

COVID-19 Vaccination Analysis using Python

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```
In [1]: import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.express as px
import plotly.offline as py
import cv2
import datetime
%matplotlib inline
```

```
In [5]: data = pd.read_csv(r".\country_vaccinations.csv")
data.head()
```

```
Out[5]:
```

	country	iso_code	date	total_vaccinations	people_vaccinated	people_fully_vaccinated	deaths
0	Afghanistan	AFG	2021-02-22	0.0	0.0	NaN	NaN
1	Afghanistan	AFG	2021-02-23	NaN	NaN	NaN	NaN
2	Afghanistan	AFG	2021-02-24	NaN	NaN	NaN	NaN
3	Afghanistan	AFG	2021-02-25	NaN	NaN	NaN	NaN
4	Afghanistan	AFG	2021-02-26	NaN	NaN	NaN	NaN

In [6]: `print(data.head())`

```

      country iso_code      date  total_vaccinations  people_vaccinated \
0  Afghanistan    AFG  2021-02-22                0.0                0.0
1  Afghanistan    AFG  2021-02-23                NaN                NaN
2  Afghanistan    AFG  2021-02-24                NaN                NaN
3  Afghanistan    AFG  2021-02-25                NaN                NaN
4  Afghanistan    AFG  2021-02-26                NaN                NaN

      people_fully_vaccinated  daily_vaccinations_raw  daily_vaccinations \
0                        NaN                        NaN                NaN
1                        NaN                        NaN            1367.0
2                        NaN                        NaN            1367.0
3                        NaN                        NaN            1367.0
4                        NaN                        NaN            1367.0

      total_vaccinations_per_hundred  people_vaccinated_per_hundred \
0                        0.0                        0.0
1                        NaN                        NaN
2                        NaN                        NaN
3                        NaN                        NaN
4                        NaN                        NaN

      people_fully_vaccinated_per_hundred  daily_vaccinations_per_million \
0                        NaN                        NaN
1                        NaN            35.0
2                        NaN            35.0
3                        NaN            35.0
4                        NaN            35.0

      vaccines      source_name
\
0  BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech  World Health Organization
1  BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech  World Health Organization
2  BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech  World Health Organization
3  BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech  World Health Organization
4  BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech  World Health Organization

      source_website
0  https://covid19.who.int/ (https://covid19.who.int/)
1  https://covid19.who.int/ (https://covid19.who.int/)
2  https://covid19.who.int/ (https://covid19.who.int/)
3  https://covid19.who.int/ (https://covid19.who.int/)
4  https://covid19.who.int/ (https://covid19.who.int/)

```

Explore data before analyzing the vaccination taken by countries

In [7]: data.info()

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 25862 entries, 0 to 25861
Data columns (total 15 columns):
#   Column                                Non-Null Count  Dtype
---  -
0   country                              25862 non-null  object
1   iso_code                             25862 non-null  object
2   date                                 25862 non-null  object
3   total_vaccinations                   14522 non-null  float64
4   people_vaccinated                    13762 non-null  float64
5   people_fully_vaccinated              11041 non-null  float64
6   daily_vaccinations_raw               12003 non-null  float64
7   daily_vaccinations                   25595 non-null  float64
8   total_vaccinations_per_hundred       14522 non-null  float64
9   people_vaccinated_per_hundred        13762 non-null  float64
10  people_fully_vaccinated_per_hundred  11041 non-null  float64
11  daily_vaccinations_per_million       25595 non-null  float64
12  vaccines                             25862 non-null  object
13  source_name                          25862 non-null  object
14  source_website                       25862 non-null  object
dtypes: float64(9), object(6)
memory usage: 3.0+ MB
```

In [8]: data.describe()

Out[8]:

	total_vaccinations	people_vaccinated	people_fully_vaccinated	daily_vaccinations_raw	dail
count	1.452200e+04	1.376200e+04	1.104100e+04	1.200300e+04	
mean	9.139252e+06	4.737802e+06	2.681353e+06	2.012910e+05	
std	4.592776e+07	1.797156e+07	1.093032e+07	1.122962e+06	
min	0.000000e+00	0.000000e+00	1.000000e+00	0.000000e+00	
25%	1.005620e+05	7.876700e+04	3.719700e+04	3.967500e+03	
50%	7.007560e+05	5.149065e+05	2.834740e+05	1.988600e+04	
75%	3.241681e+06	2.139073e+06	1.192415e+06	8.257600e+04	
max	1.029223e+09	6.220000e+08	2.232990e+08	2.360500e+07	

In [9]: `print(data.describe())`

	total_vaccinations	people_vaccinated	people_fully_vaccinated	\
count	1.452200e+04	1.376200e+04	1.104100e+04	
mean	9.139252e+06	4.737802e+06	2.681353e+06	
std	4.592776e+07	1.797156e+07	1.093032e+07	
min	0.000000e+00	0.000000e+00	1.000000e+00	
25%	1.005620e+05	7.876700e+04	3.719700e+04	
50%	7.007560e+05	5.149065e+05	2.834740e+05	
75%	3.241681e+06	2.139073e+06	1.192415e+06	
max	1.029223e+09	6.220000e+08	2.232990e+08	

	daily_vaccinations_raw	daily_vaccinations	\
count	1.200300e+04	2.559500e+04	
mean	2.012910e+05	1.020430e+05	
std	1.122962e+06	7.304361e+05	
min	0.000000e+00	0.000000e+00	
25%	3.967500e+03	8.400000e+02	
50%	1.988600e+04	6.263000e+03	
75%	8.257600e+04	3.337300e+04	
max	2.360500e+07	2.029871e+07	

	total_vaccinations_per_hundred	people_vaccinated_per_hundred	\
count	14522.000000	13762.000000	
mean	24.162602	16.291051	
std	30.690367	18.839369	
min	0.000000	0.000000	
25%	2.360000	2.052500	
50%	11.410000	8.520000	
75%	34.650000	25.207500	
max	231.010000	116.150000	

	people_fully_vaccinated_per_hundred	daily_vaccinations_per_million
count	11041.000000	25595.000000
mean	9.712350	3312.476421
std	13.466102	4512.443697
min	0.000000	0.000000
25%	1.020000	389.000000
50%	4.190000	1726.000000
75%	12.690000	4874.000000
max	114.860000	118759.000000

In [10]: `print(data.columns)`

```
Index(['country', 'iso_code', 'date', 'total_vaccinations',
      'people_vaccinated', 'people_fully_vaccinated',
      'daily_vaccinations_raw', 'daily_vaccinations',
      'total_vaccinations_per_hundred', 'people_vaccinated_per_hundred',
      'people_fully_vaccinated_per_hundred', 'daily_vaccinations_per_millio
n',
      'vaccines', 'source_name', 'source_website'],
      dtype='object')
```

```
In [12]: data.country.value_counts()
```

```
Out[12]: Norway                201  
         Scotland              193  
         Canada                189  
         China                 188  
         Russia                188  
         ...  
         Burkina Faso           13  
         Bonaire Sint Eustatius and Saba 1  
         Pitcairn               1  
         Turkmenistan           1  
         Chad                   1  
         Name: country, Length: 217, dtype: int64
```

Explore vaccination available in the dataset

```
In [14]: data.vaccines.value_counts()
```

```
Out[14]: Oxford/AstraZeneca
4326
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech
3437
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech
2222
Oxford/AstraZeneca, Pfizer/BioNTech
1697
Moderna, Pfizer/BioNTech
1394
Pfizer/BioNTech
1143
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sputnik V
1122
Oxford/AstraZeneca, Sinopharm/Beijing
1082
Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac
1033
Oxford/AstraZeneca, Sputnik V
558
Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputnik V
499
Oxford/AstraZeneca, Sinopharm/Beijing, Sputnik V
462
BBIBP-CorV, Oxford/AstraZeneca
450
Johnson&Johnson, Moderna, Pfizer/BioNTech
369
Oxford/AstraZeneca, Sinovac
364
Sinopharm/Beijing
306
BBIBP-CorV, Sputnik V
290
Pfizer/BioNTech, Sinovac
278
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing
268
Oxford/AstraZeneca, Sinovac, Sputnik V
231
Moderna, Oxford/AstraZeneca
207
Covaxin, Oxford/AstraZeneca
192
EpiVacCorona, Sputnik V
188
CanSino, Sinopharm/Beijing, Sinopharm/Wuhan, Sinovac
188
CanSino, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputnik V
178
CanSino, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac
177
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beij
ing, Sputnik V      171
Sinopharm/Beijing, Sputnik V
169
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinopharm/Wuhan, Sput
```

```

nik V                                167
BBIBP-CorV, Oxford/AstraZeneca, Sinovac, Sputnik V
148
BBIBP-CorV, Covaxin, Oxford/AstraZeneca
147
Moderna
143
QazVac, Sinopharm/HayatVax, Sputnik V
141
CanSino, Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac, Sputnik V
138
Pfizer/BioNTech, Sinopharm/Beijing
133
Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac
132
BBIBP-CorV, Covaxin, Oxford/AstraZeneca, Sputnik V
127
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac
126
Johnson&Johnson, Pfizer/BioNTech
124
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac, Sputnik V
122
Covaxin, Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac, Sputnik V
117
Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech
116
Pfizer/BioNTech, Sputnik V
114
BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech
113
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Sputnik V
111
BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech, Sputnik V
106
BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac
103
Sputnik V
81
Oxford/AstraZeneca, RBD-Dimer, Sputnik V
77
BBIBP-CorV, Moderna, Oxford/AstraZeneca, Sputnik V
68
BBIBP-CorV, Oxford/AstraZeneca, Sinovac
63
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputn
ik V                                61
Covaxin, Oxford/AstraZeneca, Sinopharm/Beijing
49
Abdala, Soberana02
32
EpiVacCorona, Oxford/AstraZeneca, Sinopharm/Beijing, Sputnik V
1
BBIBP-CorV
1
Name: vaccines, dtype: int64

```


Almost all COVID_19 Vaccines available in the dataset

Now create a new dataframe by selecting only vaccines and country columns

Exploring which vaccine is taken by which country

```
In [15]: df=data[["vaccines","country"]]  
df.head()
```

```
Out[15]:
```

	vaccines	country
0	BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech	Afghanistan
1	BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech	Afghanistan
2	BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech	Afghanistan
3	BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech	Afghanistan
4	BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech	Afghanistan

How many countries are taking each of the vaccines mentioned

```
In [16]: dict1={}
for i in df.vaccines.unique():
    dict1[i]=[df["country"][j] for j in df[df["vaccines"]==i].index]

vaccines={}
for key,value in dict1.items():
    vaccines[key]=set(value)
for i,j in vaccines.items():
    print(f"{i}:>>{j}")
```

```

BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Afghanistan'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputnik V:>>{'Tunisia', 'Albania', 'Philippines', 'Bosnia and Herzegovina'}
Oxford/AstraZeneca, Sputnik V:>>{'Kenya', 'Ghana', 'Guyana', 'Algeria', 'Nicaragua'}
Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Australia', 'Cape Verde', 'Slovenia', 'Oman', 'Panama', 'Sweden', 'Andorra', 'Costa Rica', 'Isle of Man', 'Saudi Arabia', 'Cayman Islands'}
Oxford/AstraZeneca:>>{'Ethiopia', 'Tonga', 'Tuvalu', 'Uganda', 'Vietnam', 'Dominica', 'Anguilla', 'Falkland Islands', 'Solomon Islands', 'Vanuatu', 'Yemen', 'Mali', 'Burkina Faso', 'Malawi', 'Botswana', 'Kosovo', 'Nauru', 'Liberia', 'British Virgin Islands', 'Georgia', 'South Sudan', 'Wallis and Futuna', 'Lesotho', 'Cote d'Ivoire', 'Bangladesh', 'Barbados', 'Bahamas', 'Togo', 'Madagascar', 'Saint Kitts and Nevis', 'Samoa', 'Antigua and Barbuda', 'Bhutan', 'Nigeria', 'Pitcairn', 'Eswatini', 'Myanmar', 'Sao Tome and Principe', 'Trinidad and Tobago', 'Grenada', 'Tajikistan', 'Saint Lucia', 'Angola', 'Jamaica', 'Saint Helena', 'Suriname', 'Democratic Republic of Congo', 'French Polynesia', 'Saint Vincent and the Grenadines', 'Fiji', 'Montserrat', 'Cook Islands'}
Oxford/AstraZeneca, Sinopharm/Beijing, Sputnik V:>>{'Sri Lanka', 'Djibouti', 'Argentina', 'Syria'}
Oxford/AstraZeneca, Sinovac, Sputnik V:>>{'Azerbaijan', 'Armenia'}
Pfizer/BioNTech:>>{'Kuwait', 'Monaco', 'New Zealand', 'Gibraltar', 'New Caledonia', 'Turks and Caicos Islands', 'Bermuda', 'Aruba'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Estonia', 'Austria', 'Malta', 'Latvia', 'Greece', 'Germany', 'Spain', 'Poland', 'Italy', 'Iceland', 'Belgium', 'Bulgaria', 'Ireland', 'France', 'Portugal', 'Romania', 'Czechia', 'Netherlands', 'Lithuania', 'Cyprus'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sputnik V:>>{'Lebanon', 'Mongolia', 'Montenegro', 'Serbia', 'Moldova', 'Bolivia', 'Jordan', 'Bahrain'}
BBIBP-CorV, Sputnik V:>>{'Belarus', 'Venezuela'}
Oxford/AstraZeneca, Sinopharm/Beijing:>>{'Nepal', 'Namibia', 'Gambia', 'Morocco', 'Brunei', 'Guinea-Bissau', 'Mozambique', 'Papua New Guinea', 'Seychelles', 'Belize', 'Zambia'}
Oxford/AstraZeneca, Sinovac:>>{'Indonesia', 'Benin', 'Timor', 'Thailand'}
Moderna, Pfizer/BioNTech:>>{'Faeroe Islands', 'Switzerland', 'Liechtenstein', 'Qatar', 'Bonaire Sint Eustatius and Saba', 'Japan', 'Israel', 'Norway', 'Singapore', 'Curacao'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac:>>{'El Salvador', 'Ukraine', 'Northern Cyprus', 'Uruguay', 'Ecuador', 'Colombia', 'Brazil', 'Malaysia'}
Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac:>>{'Cambodia'}
BBIBP-CorV, Oxford/AstraZeneca:>>{'Mauritania', 'Niger', 'Cameroon', 'Sierra Leone', 'Senegal'}
Moderna, Oxford/AstraZeneca, Pfizer/BioNTech:>>{'Scotland', 'Finland', 'Slovakia', 'Guernsey', 'Canada', 'England', 'Palestine', 'Rwanda', 'Wales', 'Croatia', 'Northern Ireland', 'Luxembourg', 'United Kingdom', 'Jersey', 'Sint Maarten (Dutch part)'}
Covaxin, Oxford/AstraZeneca:>>{'Central African Republic', 'India'}
BBIBP-CorV:>>{'Chad'}
CanSino, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac:>>{'Chile'}
CanSino, Sinopharm/Beijing, Sinopharm/Wuhan, Sinovac:>>{'China'}
Covaxin, Oxford/AstraZeneca, Sinopharm/Beijing:>>{'Comoros'}
BBIBP-CorV, Moderna, Oxford/AstraZeneca, Sputnik V:>>{'Congo'}
Abdala, Soberana02:>>{'Cuba'}
Johnson&Johnson, Moderna, Pfizer/BioNTech:>>{'United States', 'Denmark'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac:>>{'Dominican Republic'}

```

```

BBIBP-CorV, Oxford/AstraZeneca, Sinovac, Sputnik V:>>{'Egypt'}
Sinopharm/Beijing:>>{'Equatorial Guinea', 'Zimbabwe', 'Gabon'}
Moderna:>>{'Greenland'}
Moderna, Oxford/AstraZeneca:>>{'Guatemala', 'Taiwan'}
Sputnik V:>>{'Guinea'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Sputnik V:>>{'Honduras'}
Pfizer/BioNTech, Sinovac:>>{'Turkey', 'Hong Kong'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beij
ing, Sputnik V:>>{'Hungary'}
BBIBP-CorV, Covaxin, Oxford/AstraZeneca, Sputnik V:>>{'Iran'}
BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech, Sputnik V:>>{'Iraq'}
QazVac, Sinopharm/HayatVax, Sputnik V:>>{'Kazakhstan'}
Sinopharm/Beijing, Sputnik V:>>{'Kyrgyzstan', 'Laos'}
Johnson&Johnson, Moderna, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputn
ik V:>>{'Libya'}
Pfizer/BioNTech, Sinopharm/Beijing:>>{'Macao'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing:>>{'Peru', 'Maldives'}
BBIBP-CorV, Covaxin, Oxford/AstraZeneca:>>{'Mauritius'}
CanSino, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac, Sputnik V:>>{'Mexico'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinovac, Sputnik V:>>
{'North Macedonia'}
CanSino, Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac, Sputnik V:>>{'Pakist
an'}
Covaxin, Oxford/AstraZeneca, Sinopharm/Beijing, Sinovac, Sputnik V:>>{'Paragu
ay'}
EpiVacCorona, Sputnik V:>>{'Russia'}
Pfizer/BioNTech, Sputnik V:>>{'San Marino'}
BBIBP-CorV, Oxford/AstraZeneca, Sinovac:>>{'Somalia'}
Johnson&Johnson, Pfizer/BioNTech:>>{'South Africa'}
Johnson&Johnson, Oxford/AstraZeneca, Pfizer/BioNTech:>>{'South Korea'}
BBIBP-CorV, Oxford/AstraZeneca, Pfizer/BioNTech, Sinovac:>>{'Sudan'}
EpiVacCorona, Oxford/AstraZeneca, Sinopharm/Beijing, Sputnik V:>>{'Turkmenist
an'}
Oxford/AstraZeneca, Pfizer/BioNTech, Sinopharm/Beijing, Sinopharm/Wuhan, Sput
nik V:>>{'United Arab Emirates'}
Oxford/AstraZeneca, RBD-Dimer, Sputnik V:>>{'Uzbekistan'}

