Depression is a growing global health issue, and early identification of individuals at risk is crucial for effective intervention. In this project, I used **unsupervised learning**, specifically the **K-Means clustering algorithm**, to analyze various factors related to lifestyle, mental health history, and physical habits. The main goal was to identify groups of individuals with similar risk patterns for depression, without any predefined labels or diagnosis data.

By leveraging clustering techniques, I aimed to group people based on their common traits, such as **smoking habits**, **alcohol consumption**, **sleep patterns**, and **mental illness history**. This method helps in uncovering hidden patterns in the data, potentially providing insights into which lifestyle combinations are more likely to result in depression. Through this approach, we can better understand at-risk populations, allowing healthcare providers to target interventions more effectively.

This project showcases how unsupervised learning can play a key role in mental health prediction by grouping individuals based on their depression risk factors, even when explicit diagnostic labels are unavailable.

In [1]:
```python
# Import Libraries
import numpy as np
import pandas as pd
import warnings
warnings.filterwarnings('ignore')
```

```
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from sklearn.decomposition import PCA
from sklearn.metrics import silhouette_score
pd.set_option("display.max_rows", 500)
```

In [2]:
```
# Loading the data from csv file to a Pandas DataFrame
df = pd.read_csv("C:\\Users\\DELL\\OneDrive - Questindustries\\Documents\\Data
df.head(3)
```

Out[2]:

	Name	Age	Marital Status	Education Level	Number of Children	Smoking Status	Physical Activity Level	Employme Stat
0	Christine Barker	31	Married	Bachelor's Degree	2	Non-smoker	Active	Unemploy
1	Jacqueline Lewis	55	Married	High School	1	Non-smoker	Sedentary	Employ
2	Shannon Church	78	Widowed	Master's Degree	1	Non-smoker	Sedentary	Employ

In [3]:
```
# Finding the number of rows and columns
print(df.shape)
```

```
(1000, 16)
```

In this dataset have 50000 rows and 16 columns overall.

In [4]:
```
# Getting some information about the dataset
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000 entries, 0 to 999
Data columns (total 16 columns):
 #   Column                        Non-Null Count  Dtype  
---  ------                        --------------  -----  
 0   Name                          1000 non-null   object 
 1   Age                           1000 non-null   int64  
 2   Marital Status                1000 non-null   object 
 3   Education Level               1000 non-null   object 
 4   Number of Children            1000 non-null   int64  
 5   Smoking Status                1000 non-null   object 
 6   Physical Activity Level       1000 non-null   object 
 7   Employment Status             1000 non-null   object 
 8   Income                        1000 non-null   float64
 9   Alcohol Consumption           1000 non-null   object 
 10  Dietary Habits                1000 non-null   object 
 11  Sleep Patterns                1000 non-null   object 
 12  History of Mental Illness     1000 non-null   object 
 13  History of Substance Abuse    1000 non-null   object 
 14  Family History of Depression  1000 non-null   object 
 15  Chronic Medical Conditions    1000 non-null   object 
dtypes: float64(1), int64(2), object(13)
memory usage: 125.1+ KB
None
```

I check this dataset data type. Everything is good and there is no any null rows also.

In [5]:
```python
df.describe()
```

Out[5]:

	Age	Number of Children	Income
count	1000.000000	1000.000000	1000.000000
mean	49.052000	1.326000	51202.437610
std	17.990357	1.230951	40858.233896
min	18.000000	0.000000	68.900000
25%	33.000000	0.000000	21345.515000
50%	49.500000	1.000000	38576.120000
75%	65.000000	2.000000	76061.160000
max	80.000000	4.000000	209894.250000

In [6]:
```python
# Checking the missing values
print(df.isnull().sum())
```

```
Name                            0
Age                             0
Marital Status                  0
Education Level                 0
Number of Children              0
Smoking Status                  0
Physical Activity Level         0
Employment Status               0
Income                          0
Alcohol Consumption             0
Dietary Habits                  0
Sleep Patterns                  0
History of Mental Illness       0
History of Substance Abuse      0
Family History of Depression    0
Chronic Medical Conditions      0
dtype: int64
```

There is no null values in any rows.

In [7]:
```
print(df.duplicated().sum())
```

```
0
```

And also there is no any duplicate values.

In [8]:
```
print(df.columns)
```

```
Index(['Name', 'Age', 'Marital Status', 'Education Level',
       'Number of Children', 'Smoking Status', 'Physical Activity Level',
       'Employment Status', 'Income', 'Alcohol Consumption', 'Dietary Habits',
       'Sleep Patterns', 'History of Mental Illness',
       'History of Substance Abuse', 'Family History of Depression',
       'Chronic Medical Conditions'],
      dtype='object')
```

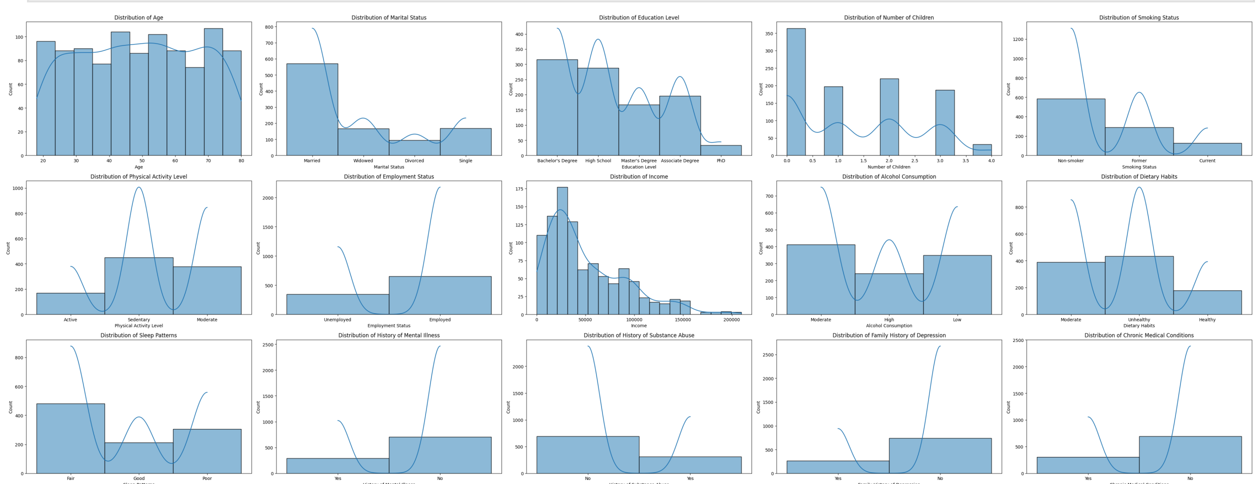
There is have these are have the columns so i focused only healthcare related columns.

In [9]:
```
df = df.drop(columns='Name',axis=1)
print(df.head(2))
```

```
   Age Marital Status    Education Level  Number of Children Smoking Status  \
0   31        Married  Bachelor's Degree                   2     Non-smoker   
1   55        Married        High School                   1     Non-smoker   

  Physical Activity Level Employment Status    Income Alcohol Consumption  \
0                  Active        Unemployed  26265.67            Moderate   
1               Sedentary          Employed  42710.36                High   

  Dietary Habits Sleep Patterns History of Mental Illness  \
0       Moderate           Fair                       Yes   
1      Unhealthy           Fair                       Yes   

  History of Substance Abuse Family History of Depression  \
0                         No                          Yes   
1                         No                           No   

  Chronic Medical Conditions  
0                        Yes  
1                        Yes  
```

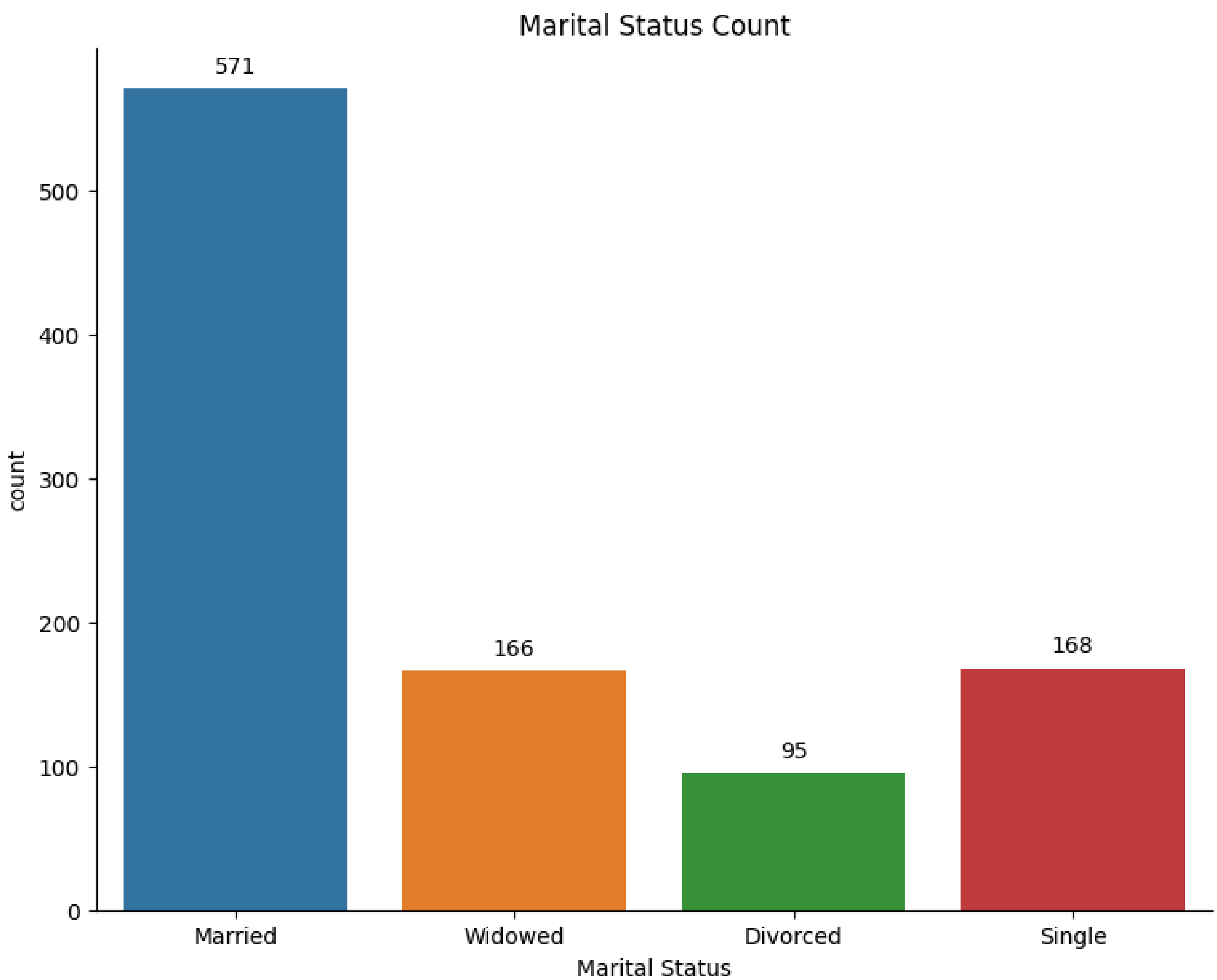
I delete name column because for it is unwanted column for this prediction.

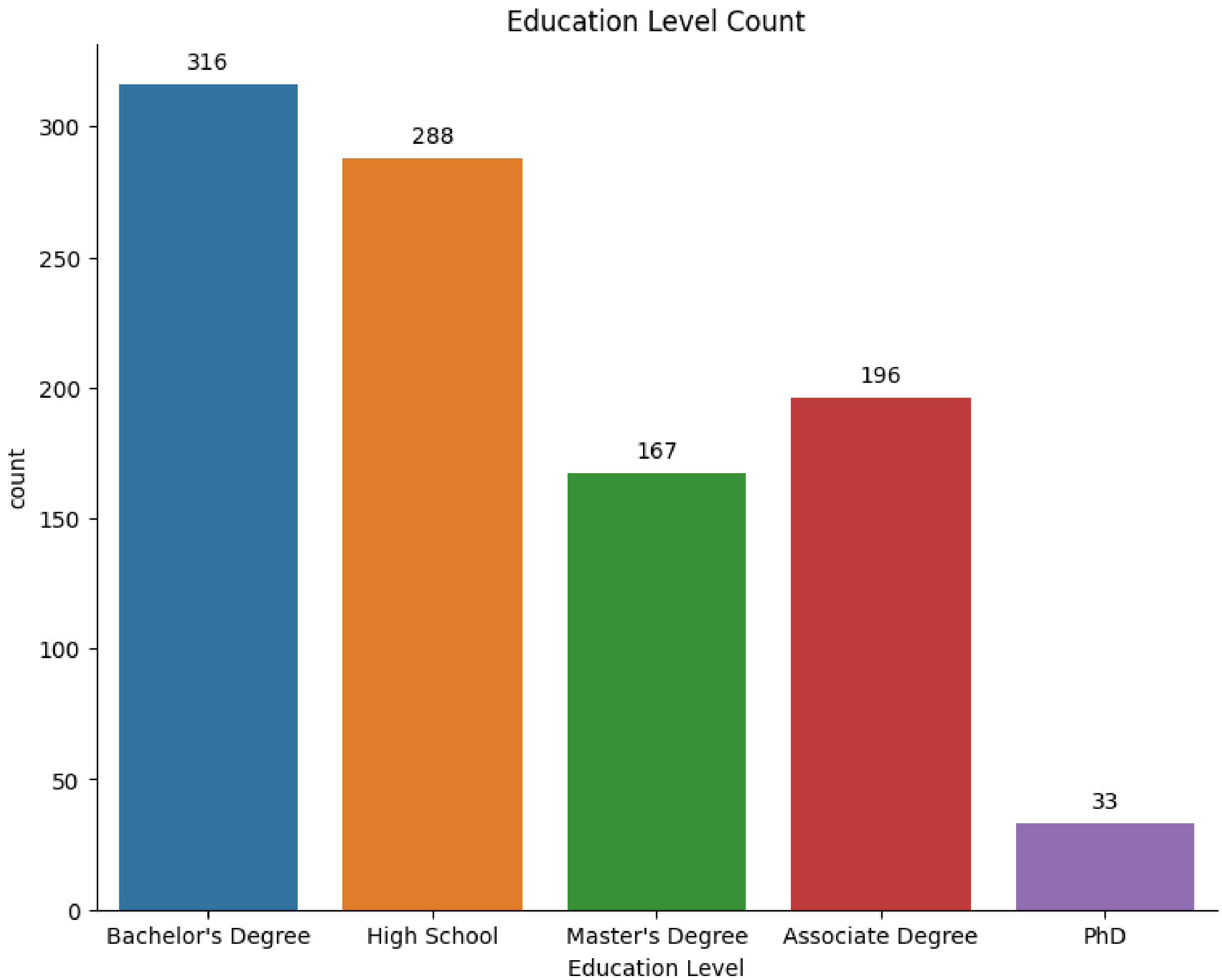
In [10]:
```python
plt.figure(figsize=(40, 25))
for i, feature in enumerate(df.columns, 1):
    plt.subplot(5, 5, i)
    sns.histplot(df[feature], kde=True, legend=df[feature])
    plt.title(f'Distribution of {feature}')
plt.tight_layout()
plt.show()
```

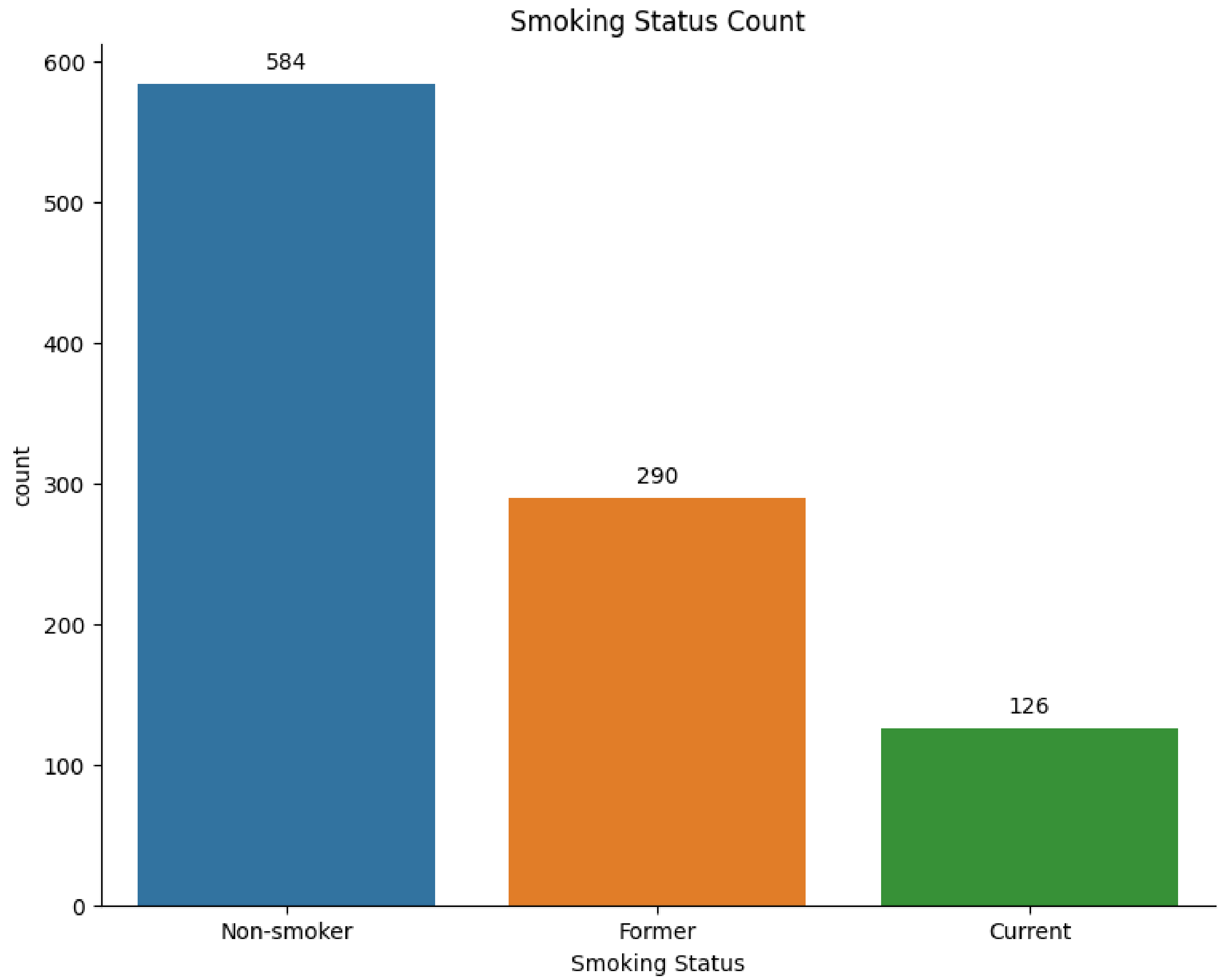


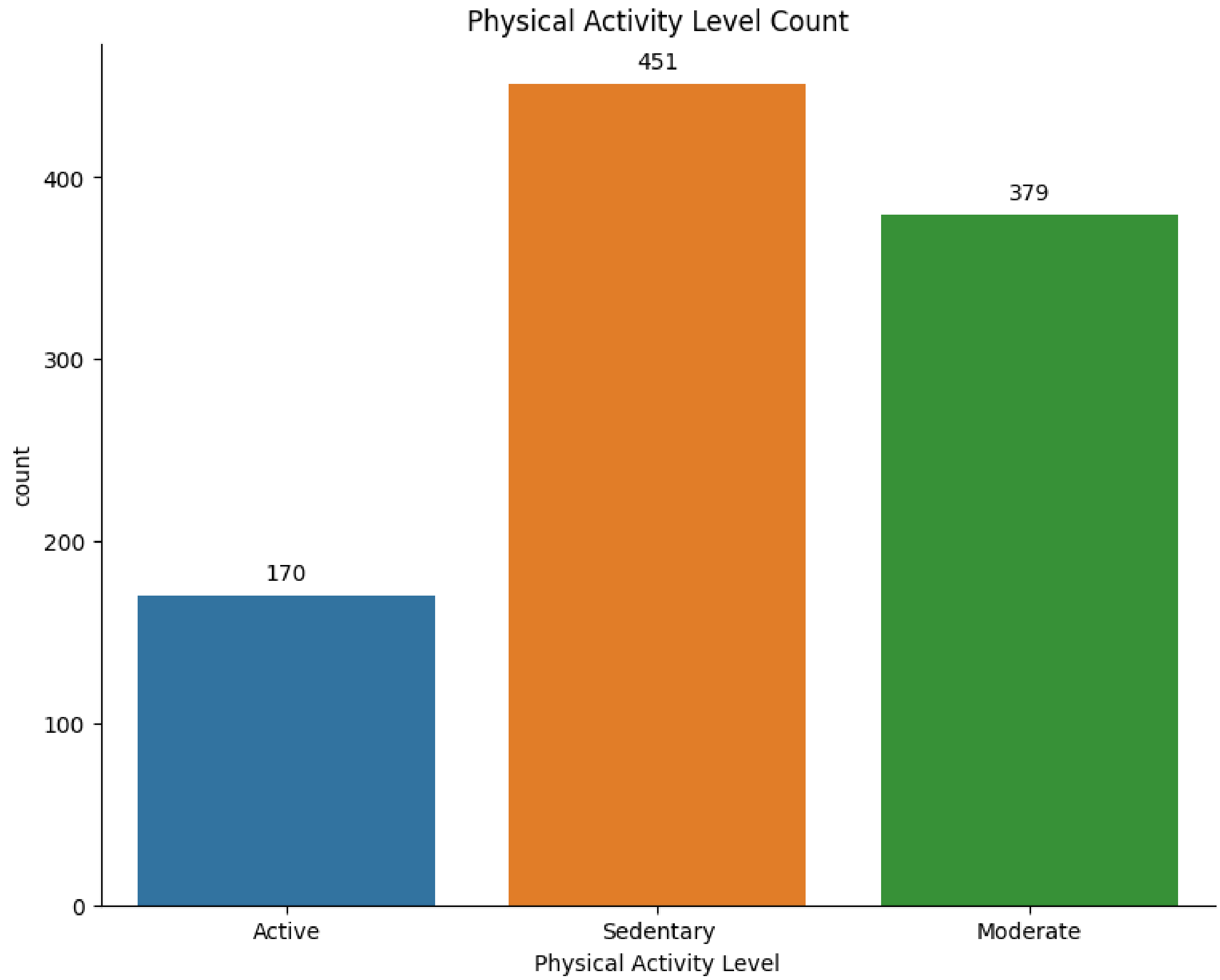
In [11]:
```python
# Loop through each column in the DataFrame
for col in df:
    if df[col].dtype == 'O':   # Check if the column is of object type (catego
        plt.figure(figsize=(9, 7))
        ax = sns.countplot(x=col, data=df, hue=col)

        # Add labels to each bar
        for p in ax.patches:
```

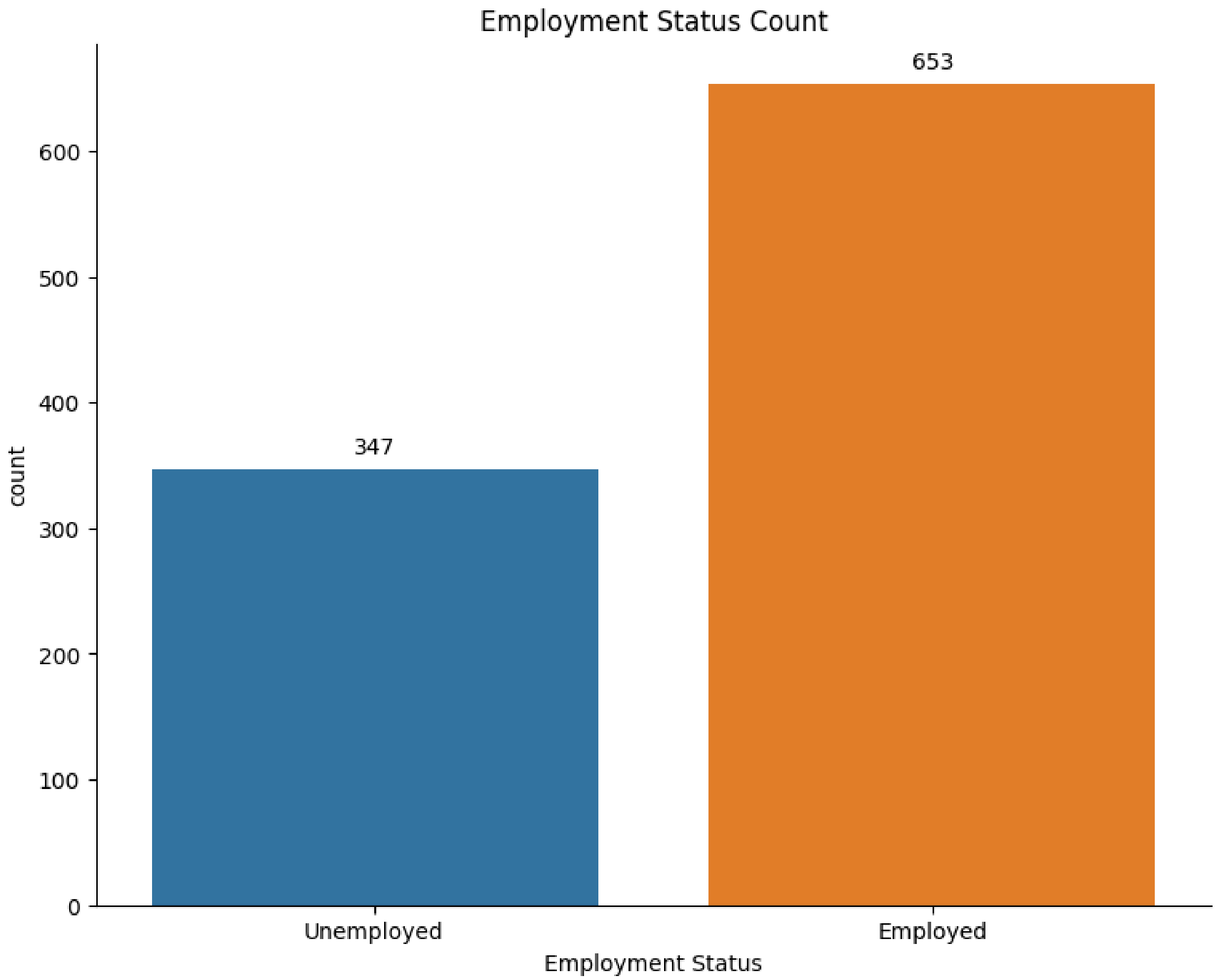
```python
            ax.annotate(format(p.get_height(), '.0f'),
                        (p.get_x() + p.get_width() / 2., p.get_height()),
                        ha = 'center', va = 'center',
                        xytext = (0, 10),
                        textcoords = 'offset points')
            ax.spines['top'].set_visible(False)
            ax.spines['right'].set_visible(False)
        plt.xticks(fontsize=None, ha='center', rotation=None, fontweight=None)
        plt.title(f"{col} Count")
        plt.show()
```



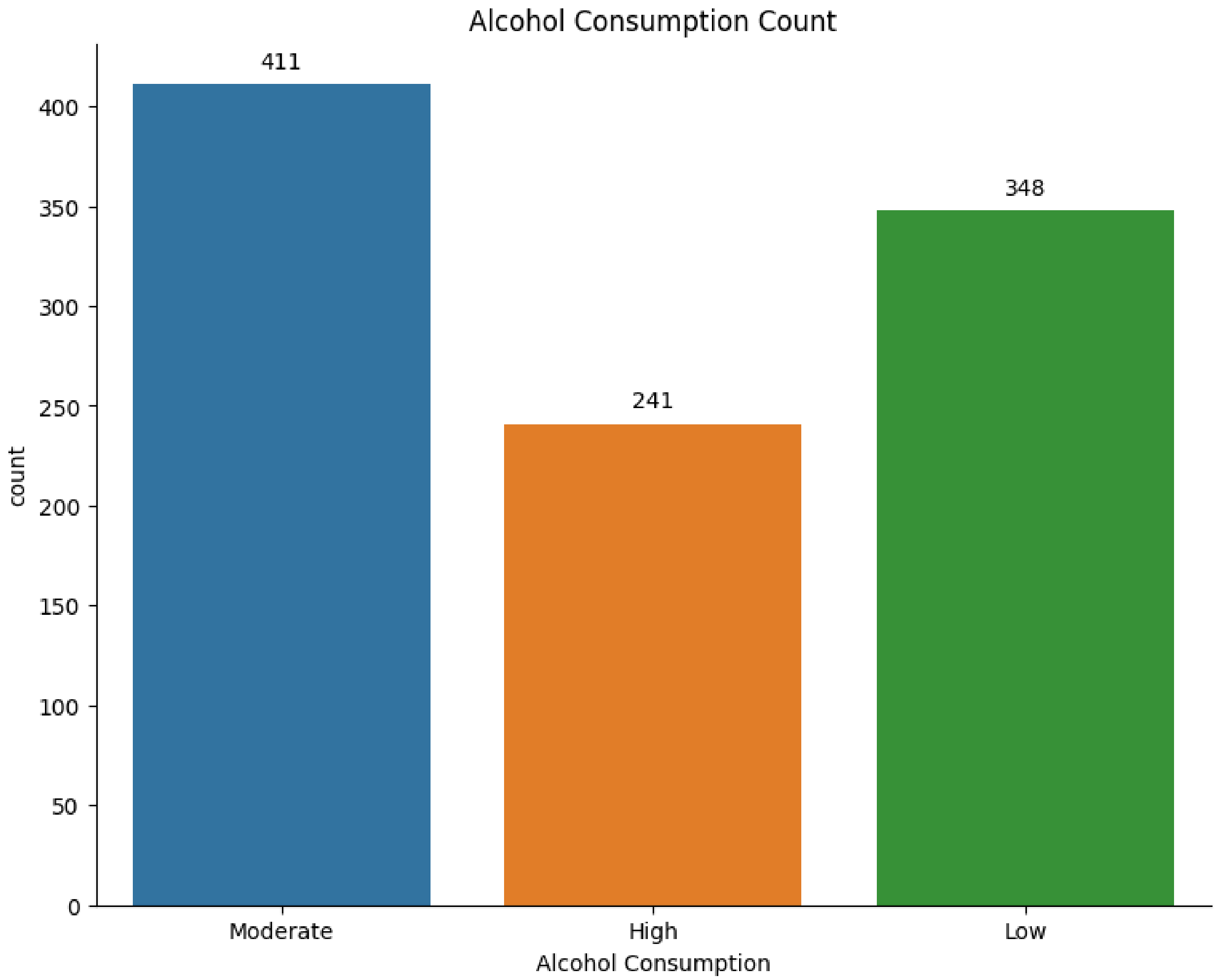

Education Level Count
316
288
196
167
33
count
300
250
200
150
100
50
0
Bachelor's Degree
High School
Master's Degree
Associate Degree
PhD
Education Level

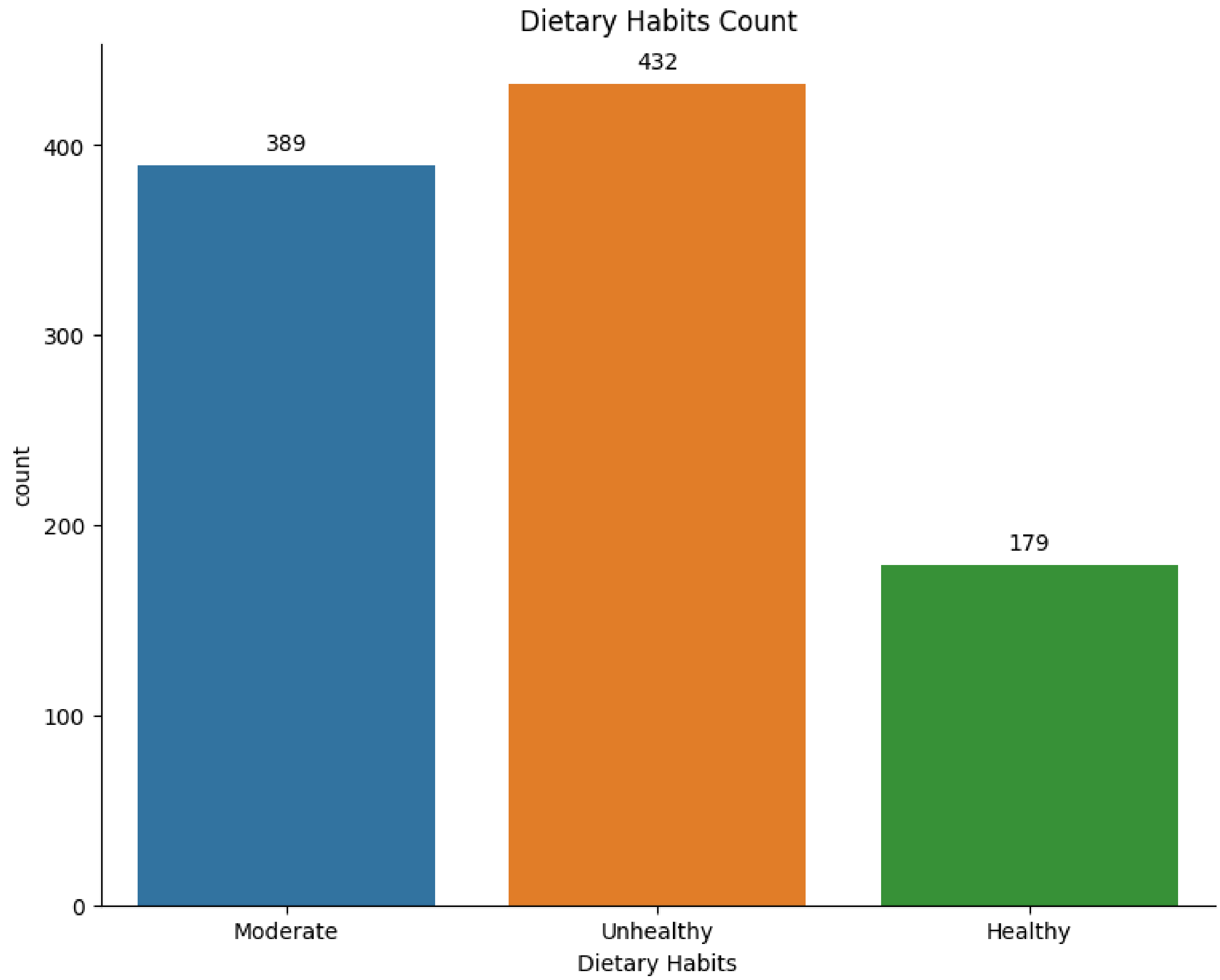

Smoking Status Count
584
290
126
600
500
400
300
200
100
0
count
Non-smoker
Former
Current
Smoking Status

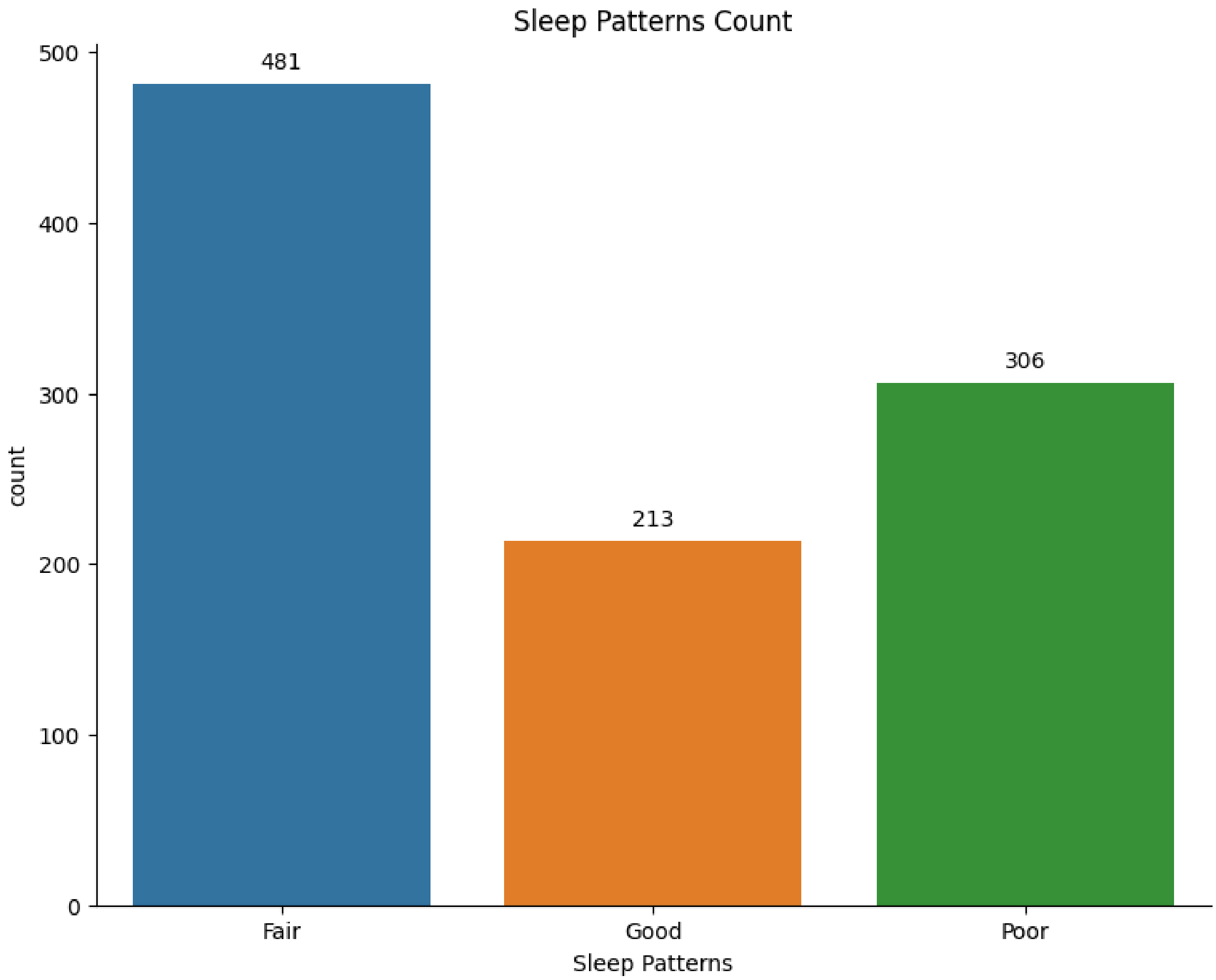

Physical Activity Level Count
451
379
170
400
300
200
100
0
count
Active
Sedentary
Moderate
Physical Activity Level

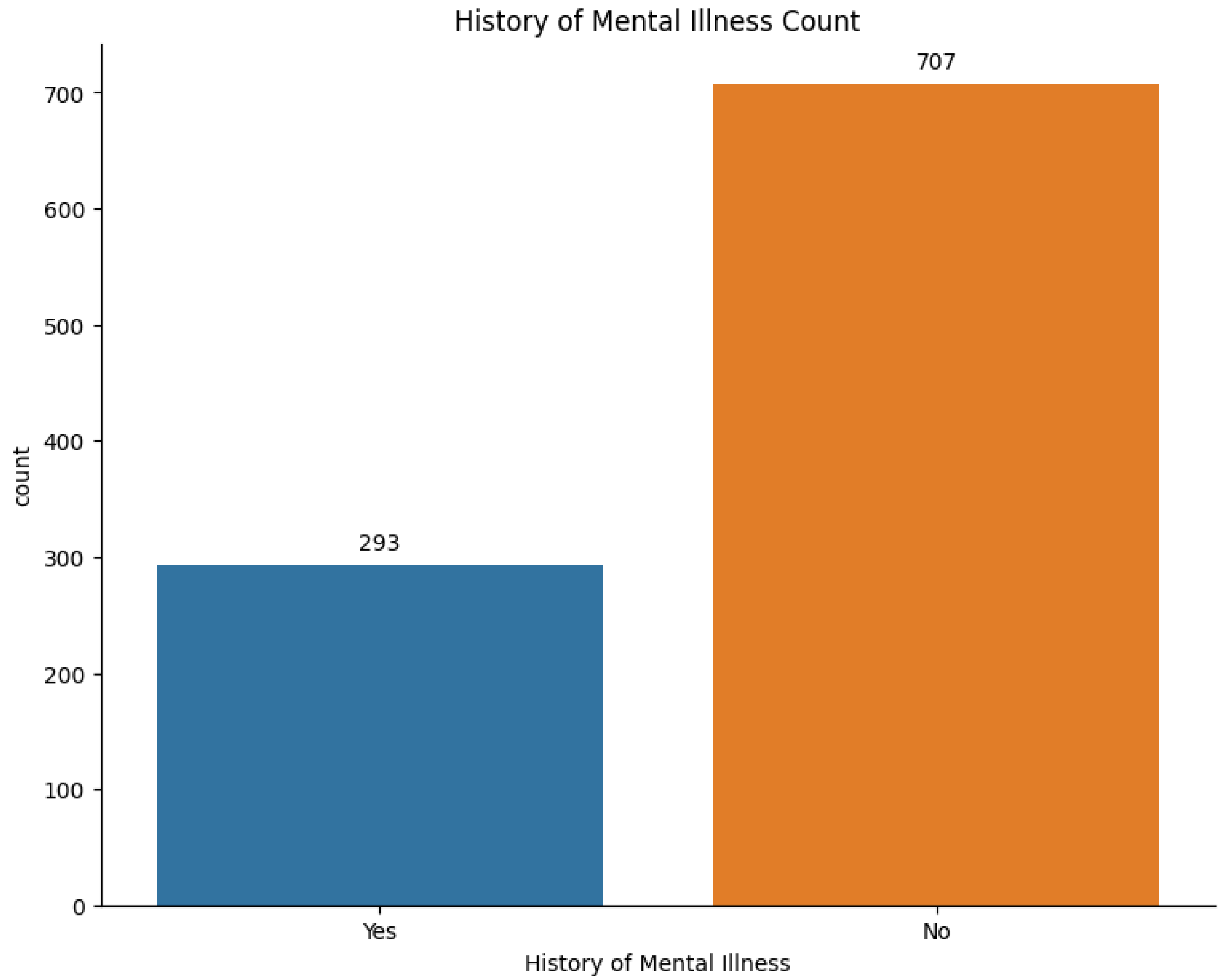


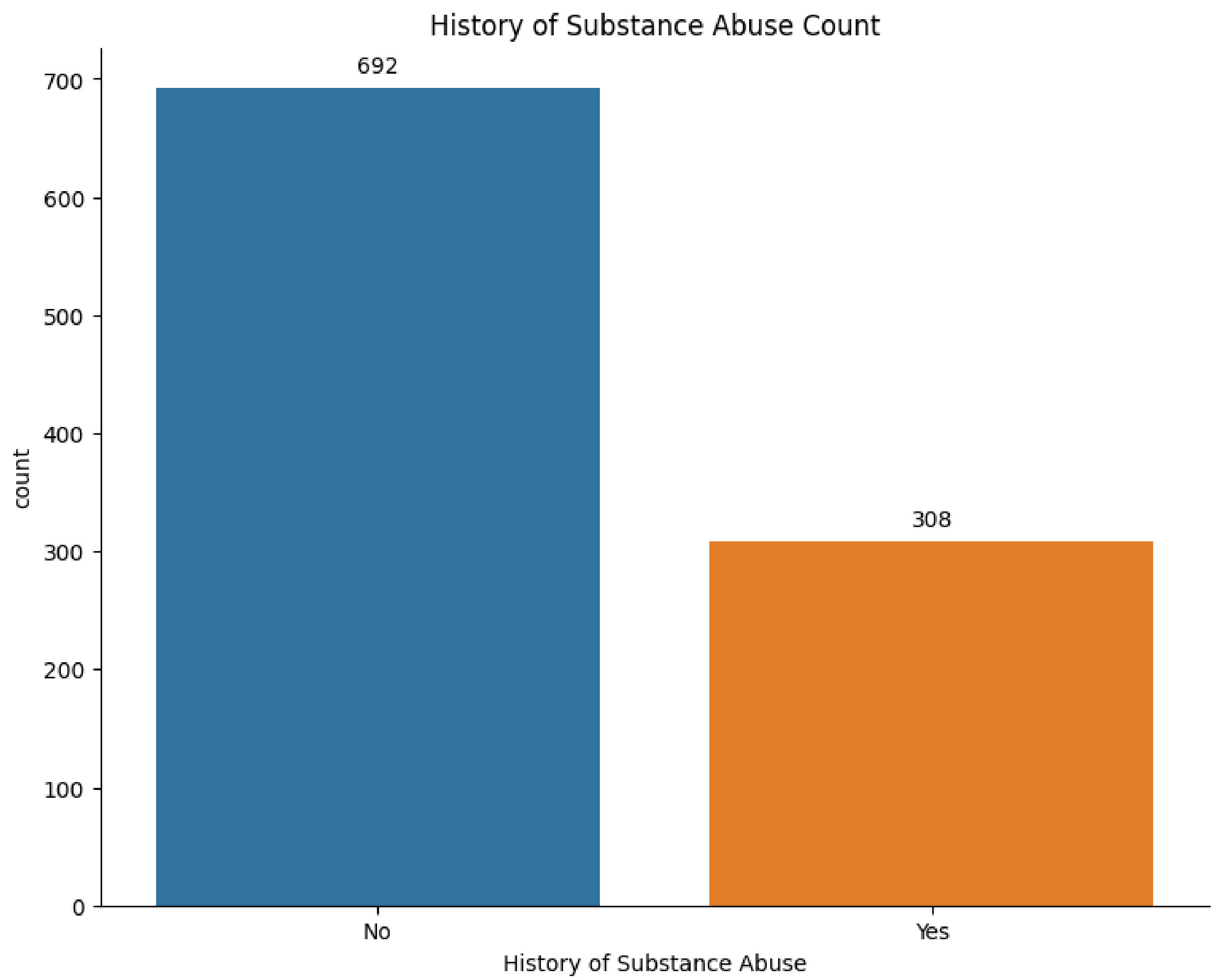
Employment Status Count
653
347
0
100
200
300
400
500
600
count
Unemployed
Employed
Employment Status

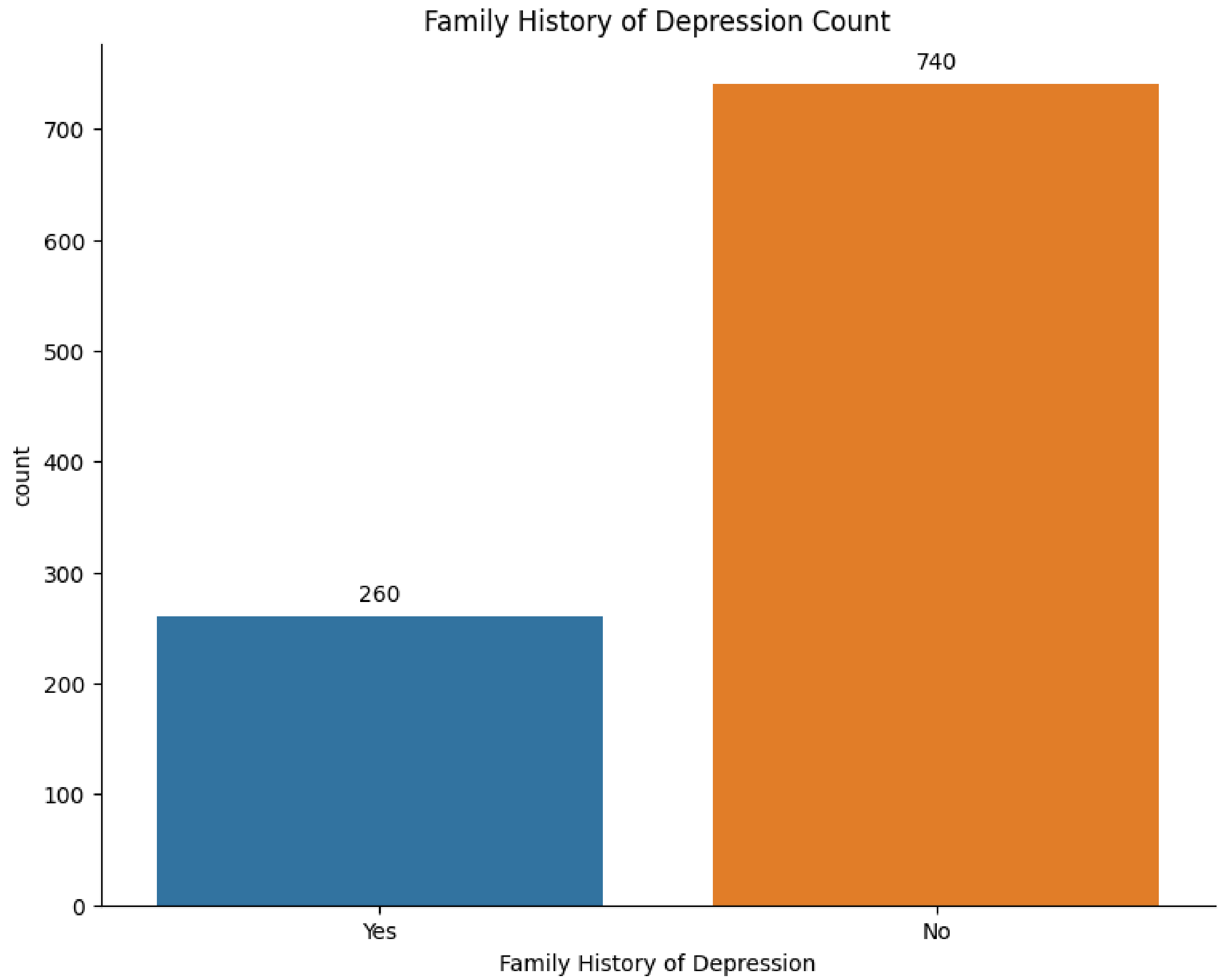

Alcohol Consumption Count
411
241
348
count
400
350
300
250
200
150
100
50
0
Moderate
High
Low
Alcohol Consumption

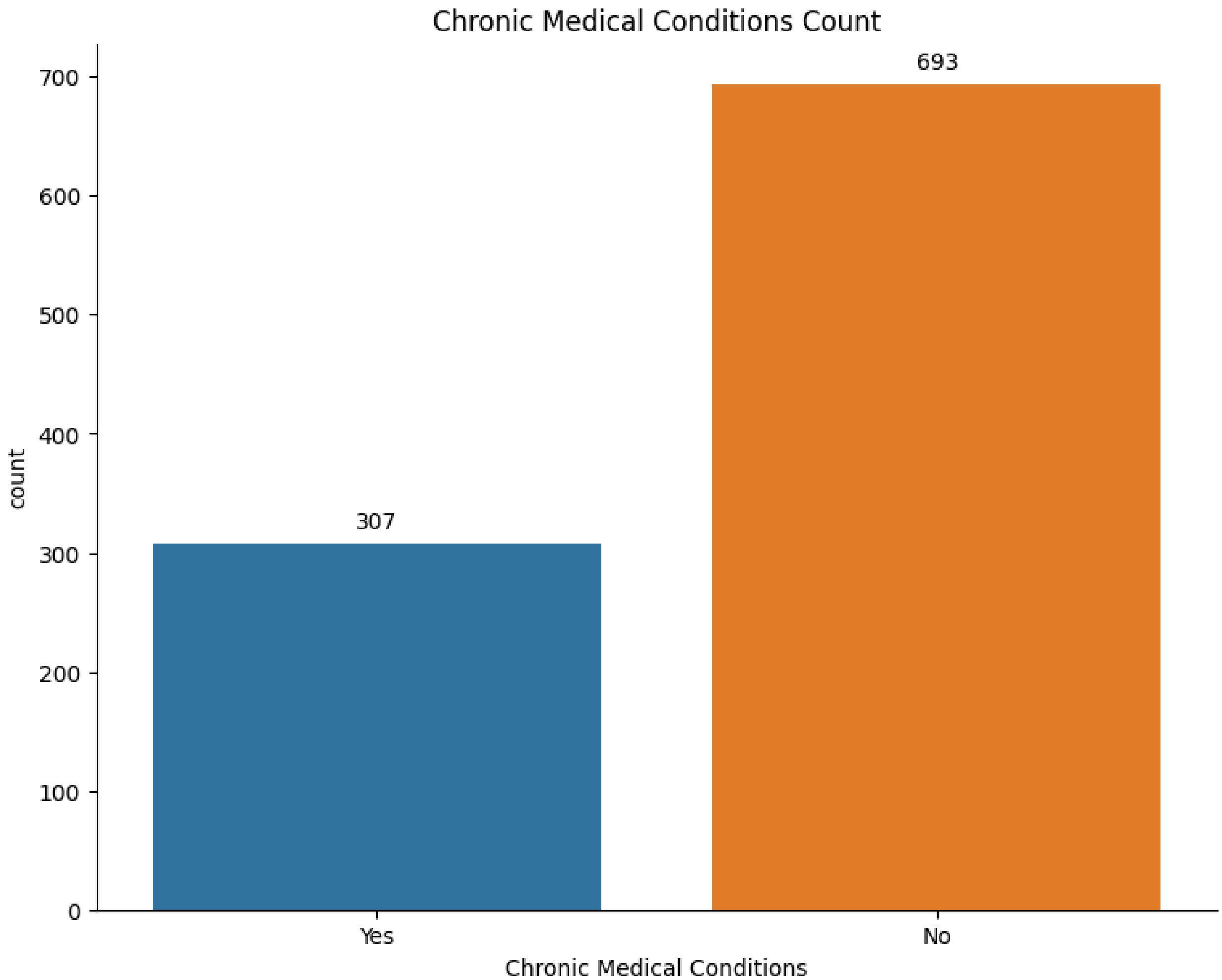

Dietary Habits Count
432
389
179
400
300
200
100
0
count
Moderate
Unhealthy
Healthy
Dietary Habits


Sleep Patterns Count
481
213
306
500
400
300
200
100
0
count
Fair
Good
Poor
Sleep Patterns


History of Mental Illness Count
count
707
293
0
100
200
300
400
500
600
700
Yes
No
History of Mental Illness


History of Substance Abuse Count
692
308
700
600
500
400
300
200
100
0
count
No
Yes
History of Substance Abuse


Family History of Depression Count
740
260
700
600
500
400
300
200
100
0
count
Yes
No
Family History of Depression



In [12]:
```
df.head(2)
```

Out[12]:

	Age	Marital Status	Education Level	Number of Children	Smoking Status	Physical Activity Level	Employment Status	Income
0	31	Married	Bachelor's Degree	2	Non-smoker	Active	Unemployed	26265.67
1	55	Married	High School	1	Non-smoker	Sedentary	Employed	42710.36

In [13]:
```
from sklearn.preprocessing import OrdinalEncoder

cols_to_encode = [
    'Marital Status',
    'Education Level',
    'Smoking Status',
    'Physical Activity Level',
    'Employment Status',
    'Alcohol Consumption',
    'Dietary Habits',
```

```
    'Sleep Patterns',
    'History of Mental Illness',
    'History of Substance Abuse',
    'Family History of Depression',
    'Chronic Medical Conditions'
]

ordinal_categories = [
    ['Single', 'Married', 'Divorced', 'Widowed'],
    ['High School', "Bachelor's Degree", "Master's Degree", 'Associate Degree'
    ['Non-smoker', 'Former', 'Current'],
    ['Sedentary', 'Moderate', 'Active'],
    ['Unemployed', 'Employed'],
    ['Low', 'Moderate', 'High'],
    ['Unhealthy', 'Moderate', 'Healthy'],
    ['Poor', 'Good', 'Fair'],
    ['No', 'Yes'],
    ['No', 'Yes'],
    ['No', 'Yes'],
    ['No', 'Yes']
]

encoder = OrdinalEncoder(categories=ordinal_categories)
df[cols_to_encode] = encoder.fit_transform(df[cols_to_encode])
```

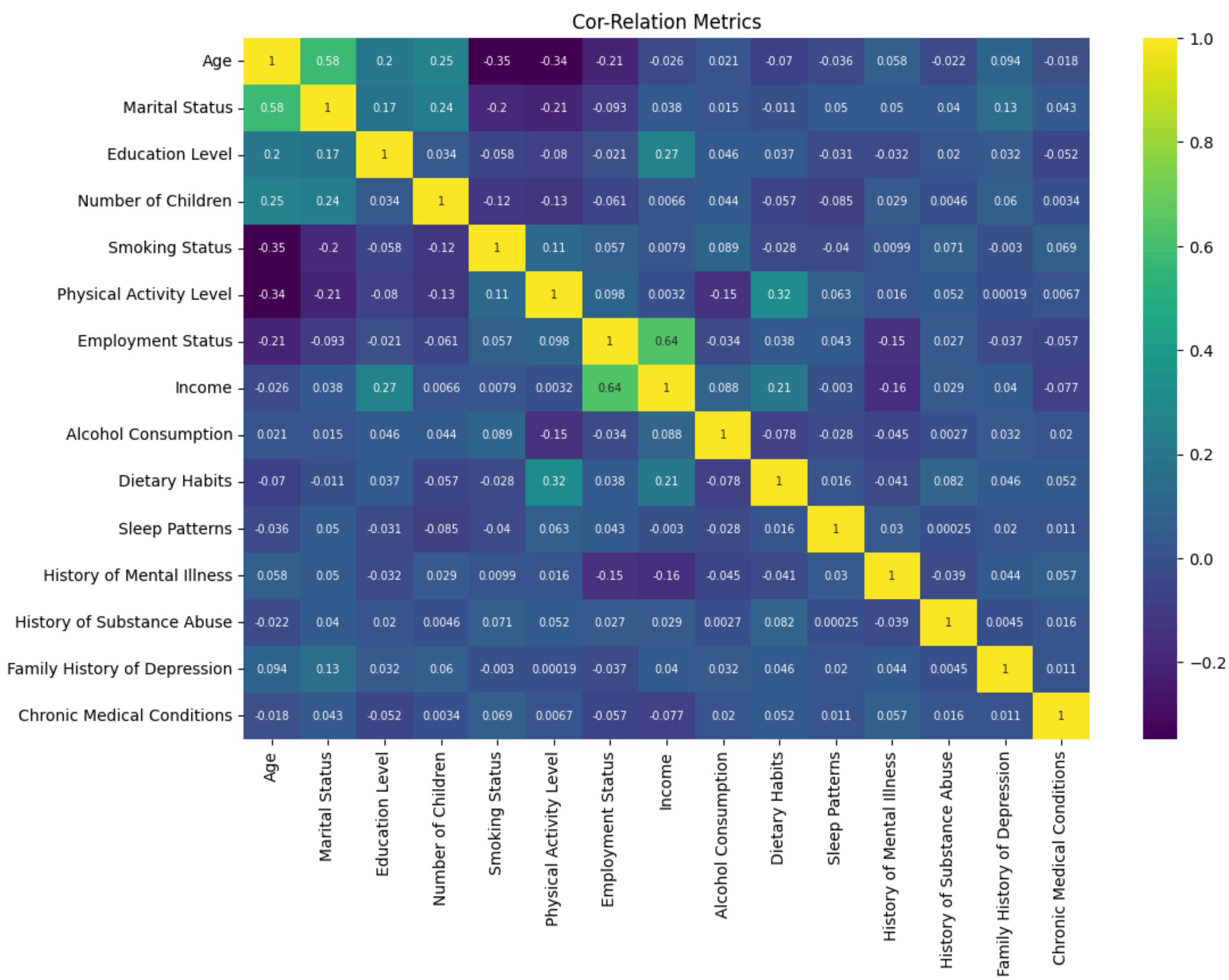
In [14]:
```
df[cols_to_encode] = df[cols_to_encode].astype(int)
```

In [15]:
```
df.head(2)
```

Out[15]:

	Age	Marital Status	Education Level	Number of Children	Smoking Status	Physical Activity Level	Employment Status	Income
0	31	1	1	2	0	2	0	26265.67
1	55	1	0	1	0	0	1	42710.36

In [16]:
```
fig = plt.figure(figsize=(12,8))
sns.heatmap(df.corr(),annot=True,annot_kws={'size':7}, cmap='viridis')
plt.title("Cor-Relation Metrics")
plt.show()
```



Replace the all the nessesary columns from categeorical to nummerical columns.

In [17]:
```
# Visualization for Age and Smoking Status.
age_smoking_bar = px.histogram(df, x=df['Age'], color=df['Smoking Status'],
                               text_auto=True, title='Smoking Status across Di
age_smoking_bar.show()
```

In [18]:
```
# Visualization for Physical Activity Level and Chronic Medical Conditions.
age_smoking_bar = px.histogram(df, x=df['Physical Activity Level'], color=df['
                               text_auto=True, title='Physical Activity Level
age_smoking_bar.show()
```

In [19]:
```
# Visualization for Income and Education Level.
age_smoking_bar = px.histogram(df, x=df['Income'], color=df['Education Level']
                               text_auto=True, title='Income Distribution acro
age_smoking_bar.show()
```

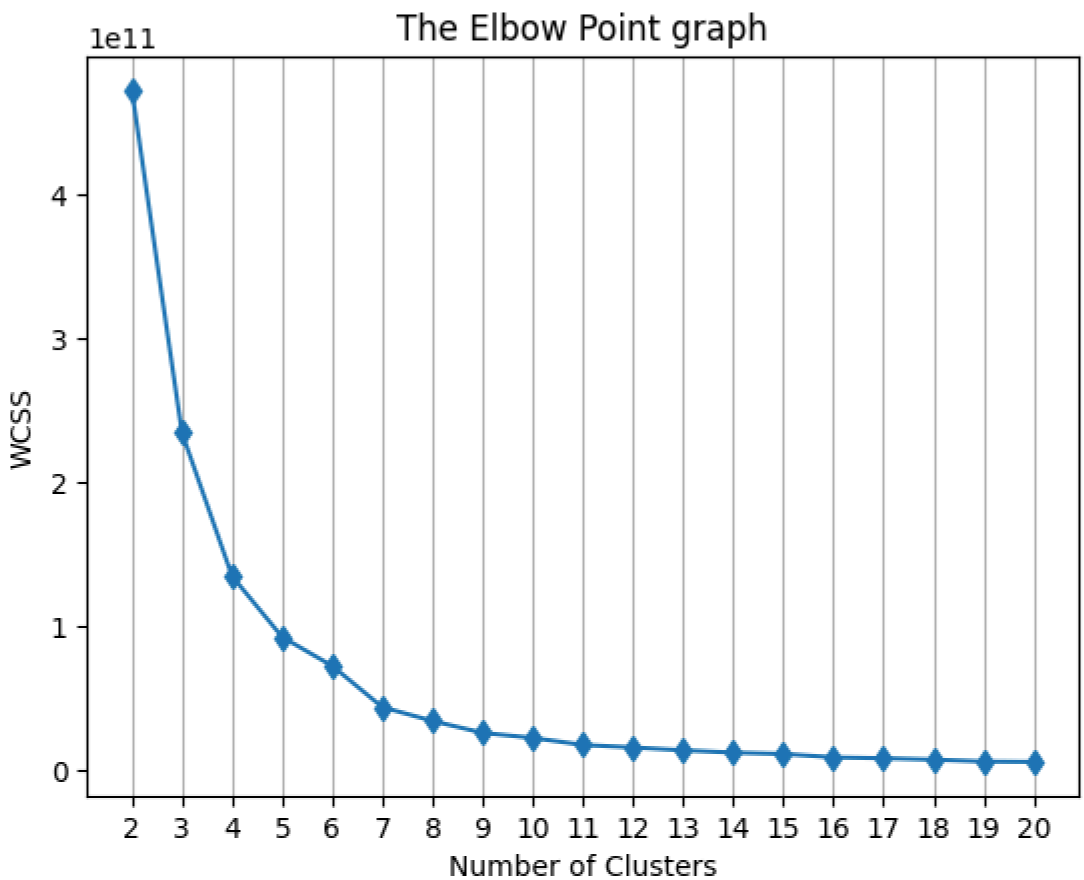
In [20]:
```
# Visualization for Alcohol Consumption and Sleep Patterns.
age_smoking_bar = px.histogram(df, x=df['Alcohol Consumption'], color=df['Slee
                               text_auto=True, title='Alcohol Consumption vs.
age_smoking_bar.show()
```

In [21]:
```
# Visualization for History of Mental Illness and Employment Status.
age_smoking_bar = px.histogram(df, x=df['History of Mental Illness'], color=df
                               text_auto=True, title='Employment Status based
age_smoking_bar.show()
```

In [22]:
```
# Visualization for Family History of Depression and Marital Status.
age_smoking_bar = px.histogram(df, x=df['Family History of Depression'], color
                               text_auto=True, title='Family History of Depres
age_smoking_bar.show()
```

In [23]:
```
# Finding wcss value for different number of clusters

wcss = []
for i in range(2, 21):
    kmeans = KMeans(n_clusters=i, init='k-means++',random_state=42)
    kmeans.fit(df)
    wcss.append(kmeans.inertia_)
```

In [24]:
```
# Plot an elbow graph
plt.plot([i for i in range(2, 21)], wcss, marker="d")
plt.xticks([i for i in range(2, 21)])
plt.title("The Elbow Point graph")
plt.xlabel("Number of Clusters")
plt.ylabel("WCSS")
plt.grid(axis="x")
plt.show()
```



In [25]:
```
# Applying KMeans

kmeans = KMeans(n_clusters=3, init="random", n_init="auto")
df['Cluster'] = kmeans.fit_predict(df)
print("Cluster sizes:\n",df['Cluster'].value_counts())
```

```
Cluster sizes:
 Cluster
2    611
0    298
1     91
Name: count, dtype: int64
```

