In [1]:

```
import numpy as np
import pandas as pd
```

In [2]:

```
df = pd.read_csv('osic.csv')
```

In [3]:

```
df.head()
```

Out[3]:

	Patient	Weeks	FVC	Percent	Age	Sex	SmokingStatus
0	ID00007637202177411956430	-4	2315	58.253649	79	Male	Ex-smoker
1	ID00007637202177411956430	5	2214	55.712129	79	Male	Ex-smoker
2	ID00007637202177411956430	7	2061	51.862104	79	Male	Ex-smoker
3	ID00007637202177411956430	9	2144	53.950679	79	Male	Ex-smoker
4	ID00007637202177411956430	11	2069	52.063412	79	Male	Ex-smoker

In [4]:

```
df.tail()
```

Out[4]:

	Patient	Weeks	FVC	Percent	Age	Sex	SmokingStatus
1544	ID00426637202313170790466	13	2712	66.594637	73	Male	Never smoked
1545	ID00426637202313170790466	19	2978	73.126412	73	Male	Never smoked
1546	ID00426637202313170790466	31	2908	71.407524	73	Male	Never smoked
1547	ID00426637202313170790466	43	2975	73.052745	73	Male	Never smoked
1548	ID00426637202313170790466	59	2774	68.117081	73	Male	Never smoked

In [5]:

```
df.shape
```

Out[5]:

```
(1549, 7)
```

In [6]:

```
df.columns
```

Out[6]:

```
Index(['Patient', 'Weeks', 'FVC', 'Percent', 'Age', 'Sex', 'SmokingStatus'], d
type='object')
```

In [7]:

```
df.duplicated().sum()
```

Out[7]:

```
0
```

In [8]:

```
df.isnull().sum()
```

Out[8]:

```
Patient          0
Weeks            0
FVC              0
Percent          0
Age              0
Sex              0
SmokingStatus    0
dtype: int64
```

In [9]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1549 entries, 0 to 1548
Data columns (total 7 columns):
 #   Column         Non-Null Count  Dtype  
---  ------         --------------  -----  
 0   Patient        1549 non-null   object 
 1   Weeks          1549 non-null   int64  
 2   FVC            1549 non-null   int64  
 3   Percent        1549 non-null   float64
 4   Age            1549 non-null   int64  
 5   Sex            1549 non-null   object 
 6   SmokingStatus  1549 non-null   object 
dtypes: float64(1), int64(3), object(3)
memory usage: 84.8+ KB
```

In [10]:

```
df.describe()
```

Out[10]:

	Weeks	FVC	Percent	Age
count	1549.000000	1549.000000	1549.000000	1549.000000
mean	31.861846	2690.479019	77.672654	67.188509
std	23.247550	832.770959	19.823261	7.057395
min	-5.000000	827.000000	28.877577	49.000000
25%	12.000000	2109.000000	62.832700	63.000000
50%	28.000000	2641.000000	75.676937	68.000000
75%	47.000000	3171.000000	88.621065	72.000000
max	133.000000	6399.000000	153.145378	88.000000

In [11]:

```
df.nunique()
```

Out[11]:

```
Patient           176
Weeks             112
FVC              1202
Percent          1536
Age                34
Sex                 2
SmokingStatus       3
dtype: int64
```

In [12]:

```
df1 = df.copy()
```

In [13]:

```
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings("ignore")
```

In [14]:

```
df['Sex'].unique()
```

Out[14]:

```
array(['Male', 'Female'], dtype=object)
```

In [15]:

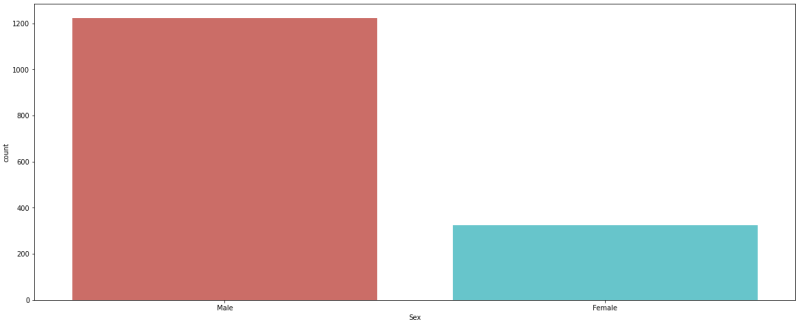
```
df['Sex'].value_counts()
```

Out[15]:

```
Male      1224
Female     325
Name: Sex, dtype: int64
```

In [16]:

```
plt.figure(figsize=(20,8))
sns.countplot('Sex', data = df, palette = 'hls')
plt.show()
```



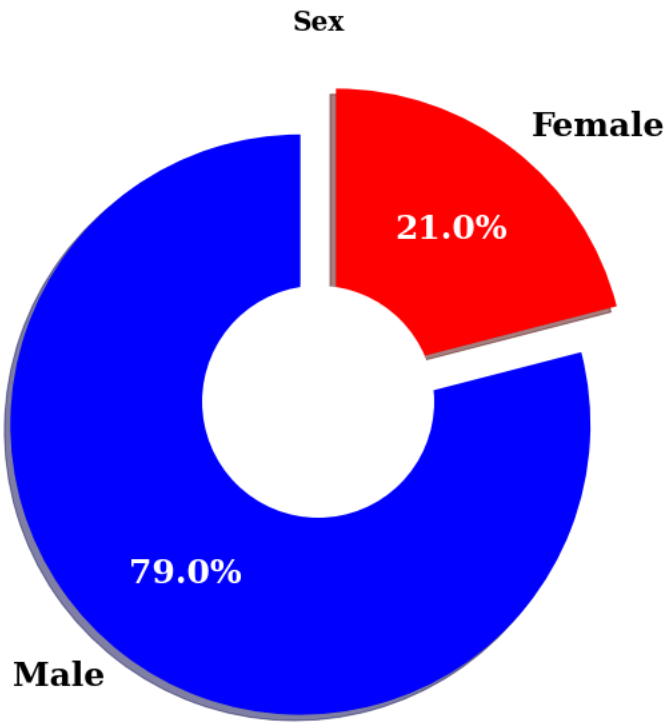
In [17]:

```
label_data = df['Sex'].value_counts()

explode = (0.1, 0.1)
plt.figure(figsize=(14, 10))
patches, texts, pcts = plt.pie(label_data,
                               labels = label_data.index,
                               colors = ['blue', 'red'],
                               pctdistance = 0.65,
                               shadow = True,
                               startangle = 90,
                               explode = explode,
                               autopct = '%1.1f%%',
                               textprops={ 'fontsize': 25,
                                           'color': 'black',
                                           'weight': 'bold',
                                           'family': 'serif' })
plt.setp(pcts, color='white')

hfont = {'fontname':'serif', 'weight': 'bold'}
plt.title('Sex', size=20, **hfont)

centre_circle = plt.Circle((0,0),0.40,fc='white')
fig = plt.gcf()
fig.gca().add_artist(centre_circle)
plt.show()
```



In [18]:

```
df['SmokingStatus'].unique()
```

Out[18]:

```
array(['Ex-smoker', 'Never smoked', 'Currently smokes'], dtype=object)
```

In [19]:

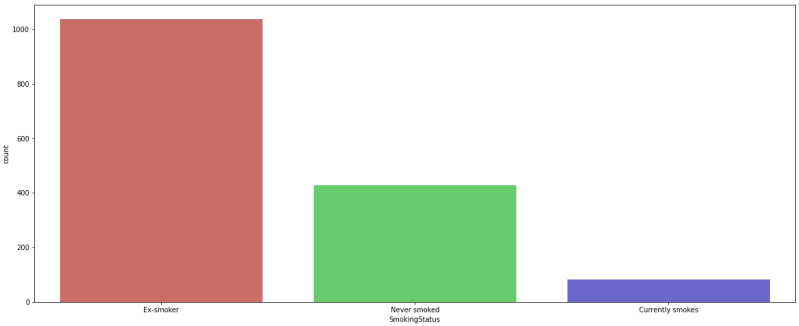
```
df['SmokingStatus'].value_counts()
```

Out[19]:

```
Ex-smoker           1038
Never smoked         429
Currently smokes      82
Name: SmokingStatus, dtype: int64
```

In [20]:

```
plt.figure(figsize=(20,8))
sns.countplot('SmokingStatus', data = df, palette = 'hls')
plt.show()
```



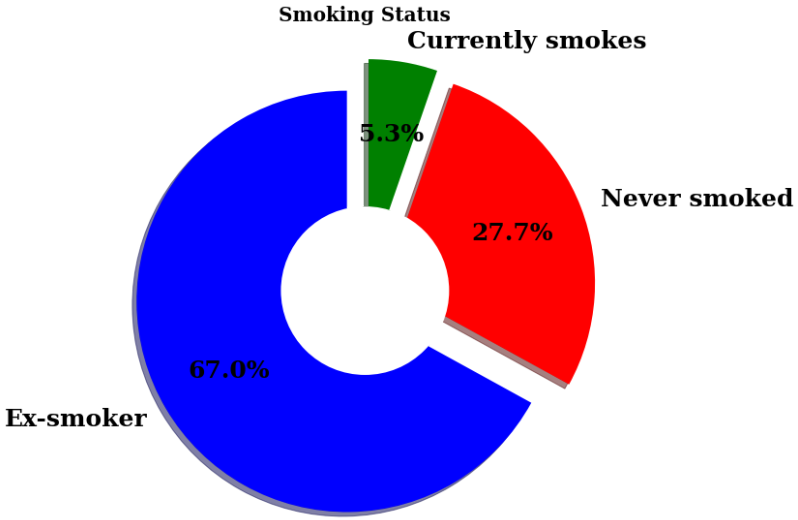
In [21]:

```
label_data = df['SmokingStatus'].value_counts()

explode = (0.1, 0.1, 0.1)
plt.figure(figsize=(14, 10))
patches, texts, pcts = plt.pie(label_data,
                               labels = label_data.index,
                               colors = ['blue', 'red', 'green'],
                               pctdistance = 0.65,
                               shadow = True,
                               startangle = 90,
                               explode = explode,
                               autopct = '%1.1f%%',
                               textprops={ 'fontsize': 25,
                                           'color': 'black',
                                           'weight': 'bold',
                                           'family': 'serif' })
plt.setp(pcts, color='black')

hfont = {'fontname':'serif', 'weight': 'bold'}
plt.title('Smoking Status', size=20, **hfont)

centre_circle = plt.Circle((0,0),0.40,fc='white')
fig = plt.gcf()
fig.gca().add_artist(centre_circle)
plt.show()
```



In [22]:

```
df = df.set_index('Patient')
```

In [23]:

```
df
```

Out[23]:

Patient	Weeks	FVC	Percent	Age	Sex	SmokingStatus
ID00007637202177411956430	-4	2315	58.253649	79	Male	Ex-smoker
ID00007637202177411956430	5	2214	55.712129	79	Male	Ex-smoker
ID00007637202177411956430	7	2061	51.862104	79	Male	Ex-smoker
ID00007637202177411956430	9	2144	53.950679	79	Male	Ex-smoker
ID00007637202177411956430	11	2069	52.063412	79	Male	Ex-smoker
...	...	...	...	...	...	...
ID00426637202313170790466	13	2712	66.594637	73	Male	Never smoked
ID00426637202313170790466	19	2978	73.126412	73	Male	Never smoked
ID00426637202313170790466	31	2908	71.407524	73	Male	Never smoked
ID00426637202313170790466	43	2975	73.052745	73	Male	Never smoked
ID00426637202313170790466	59	2774	68.117081	73	Male	Never smoked

1549 rows × 6 columns

In [24]:

```
from sklearn import preprocessing
label_encoder = preprocessing.LabelEncoder()
df['Sex']= label_encoder.fit_transform(df['Sex'])
df['SmokingStatus']= label_encoder.fit_transform(df['SmokingStatus'])
```

In [25]:

```
df['Weeks'].unique()
```

Out[25]:

```
array([ -4,   5,   7,   9,  11,  17,  29,  41,  57,   8,  13,  15,  22,
        33,  45,  60,   0,   1,   3,  25,  37,  54,   6,  19,  32,  43,
        58,  35,  39,  47,  71,  87,   2,   4,  14,  26,  12,  21,  31,
        40,  52,  69,  16,  18,  20,  38,  53,  66,  23,  44,  70,  -3,
        27,  55,  49,  51,  81,  98,  30,  34,  36,  42,  65,  59,  24,
        63,  10,  61,  -1,  48,  56,  75,  28,  76,  46,  50,  83,  62,
        79,  -5,  73, 102,  82,  97, 100,  67,  91, 107,  85,  72,  84,
        78,  64,  68,  89, 101, 116,  -2,  74,  92, 104, 117, 133,  96,
        77,  94,  86,  88,  95,  93,  80,  99], dtype=int64)
```

In [26]:

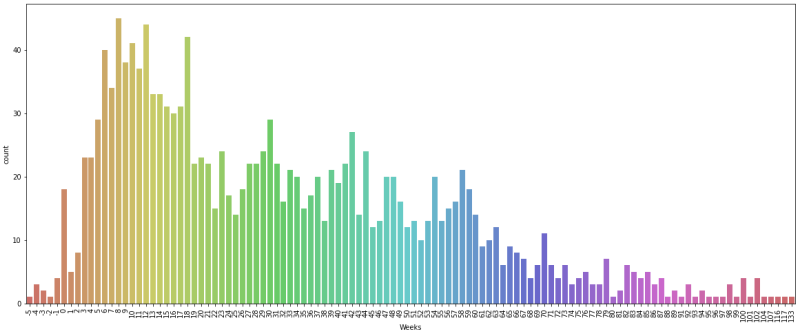
```
df['Weeks'].value_counts()
```

Out[26]:

```
 8      45
 12     44
 18     42
 10     41
 6      40
        ..
 104     1
 91      1
 107     1
-2       1
 99      1
Name: Weeks, Length: 112, dtype: int64
```

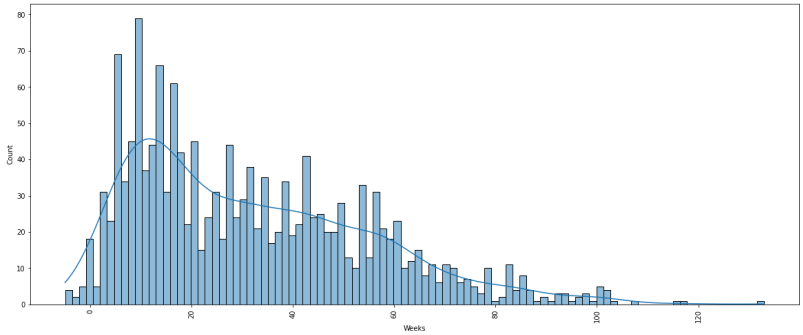
In [27]:

```
plt.figure(figsize=(20,8))
sns.countplot('Weeks', data = df, palette = 'hls')
plt.xticks(rotation = 90)
plt.show()
```



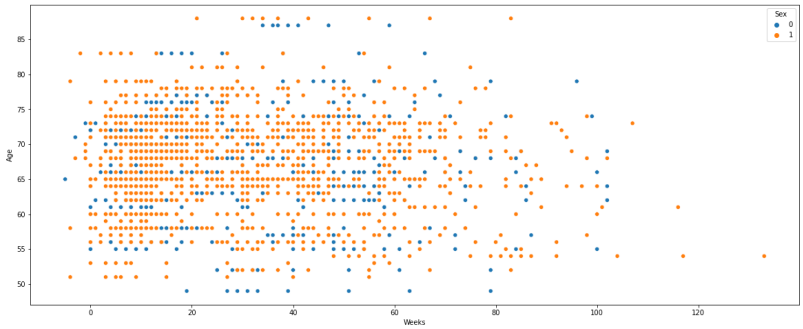
In [28]:

```
plt.figure(figsize=(20,8))
sns.histplot(df['Weeks'], bins = 100, kde = True, palette = 'hls')
plt.xticks(rotation = 90)
plt.show()
```



In [29]:

```
plt.figure(figsize=(20,8))
sns.scatterplot(data = df, x="Weeks", y="Age", hue ='Sex')
plt.show()
```



In [30]:

```
df['FVC'].unique()
```

Out[30]:

```
array([2315, 2214, 2061, ..., 2712, 2978, 2774], dtype=int64)
```

In [31]:

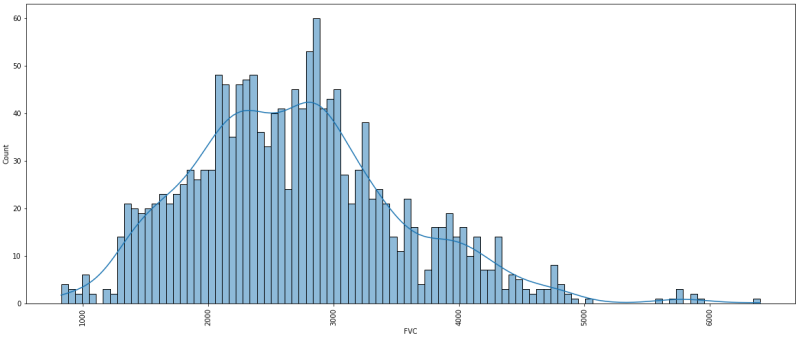
```
df['FVC'].value_counts()
```

Out[31]:

```
2474    4
2965    4
2889    4
2095    4
2708    4
       ..
3906    1
3780    1
3925    1
3907    1
2774    1
Name: FVC, Length: 1202, dtype: int64
```

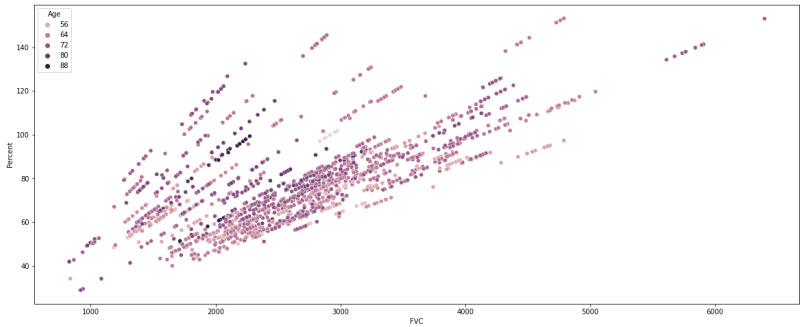
In [32]:

```
plt.figure(figsize=(20,8))
sns.histplot(df['FVC'], bins = 100, kde = True, palette = 'hls')
plt.xticks(rotation = 90)
plt.show()
```



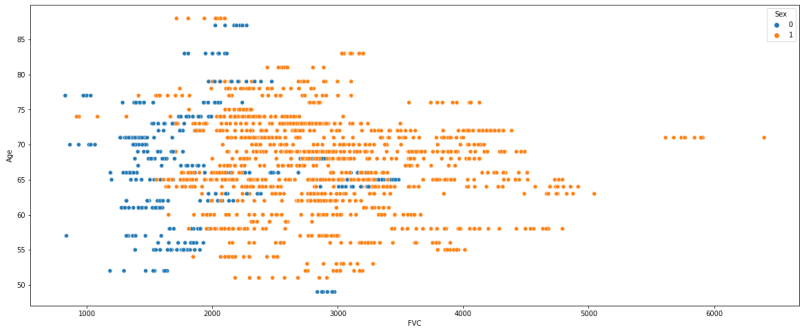
In [33]:

```
plt.figure(figsize=(20,8))
sns.scatterplot(data = df, x="FVC", y="Percent", hue ='Age')
plt.show()
```



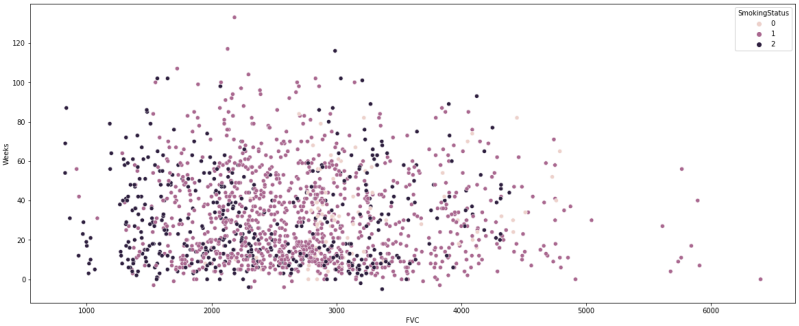
In [34]:

```
plt.figure(figsize=(20,8))
sns.scatterplot(data = df, x="FVC", y="Age", hue ='Sex')
plt.show()
```



In [35]:

```
plt.figure(figsize=(20,8))
sns.scatterplot(data = df, x="FVC", y="Weeks", hue ='SmokingStatus')
plt.show()
```



In [36]:

```
df['Percent'].unique()
```

Out[36]:

```
array([58.25364872, 55.71212884, 51.86210367, ..., 71.40752382,
       73.05274531, 68.11708084])
```

In [37]:

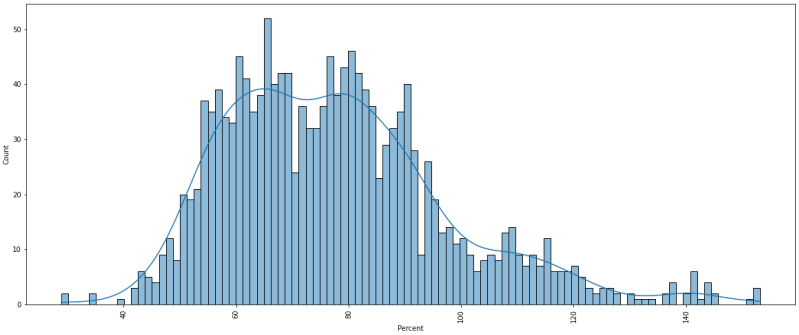
```
df['Percent'].value_counts()
```

Out[37]:

```
87.795153    2
83.282505    2
80.474296    2
57.897831    2
94.644367    2
            ..
69.492021    1
49.475076    1
55.840291    1
57.534926    1
68.117081    1
Name: Percent, Length: 1536, dtype: int64
```

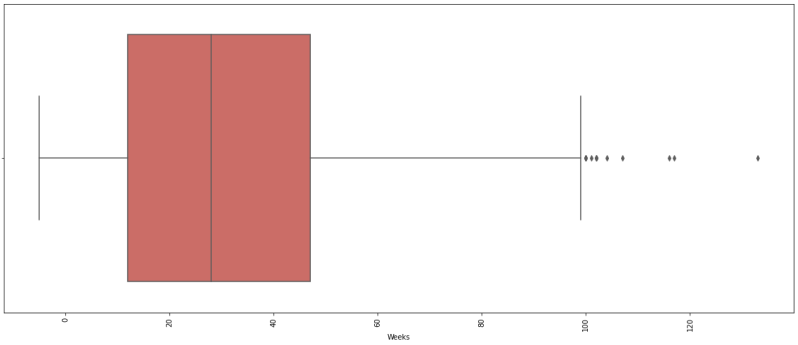
In [38]:

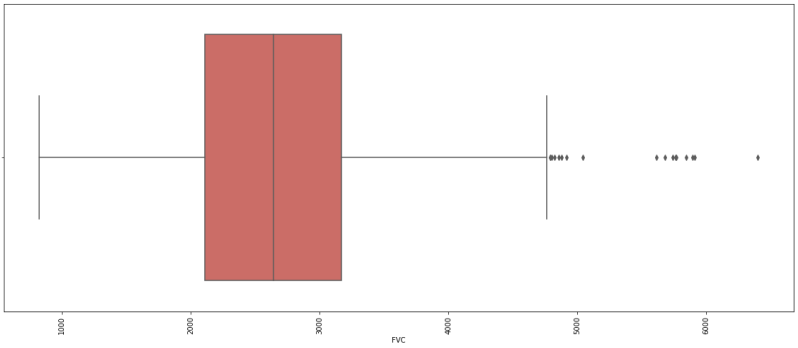
```
plt.figure(figsize=(20,8))
sns.histplot(df['Percent'], bins = 100, kde = True, palette = 'hls')
plt.xticks(rotation = 90)
plt.show()
```

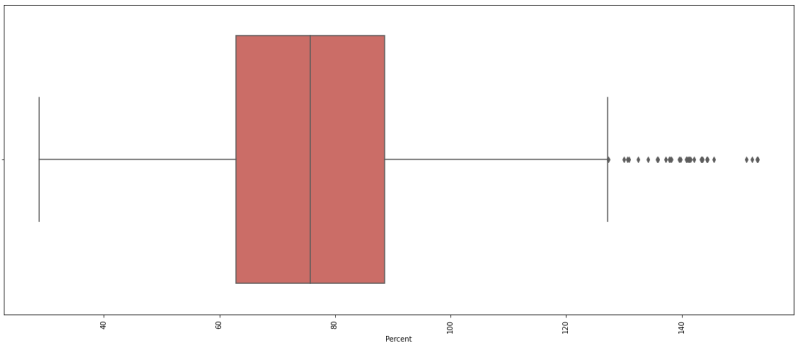


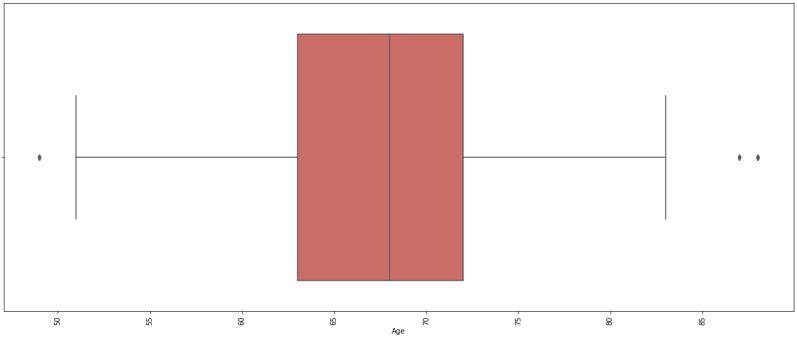
In [39]:

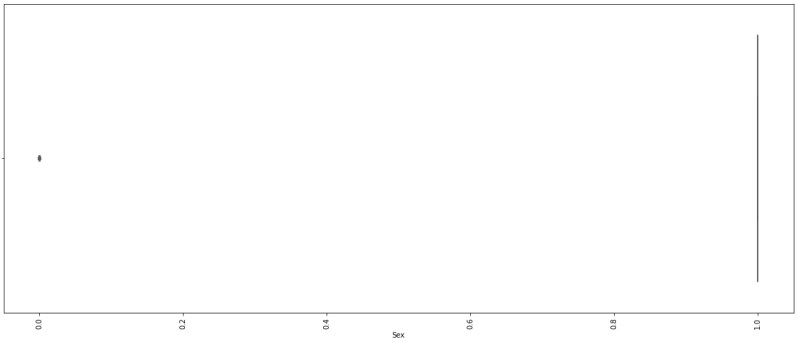
```
for i in df.columns:
    plt.figure(figsize=(20,8))
    sns.boxplot(df[i], palette = 'hls')
    plt.xticks(rotation = 90)
    plt.show()
```

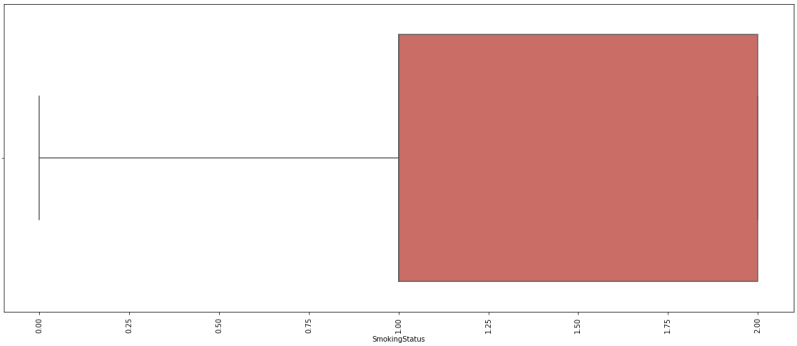






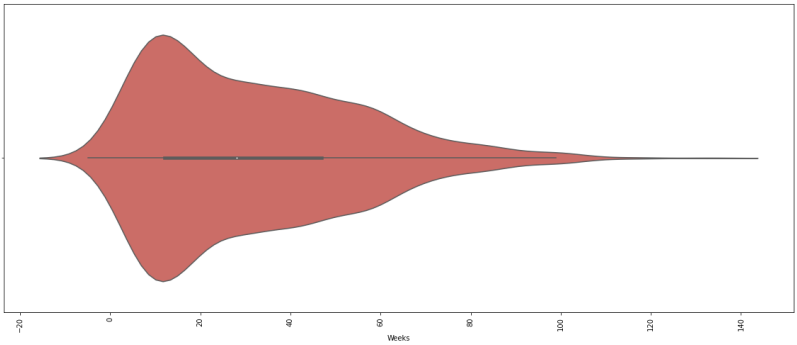

50
55
60
65
70
75
80
85
Age

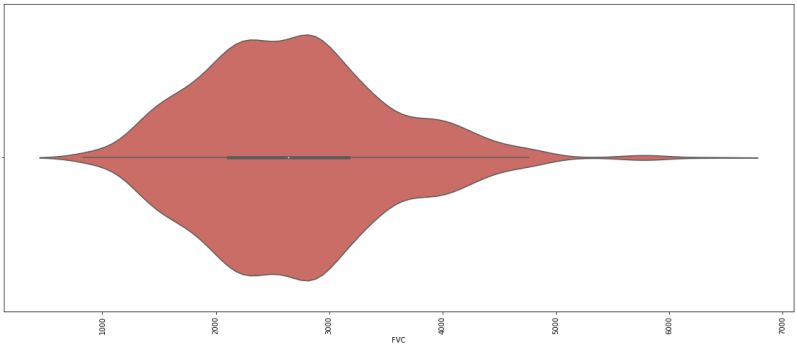

0.0
0.2
0.4
0.6
0.8
1.0
Sex

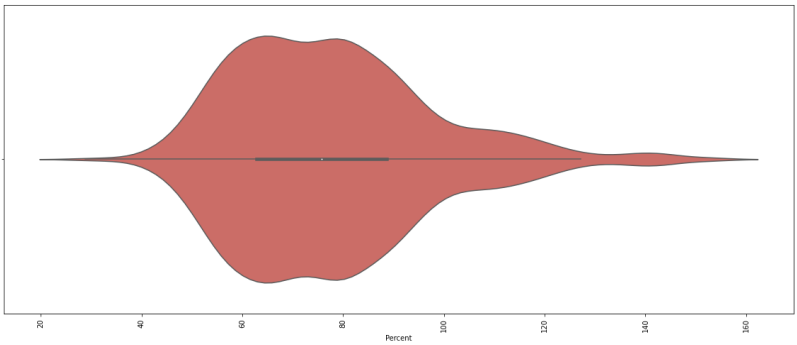

0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
SmokingStatus

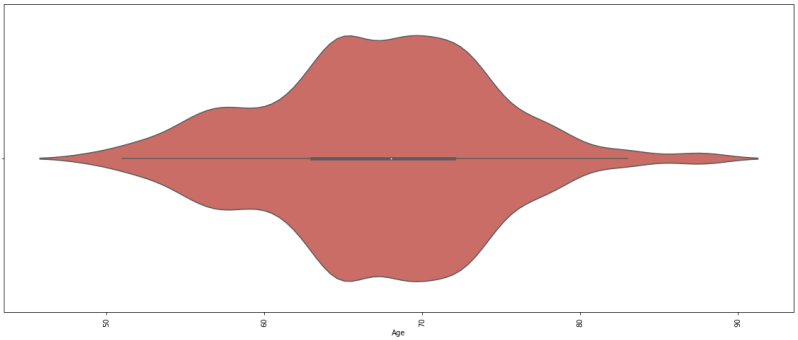
In [40]:

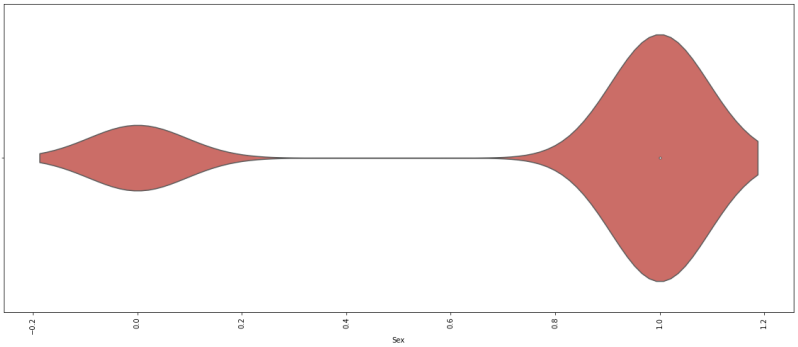
```
for i in df.columns:
    plt.figure(figsize=(20,8))
    sns.violinplot(df[i], palette = 'hls')
    plt.xticks(rotation = 90)
    plt.show()
```

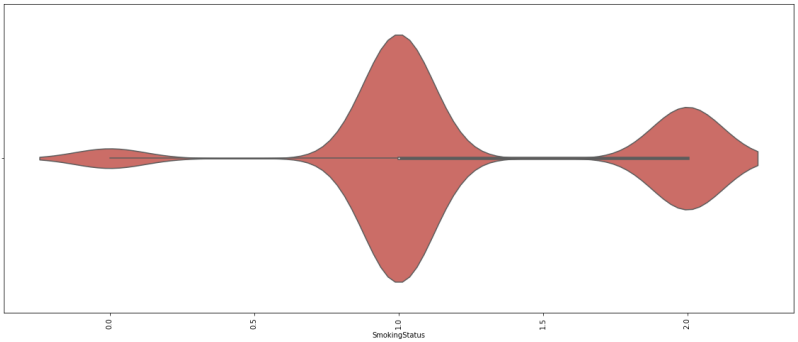






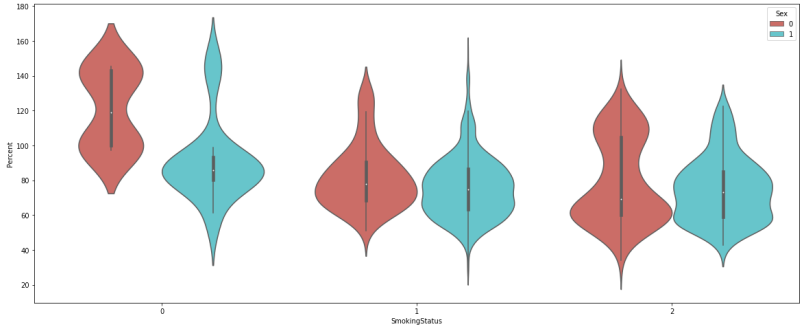

50
60
70
80
90
Age


−0.2
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Sex


0.0
0.5
1.0
1.5
2.0
SmokingStatus

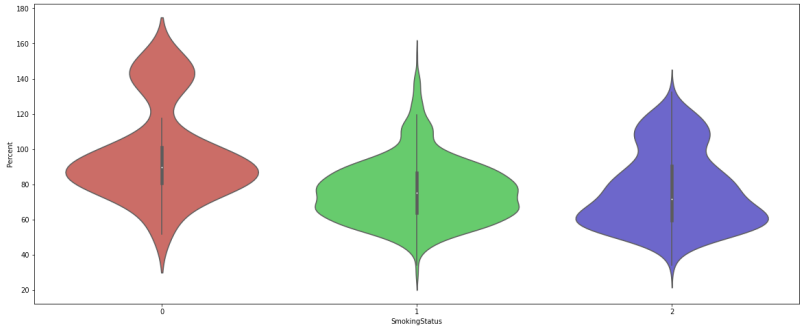
In [41]:

```
plt.figure(figsize=(20,8))
sns.violinplot(data = df, y='Percent', x='SmokingStatus', hue ='Sex',
               palette = 'hls')
plt.show()
```



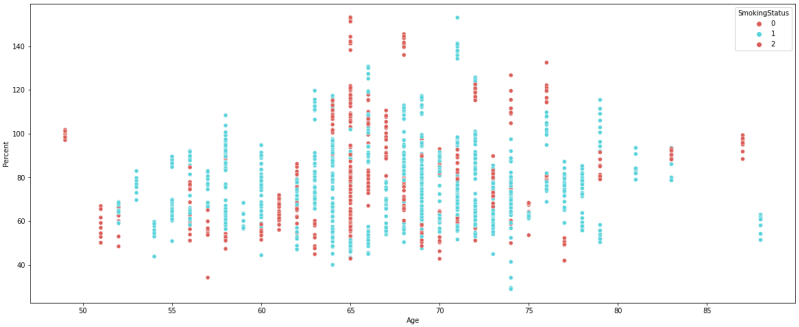
In [42]:

```
plt.figure(figsize=(20,8))
sns.violinplot(data = df, y='Percent', x='SmokingStatus',
               palette = 'hls')
plt.show()
```



In [43]:

```
plt.figure(figsize=(20,8))
sns.scatterplot(data = df, y='Percent', x='Age', hue = 'SmokingStatus',
                palette = 'hls')
plt.show()
```



In [44]:

```
df1['Patient'].unique()
```

Out[44]:

```
array(['ID00007637202177411956430', 'ID00009637202177434476278',
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       'ID00015637202177877247924', 'ID00019637202178323708467',
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       'ID00291637202279398396106', 'ID00296637202279895784347',
```
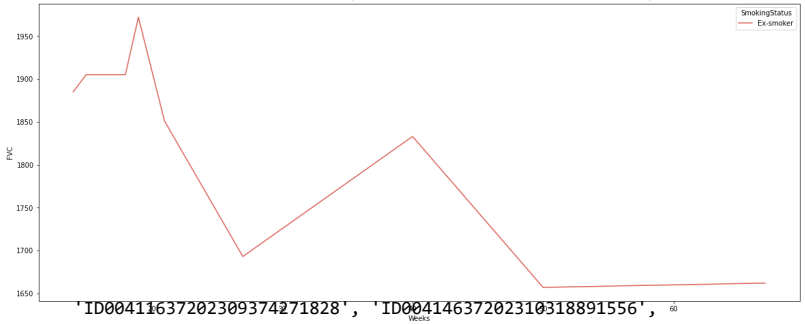
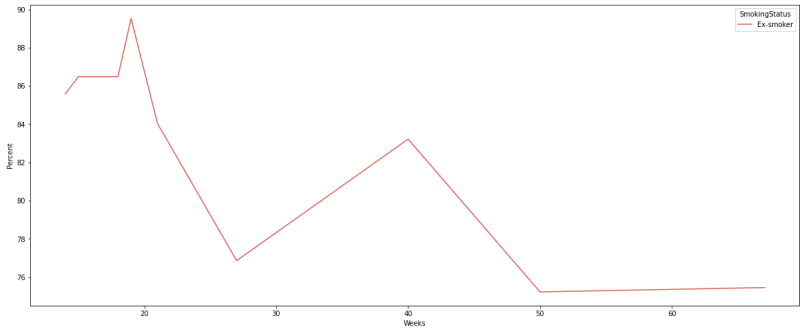

In [45]:
```
df1['Patient'].value_counts()
```

Out[45]:
```
ID00105637202208831864134    10
ID00119637202215426335765    10
ID00229637202302354240583    10
ID00140637202312378251489    10
ID00388637202302028491611    10
                             ..
ID00052637202186188008618     7
ID00034637202207684217717     7
ID00186637202247208895475     6
ID00026637202270790561585     6
ID00047637202318493801501     6
Name: Patient, Length: 176, dtype: int64
```

```
        'ID00298637202280361773446', 'ID00299637202280383305867',
In [46]:'ID00305637202281772703145', 'ID00307637202282126172865',
        'ID00309637202282195513787', 'ID00312637202282607344793',
patient1 = df1[df1.Patient == 'ID00228637202259965313869']
        'ID00317637202283194142136', 'ID00319637202283897208687',
plt.figure(figsize=(20,8))
        'ID00322637202284842245491', 'ID00323637202285211956970',
sns.lineplot(data = patient1, y='FVC', x='Weeks', hue = 'SmokingStatus',
        'ID00329637202285906759848', 'ID00331637202286306023714',
             palette = 'hls')
plt.show()
        'ID00335637202286784464927', 'ID00336637202286801879145',
        'ID00337637202286839091062', 'ID00339637202287377736231',
        'ID00340637202287399835821', 'ID00341637202287410878488',
```

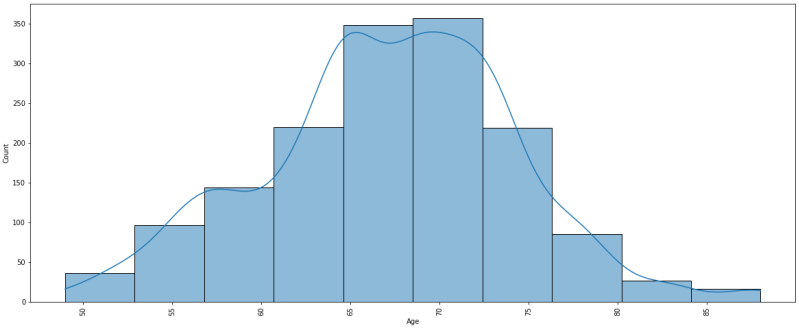



```
        'ID00411637202309374271828', 'ID00414637202310318891556',
        'ID00417637202310901214011', 'ID00419637202311204720264',
        'ID00421637202311550012437', 'ID00422637202311677017371',
In [47]:'ID00423637202312137826377', 'ID00426637202313170790466'],
      dtype=object)
patient1 = df1[df1.Patient == 'ID00228637202259965313869']
plt.figure(figsize=(20,8))
sns.lineplot(data = patient1, y='Percent', x='Weeks', hue = 'SmokingStatus',
             palette = 'hls')
plt.show()
```



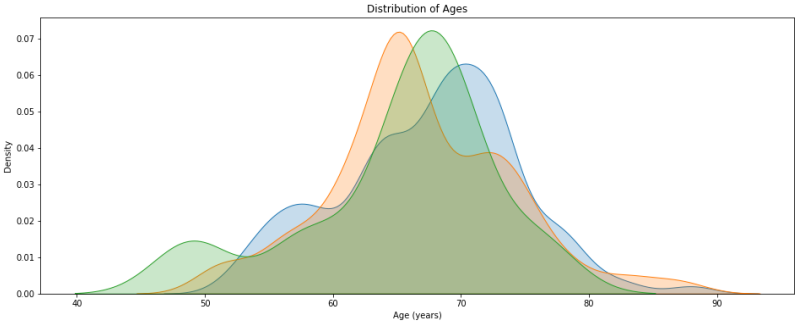
In [48]:

```
plt.figure(figsize=(20,8))
sns.histplot(df['Age'], bins = 10, kde = True, palette = 'hls')
plt.xticks(rotation = 90)
plt.show()
```



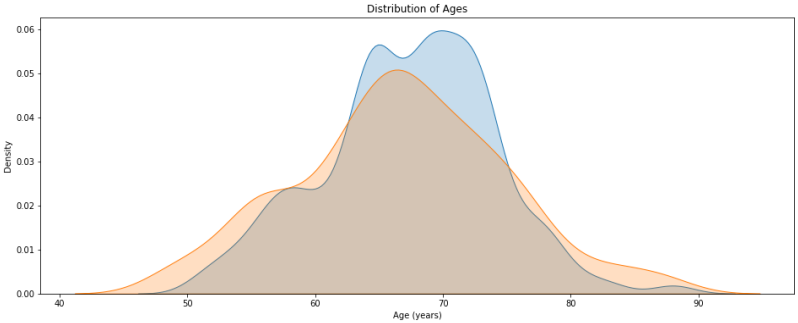
In [49]:

```
plt.figure(figsize=(16, 6))
sns.kdeplot(df1.loc[df1['SmokingStatus'] == 'Ex-smoker', 'Age'],
            label = 'Ex-smoker',shade=True)
sns.kdeplot(df1.loc[df1['SmokingStatus'] == 'Never smoked', 'Age'],
            label = 'Never smoked',shade=True)
sns.kdeplot(df1.loc[df1['SmokingStatus'] == 'Currently smokes', 'Age'],
            label = 'Currently smokes', shade=True)
plt.xlabel('Age (years)');
plt.ylabel('Density');
plt.title('Distribution of Ages');
plt.show()
```



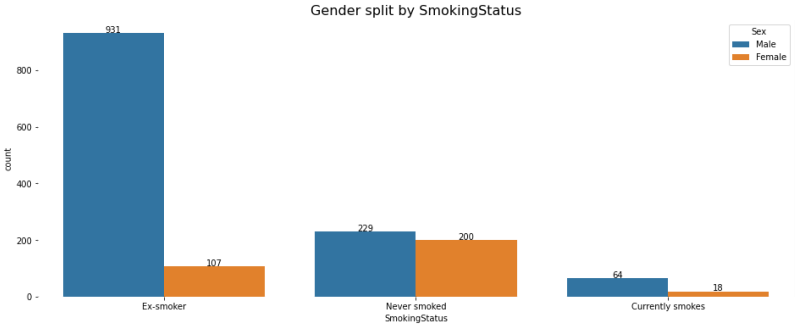
In [50]:

```
plt.figure(figsize=(16, 6))
sns.kdeplot(df1.loc[df1['Sex'] == 'Male', 'Age'], label = 'Male',shade=True)
sns.kdeplot(df1.loc[df1['Sex'] == 'Female', 'Age'], label = 'Female',shade=True)
plt.xlabel('Age (years)'); plt.ylabel('Density'); plt.title('Distribution of Ages');
plt.show()
```



In [51]:

```
plt.figure(figsize=(16, 6))
a = sns.countplot(data=df1, x='SmokingStatus', hue='Sex')
for p in a.patches:
    a.annotate(format(p.get_height(), ','),
           (p.get_x() + p.get_width() / 2.,
            p.get_height()), ha = 'center', va = 'center',
           xytext = (0, 4), textcoords = 'offset points')
plt.title('Gender split by SmokingStatus', fontsize=16)
sns.despine(left=True, bottom=True);
```



In [52]:

```
corrmat = df.corr()
f, ax = plt.subplots(figsize =(9, 8))
sns.heatmap(corrmat, ax = ax, cmap = 'RdYlBu_r', linewidths = 0.5)
plt.show()
```