```

Visualize the data to have a look at what combination of vaccines every country is using

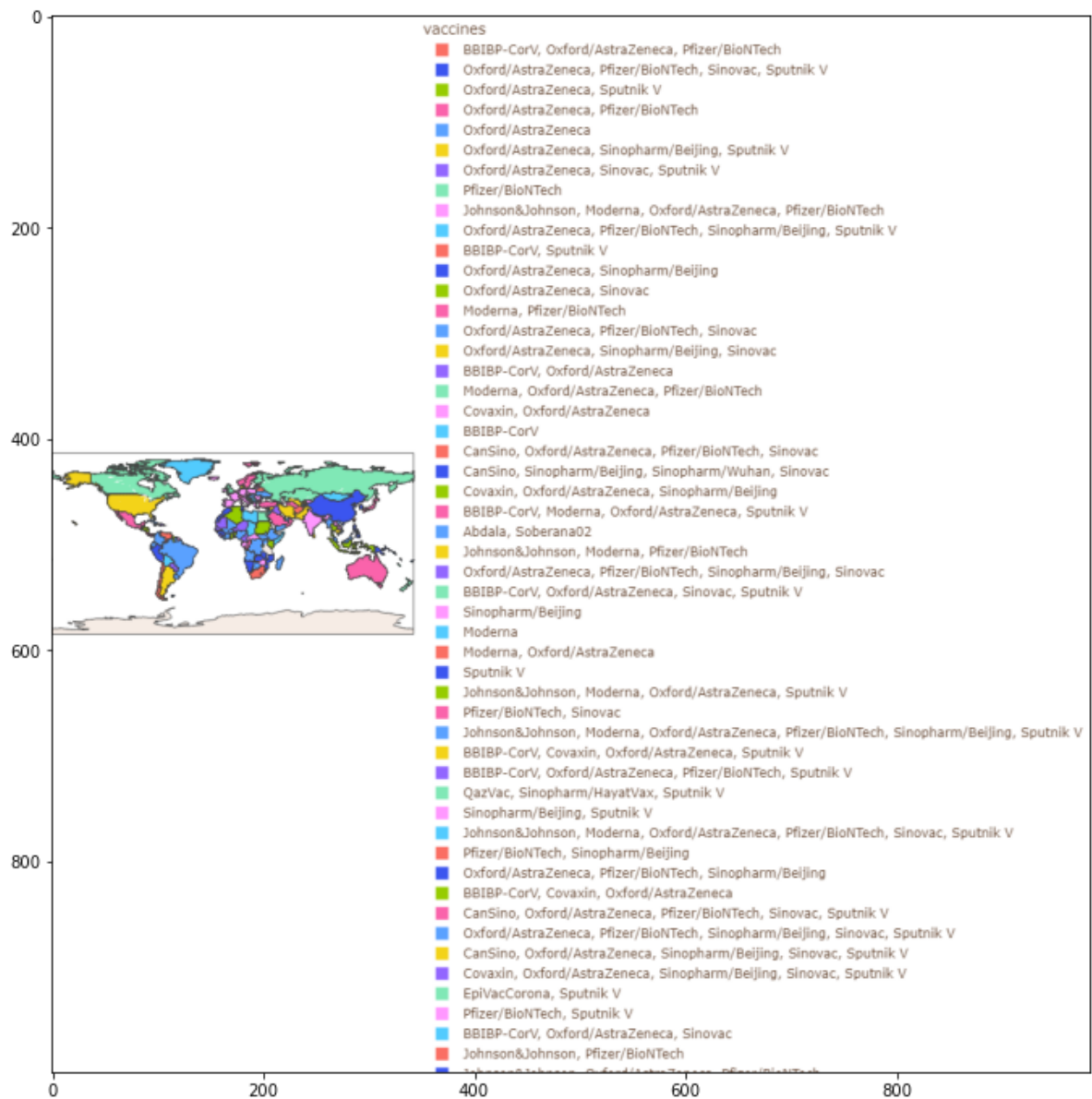
```

In [19]: vaccination_map=px.choropleth(data, locations='iso_code', color='vaccines')
vaccination_map.update_layout(height=1000, margin={"r":0,"t":0,"l":0,"b":0})
vaccination_map.show()

```

```
In [24]: final_report = cv2.imread(".\\final_report.png",cv2.COLOR_BGR2RGB)
plt.figure(figsize=(18,12))
plt.imshow(final_report)
```

Out[24]: <matplotlib.image.AxesImage at 0x212ab950b20>



In []: