Predicting_Obesity

October 19, 2023

[ ]:
```
# installing package
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sb
from sklearn.decomposition import PCA
from sklearn.preprocessing import StandardScaler
from sklearn.pipeline import Pipeline
from sklearn.ensemble import IsolationForest
# importing data
from google.colab import drive
drive.mount('/content/drive')
file_path = '/content/drive/MyDrive/ObesityDataSet_raw_and_data_sinthetic.csv'
df = pd.read_csv(file_path)
df.head()
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

[ ]:

	Gender	Age	Height	Weight	family_history_with_overweight	FAVC	FCVC	\
0	Female	21.0	1.62	64.0	yes	no	2.0	
1	Female	21.0	1.52	56.0	yes	no	3.0	
2	Male	23.0	1.80	77.0	yes	no	2.0	
3	Male	27.0	1.80	87.0	no	no	3.0	
4	Male	22.0	1.78	89.8	no	no	2.0	

	NCP	CAEC	SMOKE	CH2O	SCC	FAF	TUE	CALC	\
0	3.0	Sometimes	no	2.0	no	0.0	1.0	no	
1	3.0	Sometimes	yes	3.0	yes	3.0	0.0	Sometimes	
2	3.0	Sometimes	no	2.0	no	2.0	1.0	Frequently	
3	3.0	Sometimes	no	2.0	no	2.0	0.0	Frequently	
4	1.0	Sometimes	no	2.0	no	0.0	0.0	Sometimes	

	MTRANS	NObeyesdad
0	Public_Transportation	Normal_Weight
1	Public_Transportation	Normal_Weight
2	Public_Transportation	Normal_Weight
3	Walking	Overweight_Level_I
4	Public_Transportation	Overweight_Level_II

0.1 DATA COLUMNS

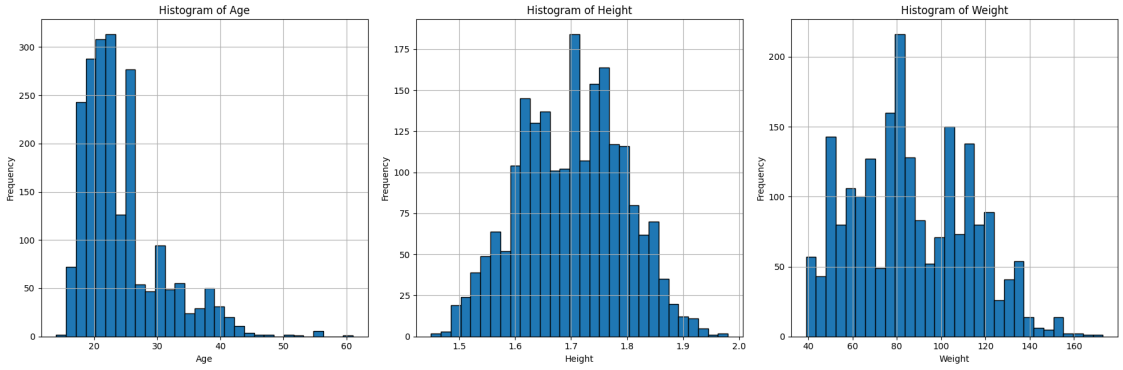
Gender
Age
Height
Weight
Family History With Overweight (FHWO)
Consumption of High Caloric Food (FAVC)
Consumption of Vegetables(FCVC)
Number of Main Meals (NCP)
Consumption of Food Between Meals (CAEC)
Smoke
Consumption of Water Daily (CH2O)
Calories Consumption Monitoring (SCC)
Physical Activity Frequency (FAF)
Time Using Technology Devices (TUE)
Consumption of Alcohol (CALC)
Transportation Used (MTRANS)
NObeyesdad (Obesity Level)

[ ]:
```
# data preprocessing
df = df.rename(columns={'family_history_with_overweight': 'FHWO', 'NObeyesdad' :
  ↪ 'Obesity Level',})
df.info()
```

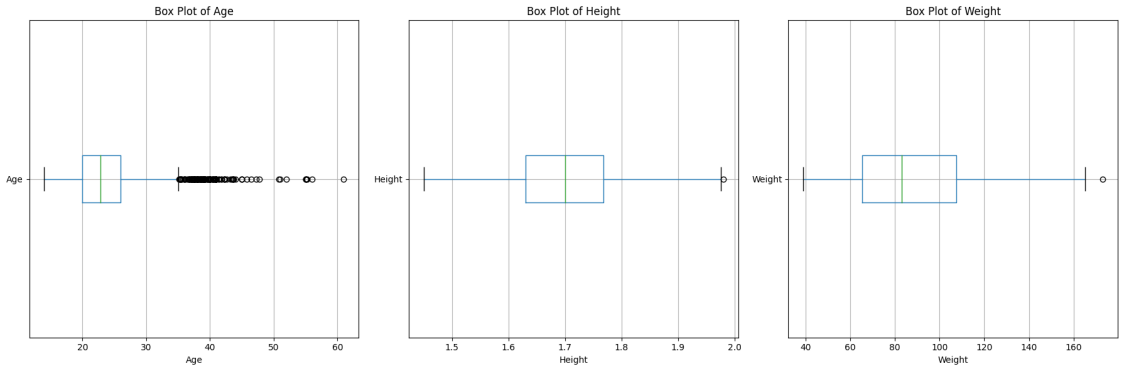
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 2111 entries, 0 to 2110
Data columns (total 17 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   Gender          2111 non-null   object
 1   Age             2111 non-null   float64
 2   Height          2111 non-null   float64
 3   Weight          2111 non-null   float64
 4   FHWO            2111 non-null   object
 5   FAVC            2111 non-null   object
 6   FCVC            2111 non-null   float64
 7   NCP             2111 non-null   float64
 8   CAEC            2111 non-null   object
 9   SMOKE           2111 non-null   object
 10  CH2O            2111 non-null   float64
 11  SCC             2111 non-null   object
 12  FAF             2111 non-null   float64
 13  TUE             2111 non-null   float64
 14  CALC            2111 non-null   object
 15  MTRANS          2111 non-null   object
 16  Obesity Level   2111 non-null   object
dtypes: float64(8), object(9)
```

```
memory usage: 280.5+ KB
```

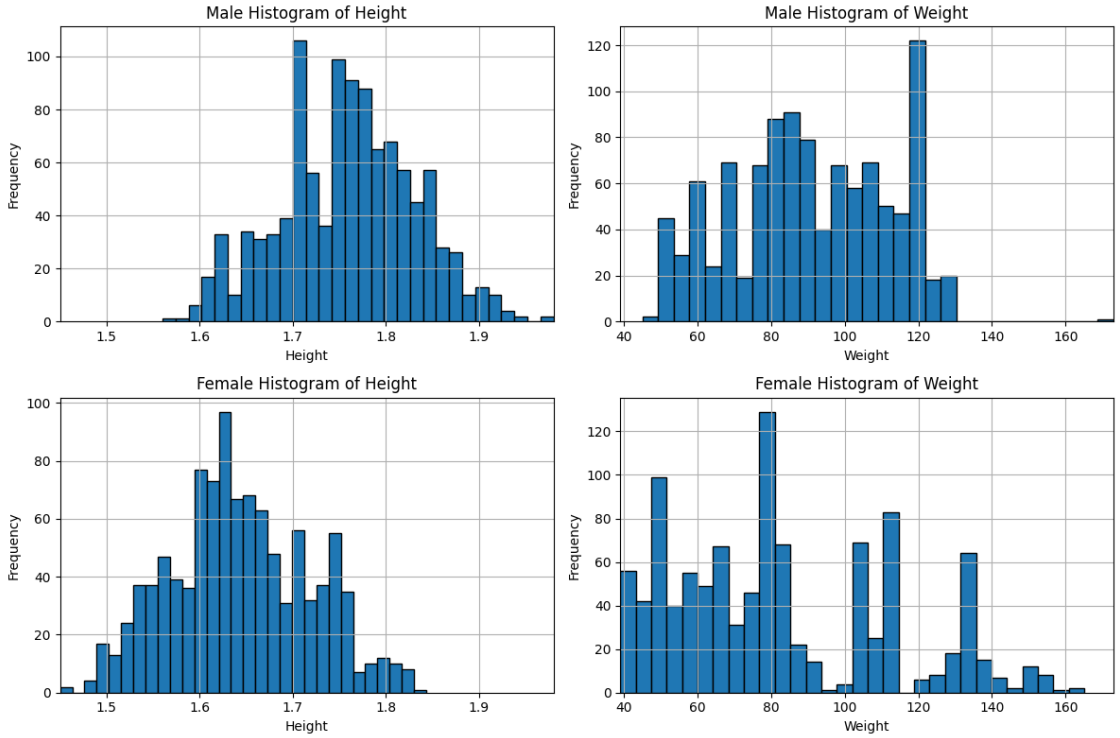
[ ]:
```python
# histogram of age, height, weight (general)
histogram_columns = ["Age", "Height", "Weight"]

fig, axs = plt.subplots(1, 3, figsize=(18, 6))

for i, column_name in enumerate(histogram_columns):
    axs[i].hist(df[column_name], bins=30, edgecolor='k')
    axs[i].set_xlabel(column_name)
    axs[i].set_ylabel("Frequency")
    axs[i].set_title(f"Histogram of {column_name}")
    axs[i].grid(True)

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



[ ]:
```python
# box plots of Age, Height, Weight
boxplot_columns = ["Age", "Height", "Weight"]

fig, axs = plt.subplots(1, len(boxplot_columns), figsize=(18, 6))

for i, column_name in enumerate(boxplot_columns):
    df.boxplot(column=column_name, ax=axs[i], vert=False)
    axs[i].set_title(f"Box Plot of {column_name}")
    axs[i].set_xlabel(column_name)

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

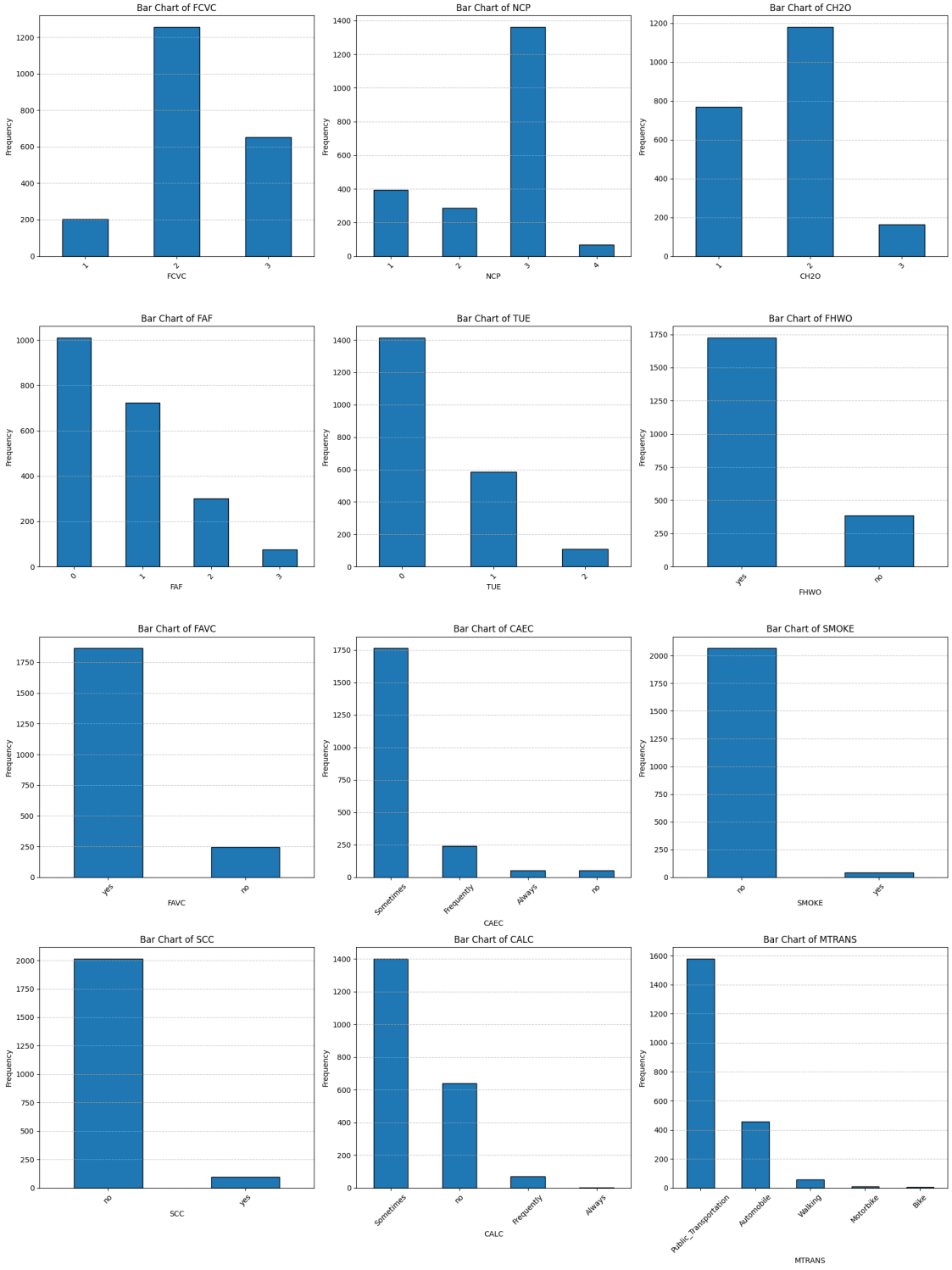


[ ]:
```
# histogram of height and weight by gender
male_data = df[df['Gender'] == 'Male']
female_data = df[df['Gender'] == 'Female']

histogram_columns = ["Height", "Weight"]

height_min = df['Height'].min()
height_max = df['Height'].max()
weight_min = df['Weight'].min()
weight_max = df['Weight'].max()

fig, axs = plt.subplots(2, 2, figsize=(12, 8))

for i, gender_data in enumerate([(male_data, 'Male'), (female_data, 'Female')]):
    for j, column_name in enumerate(histogram_columns):
        ax = axs[i, j]
        data, gender = gender_data
        ax.hist(data[column_name], bins=30, edgecolor='k')
        ax.set_xlabel(column_name)
        ax.set_ylabel("Frequency")
        ax.set_title(f"{gender} Histogram of {column_name}")
        ax.grid(True)

        if column_name == "Height":
            ax.set_xlim(height_min, height_max)
        elif column_name == "Weight":
            ax.set_xlim(weight_min, weight_max)

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



[ ]:
```
# barplot of FCVC, NCP, CH2O, FAF, TUE, FHWO, FAVC, CAEC, SMOKE, SCC, CALC,␣
 ↪MTRANS
numeric_columns_to_convert = ["FCVC", "NCP", "CH2O", "FAF", "TUE"]
df[numeric_columns_to_convert] = df[numeric_columns_to_convert].astype(int)
columns_to_plot = numeric_columns_to_convert + ["FHWO", "FAVC", "CAEC",␣
 ↪"SMOKE", "SCC", "CALC", "MTRANS"]

figsize = (6, 6)

num_plots = len(columns_to_plot)
num_rows = (num_plots - 1) // 3 + 1
num_cols = 3

fig, axs = plt.subplots(num_rows, num_cols, figsize=(18, 24))

axs = axs.ravel()

for i, column_name in enumerate(columns_to_plot):
    if column_name in numeric_columns_to_convert:
        df[column_name].value_counts().sort_index().plot(kind='bar', ax=axs[i],␣
 ↪edgecolor='k')
    else:
        counts = df[column_name].value_counts()
```

```
        counts.plot(kind='bar', ax=axs[i], edgecolor='k')

    axs[i].set_xlabel(column_name)
    axs[i].set_ylabel("Frequency")
    axs[i].set_title(f"Bar Chart of {column_name}")
    axs[i].grid(axis='y', linestyle='--', alpha=0.7)
    axs[i].tick_params(axis='x', rotation=45)

for i in range(num_plots, num_rows * num_cols):
    axs[i].axis('off')

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


Bar Chart of FCVC
Frequency
FCVC
Bar Chart of NCP
Frequency
NCP
Bar Chart of CH2O
Frequency
CH2O
Bar Chart of FAF
Frequency
FAF
Bar Chart of TUE
Frequency
TUE
Bar Chart of FHWO
Frequency
FHWO
Bar Chart of FAVC
Frequency
FAVC
Bar Chart of CAEC
Frequency
Sometimes
Frequently
Always
no
CAEC
Bar Chart of SMOKE
Frequency
no
yes
SMOKE
Bar Chart of SCC
Frequency
no
yes
SCC
Bar Chart of CALC
Frequency
Sometimes
no
Frequently
Always
CALC
Bar Chart of MTRANS
Frequency
Public_Transportation
Automobile
Walking
Motorbike
Bike
MTRANS

[ ]:
```
df.head()
```

[ ]:

	Gender	Age	Height	Weight	FHWO	FAVC	FCVC	NCP	CAEC	SMOKE	CH2O	\
0	Female	21.0	1.62	64.0	yes	no	2	3	Sometimes	no	2	
1	Female	21.0	1.52	56.0	yes	no	3	3	Sometimes	yes	3	
2	Male	23.0	1.80	77.0	yes	no	2	3	Sometimes	no	2	
3	Male	27.0	1.80	87.0	no	no	3	3	Sometimes	no	2	
4	Male	22.0	1.78	89.8	no	no	2	1	Sometimes	no	2	

	SCC	FAF	TUE	CALC	MTRANS	Obesity Level
0	no	0	1	no	Public_Transportation	Normal_Weight
1	yes	3	0	Sometimes	Public_Transportation	Normal_Weight
2	no	2	1	Frequently	Public_Transportation	Normal_Weight
3	no	2	0	Frequently	Walking	Overweight_Level_I
4	no	0	0	Sometimes	Public_Transportation	Overweight_Level_II

[ ]:
```
# Transfer categorical data into numerical data
cols = df.columns
num_cols = df._get_numeric_data().columns
cat_cols = list(set(cols) - set(num_cols))
for i in cat_cols:
    print("Column Name: " + i)
    col_val = sorted(list(set(df[i].tolist())))
    print("Column Value: " + str(col_val))
    replace_num = []
    for j in range(len(col_val)):
        replace_num.append(j)
    df[i].replace(col_val,replace_num, inplace=True)
    new_val = list(set(df[i].tolist()))
    print("Replaced Value: " + str(new_val))
df.head()
```

```
Column Name: CAEC
Column Value: ['Always', 'Frequently', 'Sometimes', 'no']
Replaced Value: [0, 1, 2, 3]
Column Name: CALC
Column Value: ['Always', 'Frequently', 'Sometimes', 'no']
Replaced Value: [0, 1, 2, 3]
Column Name: Gender
Column Value: ['Female', 'Male']
Replaced Value: [0, 1]
Column Name: Obesity Level
Column Value: ['Insufficient_Weight', 'Normal_Weight', 'Obesity_Type_I',
'Obesity_Type_II', 'Obesity_Type_III', 'Overweight_Level_I',
'Overweight_Level_II']
Replaced Value: [0, 1, 2, 3, 4, 5, 6]
Column Name: FHWO
Column Value: ['no', 'yes']
Replaced Value: [0, 1]
```

```
Column Name: SCC
Column Value: ['no', 'yes']
Replaced Value: [0, 1]
Column Name: SMOKE
Column Value: ['no', 'yes']
Replaced Value: [0, 1]
Column Name: FAVC
Column Value: ['no', 'yes']
Replaced Value: [0, 1]
Column Name: MTRANS
Column Value: ['Automobile', 'Bike', 'Motorbike', 'Public_Transportation',
'Walking']
Replaced Value: [0, 1, 2, 3, 4]
```

[ ]:

	Gender	Age	Height	Weight	FHWO	FAVC	FCVC	NCP	CAEC	SMOKE	CH2O	\
0	0	21.0	1.62	64.0	1	0	2	3	2	0	2	
1	0	21.0	1.52	56.0	1	0	3	3	2	1	3	
2	1	23.0	1.80	77.0	1	0	2	3	2	0	2	
3	1	27.0	1.80	87.0	0	0	3	3	2	0	2	
4	1	22.0	1.78	89.8	0	0	2	1	2	0	2	

	SCC	FAF	TUE	CALC	MTRANS	Obesity Level
0	0	0	1	3	3	1
1	1	3	0	2	3	1
2	0	2	1	1	3	1
3	0	2	0	1	4	5
4	0	0	0	2	3	6

[ ]:
```python
# percentage of the max categories
categorical_columns = ["FCVC", "NCP", "CH2O", "FAF", "TUE", "FHWO", "FAVC",␣
 ↪"CAEC", "SMOKE", "SCC", "CALC", "MTRANS"]

max_frequency_info = []
for column in categorical_columns:
    max_category = df[column].value_counts().idxmax()
    max_frequency = df[column].value_counts().max()
    max_percentage = (max_frequency / len(df)) * 100

    max_frequency_info.append({
        "Column": column,
        "Max Category": max_category,
        "Max Frequency": max_frequency,
        "Max Percentage": max_percentage
    })
max_frequency_df = pd.DataFrame(max_frequency_info)

print("Maximum Frequency Information for Categorical Columns:")
```

```
print(max_frequency_df)
```

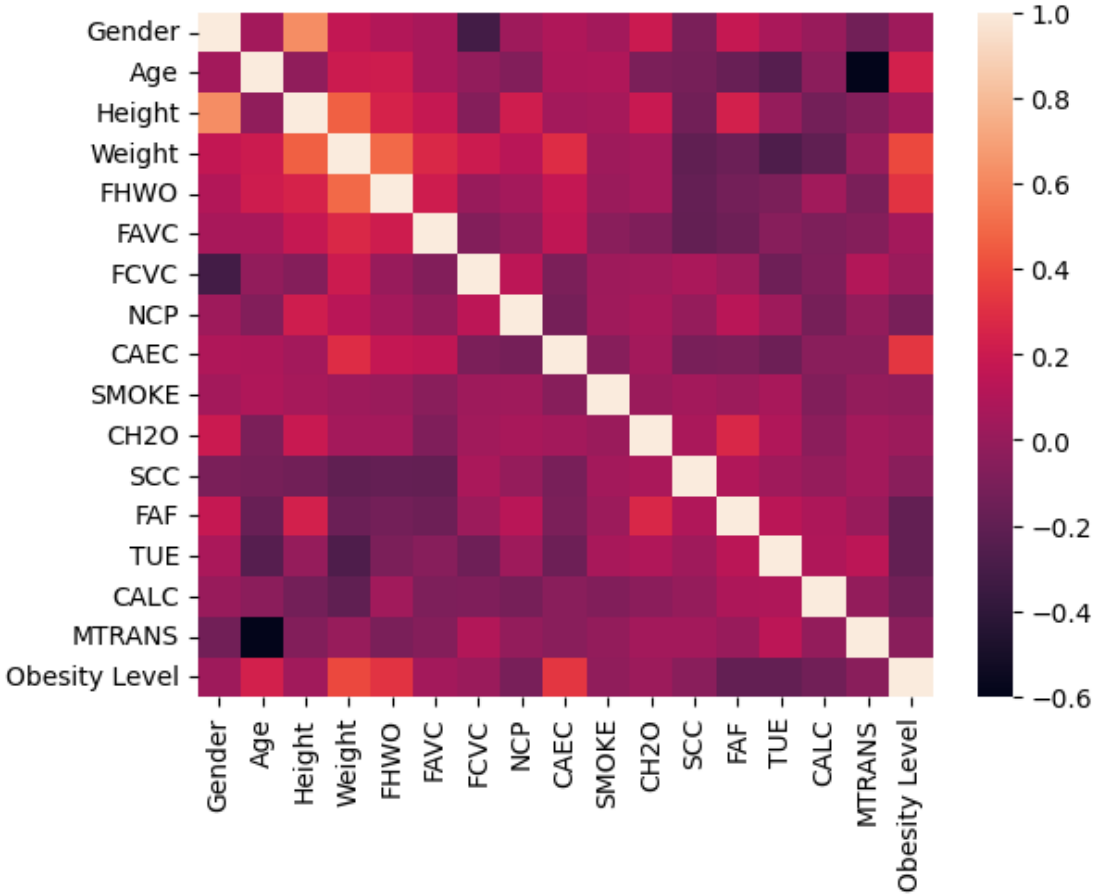
```
Maximum Frequency Information for Categorical Columns:
    Column  Max Category  Max Frequency  Max Percentage
0     FCVC             2           1257       59.545239
1      NCP             3           1362       64.519185
2     CH2O             2           1180       55.897679
3      FAF             0           1011       47.891994
4      TUE             0           1415       67.029844
5     FHWO             1           1726       81.762198
6     FAVC             1           1866       88.394126
7     CAEC             2           1765       83.609664
8    SMOKE             0           2067       97.915680
9      SCC             0           2015       95.452392
10    CALC             2           1401       66.366651
11  MTRANS             3           1580       74.846045
```

[ ]:
```
df.describe()
```

[ ]:
```
             Gender          Age       Height       Weight         FHWO  \
count  2111.000000  2111.000000  2111.000000  2111.000000  2111.000000
mean      0.505921    24.312600     1.701677    86.586058     0.817622
std       0.500083     6.345968     0.093305    26.191172     0.386247
min       0.000000    14.000000     1.450000    39.000000     0.000000
25%       0.000000    19.947192     1.630000    65.473343     1.000000
50%       1.000000    22.777890     1.700499    83.000000     1.000000
75%       1.000000    26.000000     1.768464   107.430682     1.000000
max       1.000000    61.000000     1.980000   173.000000     1.000000

              FAVC         FCVC          NCP         CAEC        SMOKE  \
count  2111.000000  2111.000000  2111.000000  2111.000000  2111.000000
mean      0.883941     2.213169     2.523449     1.859308     0.020843
std       0.320371     0.599397     0.830288     0.468543     0.142893
min       0.000000     1.000000     1.000000     0.000000     0.000000
25%       1.000000     2.000000     2.000000     2.000000     0.000000
50%       1.000000     2.000000     3.000000     2.000000     0.000000
75%       1.000000     3.000000     3.000000     2.000000     0.000000
max       1.000000     3.000000     4.000000     3.000000     1.000000

              CH2O          SCC          FAF          TUE         CALC  \
count  2111.000000  2111.000000  2111.000000  2111.000000  2111.000000
mean      1.712459     0.045476     0.734723     0.381336     2.268593
std       0.598760     0.208395     0.832812     0.582536     0.515498
min       1.000000     0.000000     0.000000     0.000000     0.000000
25%       1.000000     0.000000     0.000000     0.000000     2.000000
50%       2.000000     0.000000     1.000000     0.000000     2.000000
75%       2.000000     0.000000     1.000000     1.000000     3.000000
```

```
max       3.000000     1.000000     3.000000     2.000000     3.000000

             MTRANS  Obesity Level
count  2111.000000    2111.000000
mean      2.365230       3.015632
std       1.261423       1.952090
min       0.000000       0.000000
25%       3.000000       1.000000
50%       3.000000       3.000000
75%       3.000000       5.000000
max       4.000000       6.000000
```

[ ]:
```
# correlation plot
dataplot=sb.heatmap(df.corr())

# displaying heatmap
plt.show()

# displaying the correlation between columns
df.corr()
```



[ ]:

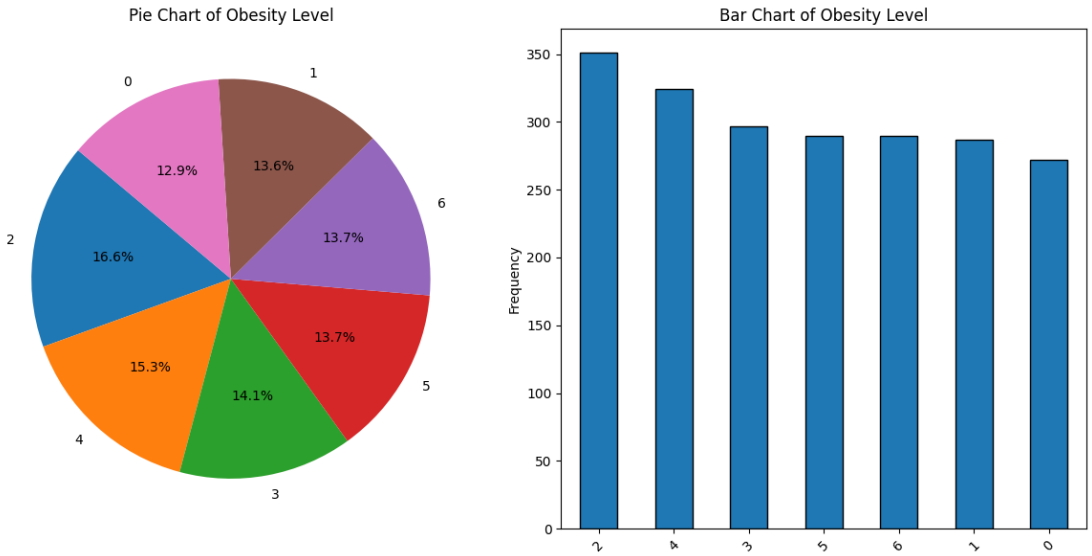
	Gender	Age	Height	Weight	FHWO	FAVC
Gender	1.000000	0.048394	0.618466	0.161668	0.102512	0.064934
Age	0.048394	1.000000	-0.025958	0.202560	0.205725	0.063902
Height	0.618466	-0.025958	1.000000	0.463136	0.247684	0.178364
Weight	0.161668	0.202560	0.463136	1.000000	0.496820	0.272300
FHWO	0.102512	0.205725	0.247684	0.496820	1.000000	0.208036
FAVC	0.064934	0.063902	0.178364	0.272300	0.208036	1.000000
FCVC	-0.317272	-0.016069	-0.070032	0.201087	0.008332	-0.073482
NCP	0.023921	-0.071102	0.214633	0.126058	0.052504	-0.019162
CAEC	0.091543	0.083739	0.048818	0.287493	0.169787	0.150068
SMOKE	0.044698	0.091987	0.055499	0.025746	0.017385	-0.050660
CH2O	0.194832	-0.098992	0.191061	0.052705	0.053889	-0.082638
SCC	-0.102633	-0.116283	-0.133753	-0.201906	-0.185422	-0.190658
FAF	0.174468	-0.170416	0.234248	-0.158726	-0.128375	-0.156302
TUE	0.071148	-0.241917	-0.006181	-0.274960	-0.097283	-0.054783
CALC	0.007616	-0.044487	-0.129732	-0.206677	0.036676	-0.089520
MTRANS	-0.137537	-0.601945	-0.073609	0.004610	-0.101540	-0.069800
Obesity Level	0.024908	0.236170	0.038986	0.387643	0.313667	0.044582

	FCVC	NCP	CAEC	SMOKE	CH2O	SCC
Gender	-0.317272	0.023921	0.091543	0.044698	0.194832	-0.102633
Age	-0.016069	-0.071102	0.083739	0.091987	-0.098992	-0.116283
Height	-0.070032	0.214633	0.048818	0.055499	0.191061	-0.133753
Weight	0.201087	0.126058	0.287493	0.025746	0.052705	-0.201906
FHWO	0.008332	0.052504	0.169787	0.017385	0.053889	-0.185422
FAVC	-0.073482	-0.019162	0.150068	-0.050660	-0.082638	-0.190658
FCVC	1.000000	0.138510	-0.100727	0.025567	0.037495	0.070328
NCP	0.138510	1.000000	-0.122478	0.035825	0.067431	-0.006166
CAEC	-0.100727	-0.122478	1.000000	-0.055282	0.048315	-0.109179
SMOKE	0.025567	0.035825	-0.055282	1.000000	0.014689	0.047731
CH2O	0.037495	0.067431	0.048315	0.014689	1.000000	0.070662
SCC	0.070328	-0.006166	-0.109179	0.047731	0.070662	1.000000
FAF	0.019344	0.126888	-0.098121	0.022590	0.266097	0.094120
TUE	-0.150120	0.028048	-0.157565	0.063889	0.095753	0.032761
CALC	-0.085690	-0.116039	-0.047540	-0.082471	-0.041402	-0.003463
MTRANS	0.105084	-0.012480	-0.048535	-0.010702	0.044987	0.043157
Obesity Level	0.014163	-0.111780	0.327295	-0.023256	0.021688	-0.050679

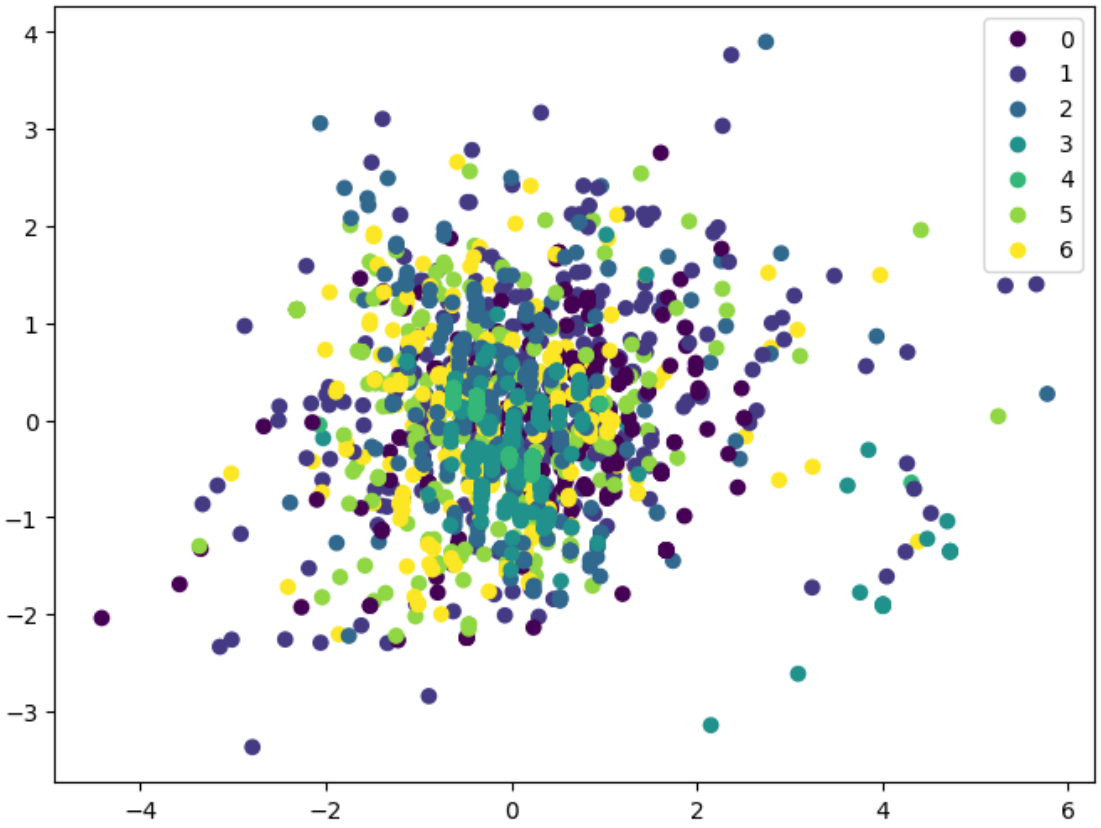
	FAF	TUE	CALC	MTRANS	Obesity Level
Gender	0.174468	0.071148	0.007616	-0.137537	0.024908
Age	-0.170416	-0.241917	-0.044487	-0.601945	0.236170
Height	0.234248	-0.006181	-0.129732	-0.073609	0.038986
Weight	-0.158726	-0.274960	-0.206677	0.004610	0.387643
FHWO	-0.128375	-0.097283	0.036676	-0.101540	0.313667
FAVC	-0.156302	-0.054783	-0.089520	-0.069800	0.044582

```
FCVC            0.019344 -0.150120 -0.085690  0.105084       0.014163
NCP             0.126888  0.028048 -0.116039 -0.012480      -0.111780
CAEC           -0.098121 -0.157565 -0.047540 -0.048535       0.327295
SMOKE           0.022590  0.063889 -0.082471 -0.010702      -0.023256
CH2O            0.266097  0.095753 -0.041402  0.044987       0.021688
SCC             0.094120  0.032761 -0.003463  0.043157      -0.050679
FAF             1.000000  0.134370  0.085458  0.008359      -0.194517
TUE             0.134370  1.000000  0.091194  0.138015      -0.194041
CALC            0.085458  0.091194  1.000000 -0.012452      -0.134632
MTRANS          0.008359  0.138015 -0.012452  1.000000      -0.046202
Obesity Level  -0.194517 -0.194041 -0.134632 -0.046202       1.000000
```

[ ]:
```python
# pie chart and bar chart of obesity level
obesity_level_counts = df["Obesity Level"].value_counts()

fig, axs = plt.subplots(1, 2, figsize=(12, 6))

axs[0].pie(obesity_level_counts, labels=obesity_level_counts.index, autopct='%1.
↪1f%%', startangle=140)
axs[0].set_title("Pie Chart of Obesity Level")

obesity_level_counts.plot(kind='bar', edgecolor='k', ax=axs[1])
axs[1].set_ylabel("Frequency")
axs[1].set_title("Bar Chart of Obesity Level")
axs[1].tick_params(axis='x', rotation=45)

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



[ ]:
```
# PCA
# the column FHMO and CAEC has the highest
# the highest correlation coefficient with obesity level
X = df.drop(['Obesity Level', 'Weight', 'Height'], axis =1)
y = df['Obesity Level']
target_names = list(set(df['Obesity Level'].tolist()))
pca = PCA()
pipe = Pipeline([('scaler', StandardScaler()), ('pca', pca)])
Xt = pipe.fit_transform(X)
plt.figure(figsize=(8,6))
plot = plt.scatter(Xt[:,4], Xt[:,8], c=y)
plt.legend(handles=plot.legend_elements()[0], labels=target_names)
plt.show()
```



[92]:
```
# Outlier Dection with IsolationForest
df1 = df.drop(['Obesity Level', 'Weight', 'Height'], axis =1)
n_sample = len(df1)
model=IsolationForest(n_estimators=100, max_samples= n_sample,␣
 ↪contamination=float(0.01), max_features= len(df1.columns))
features_name = list(df1.columns.values)
```

```
model.fit(df1[features_name])
df1['scores']= model.decision_function(df1[features_name])
df1['anomaly']= model.predict(df1[features_name])
# A negative score value and a -1 for the value of anomaly columns indicate the␣
 ↪presence of anomaly.
# A value of 1 for the anomaly represents the normal data.
anomaly = df1.loc[df1['anomaly'] == -1]
anomaly_index = list(anomaly.index)
import os
import shutil
from tabulate import tabulate
terminal_width = 60
shutil.get_terminal_size = lambda: os.terminal_size((terminal_width, 20))
headers = list(anomaly.columns.values)
table = tabulate(anomaly, headers, tablefmt="grid")
print(table)
print(len(anomaly))
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does
not have valid feature names, but IsolationForest was fitted with feature names
  warnings.warn(
```

```
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
|     |   Gender |   Age |   FHWO |   FAVC |   FCVC |   NCP |   CAEC |   SMOKE |
CH2O |   SCC |   FAF |   TUE |   CALC |   MTRANS |   anomaly |       scores |
+=====+==========+=======+========+========+========+=======+========+=========+
========+=======+=======+=======+========+==========+===========+==============+
|  18 |        0 |    30 |      1 |      1 |      3 |     4 |      1 |       1 |
1 |     0 |     0 |     0 |      3 |        0 |        -1 | -0.0104834   |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
|  21 |        0 |    52 |      1 |      1 |      3 |     1 |      2 |       1 |
2 |     0 |     0 |     0 |      3 |        0 |        -1 | -0.0245264   |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
|  25 |        1 |    20 |      1 |      0 |      2 |     4 |      1 |       1 |
2 |     0 |     3 |     2 |      3 |        3 |        -1 | -0.0112556   |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
|  30 |        1 |    29 |      0 |      1 |      1 |     4 |      1 |       0 |
3 |     0 |     0 |     1 |      3 |        2 |        -1 | -0.00732673  |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
|  68 |        1 |    30 |      1 |      1 |      1 |     3 |      3 |       1 |
2 |     1 |     0 |     0 |      1 |        0 |        -1 | -0.0532807   |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
```

92	1	55	1	0	3	4	1	0	3	1	3	0	1	4	-1	-0.0466905
119	0	19	1	0	3	3	1	1	3	0	2	1	2	0	-1	-0.00817113
132	0	19	1	1	3	3	1	1	3	1	1	2	1	3	-1	-0.0250775
133	0	61	0	1	3	3	0	0	2	0	1	1	1	3	-1	-0.00607298
142	1	23	0	1	2	3	1	1	1	0	1	1	1	0	-1	-1.97072e-05
152	0	38	1	1	2	1	0	1	2	0	0	0	2	0	-1	-0.00580758
188	1	35	1	1	3	1	3	0	3	0	3	1	1	0	-1	-0.029988
191	1	26	1	1	3	1	1	1	2	1	2	0	2	3	-1	-0.0118799
200	0	23	1	0	3	1	2	1	3	0	1	2	2	3	-1	-0.01063
217	1	21	0	0	2	3	1	0	3	1	3	1	1	0	-1	-0.00317801
232	0	51	1	0	3	3	2	1	3	1	2	0	3	3	-1	-0.0239557
236	0	21	0	1	1	3	0	0	2	1	3	0	3	0	-1	-0.00738452

```
| 245 |        0 |    20 |      0 |      0 |      3 |     3 |      2 |       1 |
2 |     0 |     2 |     1 |      2 |        0 |        -1 | -0.00376463  |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
| 252 |        1 |    56 |      1 |      0 |      2 |     3 |      2 |       1 |
2 |     0 |     1 |     0 |      1 |        0 |        -1 | -0.00592272  |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
| 277 |        1 |    21 |      0 |      1 |      2 |     4 |      0 |       1 |
3 |     0 |     3 |     2 |      2 |        4 |        -1 | -0.0394712   |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
| 333 |        0 |    23 |      0 |      0 |      3 |     4 |      0 |       0 |
3 |     1 |     3 |     0 |      3 |        0 |        -1 | -0.0236606   |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
| 495 |        1 |    19 |      1 |      1 |      3 |     1 |      0 |       0 |
1 |     1 |     0 |     0 |      3 |        2 |        -1 | -0.00784573  |
+-----+----------+-------+--------+--------+--------+-------+--------+---------+
--------+-------+-------+-------+--------+----------+-----------+--------------+
22
```

[98]:
```
# Verify the result of isolation forest
features_name = ['Gender', 'FHWO', 'FAVC', 'FCVC', 'NCP', 'CAEC', 'SMOKE',␣
 ↪'CH2O', 'SCC', 'FAF', 'TUE', 'CALC', 'MTRANS']

crosstab_result = pd.crosstab(
    round(df1['Age']),
    [df1[col] for col in features_name],
    rownames=['Age'],
    colnames=features_name,
    margins=True,
    margins_name='num_count'
)

if 'All' in crosstab_result.index:
    crosstab_result = crosstab_result.drop('All', axis=0)

pd.set_option('display.colheader_justify', 'center')
print(crosstab_result)

print(crosstab_result.loc[crosstab_result['num_count'] <= 5, 'num_count'].sum())
```

```
Gender    0                                 … 1                                \
FHWO      0                                 … 1
FAVC      0                                 … 1
FCVC      1     2                           … 3
NCP       3  4  1              2            … 3              4
```

CAEC	2	1	1			2		1			…	2					2				
SMOKE	0	0	0			0		0			…	0					0				
CH2O	1	1	1			1		1	2		…	3					1	2		3	
SCC	0	0	0			0		1	0		…	0					1	0	1	0	
FAF	1	1	0		1	0		1	0	1	…	0		1	2		2	2	2	2	
TUE	2	0	0		0	1	2	0	0	0	…	1	2	0	1		0	0	0	0	
CALC	3	2	2	3	2	3	3	2	3	3	…	2	2	2	2	3	2	3	2	2	
MTRANS	3	3	3	3	3	4	3	3	3	3	…	3	3	3	4	4	3	0	0	4	
Age											…										
14.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	1	0	0	0	0	
15.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
16.0	0	0	0	0	0	2	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
17.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
18.0	1	0	0	0	0	0	1	0	0	0	…	0	0	0	0	0	1	2	2	0	
19.0	0	0	1	0	0	0	0	1	0	0	…	0	0	0	0	0	0	0	0	0	
20.0	0	1	0	0	1	0	0	0	0	0	…	0	0	0	0	0	0	0	0	1	
21.0	0	0	0	2	0	0	0	0	0	0	…	0	1	0	1	0	0	0	0	0	
22.0	0	0	0	0	0	0	0	0	0	1	…	0	0	0	0	0	0	0	0	0	
23.0	0	0	0	2	0	0	0	0	1	1	…	0	0	0	0	0	0	0	0	0	
24.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
25.0	0	0	0	0	0	0	0	0	0	0	…	0	0	3	0	0	0	0	0	0	
26.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
27.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
28.0	0	0	0	0	0	0	0	0	0	0	…	1	0	0	0	0	0	0	0	0	
29.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
30.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
31.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
32.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
33.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
34.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
35.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
36.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
37.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
38.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
39.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
40.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
41.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
42.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
43.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
44.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
45.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
46.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
47.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
48.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
51.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
52.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
55.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	
56.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0	

											…									
61.0	0	0	0	0	0	0	0	0	0	0	…	0	0	0	0	0	0	0	0	0
num_count	1	1	1	4	1	2	1	1	1	2	…	1	1	3	1	1	1	2	2	1

Gender	num_count
FHWO	
FAVC	
FCVC	
NCP	
CAEC	
SMOKE	
CH2O	
SCC	
FAF	
TUE	
CALC	
MTRANS	
Age	
14.0	1
15.0	1
16.0	20
17.0	69
18.0	212
19.0	169
20.0	150
21.0	236
22.0	163
23.0	218
24.0	95
25.0	82
26.0	213
27.0	43
28.0	20
29.0	33
30.0	53
31.0	62
32.0	26
33.0	37
34.0	29
35.0	19
36.0	6
37.0	24
38.0	34
39.0	25
40.0	19
41.0	20
42.0	6
43.0	3
44.0	6

```
45.0            3
46.0            2
47.0            1
48.0            1
51.0            2
52.0            1
55.0            5
56.0            1
61.0            1
num_count    2111

[41 rows x 867 columns]
22
<ipython-input-98-afc9eb918183>:17: FutureWarning: column_space is deprecated
and will be removed in a future version. Use df.to_string(col_space=…)
instead.
  pd.set_option('display.column_space', 2)
```