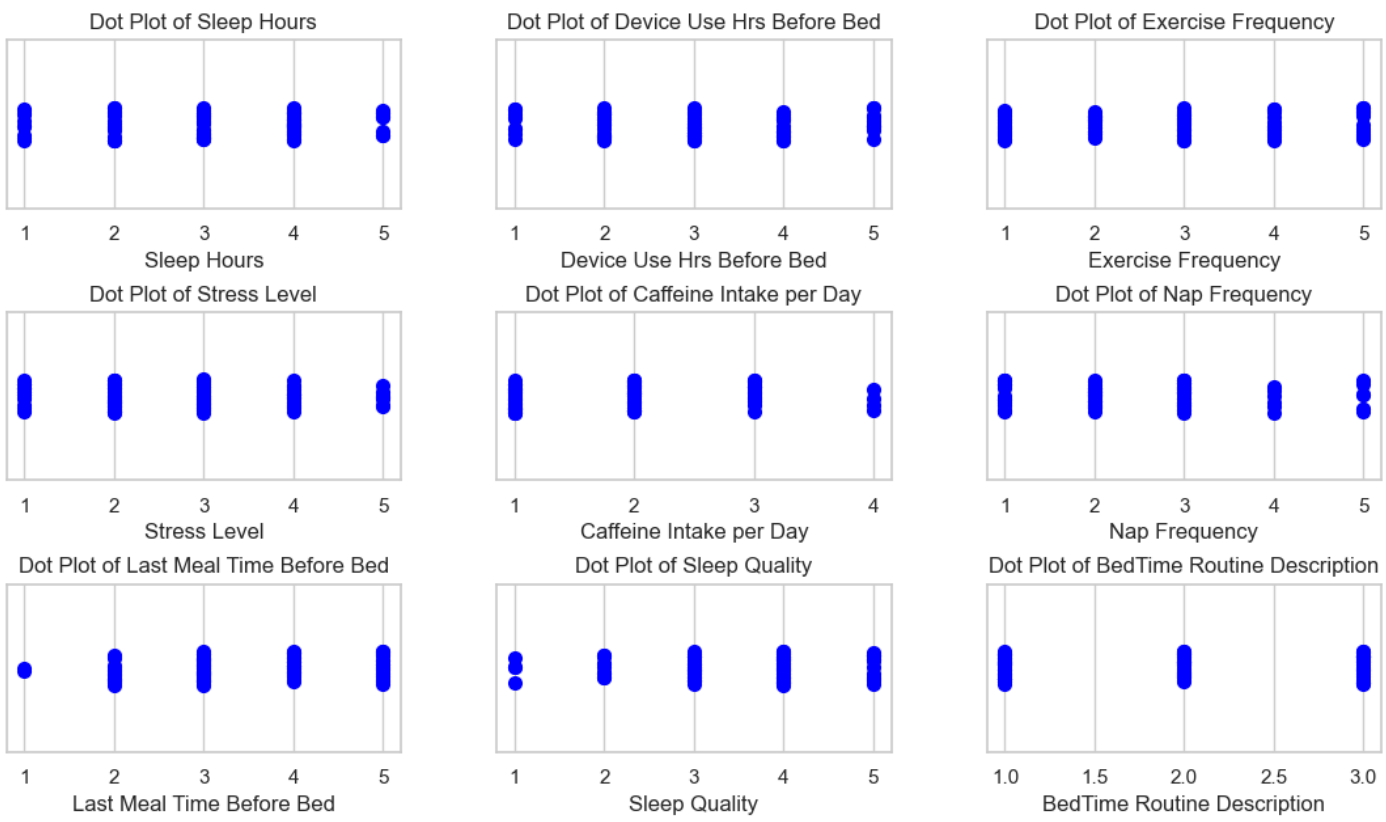
Bar charts are used to visually represent and compare categorical data, making it easy to discern patterns, trends, and variations among different groups or categories.



➢Correlation Diagram:



➢ Dot Charts:



➢ Frequency Distribution:

After looking at different graphs and charts, we then organized the data in a way that shows how often each value appears, giving us a clearer numerical understanding.

- **Sleep hours:**

```
Frequency distribution for Sleep Hours:
Sleep Hours
4    39
3    26
2    15
1    10
5    10
Name: count, dtype: int64
```

- **Device Use Hrs Before Bed:**

```
Frequency distribution for Device Use Hrs Before Bed:
Device Use Hrs Before Bed
3    32
2    29
4    16
5    13
1    10
Name: count, dtype: int64
```

- **Exercise Frequency:**

```
Frequency distribution for Exercise Frequency:
Exercise Frequency
2    26
3    22
4    19
5    17
1    16
Name: count, dtype: int64
```

- **Stress Level:**

```
Frequency distribution for Stress Level:
Stress Level
2    30
3    27
1    19
4    16
5     8
Name: count, dtype: int64
```

- **Caffeine Intake per Day:**

```
Frequency distribution for Caffeine Intake per Day:
Caffeine Intake per Day
2    43
1    39
3    14
4     4
Name: count, dtype: int64
```

- **Nap Frequency:**

```
Frequency distribution for Nap Frequency:
Nap Frequency
2    37
3    30
1    18
5     8
4     7
Name: count, dtype: int64
```

- **Last Meal Time Before Bed:**

```
Frequency distribution for Last Meal Time Before Bed:
Last Meal Time Before Bed
3    40
4    25
5    17
2    16
1     2
Name: count, dtype: int64
```

- **Sleep Quality:**

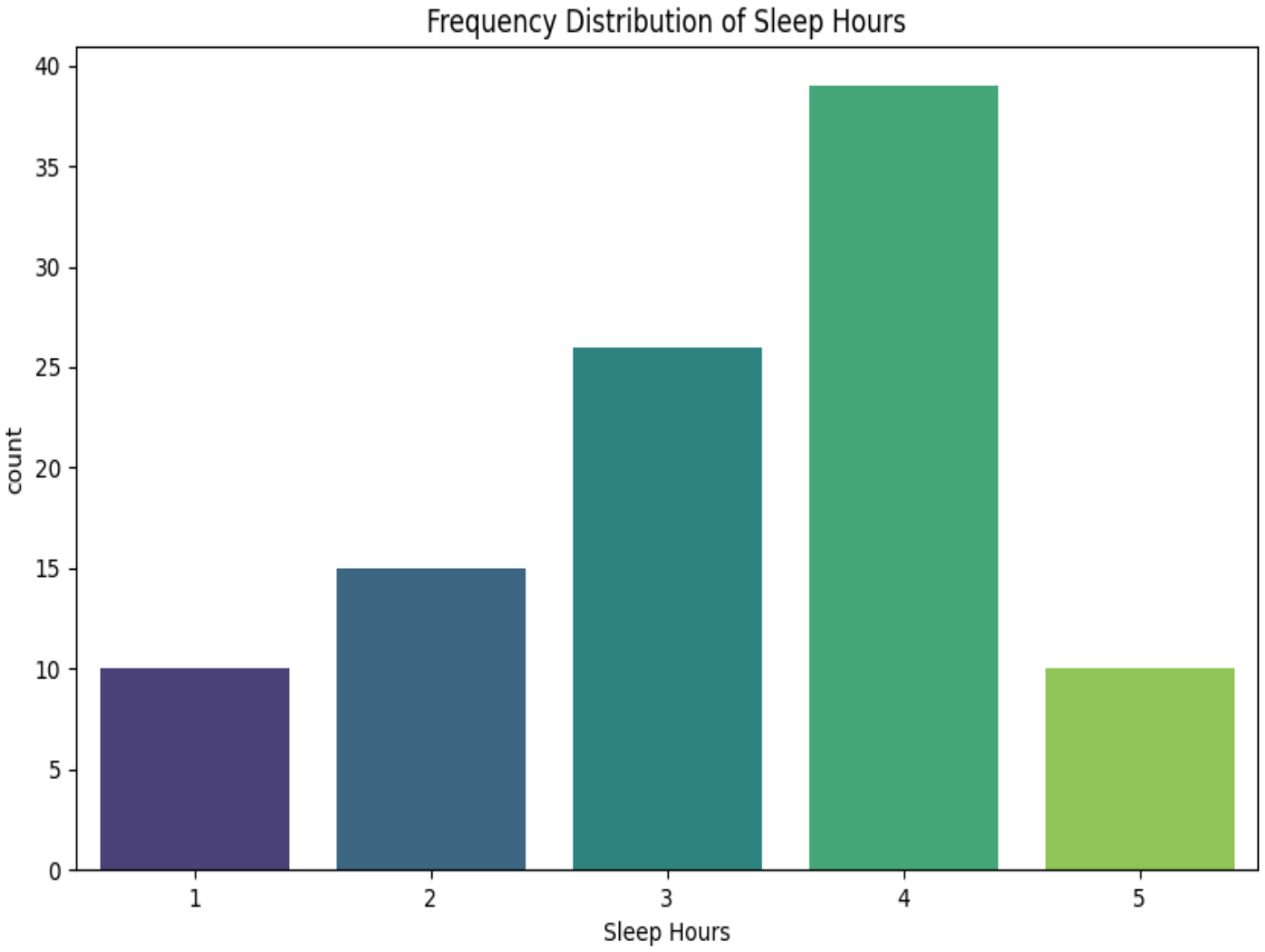
```
Frequency distribution for Sleep Quality:
Sleep Quality
4    40
3    29
5    15
2    12
1     4
Name: count, dtype: int64
```

- **Bedtime Routine Description:**

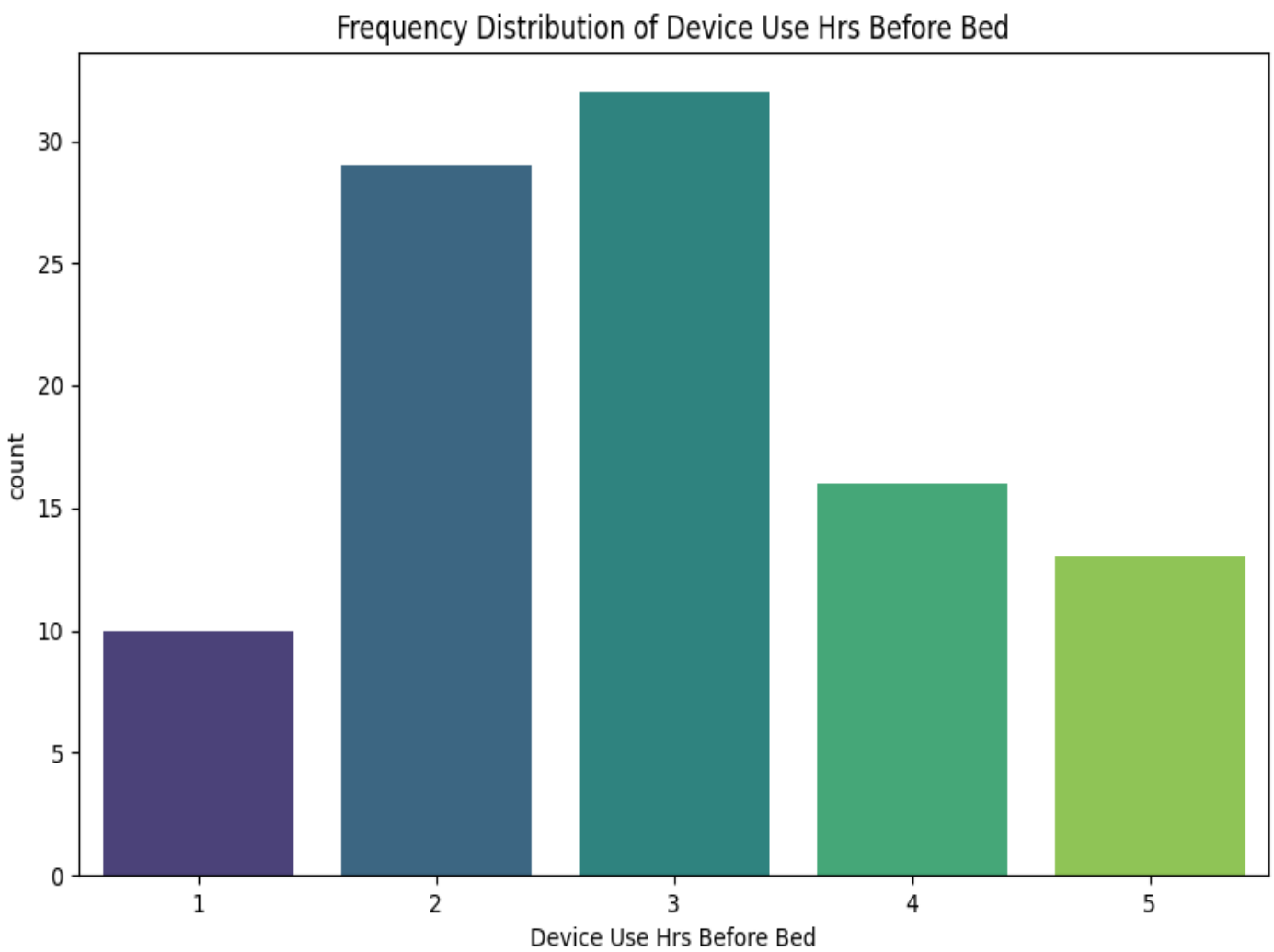
```
Frequency distribution for BedTime Routine Description:
BedTime Routine Description
2    37
1    33
3    30
Name: count, dtype: int64
```

- **Frequency Distribution Graphs:**

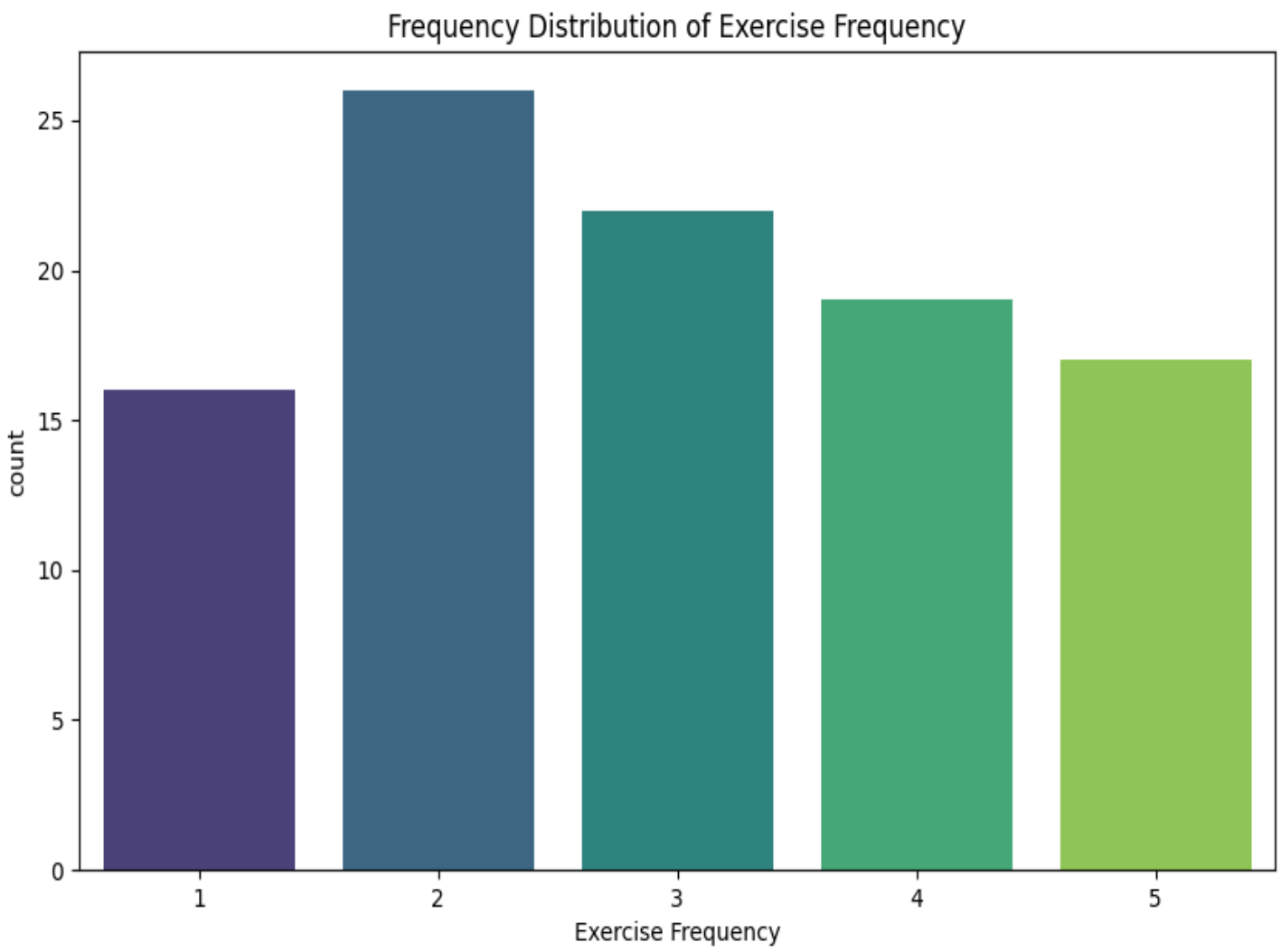
1) Sleep Hours:



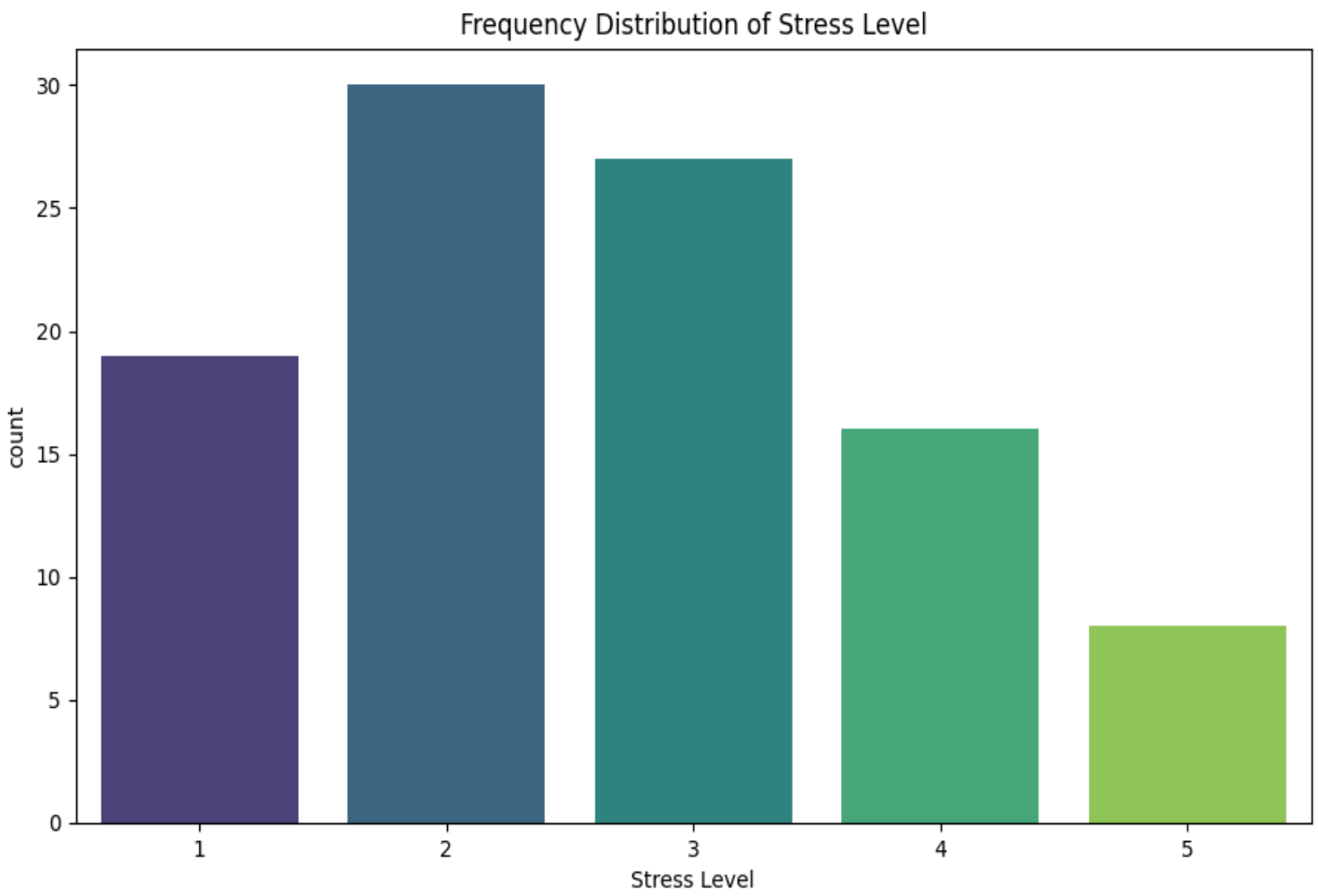
2) Device use hrs before bed:



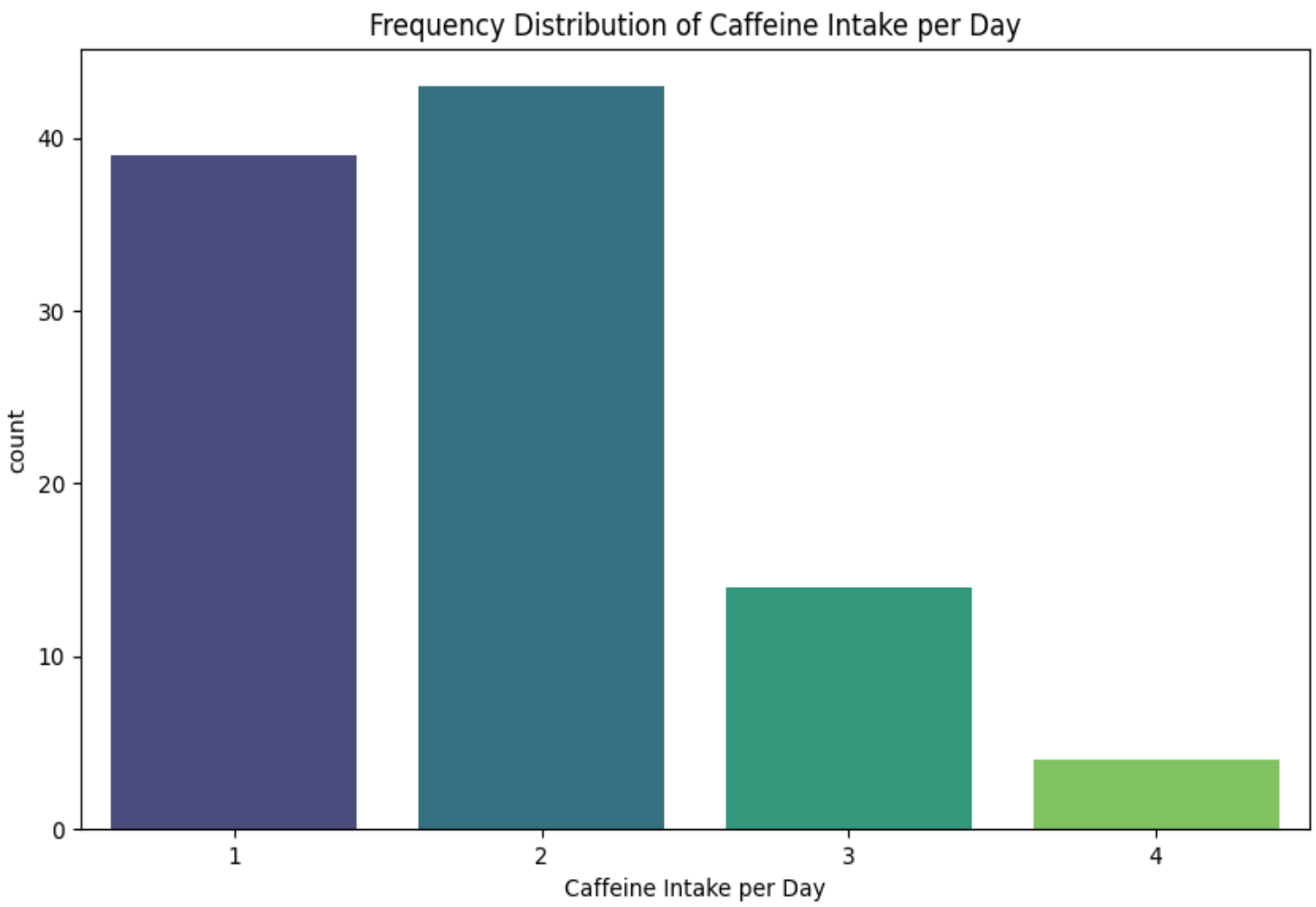
3) Exercise Frequency:



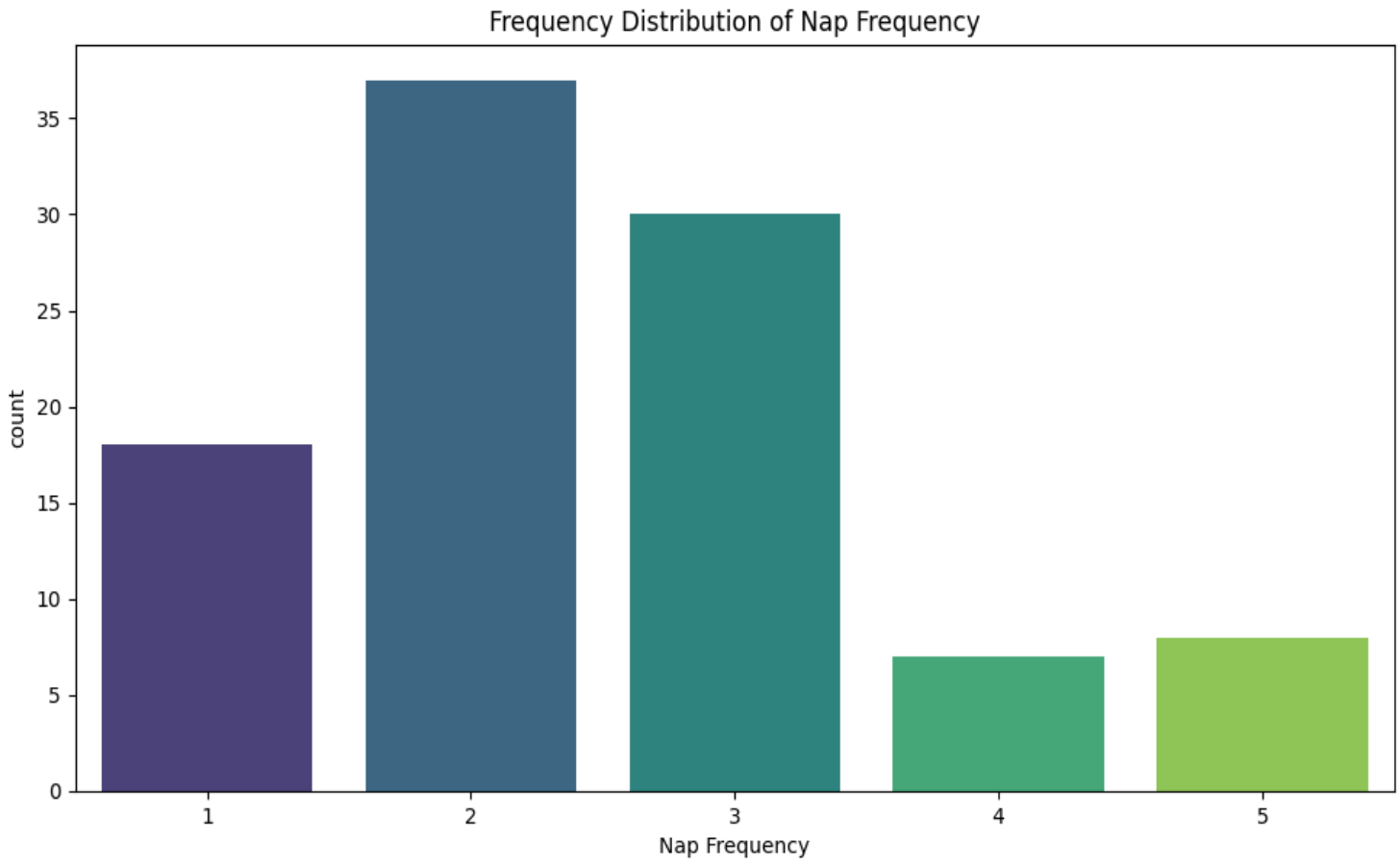
4) Stress level:



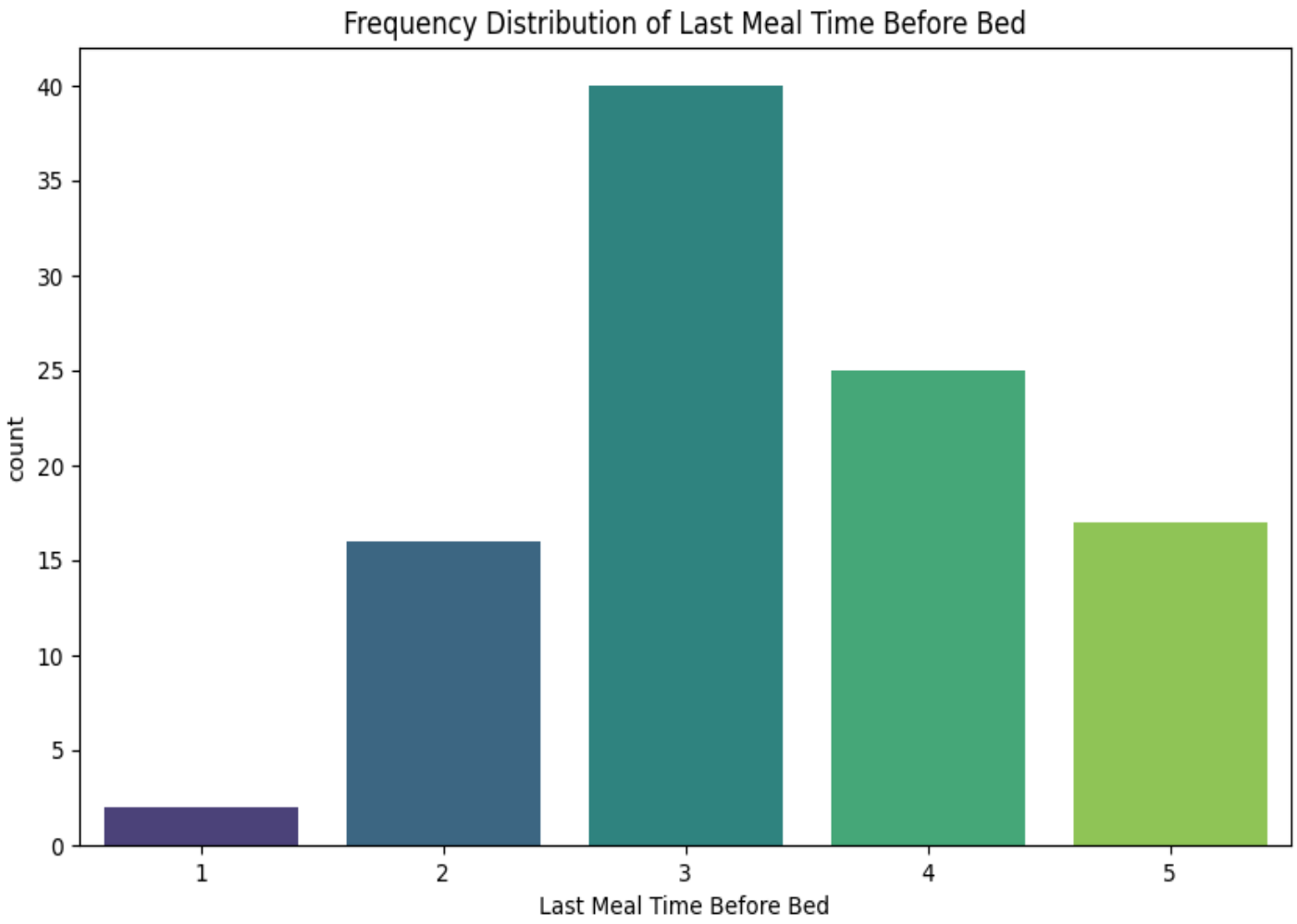
5) Caffeine intake per day:



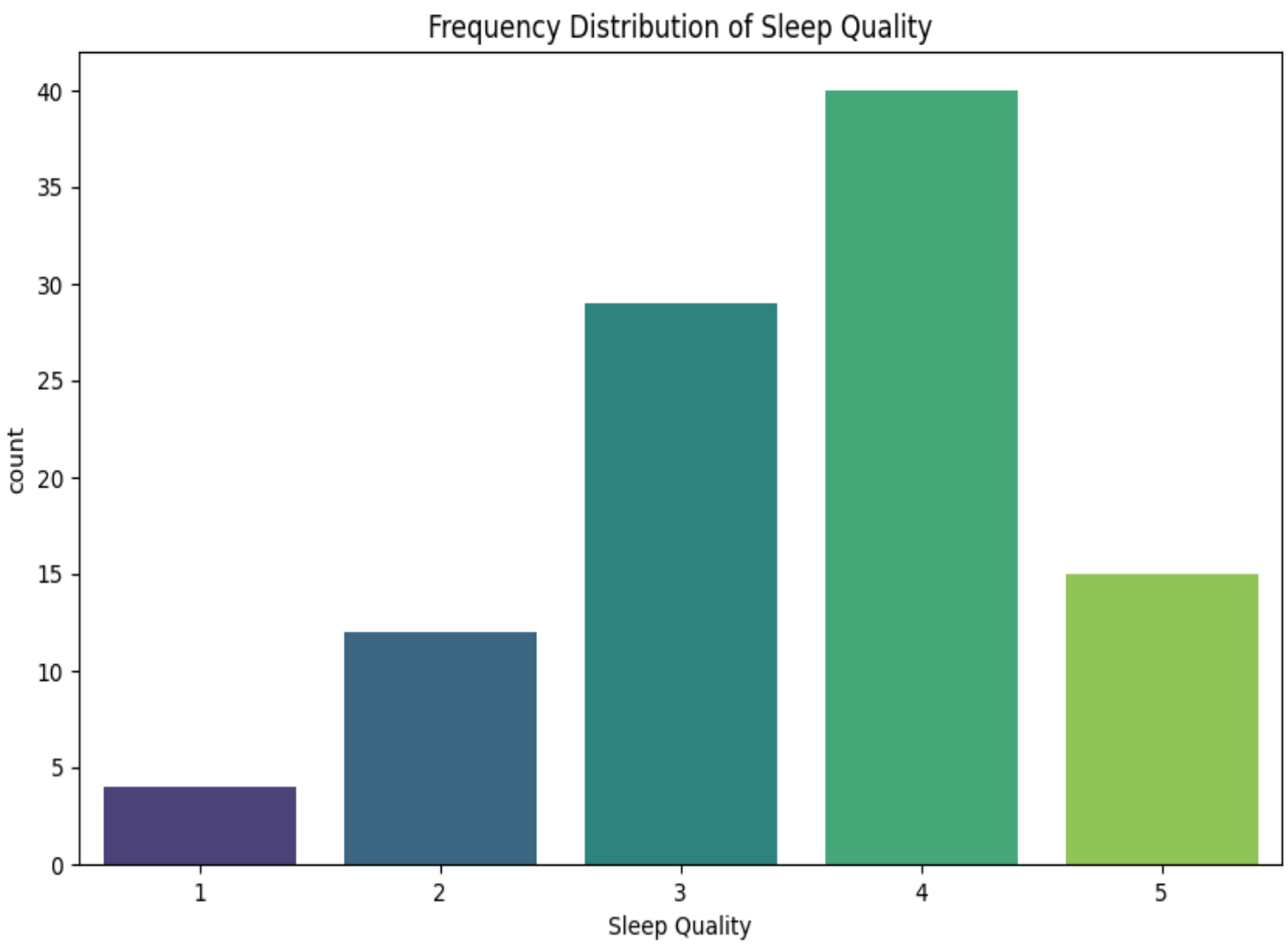
6) Nap Frequency:



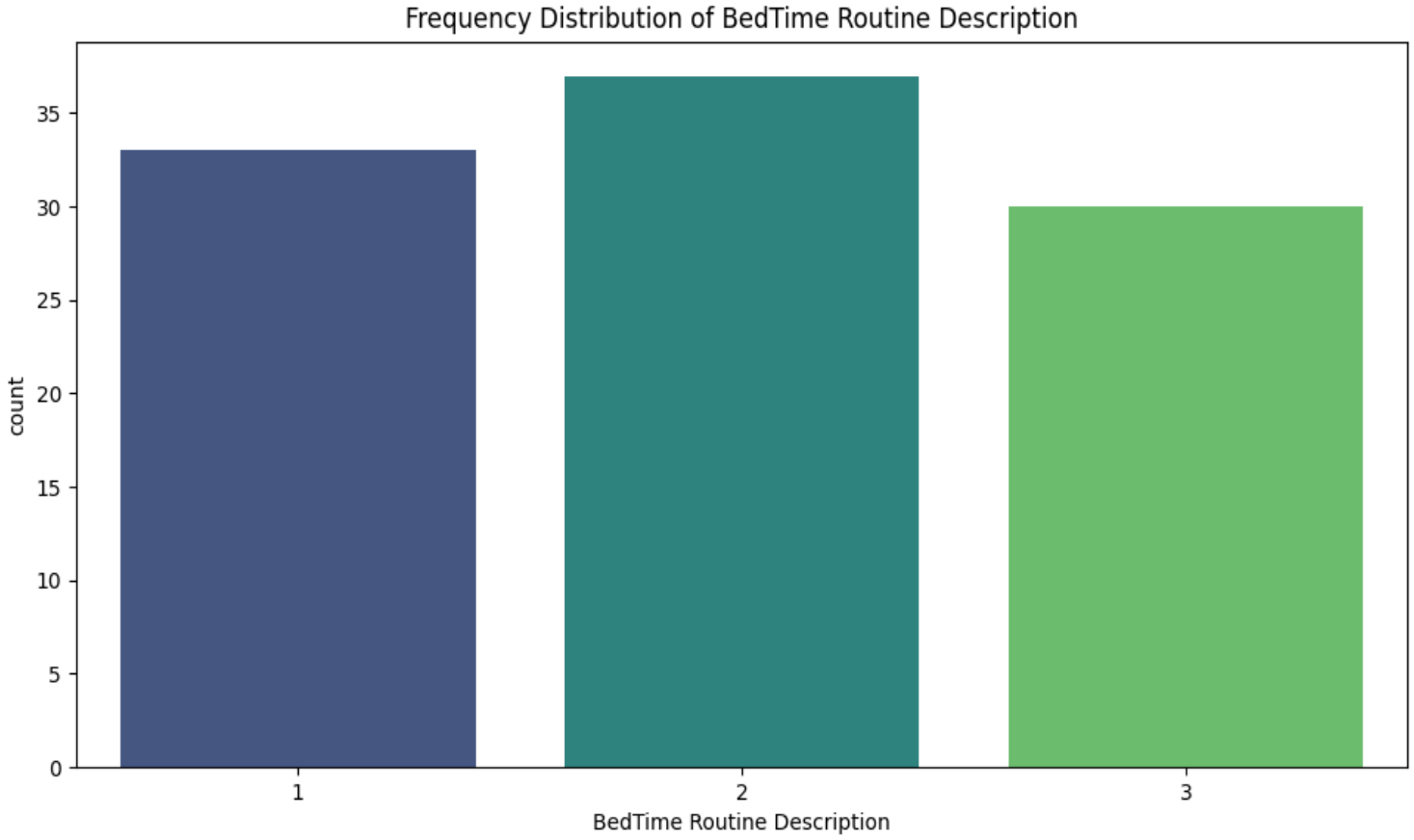
7) Last Meal Time before bed:



8) Sleep Quality:



9) Bedtime Routine description:



❖Linear regression analysis and Coclusion:

- **Between Sleep hours and stress level:**

The linear regression analysis indicates that there is a statistically significant negative relationship between sleep hours and stress level, suggesting that as sleep hours' decrease, stress level tends to increase.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:           Stress Level   R-squared:                       0.124
Model:                            OLS   Adj. R-squared:                  0.115
Method:                 Least Squares   F-statistic:                     13.87
Date:                Mon, 25 Dec 2023   Prob (F-statistic):           0.000327
Time:                        00:54:50   Log-Likelihood:                -152.47
No. Observations:                 100   AIC:                             308.9
Df Residuals:                      98   BIC:                             314.1
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          3.8366      0.340     11.274      0.000       3.161       4.512
Sleep Hours   -0.3693      0.099     -3.725      0.000      -0.566      -0.173
==============================================================================
Omnibus:                        8.456   Durbin-Watson:                   2.047
Prob(Omnibus):                  0.015   Jarque-Bera (JB):                8.587
Skew:                           0.716   Prob(JB):                       0.0137
Kurtosis:                       3.114   Cond. No.                         11.2
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

- **Between Caffeine intake and productivity:**

The below regression results suggest that there is a statistically significant negative relationship between caffeine intake per day and daily productivity ratings, indicating that higher caffeine intake is associated with lower productivity.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:     Productivity Rating?   R-squared:                       0.096
Model:                            OLS   Adj. R-squared:                  0.087
Method:                 Least Squares   F-statistic:                     10.42
Date:                Mon, 25 Dec 2023   Prob (F-statistic):            0.00169
Time:                        01:04:44   Log-Likelihood:                -199.28
No. Observations:                 100   AIC:                             402.6
Df Residuals:                      98   BIC:                             407.8
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                             coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const                      7.5930      0.442     17.194      0.000       6.717       8.469
Caffeine Intake per Day   -0.7120      0.221     -3.229      0.002      -1.150      -0.274
==============================================================================
Omnibus:                        6.650   Durbin-Watson:                   1.957
Prob(Omnibus):                  0.036   Jarque-Bera (JB):                6.309
Skew:                          -0.607   Prob(JB):                       0.0427
Kurtosis:                       3.204   Cond. No.                         5.99
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

- **Between Device use hours before bed and sleep quality:**

The regression results indicate that there is a statistically significant negative relationship between the number of hours spent using electronic devices before bedtime and the reported sleep quality. The coefficient for "Device Use Hrs. Before Bed" is -0.3919, suggesting that as the duration of device use increases, sleep quality tends to decrease.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:          Sleep Quality   R-squared:                       0.204
Model:                            OLS   Adj. R-squared:                  0.195
Method:                 Least Squares   F-statistic:                     25.05
Date:                Mon, 25 Dec 2023   Prob (F-statistic):           2.46e-06
Time:                        01:10:15   Log-Likelihood:                -131.99
No. Observations:                 100   AIC:                             268.0
Df Residuals:                      98   BIC:                             273.2
Df Model:                           1
Covariance Type:            nonrobust
================================================================================================
                                   coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------------------------
const                            4.6483      0.247     18.818      0.000       4.158       5.138
Device Use Hrs Before Bed       -0.3919      0.078     -5.005      0.000      -0.547      -0.237
==============================================================================
Omnibus:                        2.281   Durbin-Watson:                   2.454
Prob(Omnibus):                  0.320   Jarque-Bera (JB):                2.304
Skew:                          -0.337   Prob(JB):                        0.316
Kurtosis:                       2.688   Cond. No.                         9.26
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

- **Between Nap Frequency and Sleep Quality:**

The regression results suggest that there is a statistically significant positive relationship between the frequency of taking naps during the day ("Nap Frequency") and reported sleep quality. The coefficient for "Nap Frequency" is 0.2276, indicating that higher nap frequency is associated with better sleep quality.

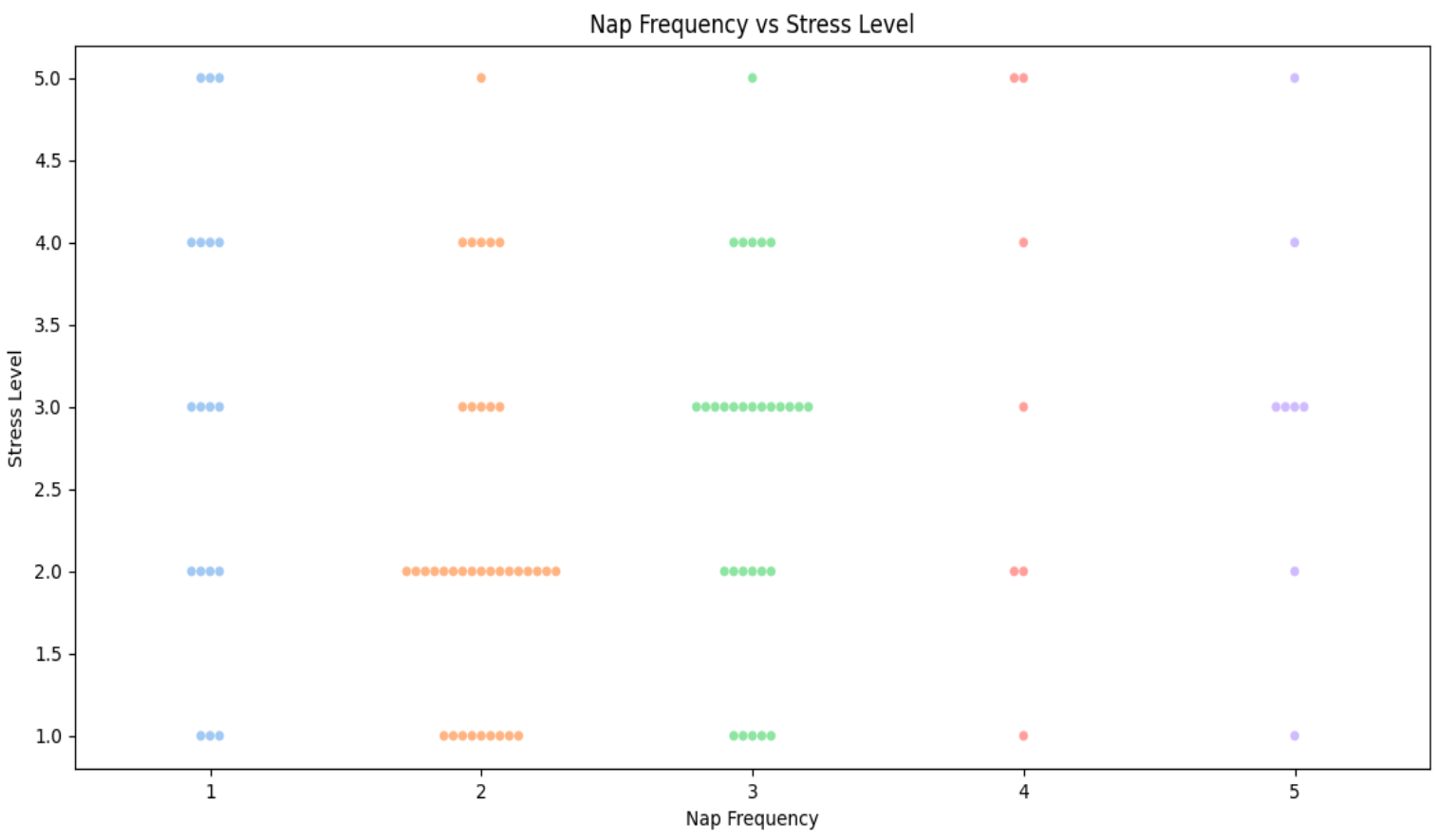
```
                            OLS Regression Results
==============================================================================
Dep. Variable:          Sleep Quality   R-squared:                       0.062
Model:                            OLS   Adj. R-squared:                  0.052
Method:                 Least Squares   F-statistic:                     6.465
Date:                Mon, 25 Dec 2023   Prob (F-statistic):             0.0126
Time:                        01:14:20   Log-Likelihood:                -140.18
No. Observations:                 100   AIC:                             284.4
Df Residuals:                      98   BIC:                             289.6
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
const          2.9309      0.245     11.969      0.000       2.445       3.417
Nap Frequency  0.2276      0.090      2.543      0.013       0.050       0.405
==============================================================================
Omnibus:                        3.419   Durbin-Watson:                   2.363
Prob(Omnibus):                  0.181   Jarque-Bera (JB):                3.410
Skew:                          -0.417   Prob(JB):                        0.182
Kurtosis:                       2.651   Cond. No.                         7.51
==============================================================================

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```

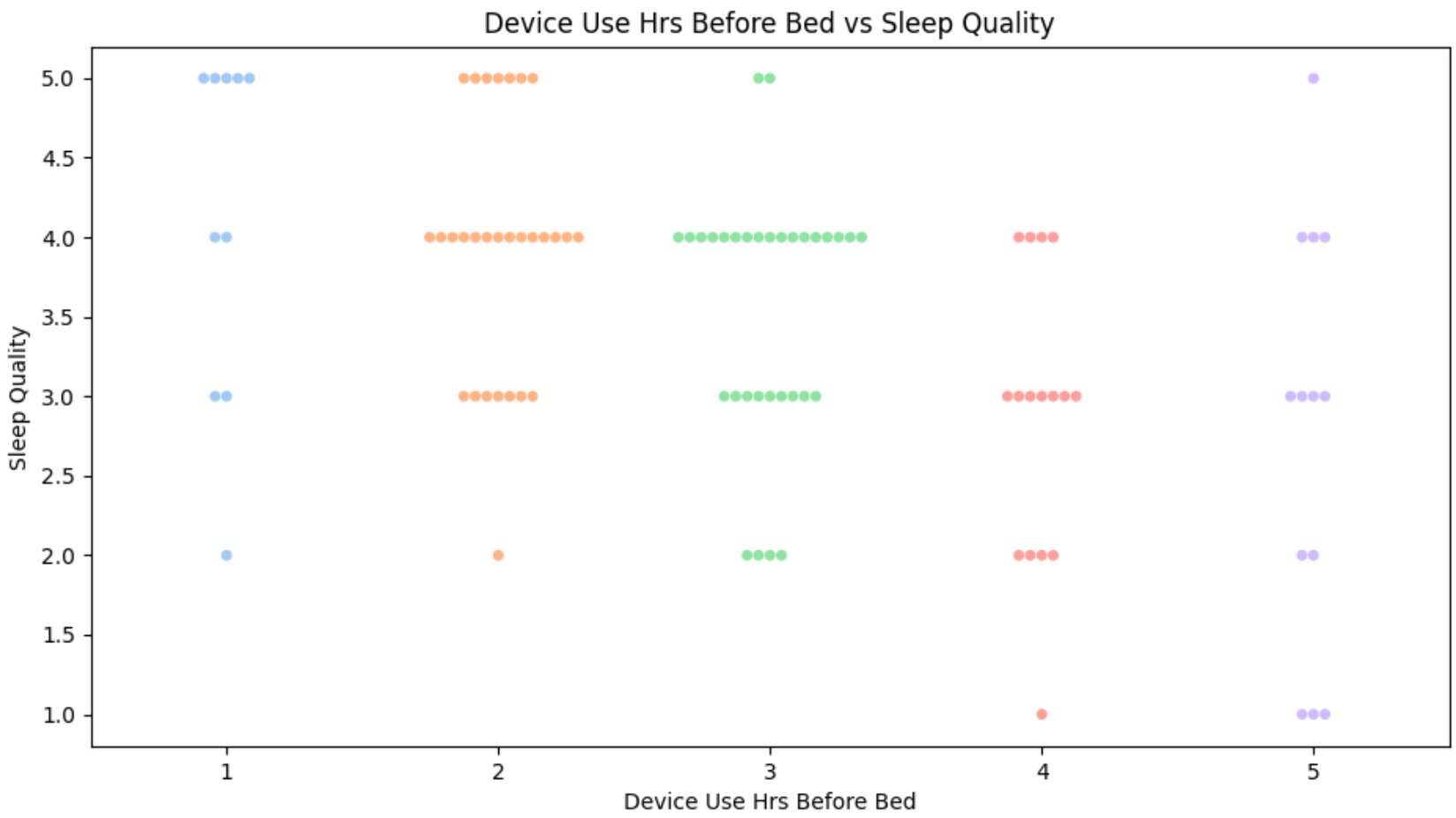
❖ Box plot Diagram:

❖Swarm plot:

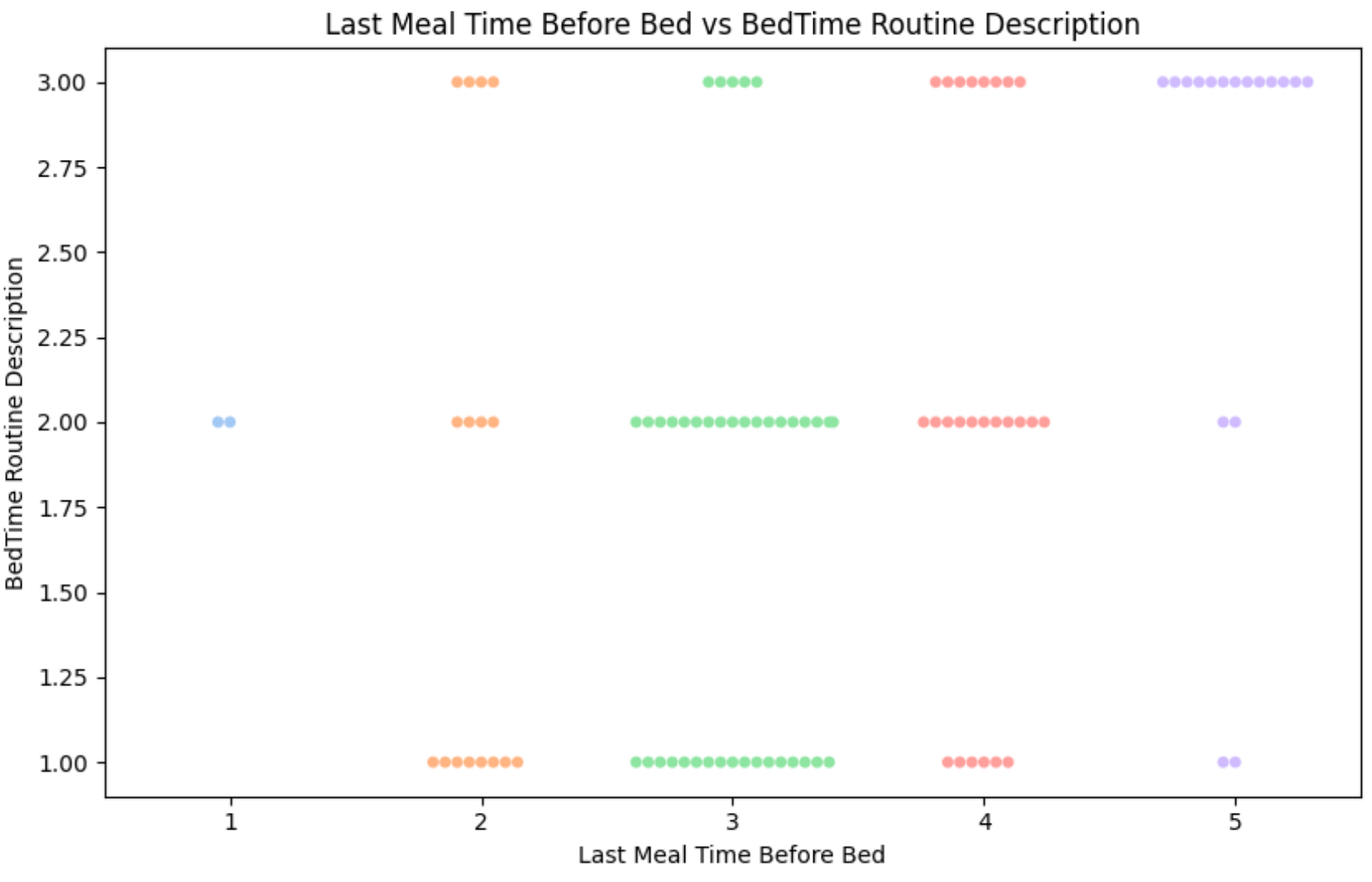
1) Between Nap Frequency and Stress Level:



2) Between Device Use Hrs Before Bed and Sleep Quality:



3) Between Bed Routine and Meal before Bed time:



Hypothesis Testing:

❖ Impact of less Hour of Sleep on the Stress Level

- **Claim 1:**

  Having sleep of less than 4 hours increase Stress level.

- **Opposite claim 1:**

  Having sleep of less than 4 hours increase Stress level.

- **H0(Null Hypothesis):**

  Having a sleep duration of less than 4 hours does not significantly increase stress levels.

- **H1(Alternative Hypothesis):**

  Having a sleep duration of less than 4 hours significantly increases stress levels.

- **Python Code:**

  Here we have performed a t-test on the claim where we have the H0 and H1 and value of alpha (0.05) which is general if not g=given we assume.

```
# Perform a t-test for independent samples
t_statistic, p_value = stats.ttest_ind(less_than_4_hours, four_hours_or_more, equal_var=False)

# Define the significance level
alpha = 0.05

# Check the p-value against the significance level
if p_value < alpha:
    print(f'Reject the null hypothesis. There is enough evidence to suggest that having less than 4 hours of sleep increases stress levels.')
else:
    print('Fail to reject the null hypothesis. There is not enough evidence to suggest that having less than 4 hours of sleep increases stress levels.')
```

- **Result:**

```
Reject the null hypothesis. There is enough evidence to suggest that having less than 4 hours of sleep increases stress levels.
```

❖ Impact of napping on the quality of Sleep:

- **Claim 2:**

  Having a nap of more than 2 hours increase the quality of sleep.

- **Opposite claim 2:**

  Having a nap of more than 2 hours donot increase the quality of sleep

- **H0(Null Hypothesis):**

  Having a nap of more than 2 does increase the quality of sleep.

- **H1(Alternative Hypothesis):**

  Having a nap of more than 2 does not increase the quality of sleep.

- **Python code:**

```
df['Nap Frequency'] = df['Nap Frequency'].map(mappings['nap_frequency'])
df['Sleep Quality'] = df['Sleep Quality'].map(mappings['sleep_quality'])

# Extract relevant columns for the analysis
nap_frequency = df['Nap Frequency']
sleep_quality = df['Sleep Quality']

# Create two groups: 'Nap more than 2' and 'Nap 2 or fewer'
nap_more_than_2 = sleep_quality[nap_frequency > 2]
nap_2_or_fewer = sleep_quality[nap_frequency <= 2]

# Perform a t-test for independent samples
t_statistic, p_value = stats.ttest_ind(nap_more_than_2, nap_2_or_fewer, equal_var=False)

# Define the significance level
alpha = 0.05

# Check the p-value against the significance level
if p_value < alpha:
    print(f'Reject the null hypothesis. There is enough evidence to suggest that having a nap of more than 2 increases the quality of sleep.')
else:
    print('Fail to reject the null hypothesis. There is not enough evidence to suggest that having a nap of more than 2 increases the quality of sleep.')
```

❖Result:

```
Fail to reject the null hypothesis. There is not enough evidence to suggest that having a nap of more than 2 increases the quality of sleep.
```

❖Impact of Caffeine Intake on Sleep Quality:

- **H0(Null Hypothesis):**
  There is no difference in sleep quality between individuals who consume 1-2 caffeinated beverages per day and those who consume 5 or more.
- **H1(Alternative Hypothesis):**
  There is a significant difference in sleep quality between individuals based on their daily caffeine intake.

  - **Python Code:**

```python
caffeine_1_2 = df[df['Caffeine Intake per Day'] == 'I consume 1-2 caffeinated beverages per day.']['Sleep Quality']
caffeine_5_more = df[df['Caffeine Intake per Day'] == 'I consume 5 or more caffeinated beverages per day.']['Sleep Quality']

# Perform t-test for independent samples
t_statistic, p_value = stats.ttest_ind(caffeine_1_2, caffeine_5_more, equal_var=False)

# Define the significance level
alpha = 0.05

# Check the p-value against the significance level
if p_value < alpha:
    print("Reject the null hypothesis. There is a significant difference in sleep quality between the two groups.")
else:
    print("Fail to reject the null hypothesis. There is no significant difference in sleep quality between the two groups.")
```

- **Result:**

```
Fail to reject the null hypothesis. There is no significant difference in sleep quality between the two groups.
```

- **Conclusion:**

  It means that based on the statistical analysis, we do not have enough evidence to conclude that there is a significant difference in sleep quality between individuals who consume 1-2 caffeinated beverages per day and those who consume 5 or more.

❖ Effect of Exercise on Stress Levels:

- **H0(Null Hypothesis):**

  The mean stress level is the same for individuals who exercise regularly and those who never exercise

- **H1(Alternative Hypothesis):**

  The mean stress level is different for individuals who exercise regularly compared to those who never exercise.

- **Python Code:**

```python
stress_level_regular_exercise = df[df['Exercise Frequency'] == 4]['Stress Level']
stress_level_never_exercise = df[df['Exercise Frequency'] == 0]['Stress Level']

# Perform a two-sample t-test
t_statistic, p_value = stats.ttest_ind(stress_level_regular_exercise, stress_level_never_exercise, equal_var=False)

# Define the significance level
alpha = 0.05

# Check the p-value against the significance level
if p_value < alpha:
    print('Reject the null hypothesis. There is a significant difference in mean stress levels between individuals who exercise regularly and those who never exercise.')
else:
    print('Fail to reject the null hypothesis. There is no significant difference in mean stress levels between individuals who exercise regularly and those who never exercise.')
```

- **Result:**

```
Fail to reject the null hypothesis. There is no significant difference in mean stress levels between individuals who exercise regularly and those who never exercise.
```

❖ Productivity and Sleep Duration:

- **H0(Null Hypothesis):**
  The mean productivity rating is not affected by the number of hours of sleep an individual gets per night.
- **H1(Alternative Hypothesis):**
  The mean productivity rating is influenced by the number of hours of sleep an individual gets per night.

  - **Python code:**

```
productivity_rating_sleep_fewer_than_4_hours = df[df['Sleep Hours'] == 1]['Productivity Rating?']
productivity_rating_4_hours_or_more = df[df['Sleep Hours'] >= 4]['Productivity Rating?']

# Perform a two-sample t-test
t_statistic, p_value = stats.ttest_ind(productivity_rating_sleep_fewer_than_4_hours, productivity_rating_4_hours_or_more, equal_var=False)

# Define the significance level
alpha = 0.05

# Check the p-value against the significance level
if p_value < alpha:
    print('Reject the null hypothesis. There is a significant difference in mean productivity ratings between individuals who sleep fewer than 4 hours and those who sleep 4 hours or more.')
else:
    print('Fail to reject the null hypothesis. There is no significant difference in mean productivity ratings between individuals who sleep fewer than 4 hours and those who sleep 4 hours or
    more.')
```

  - **Result:**

```
Reject the null hypothesis. There is a significant difference in mean productivity ratings between individuals who sleep fewer than 4 hours and those who sleep 4 hours or more.
```