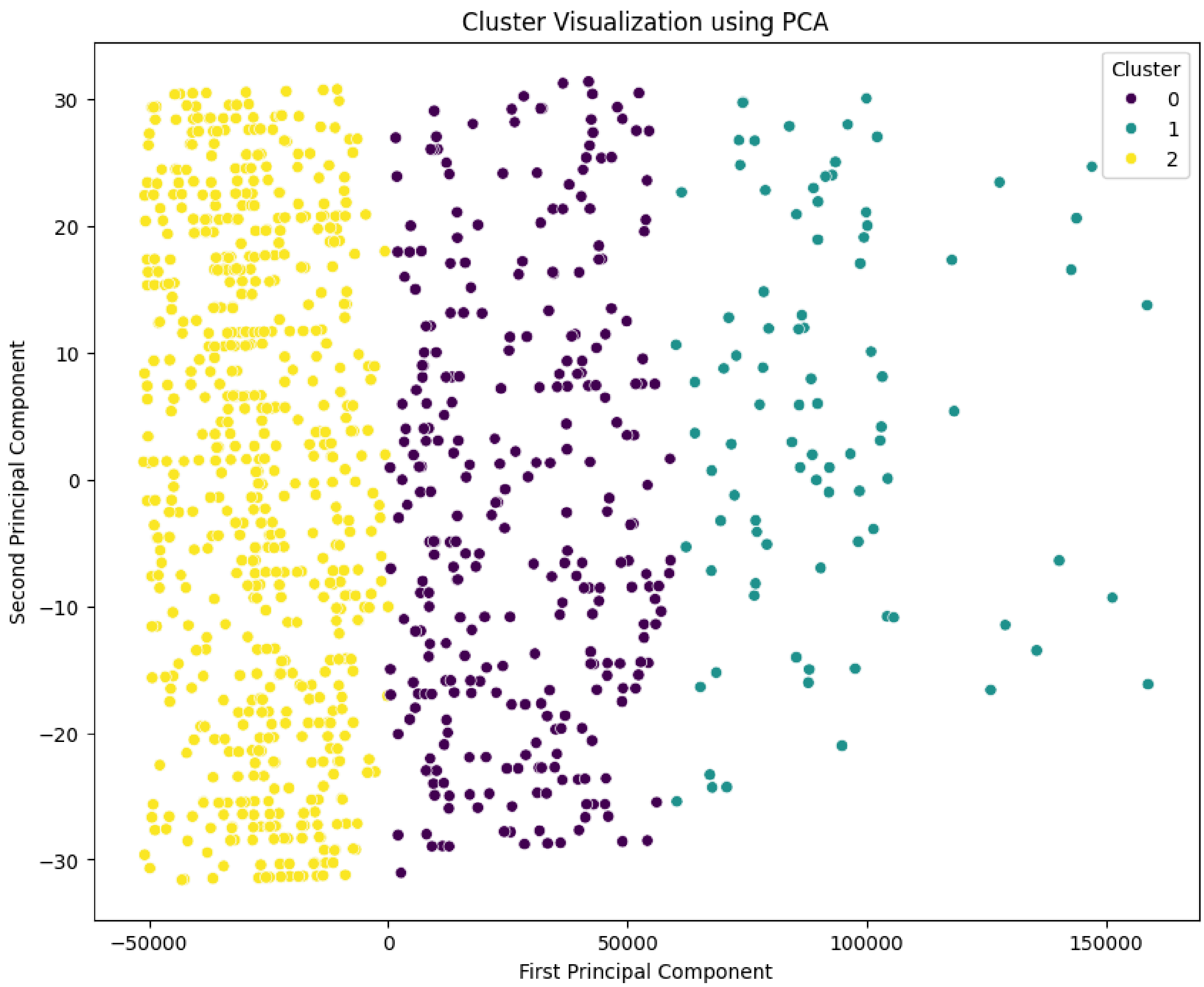
In [26]:
```
silhouette_score(df, kmeans.labels_)
```

Out[26]: 0.6413382152891879

In [27]:
```
ss = []
no_c = [j for j in range(2,21)]

for i in range(2,21):
    km1 = KMeans(n_clusters=i, init="random", n_init="auto")
    km1.fit_predict(df)
    ss.append(silhouette_score(df, km1.labels_))

ss
```

Out[27]:
```
[0.666966009013195,
 0.6413382152891879,
 0.5864359401564703,
 0.5562732023563856,
 0.584765520817268,
 0.5398568547369123,
 0.5851271383102905,
 0.5697185785981921,
 0.5682634655535632,
 0.553989633201749,
 0.5553492734709412,
 0.559304751099171,
 0.5582543922002576,
 0.5520175522608134,
 0.5497166979919407,
 0.56681225715333,
 0.5680188053014582,
 0.5499295037185933,
 0.5525334819996408]
```

In [28]:
```
# Applying PCA

pca = PCA(n_components=3)
X_pca = pca.fit_transform(df)
plt.figure(figsize=(10, 8))
sns.scatterplot(x=X_pca[:, 0], y=X_pca[:, 1], hue=df['Cluster'], palette='viri
plt.title('Cluster Visualization using PCA')
plt.xlabel('First Principal Component')
plt.ylabel('Second Principal Component')
plt.show()
```



In [29]:
```python
score = silhouette_score(df, df['Cluster'])
print(f'Silhouette Score: {score}')
```

```
Silhouette Score: 0.6413382152891879
```

In [30]:
```python
nfeatures = ['Age', 'Marital Status', 'Education Level', 'Number of Children',
       'Smoking Status', 'Physical Activity Level', 'Employment Status',
       'Income', 'Alcohol Consumption', 'Dietary Habits', 'Sleep Patterns',
       'History of Mental Illness', 'History of Substance Abuse',
       'Family History of Depression', 'Chronic Medical Conditions',
       'Cluster']
```

In [31]:
```python
cluster_means = df.groupby('Cluster')[nfeatures].mean()
print("Cluster means:\n",cluster_means)
```

```
Cluster means:
               Age  Marital Status  Education Level  Number of Children  \
Cluster
0        46.617450        1.184564         1.483221            1.275168
1        53.197802        1.604396         2.505495            1.461538
2        49.621931        1.243863         1.145663            1.330606

         Smoking Status  Physical Activity Level  Employment Status  \
Cluster
0              0.570470                 0.775168           1.000000
1              0.461538                 0.615385           1.000000
2              0.540098                 0.707038           0.432079

                Income  Alcohol Consumption  Dietary Habits  Sleep Patterns  \
Cluster
0         78543.715705             0.902685        0.993289        1.174497
1        142919.870110             1.076923        1.043956        1.164835
2         24207.368494             0.860884        0.582651        1.176759

         History of Mental Illness  History of Substance Abuse  \
Cluster
0                         0.171141                    0.328859
1                         0.219780                    0.340659
2                         0.363339                    0.292962

         Family History of Depression  Chronic Medical Conditions  Cluster
Cluster
0                            0.265101                    0.335570      0.0
1                            0.318681                    0.164835      1.0
2                            0.248773                    0.314239      2.0
```

In [32]:

```python
cluster_0 = cluster_means.iloc[0]
cluster_1 = cluster_means.iloc[1]
cluster_2 = cluster_means.iloc[2]
print("Cluster Interpretation:")

# Initialize variables
high_risk_cluster = None
average_risk_cluster = None
low_risk_cluster = None

if cluster_0['History of Mental Illness'] > cluster_1['History of Mental Illne
    high_risk_cluster = 0
    average_risk_cluster = 1
    low_risk_cluster = 2
elif cluster_1['History of Mental Illness'] > cluster_2['History of Mental Ill
    high_risk_cluster = 1
    average_risk_cluster = 2
    low_risk_cluster = 0
else:
    high_risk_cluster = 1
    average_risk_cluster = 2
    low_risk_cluster = 0
```

```
print(f"Cluster {high_risk_cluster} may represent individuals at higher risk c
print(f"Cluster {average_risk_cluster} may represent individuals at average ri
print(f"Cluster {low_risk_cluster} may represent individuals at lower risk of
```

```
Cluster Interpretation:
Cluster 1 may represent individuals at higher risk of depression.
Cluster 2 may represent individuals at average risk of depression.
Cluster 0 may represent individuals at lower risk of depression.
```

In [33]:
```
df['Depression_Risk'] = df['Cluster'].map({high_risk_cluster: 'High Risk', ave
```

In [34]:
```
print("Sample of results:")
print(df[['Age', 'Income', 'History of Mental Illness', 'Family History of Dep
```

```
Sample of results:
     Age     Income  History of Mental Illness  Family History of Depression  \
674   65    4518.38                          1                             0
767   57   47544.24                          1                             1
784   20   13382.05                          0                             0
336   21   59183.80                          0                             1
342   61  209701.03                          0                             0
379   73   10539.86                          1                             0
950   65    5326.36                          0                             0
585   72    2154.82                          1                             0
63    71  140015.25                          0                             1
26    27   68139.93                          0                             0

    Depression_Risk
674    Average Risk
767    Average Risk
784    Average Risk
336        Low Risk
342       High Risk
379    Average Risk
950    Average Risk
585    Average Risk
63        High Risk
26         Low Risk
```

In [35]:
```
df['Depression_Risk'].value_counts()
```

Out[35]:
```
Depression_Risk
Average Risk    611
Low Risk        298
High Risk        91
Name: count, dtype: int64
```

In [36]:
```
df.to_csv('depression_risk_prediction.csv', index=False)
print("Full results saved to 'depression_risk_prediction.csv'")
```

```
Full results saved to 'depression_risk_prediction.csv'
```