In [1]:
```
import numpy as np, pandas as pd
from IPython.display import Image
import matplotlib.pyplot as plt, seaborn as sns
import scipy
import warnings
import plotly.express as px
from itertools import product
import statsmodels.api as sm
import datetime
from tqdm import tqdm
warnings.filterwarnings('ignore')
```

In [2]:
```
#Loading Data
data = pd.read_csv('/Users/user/Desktop/idsFinalProject/country_vaccinations.csv')
```

In [3]:
```
data
```

Out[3]:

	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	da
0	Afghanistan	AFG	2021-02-22	0.0	0.0	NaN	
1	Afghanistan	AFG	2021-02-23	NaN	NaN	NaN	
2	Afghanistan	AFG	2021-02-24	NaN	NaN	NaN	
3	Afghanistan	AFG	2021-02-25	NaN	NaN	NaN	
4	Afghanistan	AFG	2021-02-26	NaN	NaN	NaN	
...	...	...	...	...	...	...	
26233	Zimbabwe	ZWE	2021-06-18	1131397.0	700244.0	431153.0	
26234	Zimbabwe	ZWE	2021-06-19	1133920.0	701348.0	432572.0	
26235	Zimbabwe	ZWE	2021-06-20	1138733.0	703065.0	435668.0	
26236	Zimbabwe	ZWE	2021-06-21	1140852.0	704001.0	436851.0	
26237	Zimbabwe	ZWE	2021-06-22	1146378.0	706158.0	440220.0	

26238 rows × 15 columns

In [4]:
```
data.shape
```

Out[4]:
```
(26238, 15)
```

In [5]:
```
#Checking Missing Data
data.isna().sum()
```

Out[5]:
```
country                                    0
iso_code                                   0
date                                       0
total_vaccinations                     11490
people_vaccinated                      12267
people_fully_vaccinated                14959
daily_vaccinations_raw                 14048
daily_vaccinations                       273
total_vaccinations_per_hundred         11490
people_vaccinated_per_hundred          12267
people_fully_vaccinated_per_hundred    14959
daily_vaccinations_per_million           273
vaccines                                   0
source_name                                0
source_website                             0
dtype: int64
```

In [6]:
```
data = data.drop(data[data.total_vaccinations.isna()].index)
```

In [7]:
```
data.isna().sum()
```

Out[7]:
```
country                                   0
iso_code                                  0
date                                      0
total_vaccinations                        0
people_vaccinated                       921
people_fully_vaccinated                3509
daily_vaccinations_raw                 2558
daily_vaccinations                      217
total_vaccinations_per_hundred            0
people_vaccinated_per_hundred           921
people_fully_vaccinated_per_hundred    3509
daily_vaccinations_per_million          217
vaccines                                  0
source_name                               0
source_website                            0
dtype: int64
```

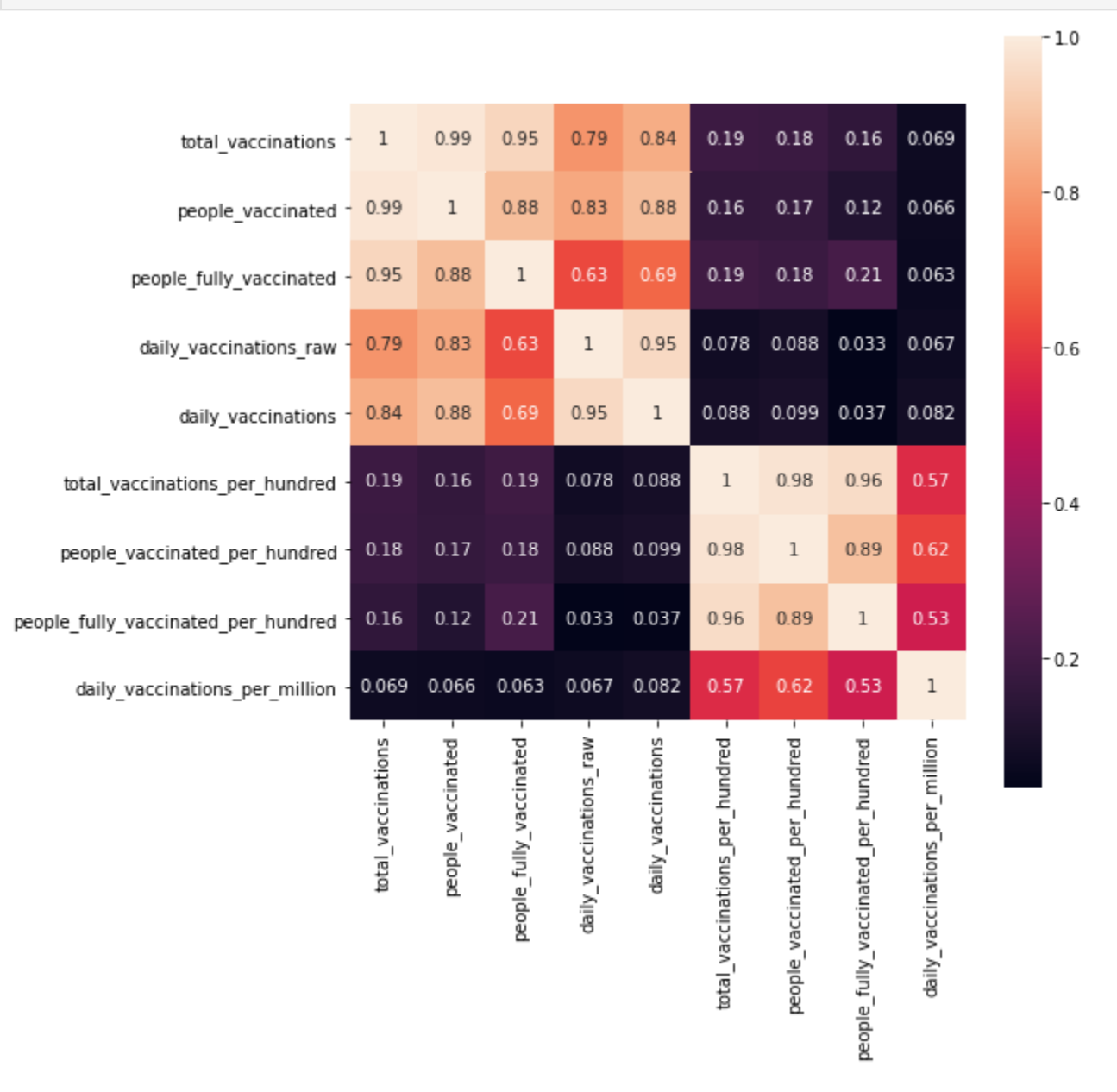
In [8]:
```
check_data = data.drop(data[data.people_vaccinated.isna()].index)
```

In [9]:
```
check_data.head()
```

Out[9]:

	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_v
0	Afghanistan	AFG	2021-02-22	0.0	0.0	NaN	
6	Afghanistan	AFG	2021-02-28	8200.0	8200.0	NaN	
22	Afghanistan	AFG	2021-03-16	54000.0	54000.0	NaN	
44	Afghanistan	AFG	2021-04-07	120000.0	120000.0	NaN	
59	Afghanistan	AFG	2021-04-22	240000.0	240000.0	NaN	

In [10]:
```
#As can bee seen from data, the values of total_vaccinations column are mostly the sa
#Also can bee seen from the heatmap, these features have almost ideal correlation.
plt.subplots(figsize=(8, 8))
sns.heatmap(check_data.corr(), annot=True, square=True)
plt.show()
```



In [11]:
```
#filling the missing values with the difference of these column's mean values.
diff = check_data.total_vaccinations.mean() - check_data.people_vaccinated.mean()
diff_per_hundred = check_data.total_vaccinations_per_hundred.mean() - check_data.peopl

data.people_vaccinated = data.people_vaccinated.fillna(data.total_vaccinations - diff)
data.people_vaccinated_per_hundred = data.people_vaccinated_per_hundred.fillna(data.to
```

In [12]:
```
data.isna().sum()
```

Out[12]:
```
country                                   0
iso_code                                  0
date                                      0
total_vaccinations                        0
people_vaccinated                         0
people_fully_vaccinated                3509
daily_vaccinations_raw                 2558
daily_vaccinations                      217
total_vaccinations_per_hundred            0
people_vaccinated_per_hundred             0
people_fully_vaccinated_per_hundred    3509
daily_vaccinations_per_million          217
vaccines                                  0
source_name                               0
source_website                            0
dtype: int64
```

In [13]:
```
#daily_vaccinations and daily_vaccinations_per_million greatly correlates with people_
#So, just fill missing values with zeros.
data.daily_vaccinations = data.daily_vaccinations.fillna(0)
data.daily_vaccinations_per_million = data.daily_vaccinations_per_million.fillna(0)
```

In [14]:
```
data.isna().sum()
```

Out[14]:
```
country                                   0
iso_code                                  0
date                                      0
total_vaccinations                        0
people_vaccinated                         0
people_fully_vaccinated                3509
daily_vaccinations_raw                 2558
daily_vaccinations                        0
total_vaccinations_per_hundred            0
people_vaccinated_per_hundred             0
people_fully_vaccinated_per_hundred    3509
daily_vaccinations_per_million            0
vaccines                                  0
source_name                               0
source_website                            0
dtype: int64
```

In [15]:
```
#people_fully_vaccinated and people_fully_vaccinated_per_hundred greatly correlates w
#Just filling missing values with 0.
data.people_fully_vaccinated = data.people_fully_vaccinated.fillna(0)
data.people_fully_vaccinated_per_hundred = data.people_fully_vaccinated_per_hundred.f
```

In [16]:
```
data.isna().sum()
```

Out[16]:
```
country                                   0
iso_code                                  0
date                                      0
total_vaccinations                        0
people_vaccinated                         0
people_fully_vaccinated                   0
daily_vaccinations_raw                 2558
daily_vaccinations                        0
total_vaccinations_per_hundred            0
people_vaccinated_per_hundred             0
people_fully_vaccinated_per_hundred       0
daily_vaccinations_per_million            0
vaccines                                  0
source_name                               0
source_website                            0
dtype: int64
```

In [17]:
```
#daily_vaccinations_raw greatly correlates with daily_vaccinations.
#Just filling missing values with 0.
data.daily_vaccinations_raw = data.daily_vaccinations_raw.fillna(0)
```

In [18]:
```
data.isna().sum()
```

Out[18]:
```
country                                0
iso_code                               0
date                                   0
total_vaccinations                     0
people_vaccinated                      0
people_fully_vaccinated                0
daily_vaccinations_raw                 0
daily_vaccinations                     0
total_vaccinations_per_hundred         0
people_vaccinated_per_hundred          0
people_fully_vaccinated_per_hundred    0
daily_vaccinations_per_million         0
vaccines                               0
source_name                            0
source_website                         0
dtype: int64
```

In [19]:
```
#finding out which countries have missing iso-code.
data[data.iso_code.isna()].country.unique()
```

Out[19]:
```
array([], dtype=object)
```

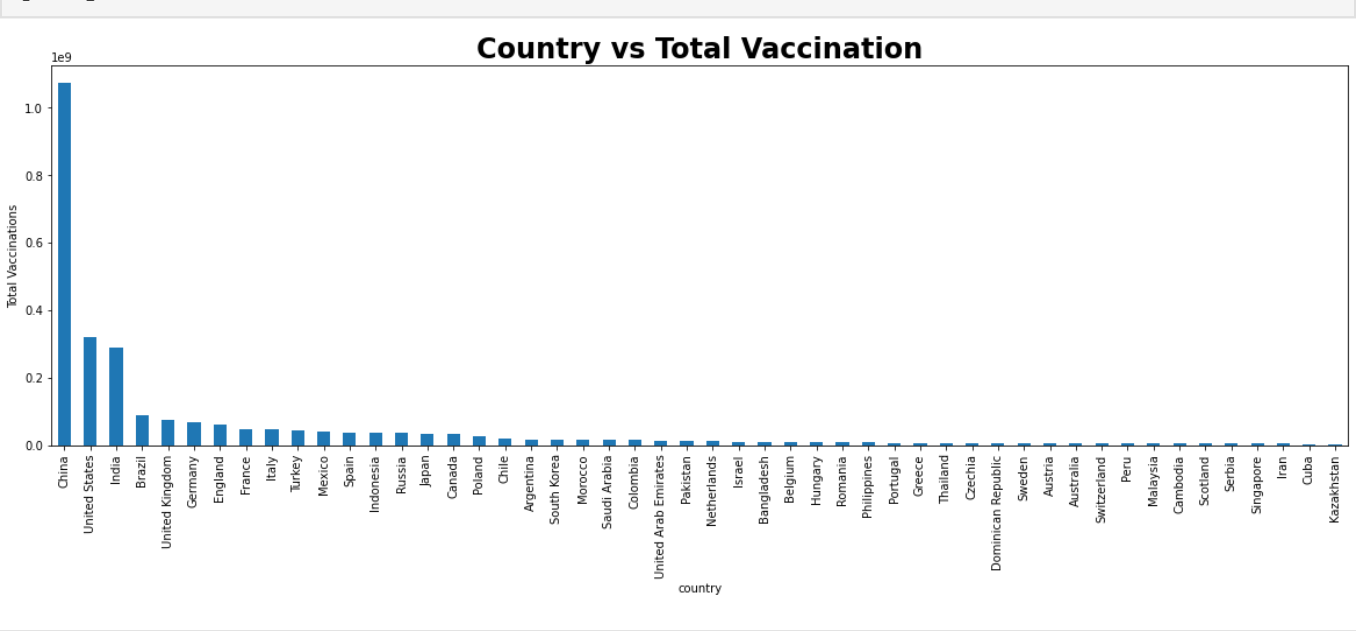
In [20]:
```
#filling missing iso-codes with appropriate ones.
data[data.country == 'England'] = data[data.country == 'England'].fillna('GB-ENG')
data[data.country == 'Northern Ireland'] == data[data.country == 'Northern Ireland'].
data[data.country == 'Scotland'] = data[data.country == 'Scotland'].fillna('GB-SCT')
data[data.country == 'Wales'] = data[data.country == 'Wales'].fillna('GB-WLS')
data = data.fillna('NC')
```

In [21]:
```
data.isna().sum()
```

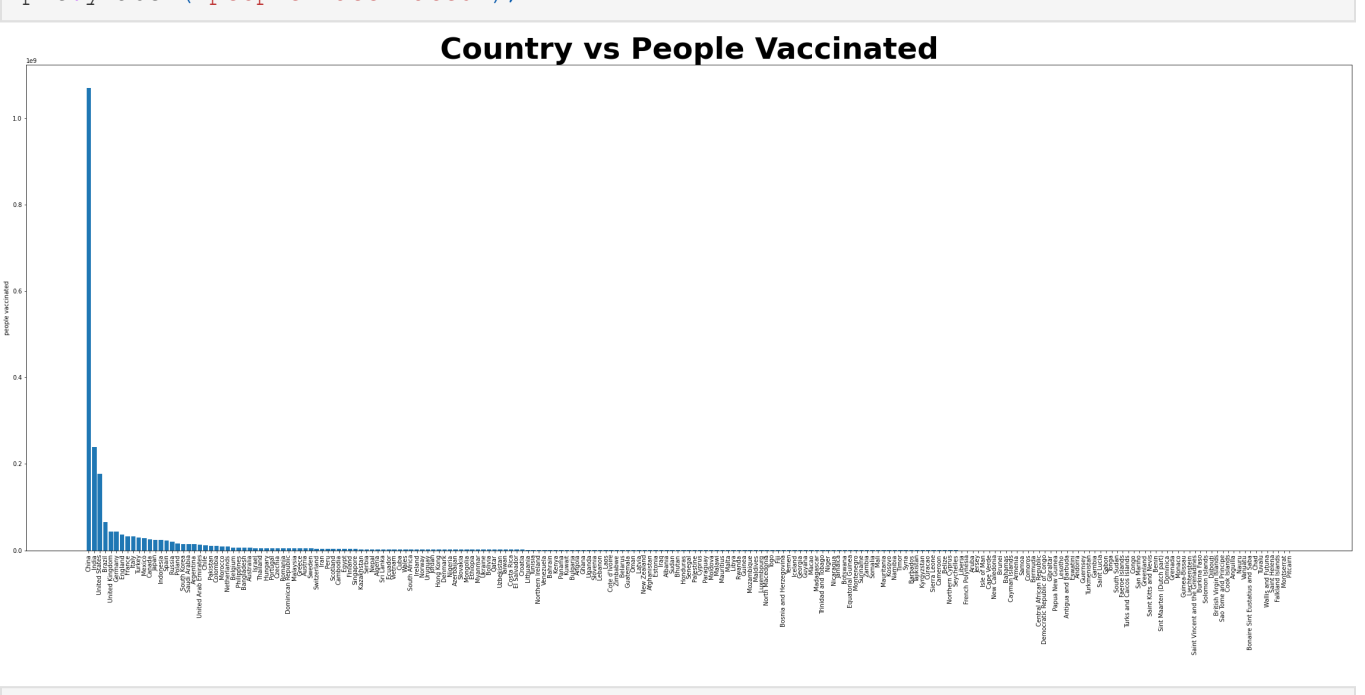
Out[21]:
```
country                                0
iso_code                               0
date                                   0
total_vaccinations                     0
people_vaccinated                      0
people_fully_vaccinated                0
daily_vaccinations_raw                 0
daily_vaccinations                     0
total_vaccinations_per_hundred         0
people_vaccinated_per_hundred          0
people_fully_vaccinated_per_hundred    0
daily_vaccinations_per_million         0
vaccines                               0
source_name                            0
source_website                         0
dtype: int64
```

Visualizations

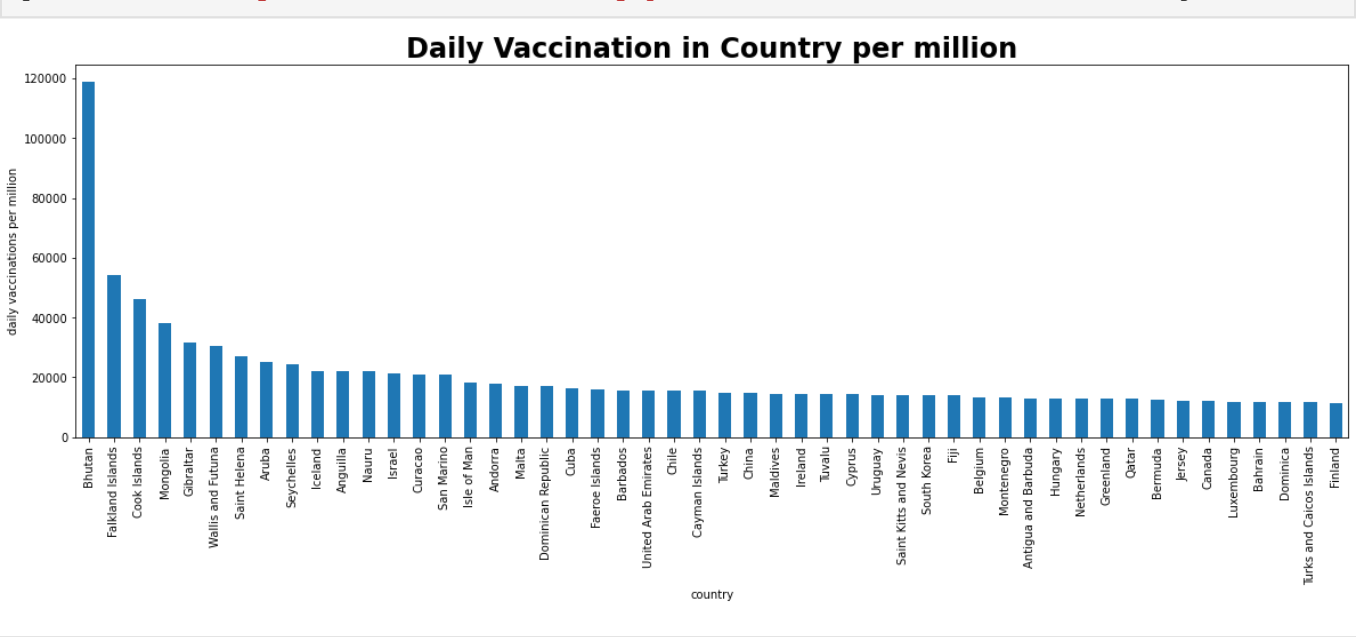
In [22]:
```
plt.figure(figsize=(20, 6))
data.groupby('country')['total_vaccinations'].max().sort_values(ascending=False)[:50]
plt.title('Country vs Total Vaccination', fontsize=24, fontweight='bold')
plt.ylabel('Total Vaccinations');
```



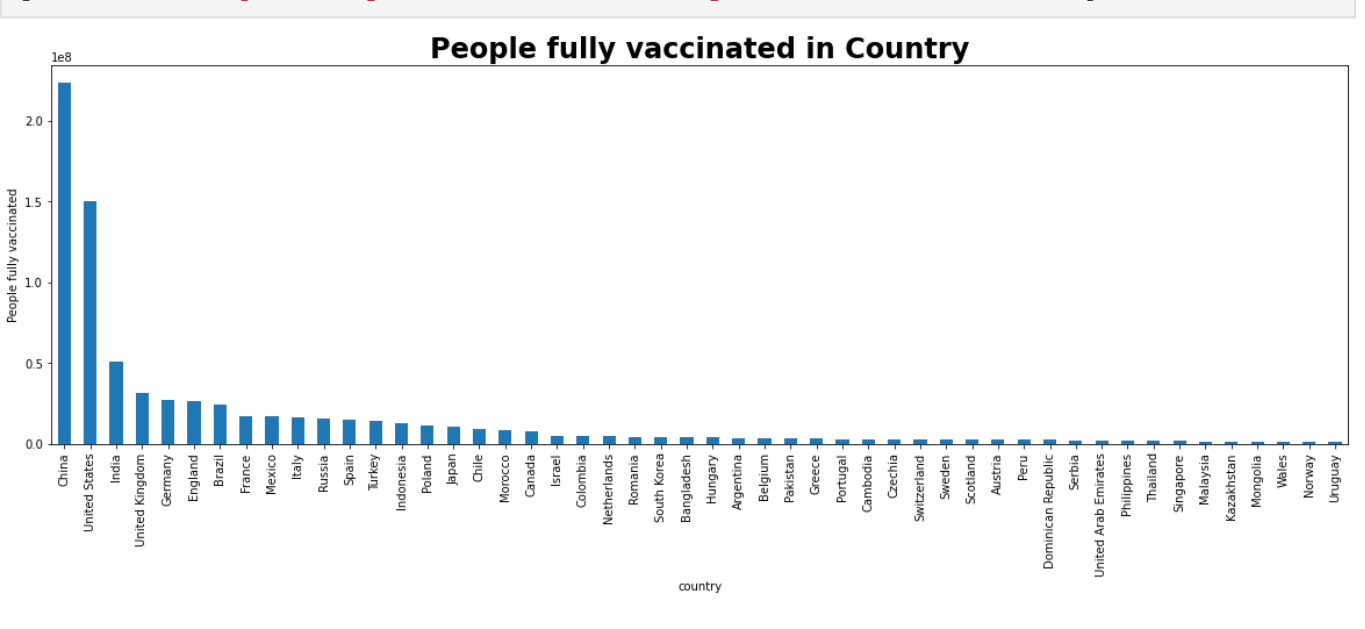
In [23]:
```
plt.figure(figsize=(40, 15))
data1 = data.groupby('country')['people_vaccinated'].max().sort_values(ascending=False
plt.bar(data1.index, data1);
plt.xticks(rotation='90')
plt.yticks()
plt.title('Country vs People Vaccinated', fontsize=50, fontweight='bold')
plt.ylabel('people vaccinated');
```



In [24]:
```
plt.figure(figsize=(20, 6))
data.groupby('country')['daily_vaccinations_per_million'].max().sort_values(ascending=
plt.ylabel('daily vaccinations per million')
plt.title('Daily Vaccination in Country per million', fontsize=24, fontweight='bold')
```



In [25]:
```
plt.figure(figsize=(20, 6))
data.groupby('country')['people_fully_vaccinated'].max().sort_values(ascending=False)
plt.ylabel('People fully vaccinated')
plt.title('People fully vaccinated in Country', fontsize=24, fontweight='bold');
```



Working on just Data related to Pakistan

In [26]:
```
#Sorting out Pakistan's Data from the complete dataset
df_pak = data[ data['country'] == 'Pakistan' ]
```

In [27]:
```
df_pak.head()
```

Out[27]:

	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_v
18114	Pakistan	PAK	2021-02-02	0.0	0.0	0.0	
18122	Pakistan	PAK	2021-02-10	27228.0	27228.0	0.0	
18129	Pakistan	PAK	2021-02-17	52768.0	52768.0	0.0	
18133	Pakistan	PAK	2021-02-21	72882.0	72882.0	0.0	
18154	Pakistan	PAK	2021-03-14	350000.0	350000.0	0.0	

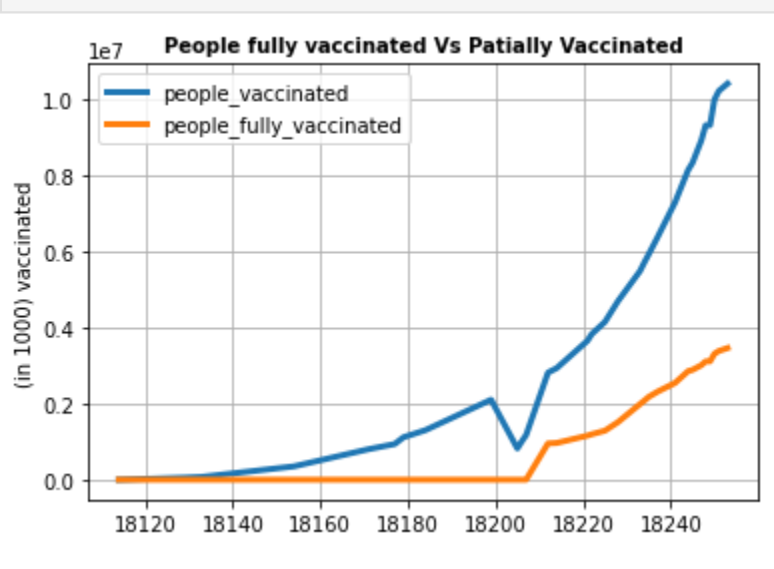
In [28]:
```
df_pak.isnull().sum()
```

Out[28]:
```
country                                0
iso_code                               0
date                                   0
total_vaccinations                     0
people_vaccinated                      0
people_fully_vaccinated                0
daily_vaccinations_raw                 0
daily_vaccinations                     0
total_vaccinations_per_hundred         0
people_vaccinated_per_hundred          0
people_fully_vaccinated_per_hundred    0
daily_vaccinations_per_million         0
vaccines                               0
source_name                            0
source_website                         0
dtype: int64
```

No need to drop any values as no Na values

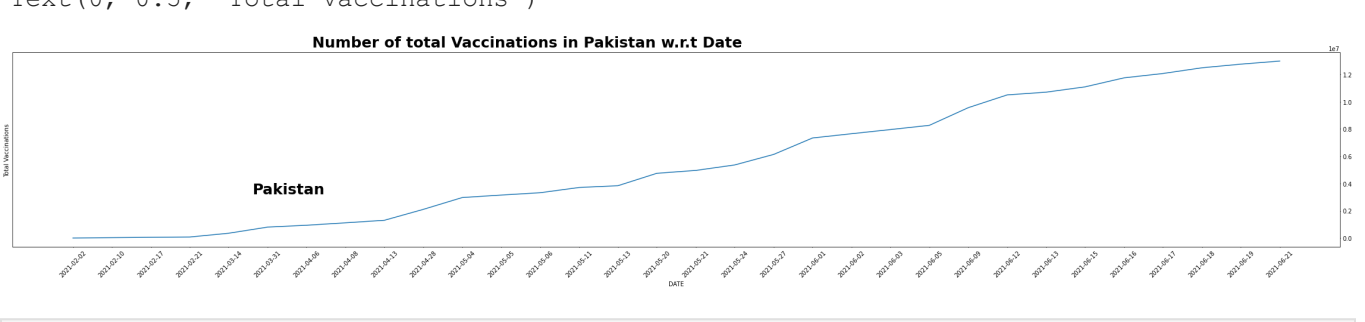
Visualizations of Pakistan's Dataset

In [29]:
```
df_pak[['people_vaccinated', 'people_fully_vaccinated']].plot(ylabel = '(in 1000) vacc
plt.grid()
plt.title('People fully vaccinated Vs Patially Vaccinated', fontsize=10, fontweight='b
```



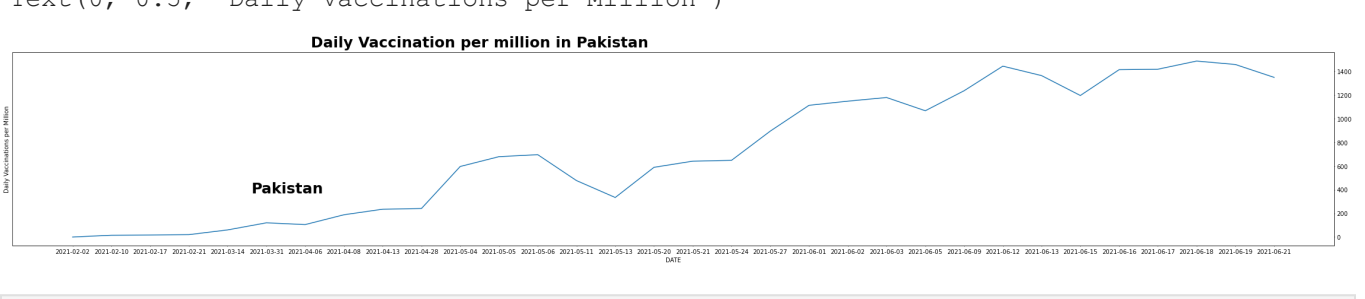
In [30]:
```
fig, ax = plt.subplots(1,1, figsize=(40,6))

g1 = sns.lineplot(x=df_pak['date'],y=df_pak['total_vaccinations'])

fig.text(0.3, 0.9, 'Number of total Vaccinations in Pakistan w.r.t Date',
       fontsize=25, fontweight='bold',color='black')
fig.text(0.265, 0.33, 'Pakistan',
        fontsize=25, fontweight='bold')
ax.yaxis.tick_right()
ax.tick_params(length=1)
plt.xlabel('DATE')
plt.xticks(rotation=45)
plt.ylabel('Total Vaccinations')
```

Out[30]:
```
Text(0, 0.5, 'Total Vaccinations')
```

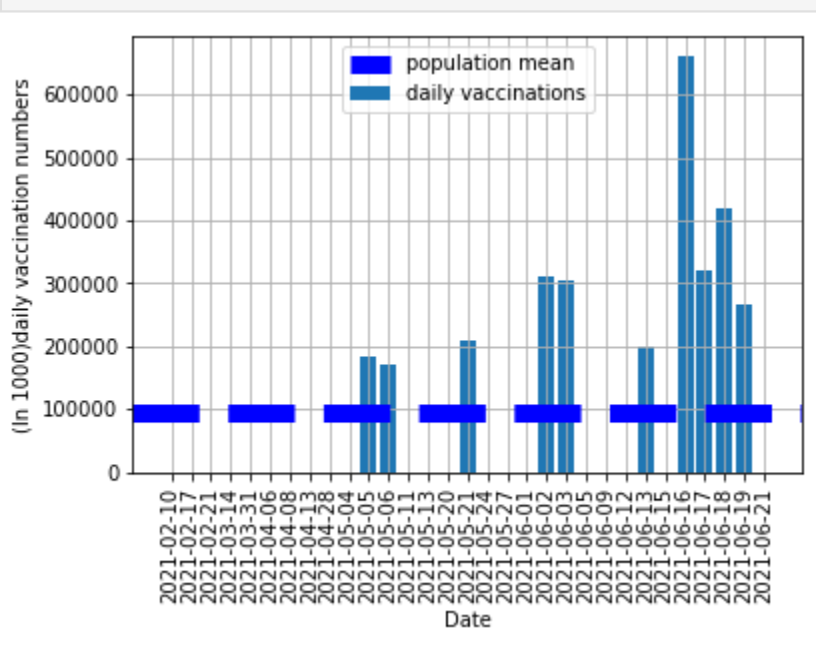


In [31]:
```
fig, ax = plt.subplots(1,1, figsize=(40,6))

g1 = sns.lineplot(x=df_pak['date'],y=df_pak['daily_vaccinations_per_million'])

fig.text(0.3, 0.9, 'Daily Vaccination per million in Pakistan',
       fontsize=25, fontweight='bold',color='black')
fig.text(0.265, 0.33, 'Pakistan',
        fontsize=25, fontweight='bold')
plt.xticks()
ax.yaxis.tick_right()
ax.tick_params(length=1)
plt.xlabel('DATE')
plt.ylabel('Daily Vaccinations per Million')
```

Out[31]:
```
Text(0, 0.5, 'Daily Vaccinations per Million')
```



In [32]:
```
plt.bar(df_pak['date'][1:], df_pak['daily_vaccinations_raw'][1:], label = 'daily vacci
plt.xlabel('Date')
plt.ylabel('(In 1000)daily vaccination numbers')
plt.axhline(y = np.mean(df_pak['daily_vaccinations_raw']), color = 'blue', ls = '--',
plt.legend(loc = 9)
plt.xticks(rotation = 90)
plt.grid()
```



In [ ]: