In [173…

```
import pandas as pd
import warnings
warnings.filterwarnings("ignore")
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
```

In [174…

```
df = pd.read_csv("pharmaceutical_data.csv")
```

In [175…

```
df.head()
```

Out[175…

	Drug Name	Drug ID	Strength	Pack Size	Price	Expiry Date	Batch Number	Manufacture Date	Country of Origin	Inte
0	Azee	53117687-8e75-4a5c-9ee6-214dc99d7501	780	44	25.90	2027-10-31	26077521-5fff-4787-90a0-742fae339f13	2022-05-29	Switzerland	ex
1	Dolo-650	cd034bd8-eb76-4591-918c-c6d7f3ba4f1e	440	3	69.72	2026-01-04	483e6b86-d4a1-42fa-a682-f0b6f9af3c9d	2021-09-12	India	Inte t t
2	Azee	72c5f808-c24c-43bc-a37a-e20119e58659	254	40	439.48	2025-04-16	026167e1-c266-4304-8fd7-15bcbabcc3f7	2019-03-16	Germany	W ra
3	Pantocid	54707665-e2da-496e-bda7-f2a59785ecbd	633	42	392.85	2024-05-20	de39c145-7832-4955-8387-36166b866b4a	2019-11-16	Germany	
4	Dolo-650	595268d8-33ef-4a18-817b-b9deb05e0d9b	157	4	251.49	2026-06-05	aed34a8e-0c09-42f5-b7b0-186df12a6a6f	2023-09-03	United States	Sim trip alv

5 rows × 23 columns

Checking all the avaiable features & Dropping unwanted features (id's)

In [127…

```
df.columns
```

Out[127…

```
Index(['Drug Name', 'Drug ID', 'Strength', 'Pack Size', 'Price', 'Expiry Date',
       'Batch Number', 'Manufacture Date', 'Country of Origin',
       'Drug Interactions', 'Patient Age Group', 'Patient Gender',
       'Patient Weight', 'Geographic Region', 'Sales Volume', 'Manufacturer',
       'Generic Drug Name', 'Route of Adminstration', 'Storage Conditions',
       'Prescription Required', 'Therapeutic Class', 'Dosage Form',
       'Adverse Reactions'],
      dtype='object')
```

In [128…

```
df.drop(columns=['Drug ID', 'Batch Number'], inplace=True)
```

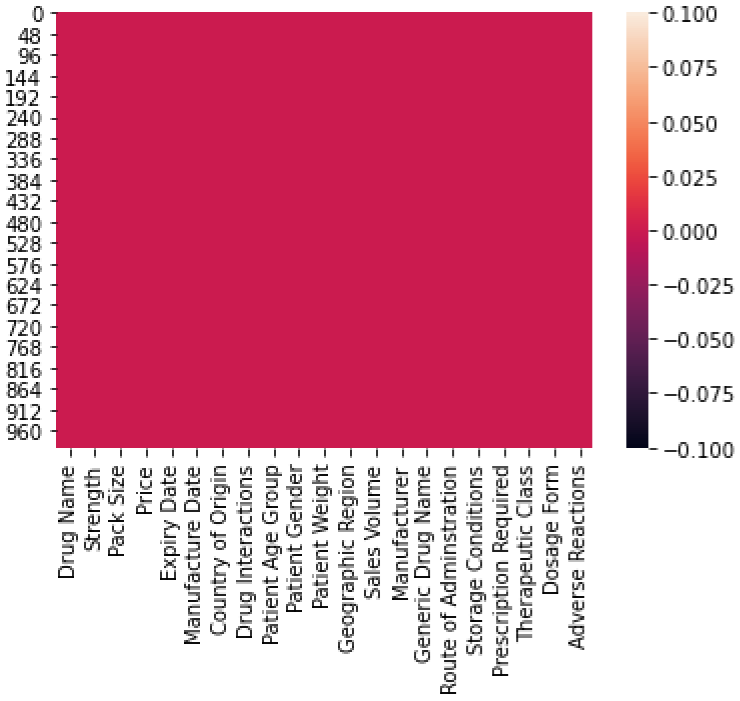
Checking Null Values in data

In [129…

```
sns.heatmap(df.isnull())  ## Ploting heatmap to see if there is any null value or not -
```

Out[129…

```
<AxesSubplot:>
```



In [130…

```
df.isnull().sum()  # checking for no null values
```

Out[130…

```
Drug Name                 0
Strength                  0
Pack Size                 0
Price                     0
Expiry Date               0
Manufacture Date          0
Country of Origin         0
Drug Interactions         0
Patient Age Group         0
Patient Gender            0
Patient Weight            0
Geographic Region         0
Sales Volume              0
Manufacturer              0
Generic Drug Name         0
Route of Adminstration    0
Storage Conditions        0
Prescription Required     0
Therapeutic Class         0
```

```
Dosage Form              0
Adverse Reactions        0
dtype: int64
```

In [131…

```
### Checking if there is any duplicate row in data frame or not
df[df.duplicated()]  ## found no duplicate row in dataframe
```

Out[131…

Drug Name	Strength	Pack Size	Price	Expiry Date	Manufacture Date	Country of Origin	Drug Interactions	Patient Age Group	Patient Gender	...	Geogra Re

0 rows × 21 columns

checking Descriptive parameters of data

In [132…

```
df.describe()
```

Out[132…

	Strength	Pack Size	Price	Patient Weight	Sales Volume
count	1000.000000	1000.000000	1000.000000	1000.00000	1000.000000
mean	497.086000	24.551000	254.965910	74.58700	51.621000
std	307.469807	14.271548	152.297606	14.35132	29.193417
min	1.000000	1.000000	3.610000	50.00000	1.000000
25%	225.000000	12.000000	124.427500	62.75000	25.000000
50%	487.500000	24.000000	254.295000	75.00000	52.000000
75%	751.750000	37.000000	378.957500	87.00000	77.000000
max	1809.000000	50.000000	1107.000000	100.00000	100.000000

In [133…

```
df.columns
```

Out[133…

```
Index(['Drug Name', 'Strength', 'Pack Size', 'Price', 'Expiry Date',
       'Manufacture Date', 'Country of Origin', 'Drug Interactions',
       'Patient Age Group', 'Patient Gender', 'Patient Weight',
       'Geographic Region', 'Sales Volume', 'Manufacturer',
       'Generic Drug Name', 'Route of Adminstration', 'Storage Conditions',
       'Prescription Required', 'Therapeutic Class', 'Dosage Form',
       'Adverse Reactions'],
      dtype='object')
```

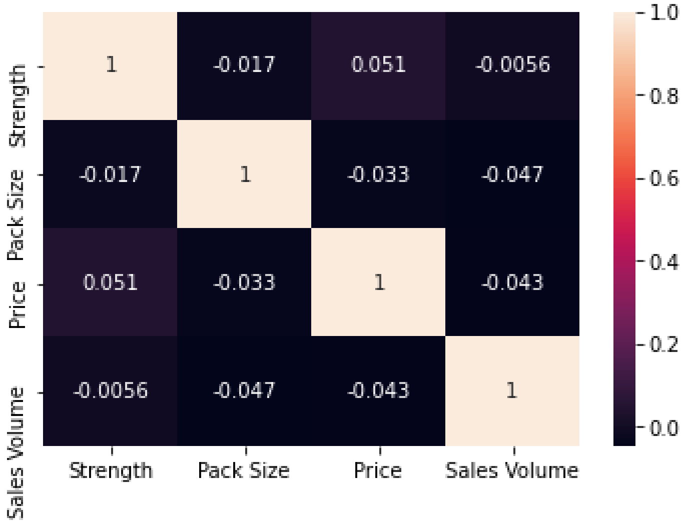
In [134…

```
# Checking correlation
sns.heatmap(df[['Strength', 'Pack Size', 'Price', 'Sales Volume']].corr(), annot=True)

# There is poor correlation between overall price, strength, packsize, and sales volume
```

Out[134…

```
<AxesSubplot:>
```



Univariate Analysis

In [135…

```
df.columns
```

Out[135…

```
Index(['Drug Name', 'Strength', 'Pack Size', 'Price', 'Expiry Date',
       'Manufacture Date', 'Country of Origin', 'Drug Interactions',
       'Patient Age Group', 'Patient Gender', 'Patient Weight',
       'Geographic Region', 'Sales Volume', 'Manufacturer',
       'Generic Drug Name', 'Route of Adminstration', 'Storage Conditions',
       'Prescription Required', 'Therapeutic Class', 'Dosage Form',
       'Adverse Reactions'],
      dtype='object')
```

Drug Name

In [136…

```
print("*******There are ", len(df['Drug Name'].unique()), " different Drugs in the data
df['Drug Name'].unique()
```

```
*******There are  10  different Drugs in the dataframe********
```

Out[136…

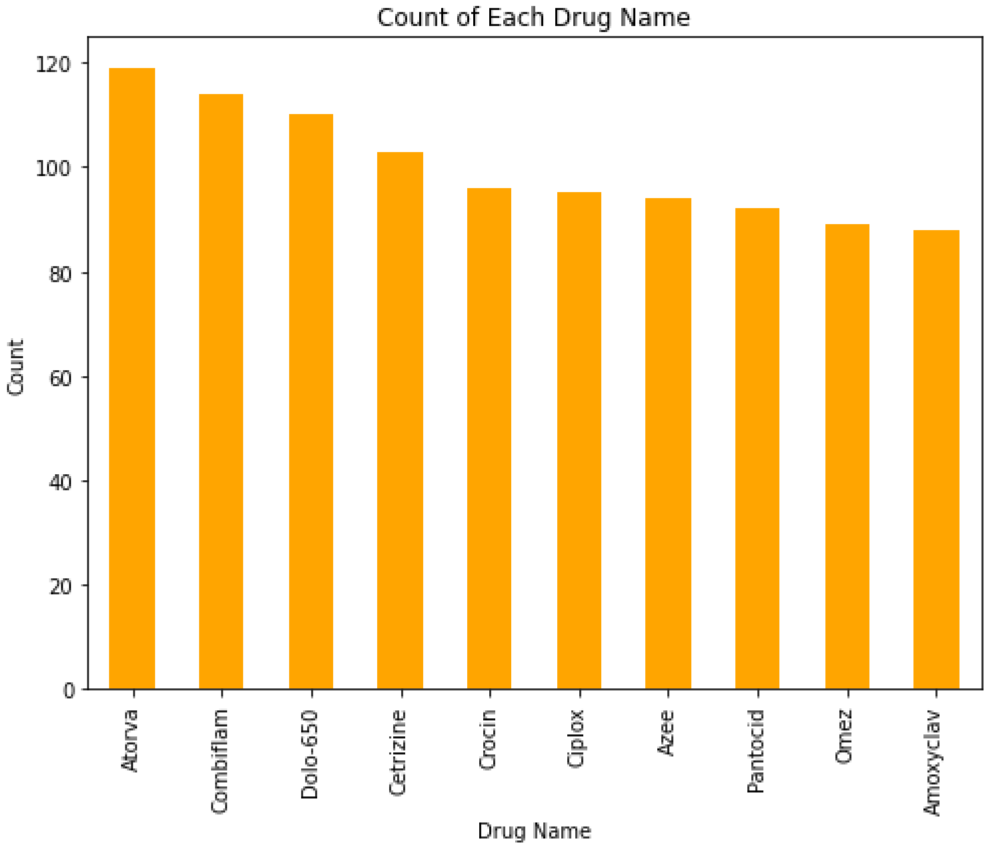
```
array(['Azee', 'Dolo-650', 'Pantocid', 'Crocin', 'Amoxyclav', 'Combiflam',
       'Omez', 'Atorva', 'Ciplox', 'Cetrizine'], dtype=object)
```

In [137…

```
## Count of each type of drugs
df['Drug Name'].value_counts().plot(kind='bar', figsize=(8, 6), color='orange')
plt.title('Count of Each Drug Name')
plt.xlabel('Drug Name')
plt.ylabel('Count')
```

Out[137…

```
Text(0, 0.5, 'Count')
```



In [138…

```
df['Drug Name'].value_counts()
#Cetizine has occured the most number of time in sample
```

Out[138…

```
Drug Name
Atorva        119
Combiflam     114
Dolo-650      110
Cetrizine     103
Crocin         96
Ciplox         95
Azee           94
Pantocid       92
Omez           89
Amoxyclav      88
Name: count, dtype: int64
```

Country of Origin

In [139…

```
df['Country of Origin'].unique()

# 4 different countries as country of origin
```

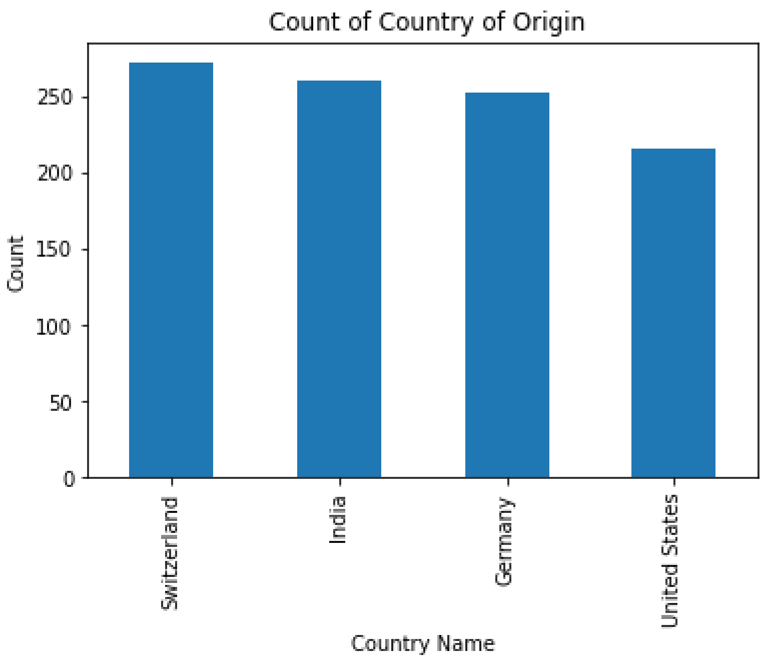
Out[139…

```
array(['Switzerland', 'India', 'Germany', 'United States'], dtype=object)
```

In [140…

```
df['Country of Origin'].value_counts().plot(kind='bar', figsize = (6,4))
plt.title(" Count of Country of Origin")
plt.xlabel("Country Name")
plt.ylabel('Count')
```

```
Out[140… Text(0, 0.5, 'Count')
```



```
In [141… df['Country of Origin'].value_counts()
```

```
Out[141… Country of Origin
         Switzerland      272
         India            260
         Germany          252
         United States    216
         Name: count, dtype: int64
```

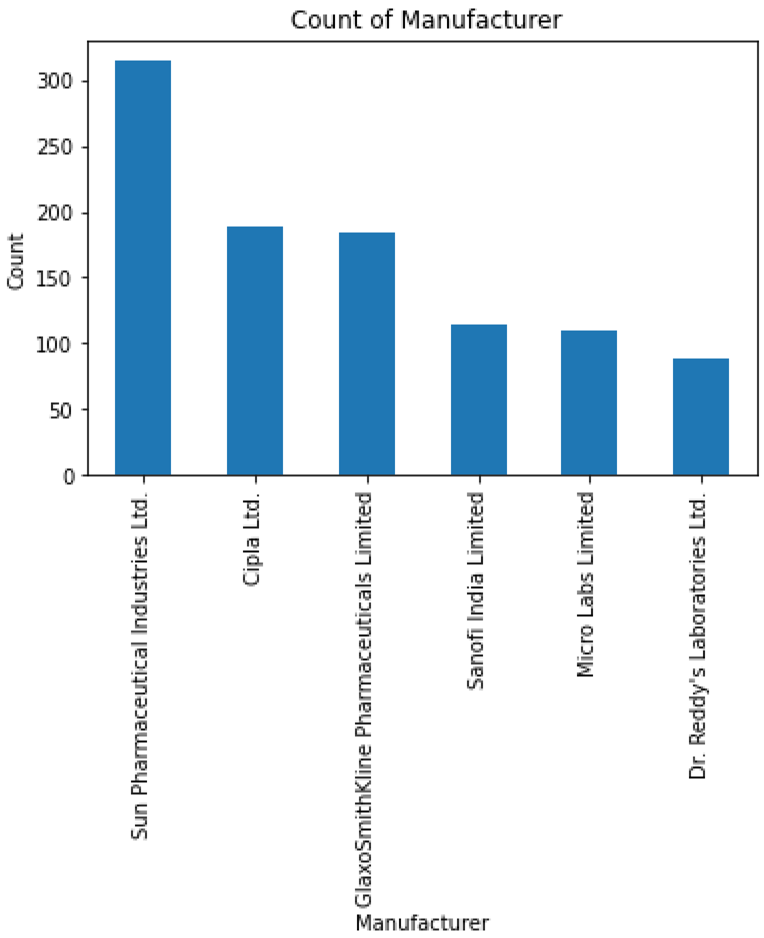
Manufacturer

```
In [142… df['Manufacturer'].unique() # 6 different Manufacturer
```

```
Out[142… array(['Cipla Ltd.', 'Micro Labs Limited',
                'Sun Pharmaceutical Industries Ltd.',
                'GlaxoSmithKline Pharmaceuticals Limited', 'Sanofi India Limited',
                "Dr. Reddy's Laboratories Ltd."], dtype=object)
```

```
In [143… df['Manufacturer'].value_counts().plot(kind='bar', figsize = (6,4))
         plt.title(" Count of Manufacturer")
         plt.xlabel("Manufacturer")
         plt.ylabel('Count')
```

```
Out[143… Text(0, 0.5, 'Count')
```



In [144…

```
df['Manufacturer'].value_counts()
```

Out[144…

```
Manufacturer
Sun Pharmaceutical Industries Ltd.         314
Cipla Ltd.                                 189
GlaxoSmithKline Pharmaceuticals Limited    184
Sanofi India Limited                       114
Micro Labs Limited                         110
Dr. Reddy's Laboratories Ltd.               89
Name: count, dtype: int64
```

'Generic Drug Name'

In [145…

```
df['Generic Drug Name'].unique()
# 9 different genric drugs
```

Out[145…

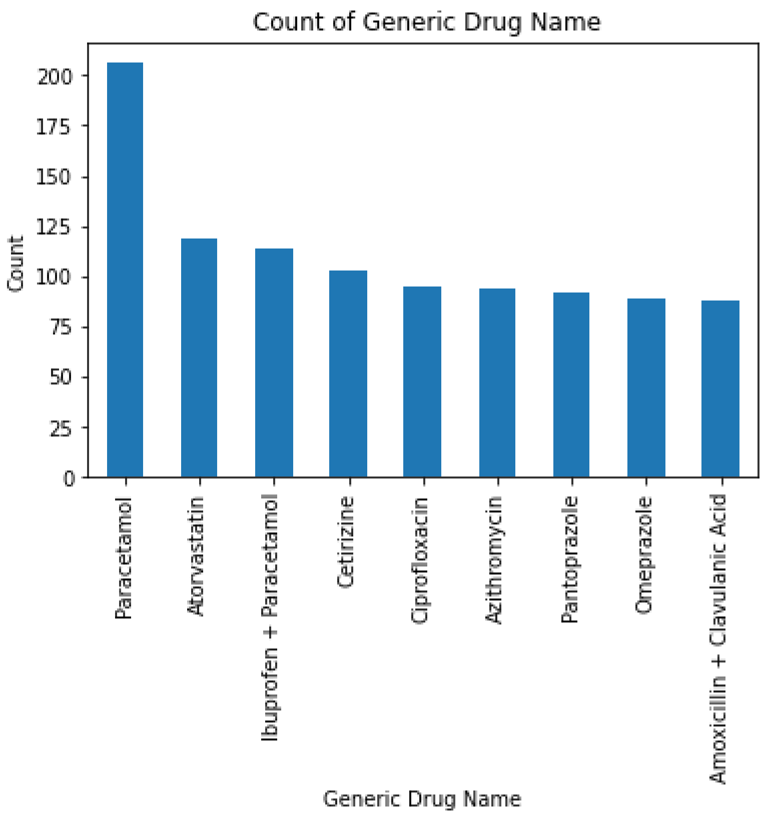
```
array(['Azithromycin', 'Paracetamol', 'Pantoprazole',
       'Amoxicillin + Clavulanic Acid', 'Ibuprofen + Paracetamol',
       'Omeprazole', 'Atorvastatin', 'Ciprofloxacin', 'Cetirizine'],
      dtype=object)
```

In [146…

```
df['Generic Drug Name'].value_counts().plot(kind='bar', figsize = (6,4))
plt.title(" Count of Generic Drug Name")
plt.xlabel('Generic Drug Name')
plt.ylabel('Count')
```

Out[146…

```
Text(0, 0.5, 'Count')
```



In [147…

```
df['Generic Drug Name'].value_counts()
```

Out[147…

```
Generic Drug Name
Paracetamol                      206
Atorvastatin                     119
Ibuprofen + Paracetamol          114
Cetirizine                       103
Ciprofloxacin                     95
Azithromycin                      94
Pantoprazole                      92
Omeprazole                        89
Amoxicillin + Clavulanic Acid     88
Name: count, dtype: int64
```

'Geographic Region'

In [148…

```
df['Geographic Region'].unique()
```

Out[148…

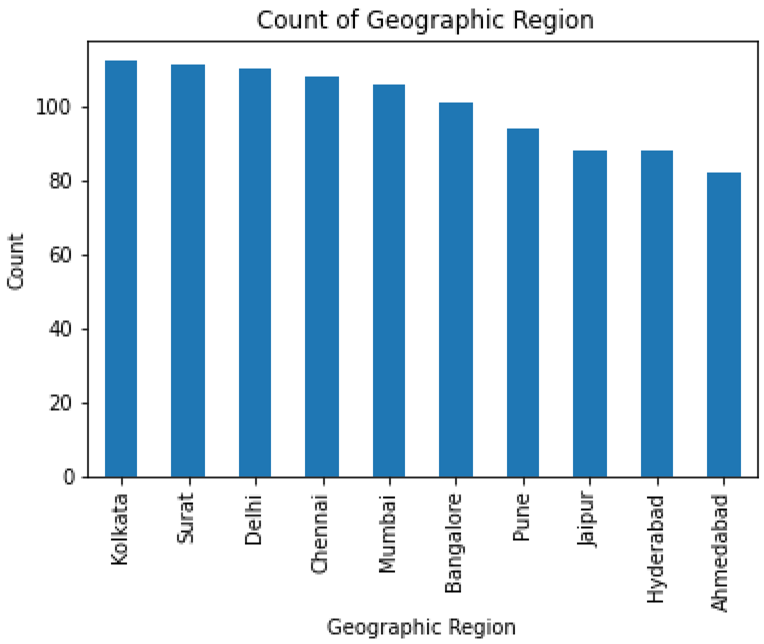
```
array(['Jaipur', 'Chennai', 'Kolkata', 'Ahmedabad', 'Mumbai', 'Hyderabad',
       'Bangalore', 'Pune', 'Delhi', 'Surat'], dtype=object)
```

In [149…

```
df['Geographic Region'].value_counts().plot(kind='bar', figsize = (6,4))
plt.title(" Count of Geographic Region")
plt.xlabel('Geographic Region')
plt.ylabel('Count')
```

Out[149…

```
Text(0, 0.5, 'Count')
```



In [150…

```
df['Geographic Region'].value_counts()
```

Out[150…

```
Geographic Region
Kolkata      112
Surat        111
Delhi        110
Chennai      108
Mumbai       106
Bangalore    101
Pune          94
Jaipur        88
Hyderabad     88
Ahmedabad     82
Name: count, dtype: int64
```

Patient Age Group

In [151…

```
df['Patient Age Group'].unique() # 3 age group
```

Out[151…

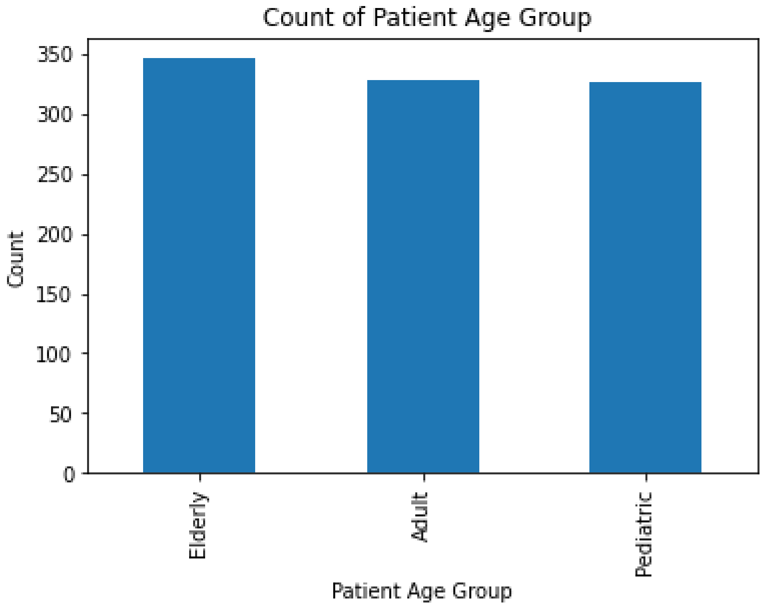
```
array(['Adult', 'Elderly', 'Pediatric'], dtype=object)
```

In [152…

```
df['Patient Age Group'].value_counts().plot(kind='bar', figsize = (6,4))
plt.title(" Count of Patient Age Group")
plt.xlabel("Patient Age Group")
plt.ylabel('Count')
```

Out[152…

```
Text(0, 0.5, 'Count')
```



df['Patient Age Group'].value_counts()

'Patient Gender'

In [153…

```
df['Patient Gender'].value_counts()
```

Out[153…

```
Patient Gender
Male      502
Female    498
Name: count, dtype: int64
```

Outlier Analysis

In [154…

```
df.columns
```

Out[154…

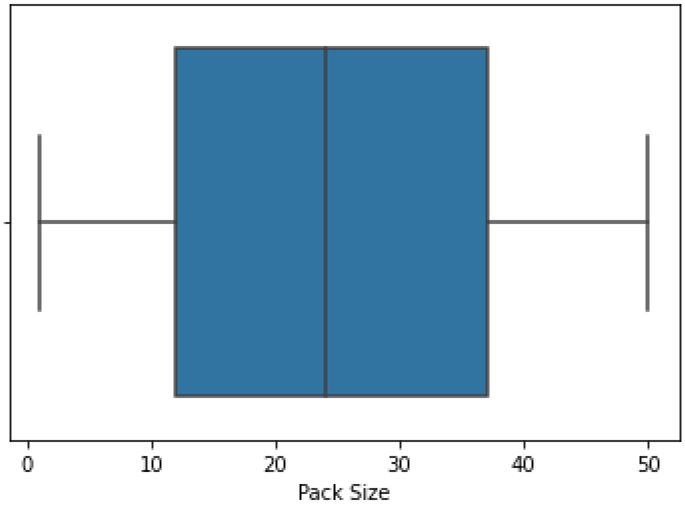
```
Index(['Drug Name', 'Strength', 'Pack Size', 'Price', 'Expiry Date',
       'Manufacture Date', 'Country of Origin', 'Drug Interactions',
       'Patient Age Group', 'Patient Gender', 'Patient Weight',
       'Geographic Region', 'Sales Volume', 'Manufacturer',
       'Generic Drug Name', 'Route of Adminstration', 'Storage Conditions',
       'Prescription Required', 'Therapeutic Class', 'Dosage Form',
       'Adverse Reactions'],
      dtype='object')
```

In [160…

```
sns.boxplot(df["Pack Size"]) # no outlier
```

Out[160…

```
<AxesSubplot:xlabel='Pack Size'>
```

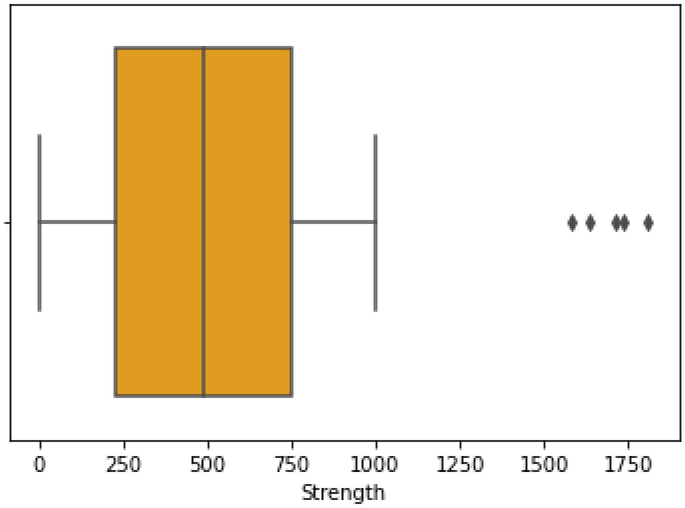


In [164…

```
sns.boxplot(df['Strength'], color='orange') #Outlier indetified
```

Out[164…

```
<AxesSubplot:xlabel='Strength'>
```

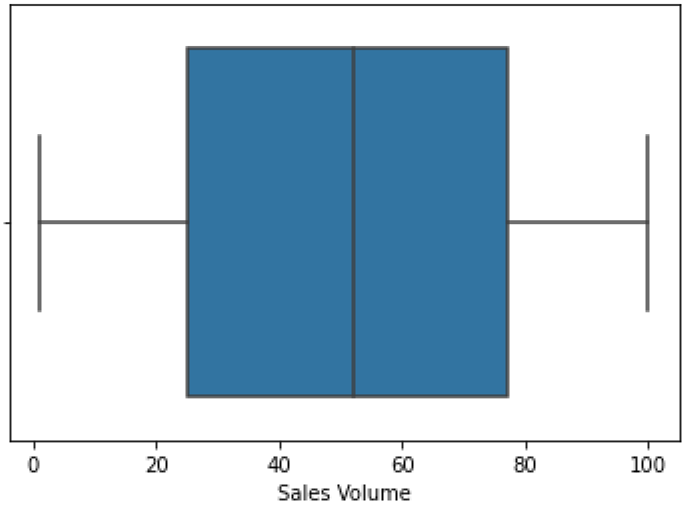


In [163…

```
sns.boxplot(df['Sales Volume']) # no outlier indetified
```

Out[163…

```
<AxesSubplot:xlabel='Sales Volume'>
```

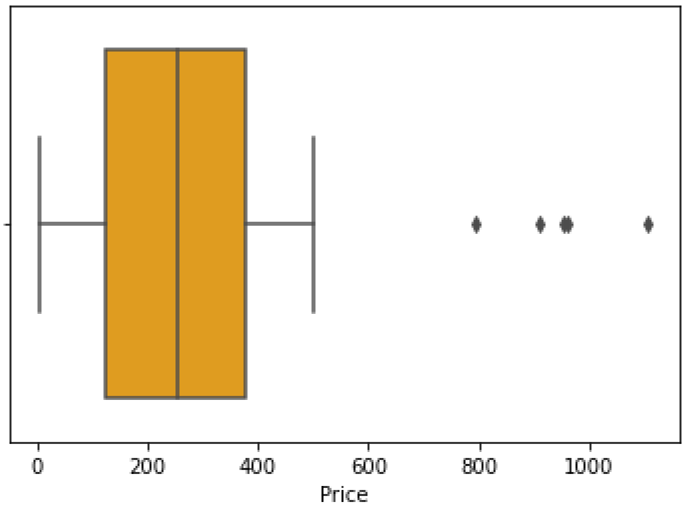


In [176…

```
sns.boxplot(df['Price'],color='orange')## Outlier indentified
```

Out[176…

```
<AxesSubplot:xlabel='Price'>
```



Outlier treatmeant

In [167…

```
def outlier_treatment(df , col_name):
    upper_boundary = df[col_name].mean() + 3*df[col_name].std()
    lower_boundary = df[col_name].mean()  - 3*df[col_name].std()
    return upper_boundary, lower_boundary
```

In [177…

```
ub_str, lb_str = outlier_treatment(df, 'Strength' ) # getting upper and lower limits fo
ub_price, lb_price = outlier_treatment(df, 'Price') # getting upper and lower limits fo
```

In [178…

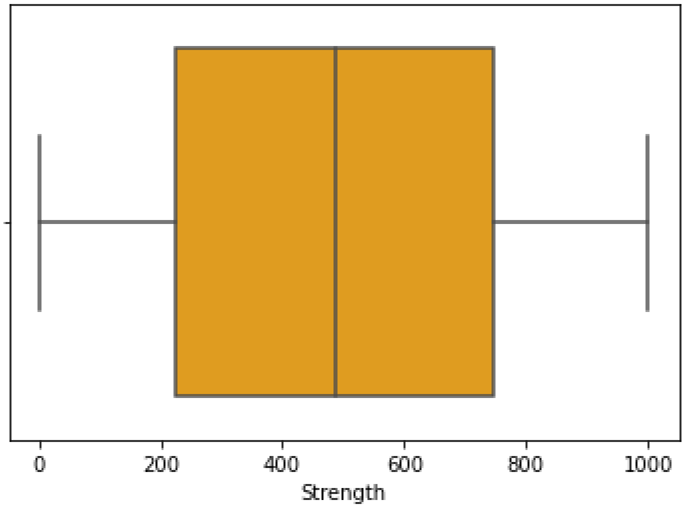
```
df = df[df['Strength'] <=ub_str]
df = df[df['Price'] <= ub_price]
```

In [181…

```
sns.boxplot(df['Strength'], color='orange') #treated  Strength
```

Out[181…

```
<AxesSubplot:xlabel='Strength'>
```

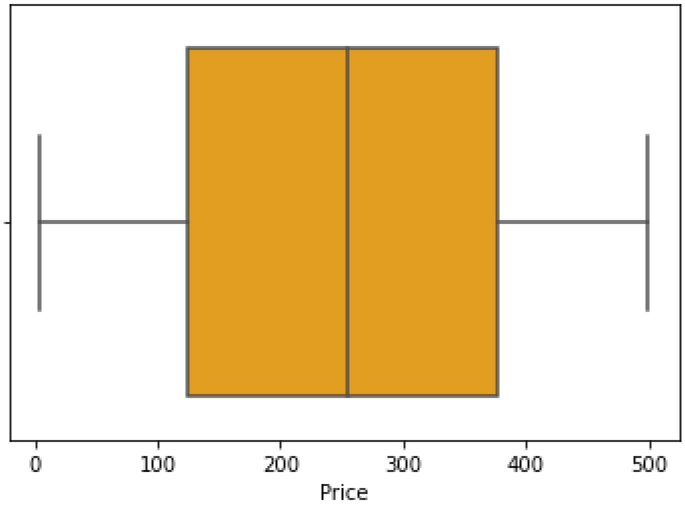


In [182…

```
sns.boxplot(df['Price'],color='orange')## treated Price
```

Out[182…

```
<AxesSubplot:xlabel='Price'>
```



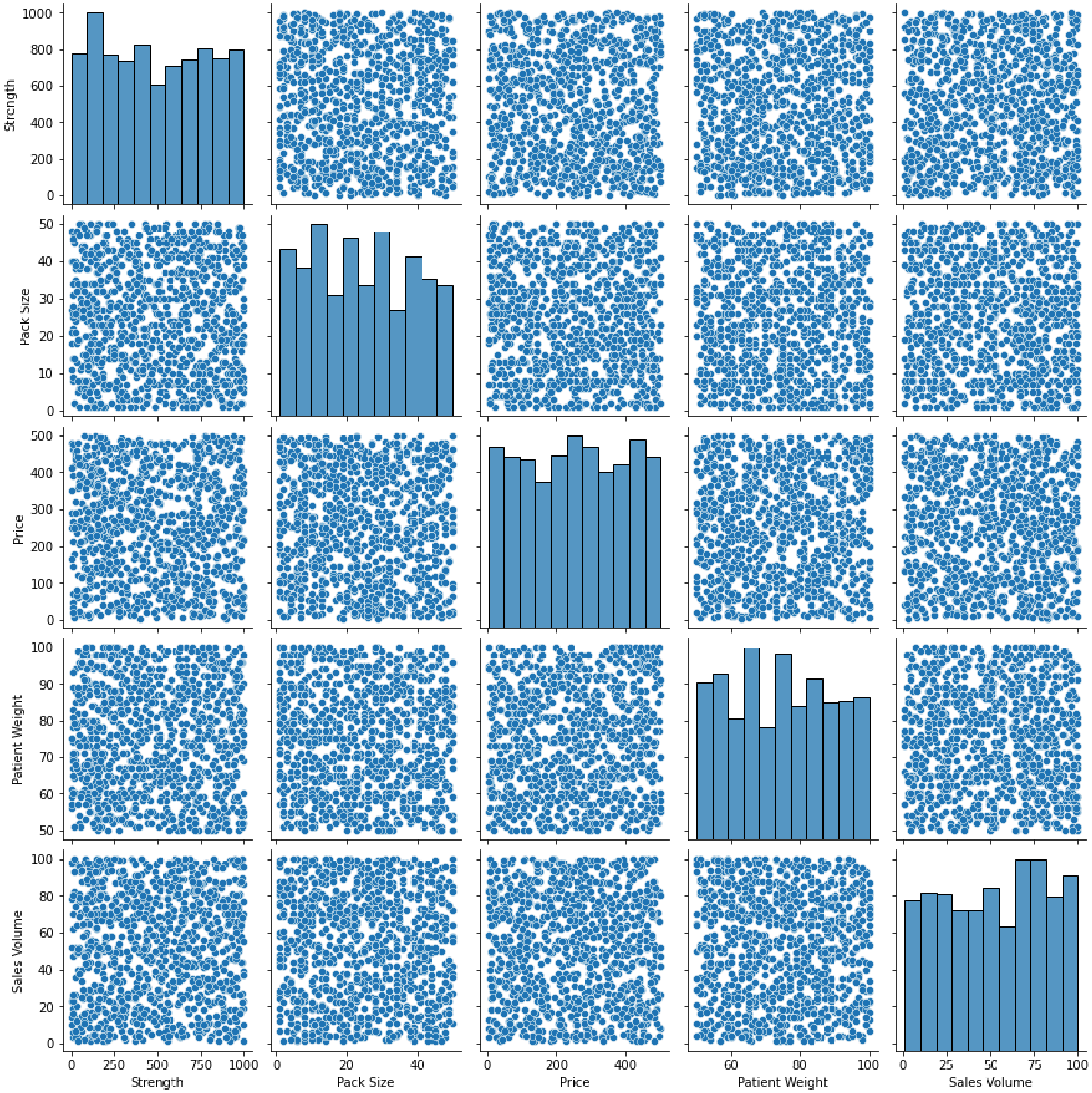
Bivariate Analysis

In [193…

```
sns.pairplot(df)
```

Out[193…

```
<seaborn.axisgrid.PairGrid at 0x281f0922ca0>
```

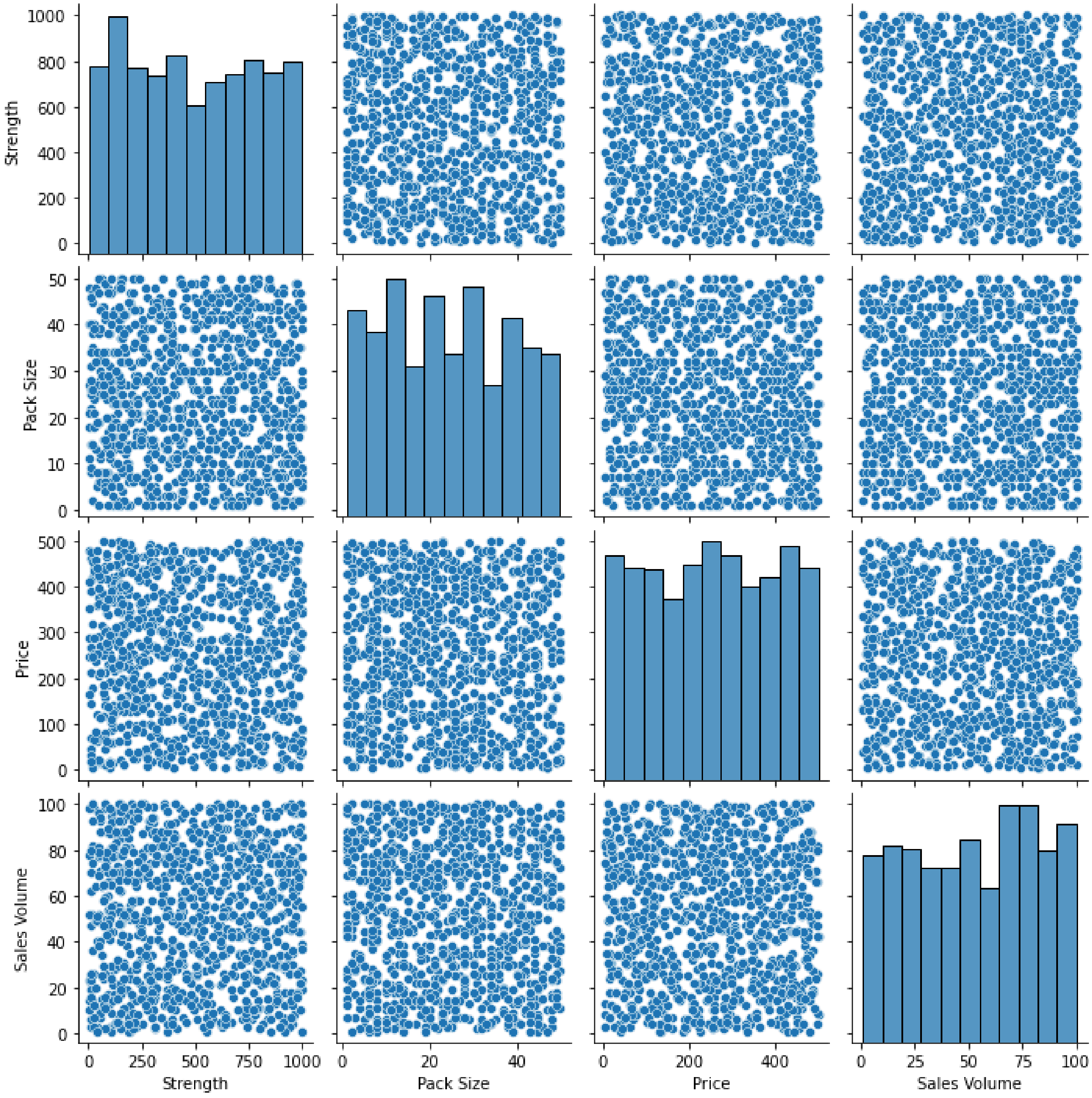


In [195…

```
sns.pairplot(df[['Strength', 'Pack Size', 'Price','Sales Volume']])## Data seems to be
```

Out[195…

```
<seaborn.axisgrid.PairGrid at 0x281e6b65100>
```



In [196…

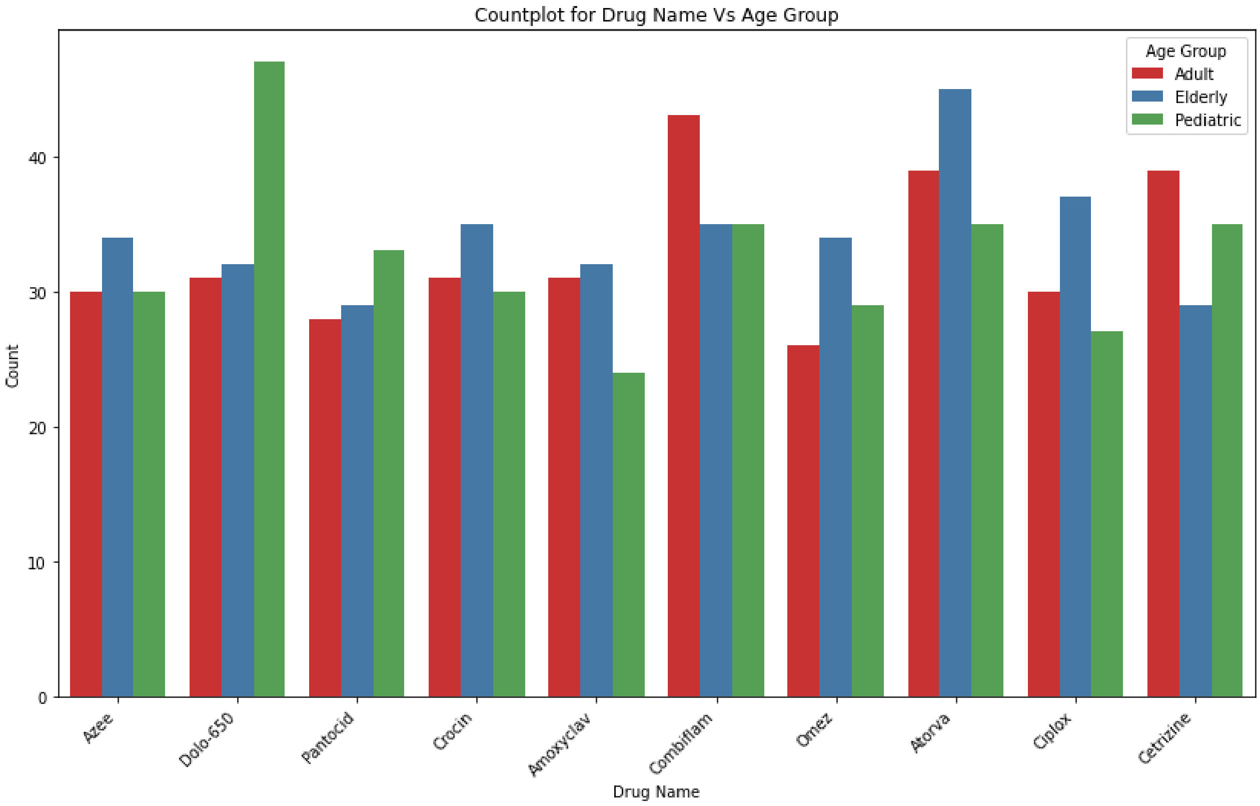
```
df.columns
```

Out[196…

```
Index(['Drug Name', 'Drug ID', 'Strength', 'Pack Size', 'Price', 'Expiry Date',
       'Batch Number', 'Manufacture Date', 'Country of Origin',
       'Drug Interactions', 'Patient Age Group', 'Patient Gender',
       'Patient Weight', 'Geographic Region', 'Sales Volume', 'Manufacturer',
       'Generic Drug Name', 'Route of Adminstration', 'Storage Conditions',
       'Prescription Required', 'Therapeutic Class', 'Dosage Form',
       'Adverse Reactions'],
      dtype='object')
```

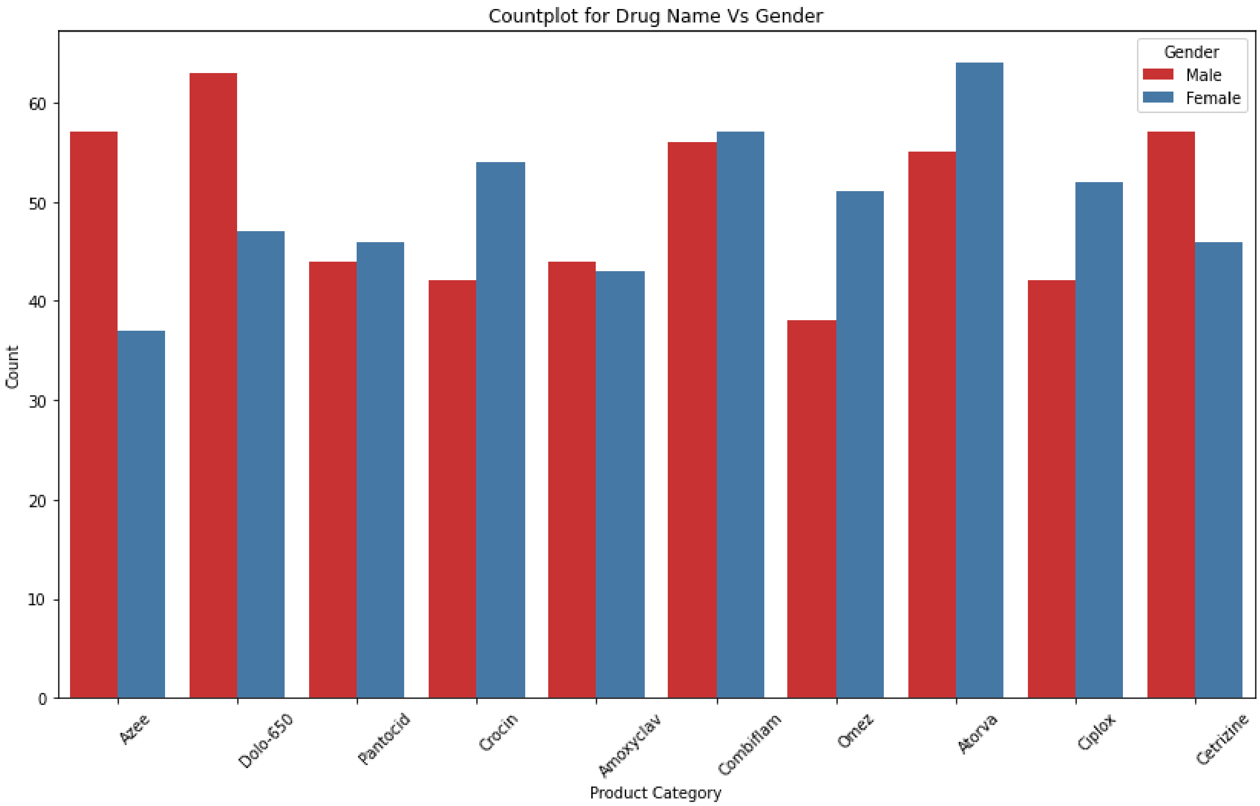
In [201…

```
plt.figure(figsize=(14, 8))
sns.countplot(data=df, x='Drug Name', hue='Patient Age Group', palette='Set1')
plt.title('Countplot for Drug Name Vs Age Group')
plt.xlabel('Drug Name')
plt.ylabel('Count')
plt.legend(title='Age Group')
plt.xticks(rotation=45, ha='right')
plt.show()
```



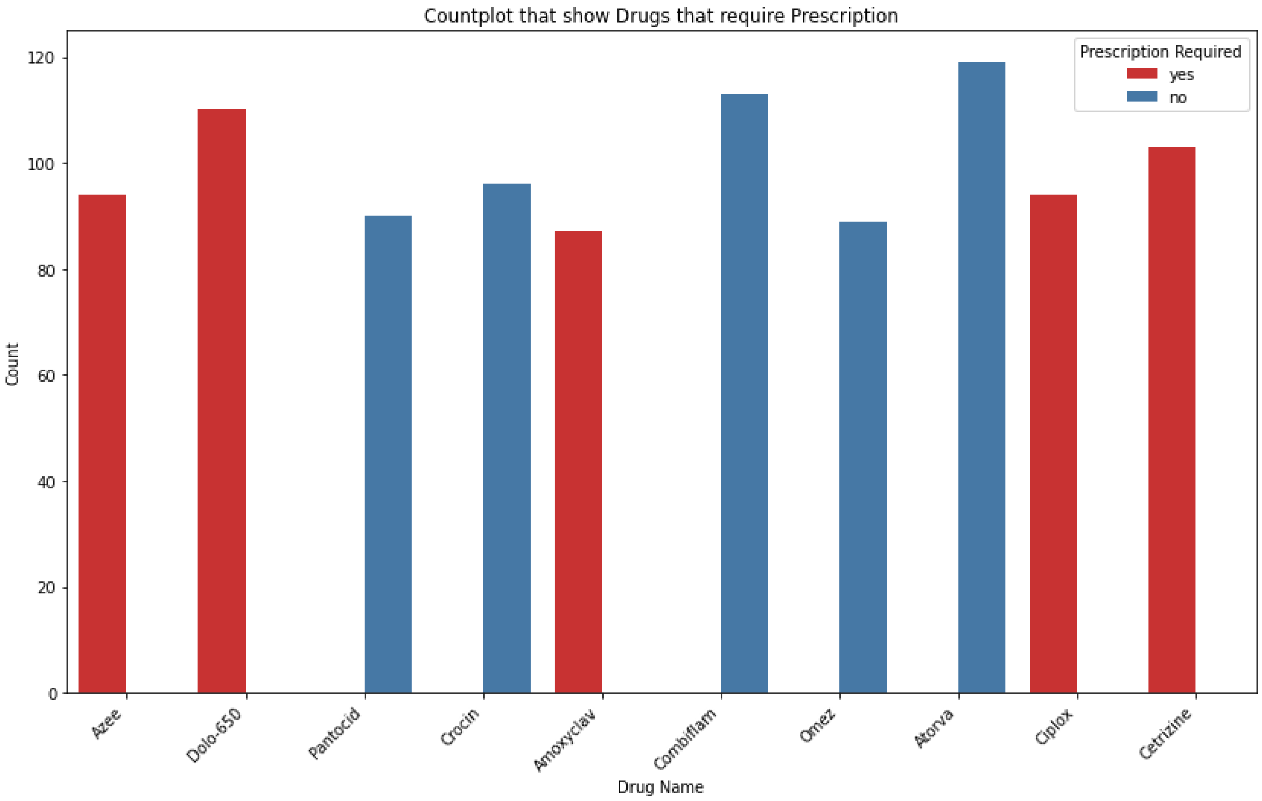
In [202…

```
plt.figure(figsize=(14, 8))
sns.countplot(data=df, x='Drug Name', hue='Patient Gender', palette='Set1')
plt.title('Countplot for Drug Name Vs Gender')
plt.xlabel('Product Category')
plt.ylabel('Count')
plt.legend(title='Gender')
plt.xticks(rotation=45, ha='left')
plt.show()
```



In [205…

```
plt.figure(figsize=(14, 8))
sns.countplot(data=df, x='Drug Name', hue='Prescription Required', palette='Set1')
plt.title('Countplot that show Drugs that require Prescription')
plt.xlabel('Drug Name')
plt.ylabel('Count')
plt.legend(title='Prescription Required')
plt.xticks(rotation=45, ha='right')
plt.show()
```

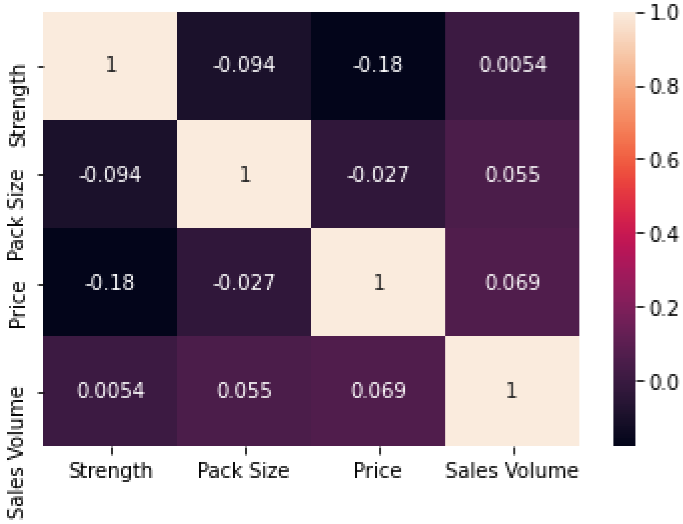


Correlation in 'Strength', 'Pack Size', 'Price', 'Sales Volume' at Drug Level

In [226…

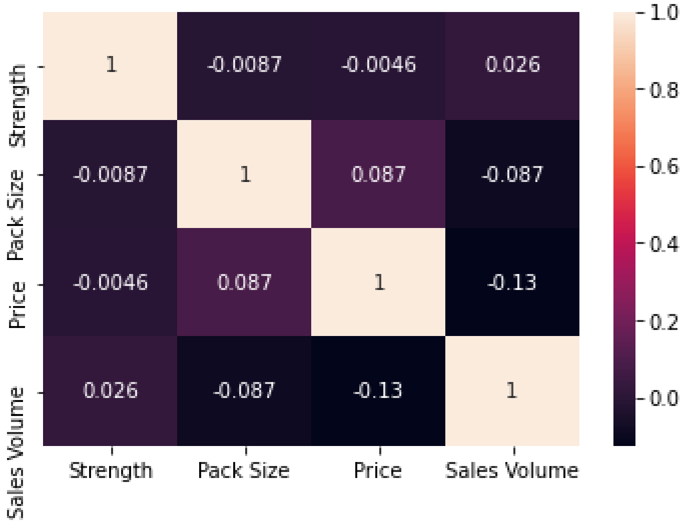
```
for drug in df['Drug Name'].unique():
    print("Checking correlation for Drug ", drug)
    plt.subplot()
    sns.heatmap(df[df['Drug Name']== drug][['Strength', 'Pack Size', 'Price', 'Sales Vo
    plt.show()
# There is slight to no correlation at drug level also
```

```
Checking correlation for Drug  Azee
```

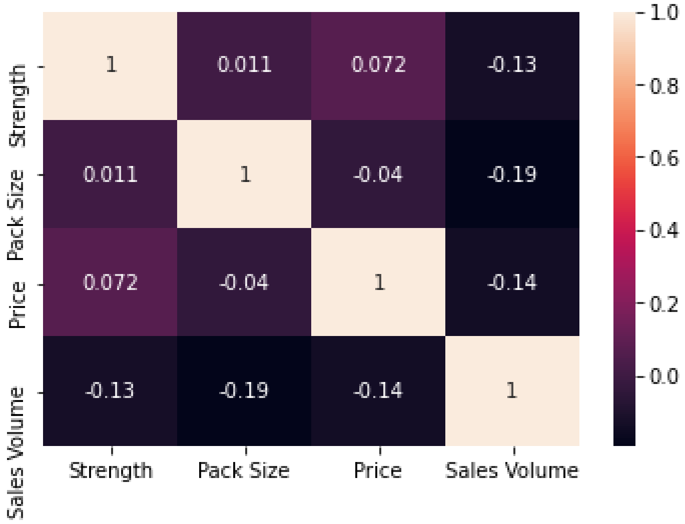


	Strength	Pack Size	Price	Sales Volume
Strength	1	-0.094	-0.18	0.0054
Pack Size	-0.094	1	-0.027	0.055
Price	-0.18	-0.027	1	0.069
Sales Volume	0.0054	0.055	0.069	1

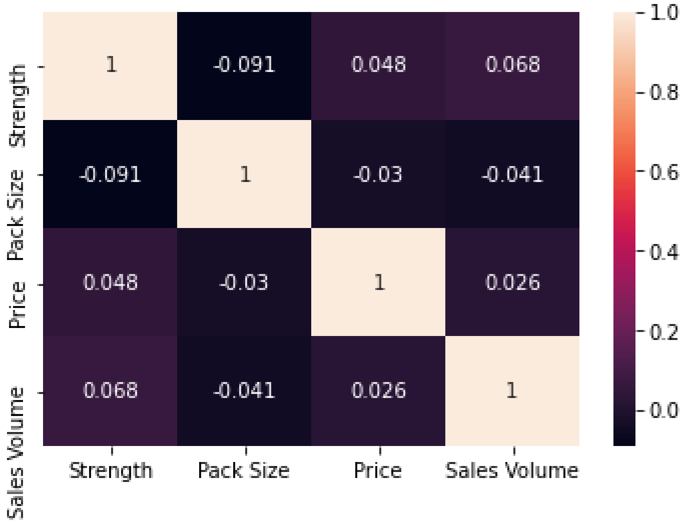
```
Checking correlation for Drug  Dolo-650
```



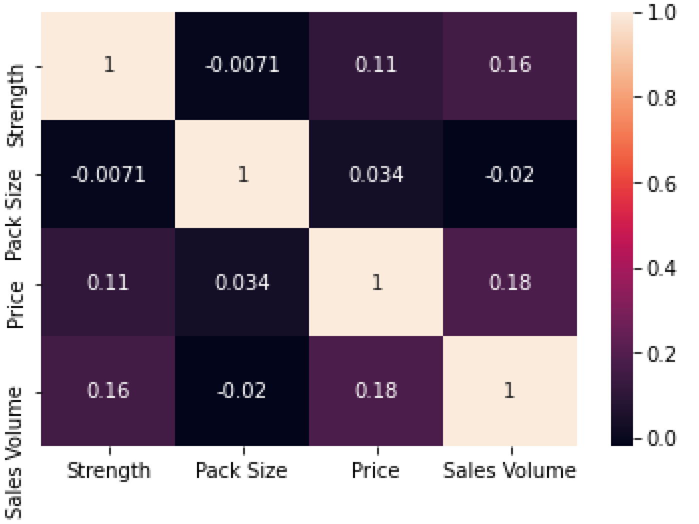
```
Checking correlation for Drug  Pantocid
```



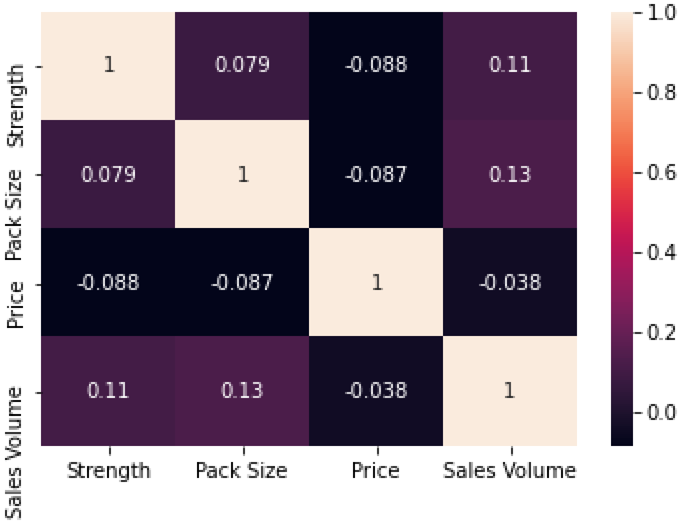
```
Checking correlation for Drug  Crocin
```



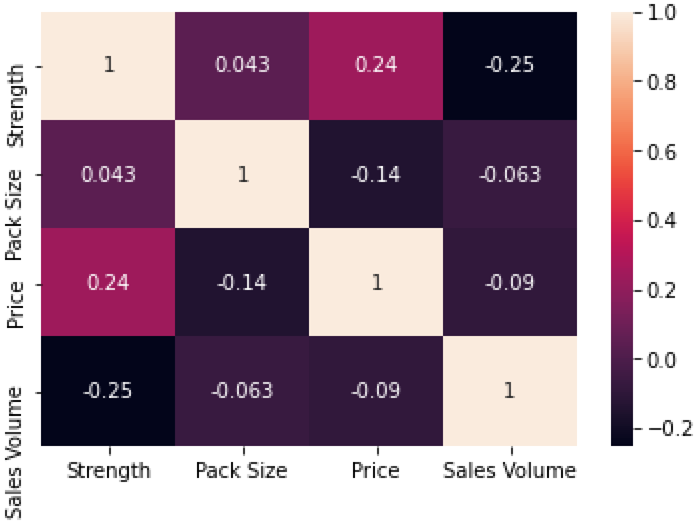
```
Checking correlation for Drug  Amoxyclav
```



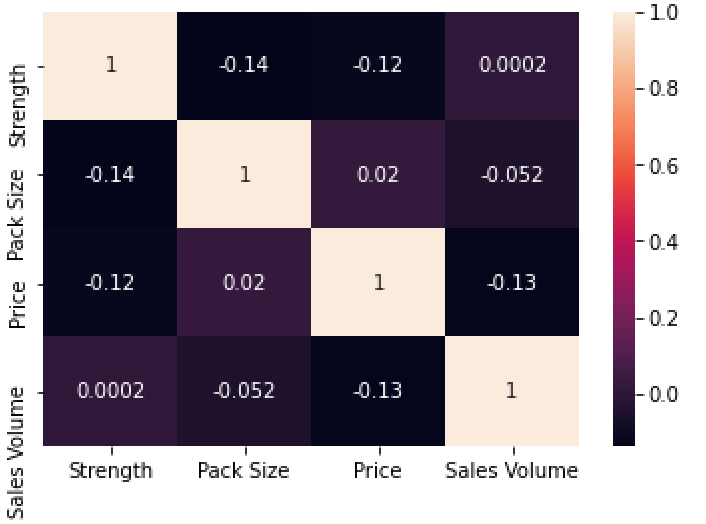
```
Checking correlation for Drug  Combiflam
```



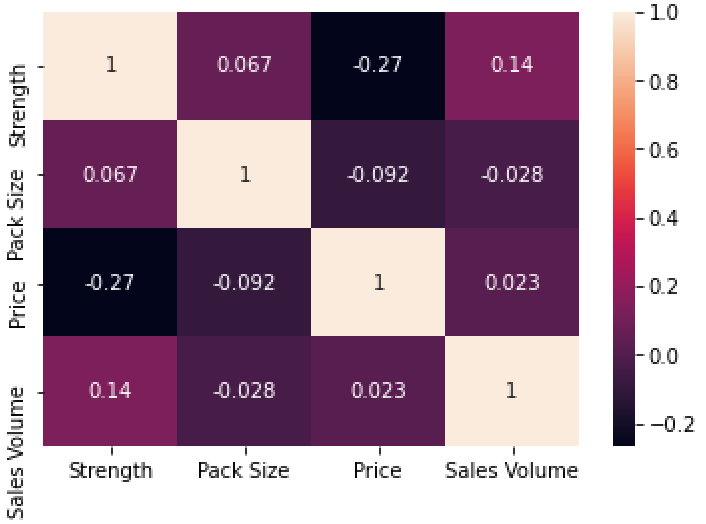
```
Checking correlation for Drug  Omez
```



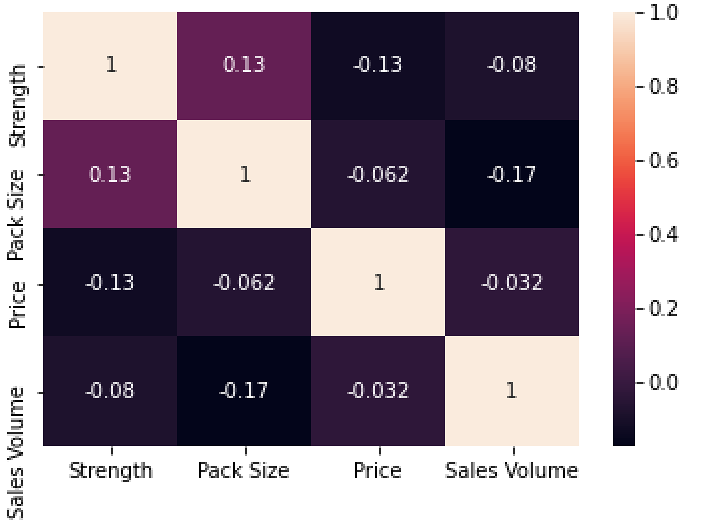
```
Checking correlation for Drug  Atorva
```



```
Checking correlation for Drug  Ciplox
```



```
Checking correlation for Drug  Cetrizine
```



In [206…

```
df.describe()
```

Out[206…

	Strength	Pack Size	Price	Patient Weight	Sales Volume
count	995.000000	995.000000	995.000000	995.000000	995.000000

	Strength	Pack Size	Price	Patient Weight	Sales Volume
mean	491.070352	24.581910	251.496392	74.568844	51.694472
std	296.204075	14.255151	144.399080	14.360410	29.182923
min	1.000000	1.000000	3.610000	50.000000	1.000000
25%	224.500000	12.000000	124.035000	62.000000	25.500000
50%	486.000000	24.000000	253.850000	75.000000	52.000000
75%	747.500000	37.000000	377.195000	87.000000	77.000000
max	1000.000000	50.000000	499.400000	100.000000	100.000000

Findings from the data based on analysis till now are as follow: 1. Number of Data points 1000 after treatment it data point became 995 2. 16 categorical features and 5 non categorical features 3. mean strenght of medicine is 491 units 4. Pack size is in range 1 to 50 with mean 24.58 5. price ranges from 3.6 to 499 with mean at 50.21 6. weight of patient is in range 50 to 100 with mean weight at 75 7. sales volume is in range 1 to 100 with mean arround 49.71 Overall data has no null values, no duplicate values, outlier treatment is already done There are some variation in consumption pattern among various gender There are very weak sign of correlation in data for price, weight, and sales volume

```
In [ ]:
```

```
In [ ]:
```