Covid-19

June 23, 2025

```
[187]: import numpy as np
       import pandas as pd
       import matplotlib.pyplot as plt
       import seaborn as sns
```

The aim of the project is to conduct an exploratory analysis of the spread of the COVID-19 pandemic in time and geographic terms from January to July 2020. The project aims to identify trends, comparisons between countries and regions, as well as calculate key metrics such as mortality, recovery rate.

Specific sub-goals: Understand the dynamics of infections, deaths and recoveries over time.

Compare countries and continents by the scale and impact of the pandemic.

Calculate secondary metrics: mortality, recovery rate.

Present information using graphs for visual analysis.

Lat -> Latitude of location

Long -> Longitude of location

Date -> Cumulative report date

Confirmed -> Total number of confirmed cases to date

Death -> Total number of deaths to date

Recovered -> Total number of recovered cases to date

Active -> Active

```
[188]: covid = pd.read_csv("D:/ProjectsKaggle/COVID-19 Dataset/covid_19_clean_complete.
        ↪csv")
       covid.head()
```

```
[188]:   Province/State Country/Region       Lat       Long        Date  Confirmed  \
       0            NaN    Afghanistan  33.93911  67.709953  2020-01-22          0
       1            NaN        Albania  41.15330  20.168300  2020-01-22          0
       2            NaN        Algeria  28.03390   1.659600  2020-01-22          0
       3            NaN        Andorra  42.50630   1.521800  2020-01-22          0
       4            NaN         Angola -11.20270  17.873900  2020-01-22          0
```

```
   Deaths  Recovered  Active             WHO Region
0       0          0       0  Eastern Mediterranean
1       0          0       0                 Europe
2       0          0       0                 Africa
3       0          0       0                 Europe
4       0          0       0                 Africa
```

View columns and general statistics

[189]:

```
covid.info()
covid.describe()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 49068 entries, 0 to 49067
Data columns (total 10 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   Province/State  14664 non-null  object
 1   Country/Region  49068 non-null  object
 2   Lat             49068 non-null  float64
 3   Long            49068 non-null  float64
 4   Date            49068 non-null  object
 5   Confirmed       49068 non-null  int64
 6   Deaths          49068 non-null  int64
 7   Recovered       49068 non-null  int64
 8   Active          49068 non-null  int64
 9   WHO Region      49068 non-null  object
dtypes: float64(2), int64(4), object(4)
memory usage: 3.7+ MB
```

[189]:

```
                 Lat          Long     Confirmed         Deaths     Recovered  \
count   49068.000000  49068.000000  4.906800e+04   49068.000000  4.906800e+04
mean       21.433730     23.528236  1.688490e+04     884.179160  7.915713e+03
std        24.950320     70.442740  1.273002e+05    6313.584411  5.480092e+04
min       -51.796300   -135.000000  0.000000e+00       0.000000  0.000000e+00
25%         7.873054    -15.310100  4.000000e+00       0.000000  0.000000e+00
50%        23.634500     21.745300  1.680000e+02       2.000000  2.900000e+01
75%        41.204380     80.771797  1.518250e+03      30.000000  6.660000e+02
max        71.706900    178.065000  4.290259e+06  148011.000000  1.846641e+06

              Active
count   4.906800e+04
mean    8.085012e+03
std     7.625890e+04
min    -1.400000e+01
25%     0.000000e+00
50%     2.600000e+01
```

```
75%      6.060000e+02
max      2.816444e+06
```

```
[190]: covid.shape
```

```
[190]: (49068, 10)
```

```
[191]: missing_values = covid.isnull().sum().sort_values(ascending=False)
        missing_values
```

```
[191]: Province/State    34404
        Country/Region        0
        Lat                   0
        Long                  0
        Date                  0
        Confirmed             0
        Deaths                0
        Recovered             0
        Active                0
        WHO Region            0
        dtype: int64
```

```
[192]: covid.columns
```

```
[192]: Index(['Province/State', 'Country/Region', 'Lat', 'Long', 'Date', 'Confirmed',
               'Deaths', 'Recovered', 'Active', 'WHO Region'],
              dtype='object')
```

Checking for duplicates

```
[193]: covid.duplicated().sum()
```

```
[193]: np.int64(0)
```

In which countries/regions have confirmed cases of infection been recorded. Total number of infected. Top 10 countries by infected.

```
[194]: conf = covid.groupby("Country/Region")["Confirmed"].sum()
        conf.head()
```

```
[194]: Country/Region
        Afghanistan    1936390
        Albania         196702
        Algeria        1179755
        Andorra          94404
        Angola           22662
        Name: Confirmed, dtype: int64
```

[195]:
```
conf_all = covid["Confirmed"].sum()
conf_all
```

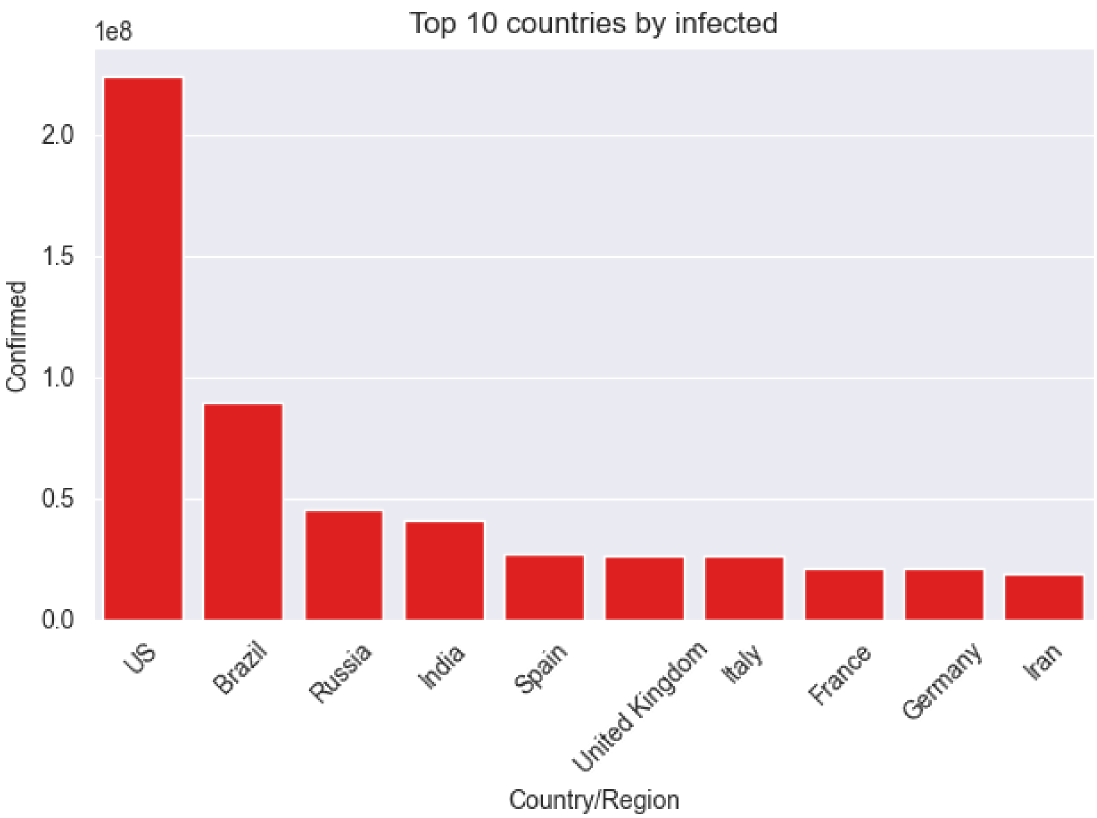
[195]:
```
np.int64(828508482)
```

[196]:
```
conf_top_10 = conf.sort_values(ascending=False)[:10]
conf_top_10_df = conf_top_10.reset_index()
conf_top_10
```

[196]:
```
Country/Region
US                  224345948
Brazil               89524967
Russia               45408411
India                40883464
Spain                27404045
United Kingdom       26748587
Italy                26745145
France               21210926
Germany              21059152
Iran                 19339267
Name: Confirmed, dtype: int64
```

Number of infected in different countries

[242]:
```
sns.barplot(data = conf_top_10_df, x = "Country/Region", y = "Confirmed",␣
 ↪color="red")
plt.title("Top 10 countries by infected")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



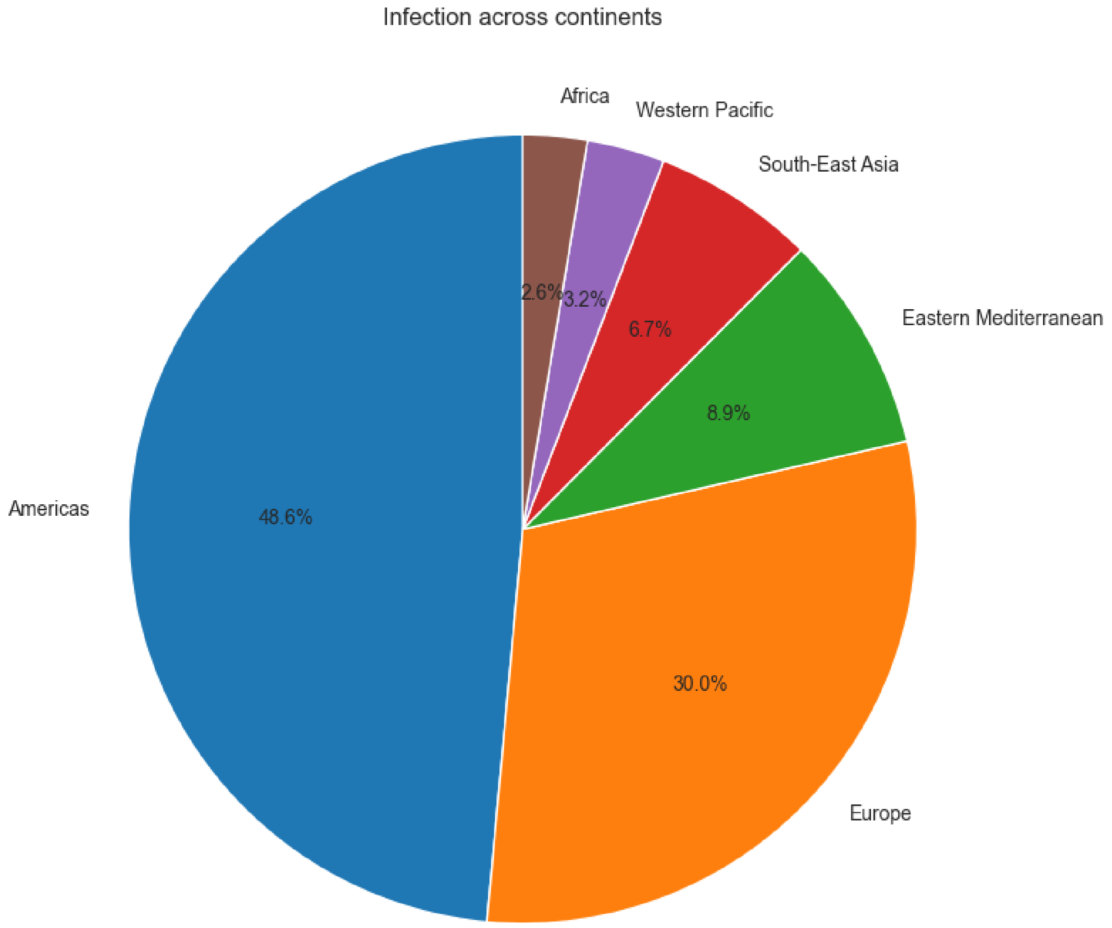
Number of infected by continent

```
[198]: conf_cont = covid.groupby("WHO Region")["Confirmed"].sum().
         ↪sort_values(ascending=False)
       conf_cont = conf_cont.reset_index()
       conf_cont
```

```
[198]:               WHO Region   Confirmed
       0              Americas   402261194
       1                Europe   248879793
       2  Eastern Mediterranean    74082892
       3        South-East Asia    55118365
       4        Western Pacific    26374411
       5                 Africa    21791827
```

Infection graph by continent

```
[235]: plt.figure(figsize=(9,9))
       plt.pie(conf_cont["Confirmed"], labels=conf_cont["WHO Region"], autopct="%1.
         ↪1f%%", startangle=90)
       plt.title("Infection across continents")
plt.show()
```



As you can see from the graph, Europe and America are the clear leaders in terms of the number of infected.

Plotting a timeline chart for Europe and America

```
[201]: europe_covid = covid[covid["WHO Region"] == "Europe"].copy()
       europe_covid
```

```
[201]:                      Province/State  Country/Region      Lat     Long  \
        1                             NaN         Albania  41.1533  20.1683
        3                             NaN         Andorra  42.5063   1.5218
        7                             NaN         Armenia  40.0691  45.0382
        16                            NaN         Austria  47.5162  14.5501
        17                            NaN      Azerbaijan  40.1431  47.5769
```

```
…                             …            …       …       …
49053       British Virgin Islands  United Kingdom  18.4207 -64.6400
49054      Turks and Caicos Islands  United Kingdom  21.6940 -71.7979
49059  Falkland Islands (Malvinas)  United Kingdom -51.7963 -59.5236
49060     Saint Pierre and Miquelon          France  46.8852 -56.3159
49066                          NaN      Tajikistan  38.8610  71.2761

             Date  Confirmed  Deaths  Recovered  Active WHO Region
1      2020-01-22          0       0          0       0     Europe
3      2020-01-22          0       0          0       0     Europe
7      2020-01-22          0       0          0       0     Europe
16     2020-01-22          0       0          0       0     Europe
17     2020-01-22          0       0          0       0     Europe
…            …       …     …        …      …       …
49053  2020-07-27          8       1          7       0     Europe
49054  2020-07-27         99       2         36      61     Europe
49059  2020-07-27         13       0         13       0     Europe
49060  2020-07-27          4       0          1       3     Europe
49066  2020-07-27       7235      60       6028    1147     Europe

[15040 rows x 10 columns]
```

Top 10 infected countries in Europe

[202]:

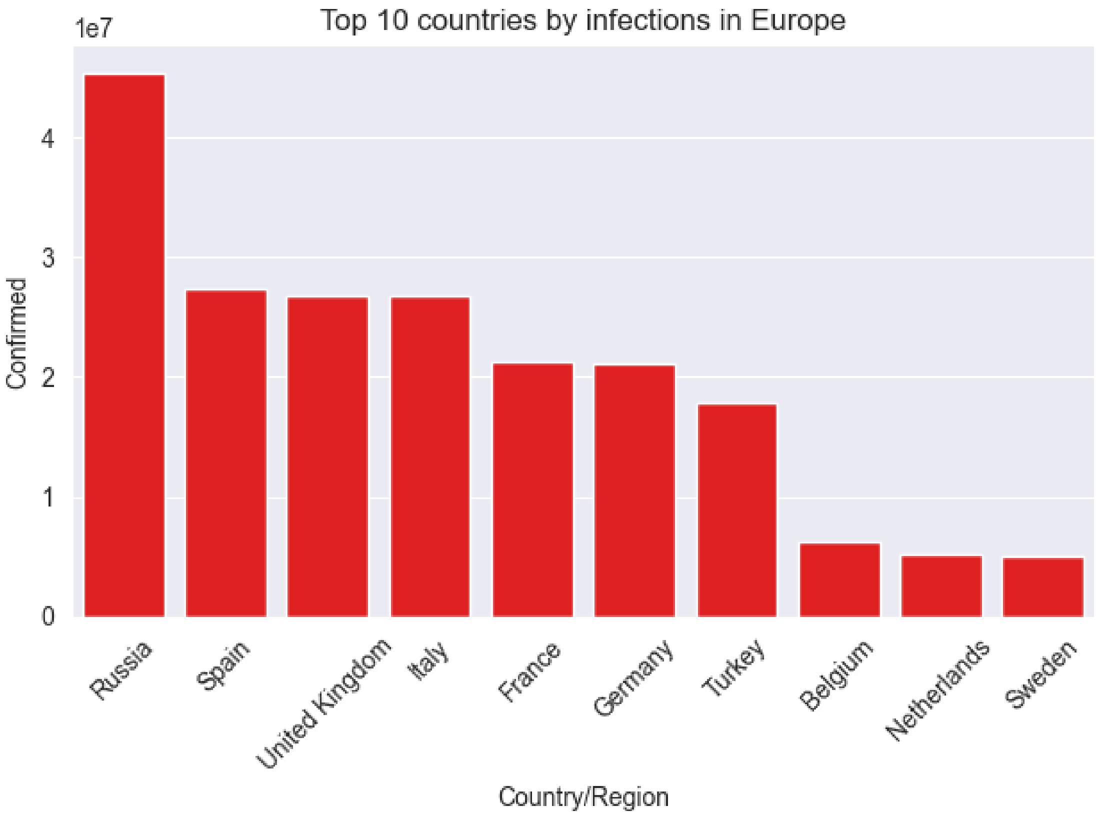
```
europe_conf = europe_covid.groupby("Country/Region")["Confirmed"].sum().
  ↪sort_values(ascending=False)[:10]
europe_conf = europe_conf.reset_index()
europe_conf.head()
```

[202]:

```
   Country/Region  Confirmed
0          Russia   45408411
1           Spain   27404045
2  United Kingdom   26748587
3           Italy   26745145
4          France   21210926
```

[203]:

```
sns.barplot(data = europe_conf, x = "Country/Region", y = "Confirmed",␣
  ↪color="red")
plt.title("Top 10 countries by infections in Europe")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



Top 10 Countries by Mortality in Europe

[204]:

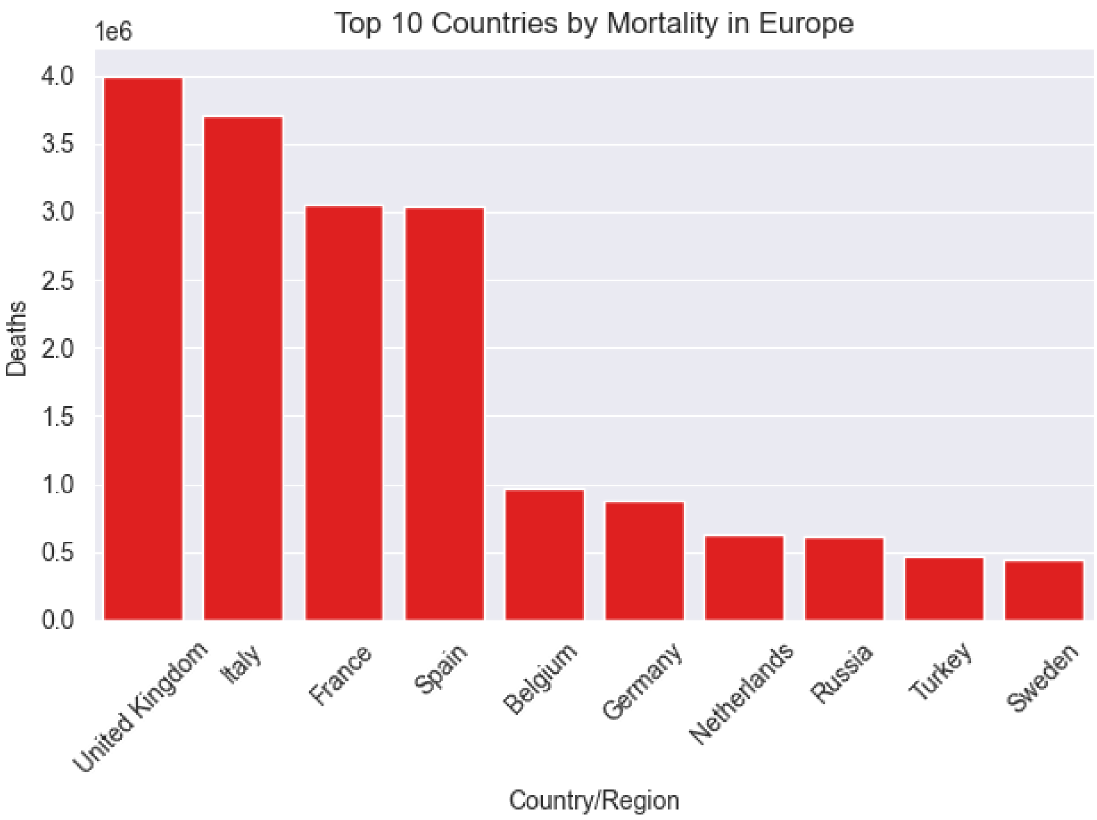
```
europe_d = europe_covid.groupby("Country/Region")["Deaths"].sum().
  ↪sort_values(ascending=False)[:10]
europe_d = europe_d.reset_index()
europe_d.head()
```

[204]:

```
   Country/Region   Deaths
0  United Kingdom  3997775
1           Italy  3707717
2          France  3048524
3           Spain  3033030
4         Belgium   963679
```

[205]:

```
sns.barplot(data = europe_d, x = "Country/Region", y = "Deaths", color="red")
plt.title("Top 10 Countries by Mortality in Europe")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```

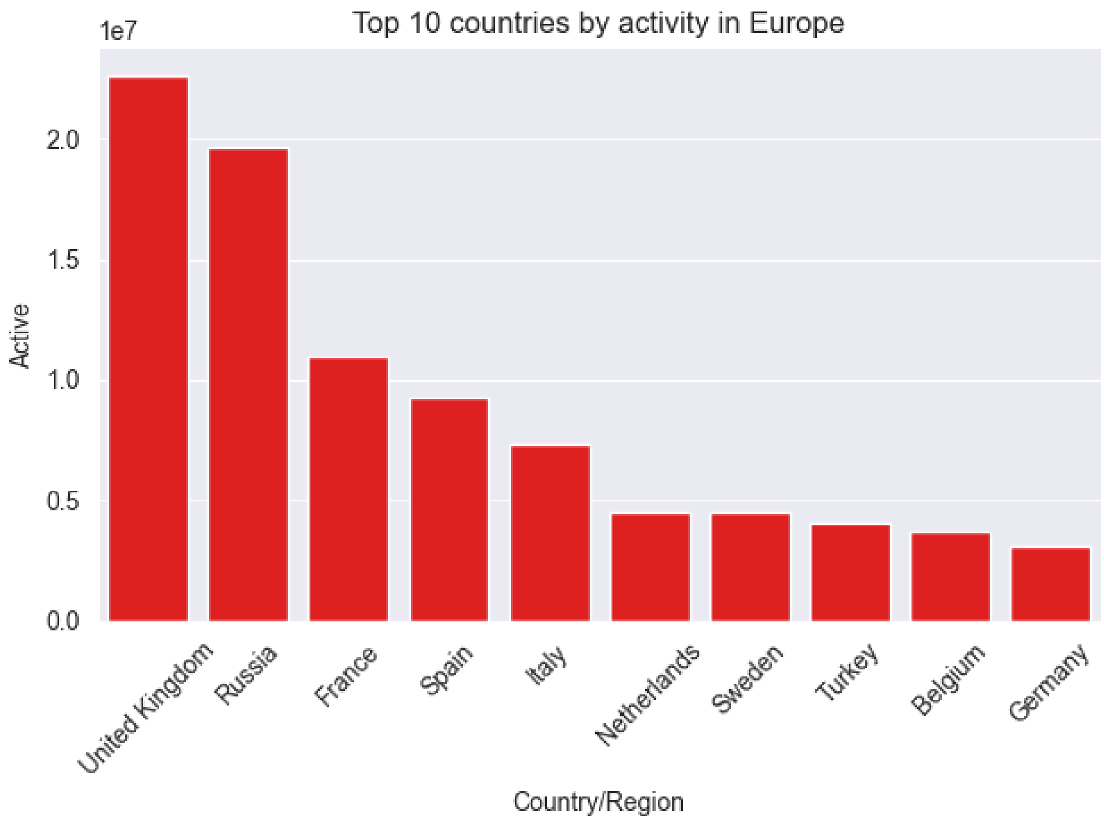


Top 10 countries by activity in Europe

[206]:
```
europe_a = europe_covid.groupby("Country/Region")["Active"].sum().
  ↪sort_values(ascending=False)[:10]
europe_a = europe_a.reset_index()
europe_a.head()
```

[206]:
```
   Country/Region    Active
0  United Kingdom  22624595
1          Russia  19668578
2          France  10980287
3           Spain   9277432
4           Italy   7363518
```

[207]:
```
sns.barplot(data = europe_a, x = "Country/Region", y = "Active", color="red")
plt.title("Top 10 countries by activity in Europe")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



Total number of infected in Europe

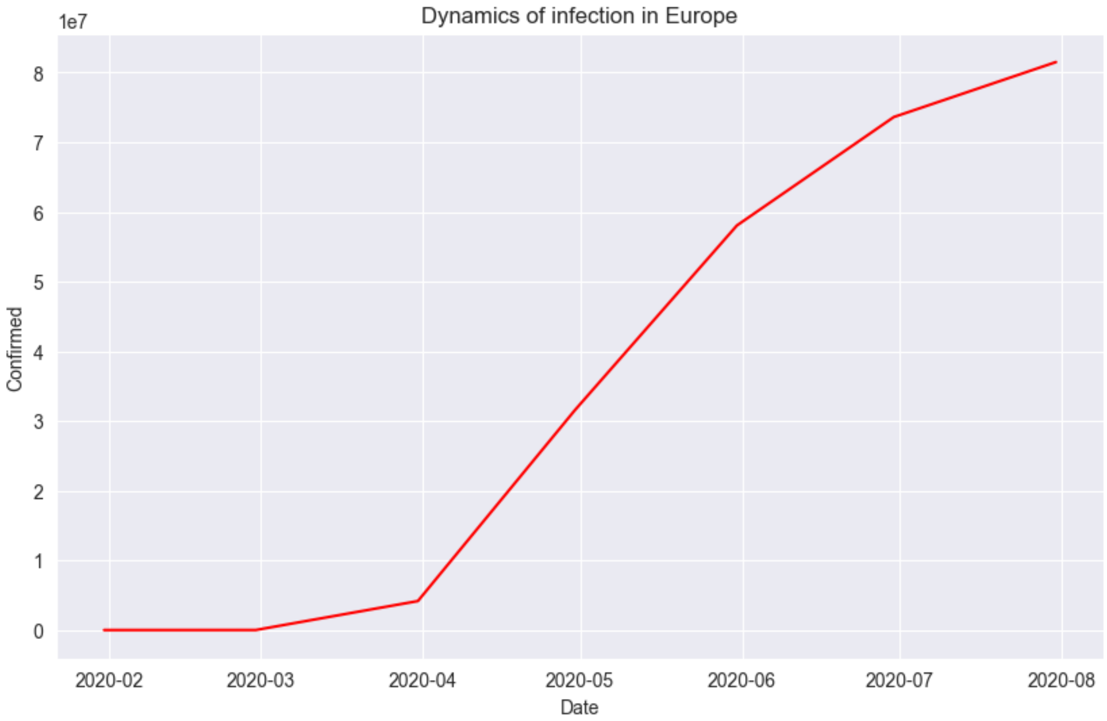
[208]:
```
europe_all = europe_covid["Confirmed"].sum()
europe_all
```

[208]:
```
np.int64(248879793)
```

For better visualization, we convert the daily date into a monthly date.

[209]:
```
europe_covid["Date"] = pd.to_datetime(europe_covid["Date"])
```

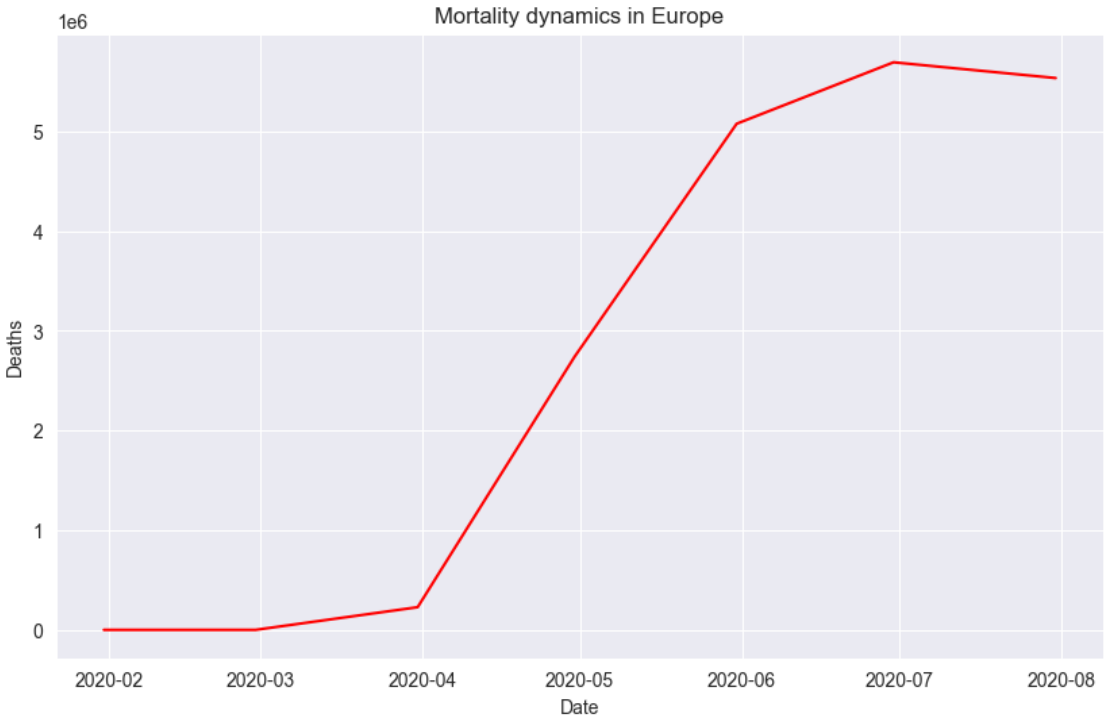
[210]:
```
europe_daily_conf = europe_covid.groupby("Date")["Confirmed"].sum().
  ↪reset_index()
europe_monthly_conf = europe_daily_conf.set_index("Date").resample("ME").sum().
  ↪reset_index()
plt.figure(figsize=(10,6))
sns.lineplot(data = europe_monthly_conf, x = "Date", y = "Confirmed",␣
  ↪color="red")
plt.title("Dynamics of infection in Europe")
plt.show()
```



Dynamics of infection in Europe

Mortality dynamics in Europe

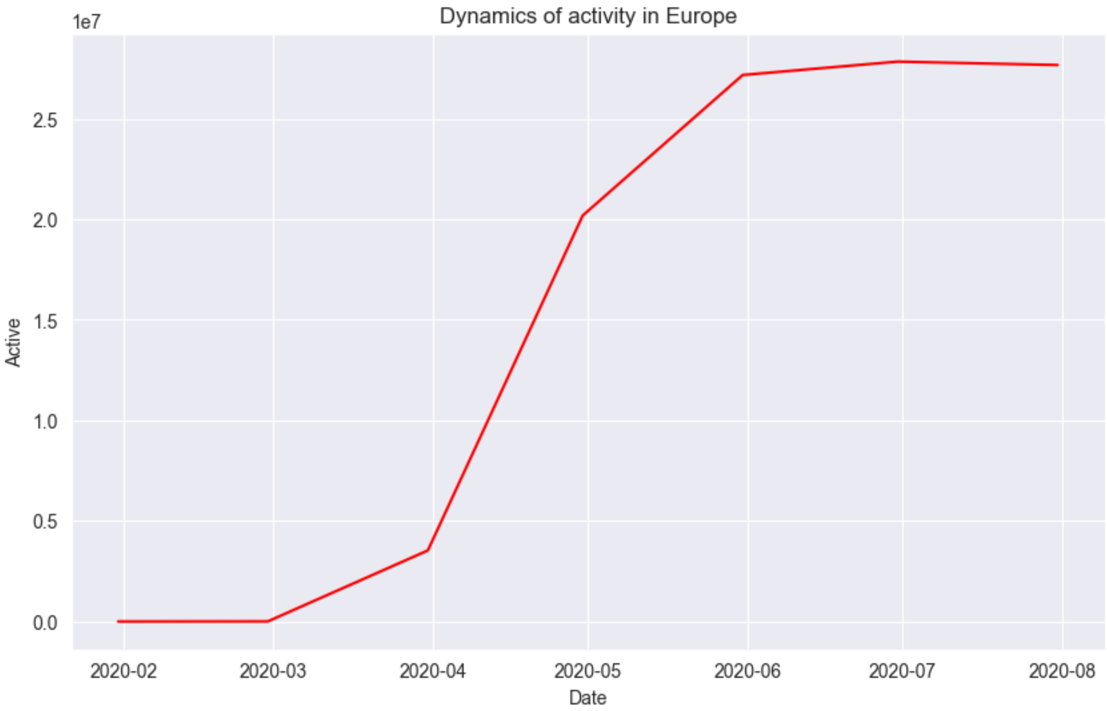
```
[211]: europe_daily_d = europe_covid.groupby("Date")["Deaths"].sum().reset_index()
       europe_monthly_d = europe_daily_d.set_index("Date").resample("ME").sum().
        ↪reset_index()
       plt.figure(figsize=(10,6))
       sns.lineplot(data = europe_monthly_d, x = "Date", y = "Deaths", color="red")
       plt.title("Mortality dynamics in Europe")
       plt.show()
```



Mortality dynamics in Europe

Dynamics of activity in Europe

[212]:
```python
europe_daily_a = europe_covid.groupby("Date")["Active"].sum().reset_index()
europe_monthly_a = europe_daily_a.set_index("Date").resample("ME").sum().
  ↪reset_index()
plt.figure(figsize=(10,6))
sns.lineplot(data = europe_monthly_a, x = "Date", y = "Active", color="red")
plt.title("Dynamics of activity in Europe")
plt.show()
```



Dynamics of activity in Europe

The graphs show that the sharp rise occurs from 2020-04 to 2020-06. This means that the virus has not yet been detected or measures have not yet been taken to stop it. The graph of infected people shows that the infection is slowing down, which indicates that measures have been taken to combat the virus. The mortality graph has even begun to decline.

[213]:
```
america_covid = covid[covid["WHO Region"] == "Americas"].copy()
america_covid
```

[213]:
```
               Province/State        Country/Region        Lat        Long  \
5                         NaN   Antigua and Barbuda  17.060800  -61.796400
6                         NaN             Argentina -38.416100  -63.616700
18                        NaN               Bahamas  25.025885  -78.035889
21                        NaN              Barbados  13.193900  -59.543200
26                        NaN               Bolivia -16.290200  -63.588700
…                           …                     …          …           …
49037                     NaN               Grenada  12.116500  -61.679000
49041                     NaN                Belize  17.189900  -88.497600
49047                     NaN Saint Kitts and Nevis  17.357822  -62.782998
49048   Northwest Territories                Canada  64.825500 -124.845700
49049                   Yukon                Canada  64.282300 -135.000000

             Date  Confirmed  Deaths  Recovered  Active WHO Region
5      2020-01-22          0       0          0       0   Americas
```

```
6      2020-01-22          0       0          0       0  Americas
18     2020-01-22          0       0          0       0  Americas
21     2020-01-22          0       0          0       0  Americas
26     2020-01-22          0       0          0       0  Americas
…            …       …     …        …     …        …
49037  2020-07-27         23       0         23       0  Americas
49041  2020-07-27         48       2         26      20  Americas
49047  2020-07-27         17       0         15       2  Americas
49048  2020-07-27          5       0          0       5  Americas
49049  2020-07-27         14       0          0      14  Americas

[8648 rows x 10 columns]
```

Top 10 countries by number of infected in America

[214]:

```
america_conf = america_covid.groupby("Country/Region")["Confirmed"].sum().
  ↪sort_values(ascending=False)[:10]
america_conf = america_conf.reset_index()
america_conf
```

[214]:

```
       Country/Region  Confirmed
0                  US  224345948
1              Brazil   89524967
2                Peru   19263916
3               Chile   16935654
4              Mexico   14946202
5              Canada    9356551
6            Colombia    6893122
7             Ecuador    4678496
8           Argentina    4450658
9  Dominican Republic    2495433
```

Top 10 Countries by Death Rate in America

[215]:

```
america_d = america_covid.groupby("Country/Region")["Deaths"].sum().
  ↪sort_values(ascending=False)[:10]
america_d = america_d.reset_index()
america_d
```

[215]:

```
  Country/Region    Deaths
0             US  11011411
1         Brazil   3938034
2         Mexico   1728277
3         Canada    699566
4           Peru    652113
5        Ecuador    346618
6          Chile    322480
```

```
7       Colombia    236525
8      Argentina     97749
9        Bolivia     78032
```

Top 10 countries by infection activity in America

```
[216]: america_a = america_covid.groupby("Country/Region")["Active"].sum().
        ↪sort_values(ascending=False)[:10]
       america_a = america_a.reset_index()
       america_a
```

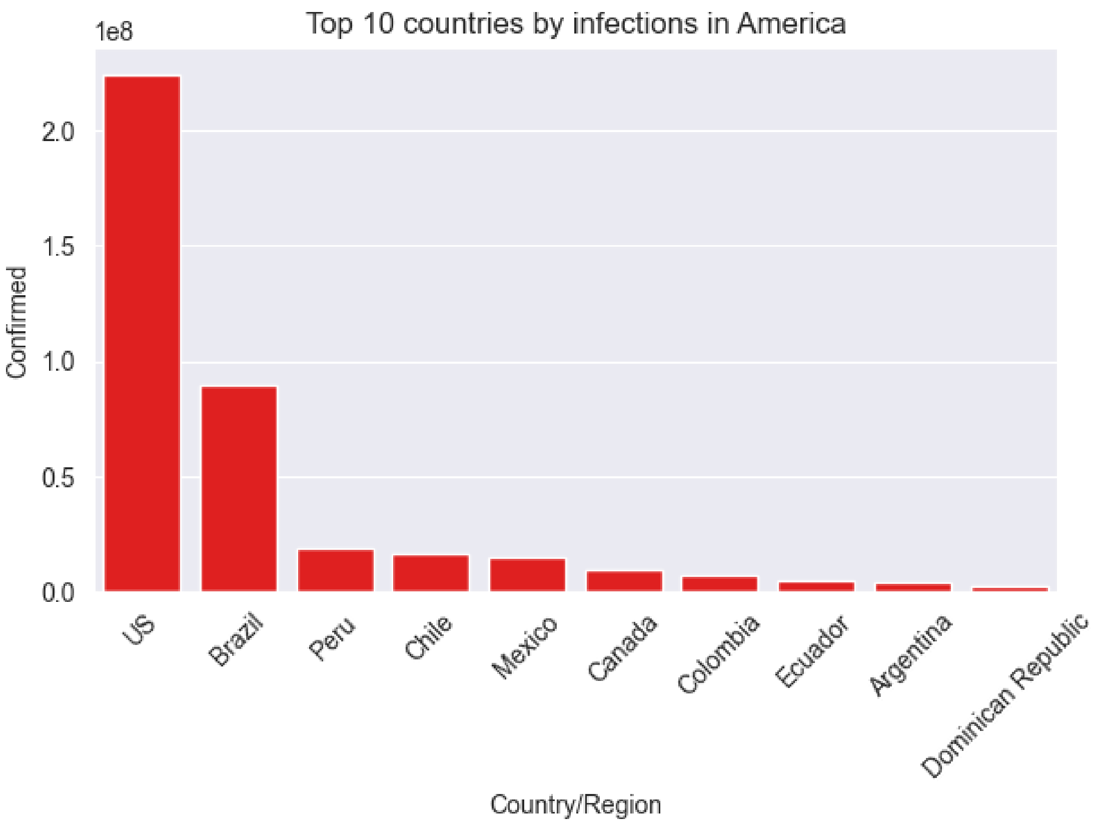
```
[216]:   Country/Region     Active
       0             US  156981121
       1         Brazil   31094060
       2         Canada    8656985
       3           Peru    7748957
       4       Colombia    3832786
       5          Chile    3320581
       6      Argentina    2672885
       7        Ecuador    2559668
       8         Mexico    2076700
       9        Bolivia    1520666
```

Total number of infected in America

```
[217]: america_all = america_covid["Confirmed"].sum()
       america_all
```

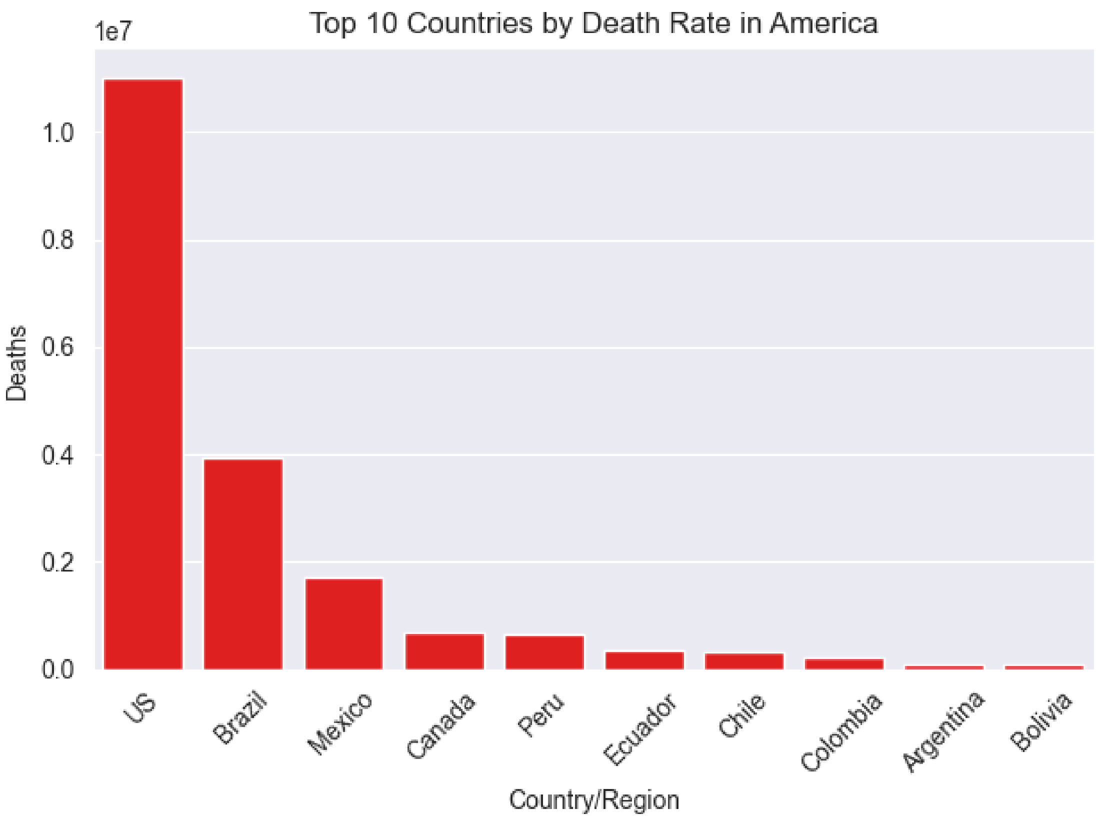
```
[217]: np.int64(402261194)
```

```
[236]: sns.barplot(data = america_conf, x = "Country/Region", y = "Confirmed",␣
        ↪color="red")
       plt.title("Top 10 countries by infections in America")
       plt.xticks(rotation=45)
       plt.tight_layout()
       plt.show()
```



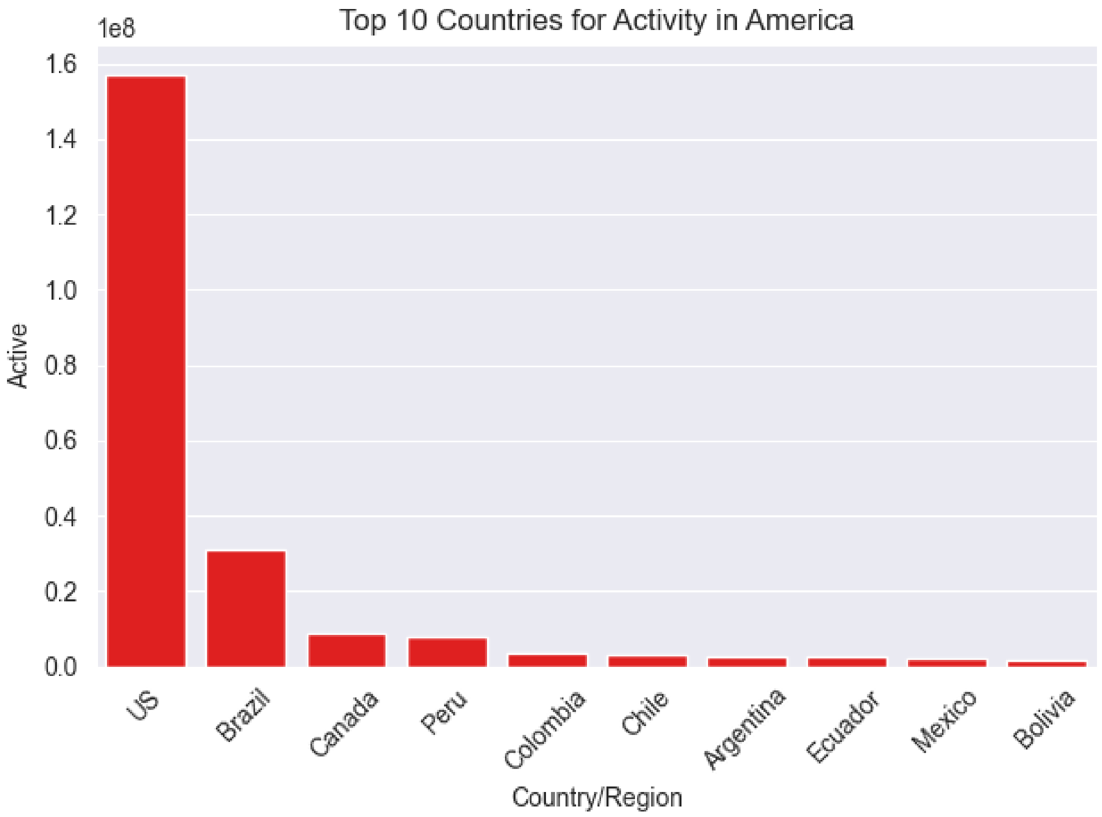
Top 10 countries by infections in America

```
[240]: sns.barplot(data = america_d, x = "Country/Region", y = "Deaths", color="red")
plt.title("Top 10 Countries by Death Rate in America")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



Top 10 Countries by Death Rate in America

```
[241]: sns.barplot(data = america_a, x = "Country/Region", y = "Active", color="red")
       plt.title("Top 10 Countries for Activity in America")
       plt.xticks(rotation=45)
       plt.tight_layout()
       plt.show()
```

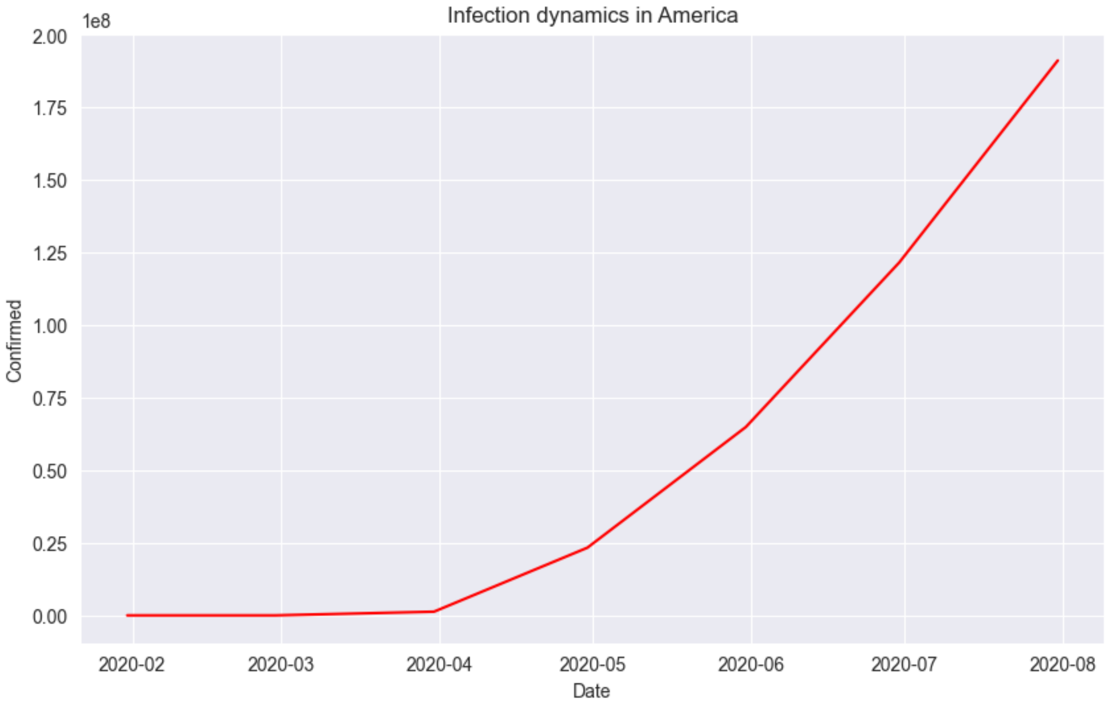


Top 10 Countries for Activity in America

Infection dynamics in America

[221]:
```
america_covid["Date"] = pd.to_datetime(america_covid["Date"])
```

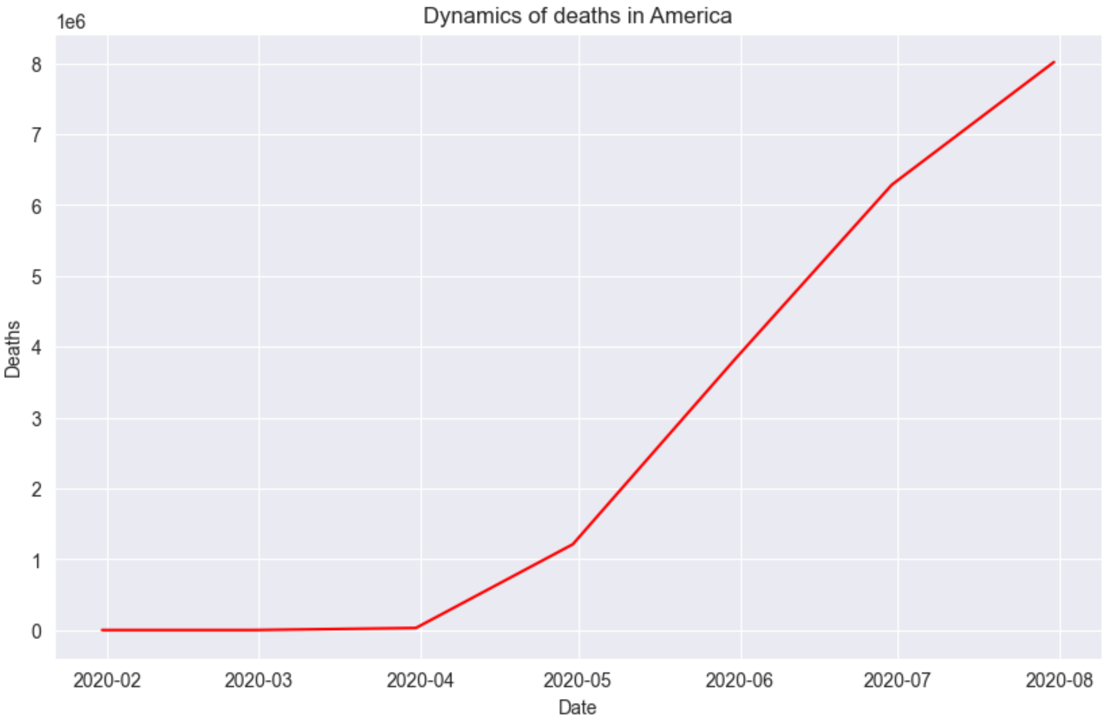
[237]:
```
america_daily_conf = america_covid.groupby("Date")["Confirmed"].sum().
  ↪reset_index()
america_monthly_conf = america_daily_conf.set_index("Date").resample("ME").
  ↪sum().reset_index()
plt.figure(figsize=(10,6))
sns.lineplot(data = america_monthly_conf, x = "Date", y = "Confirmed",␣
  ↪color="red")
plt.title("Infection dynamics in America")
plt.show()
```



Infection dynamics in America

Dynamics of deaths in America

[238]:
```
america_daily_d = america_covid.groupby("Date")["Deaths"].sum().reset_index()
america_monthly_d = america_daily_d.set_index("Date").resample("ME").sum().
  ↪reset_index()
plt.figure(figsize=(10,6))
sns.lineplot(data = america_monthly_d, x = "Date", y = "Deaths", color="red")
plt.title("Dynamics of deaths in America")
plt.show()
```

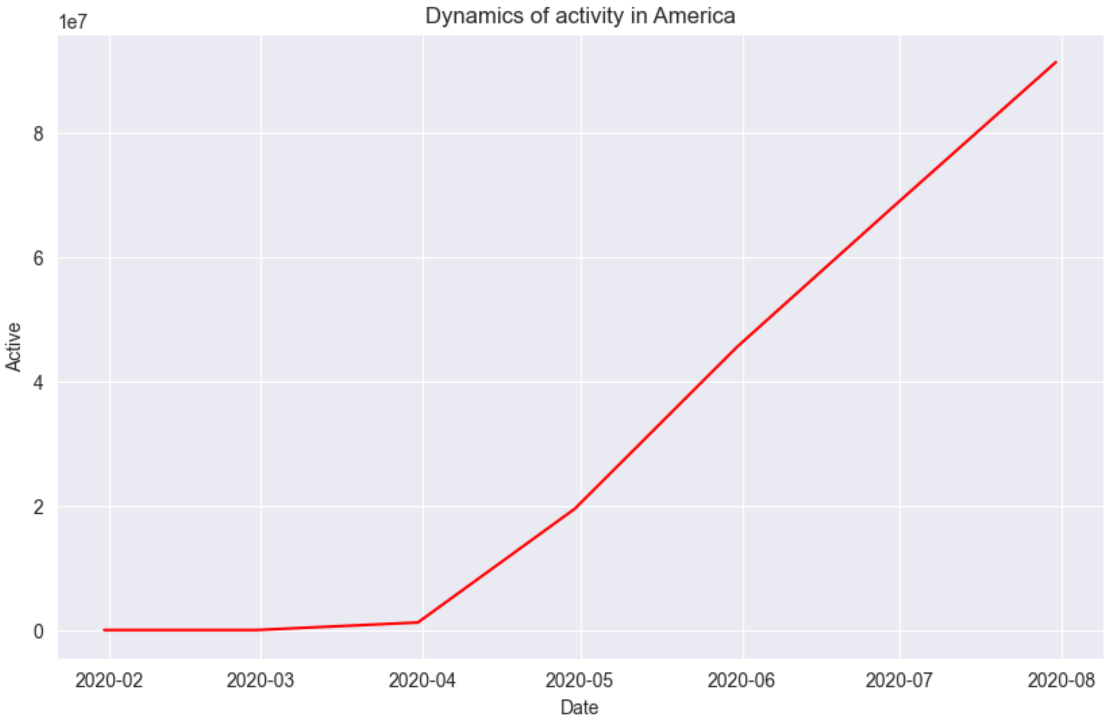


Dynamics of deaths in America

Dynamics of activity in America

[239]:

```
america_daily_a = america_covid.groupby("Date")["Active"].sum().reset_index()
america_monthly_a = america_daily_a.set_index("Date").resample("ME").sum().
 ↪reset_index()
plt.figure(figsize=(10,6))
sns.lineplot(data = america_monthly_a, x = "Date", y = "Active", color="red")
plt.title("Dynamics of activity in America")
plt.show()
```



Dynamics of activity in America

As in Europe, the sharp rise began in 2020-04, but continued to rise continuously in the following months for both the infection and mortality graphs.

Let's add new metrics for further analysis

[225]:
```
sm_all = covid.groupby("Country/Region")[["Confirmed", "Deaths", "Recovered",␣
 ↪"Active"]].sum().copy()
```

Mortality

[226]:
```
sm_all["Fatality Rate"] = sm_all["Deaths"] / sm_all["Confirmed"]
sm_all["Fatality Rate"]
```

[226]:
```
Country/Region
Afghanistan           0.025355
Albania               0.029019
Algeria               0.066092
Andorra               0.057445
Angola                0.047569
                        …
West Bank and Gaza    0.005868
Western Sahara        0.069922
Yemen                 0.263575
```

```
Zambia                    0.020422
Zimbabwe                  0.017345
Name: Fatality Rate, Length: 187, dtype: float64
```

Mortality for Europe

[227]:
```
europe_sm = europe_covid[["Confirmed", "Deaths", "Recovered", "Active"]].sum().
  ↪copy()
fatal_europe = europe_sm["Deaths"] / europe_sm["Confirmed"]
fatal_europe
```

[227]:
```
np.float64(0.07743111551045045)
```

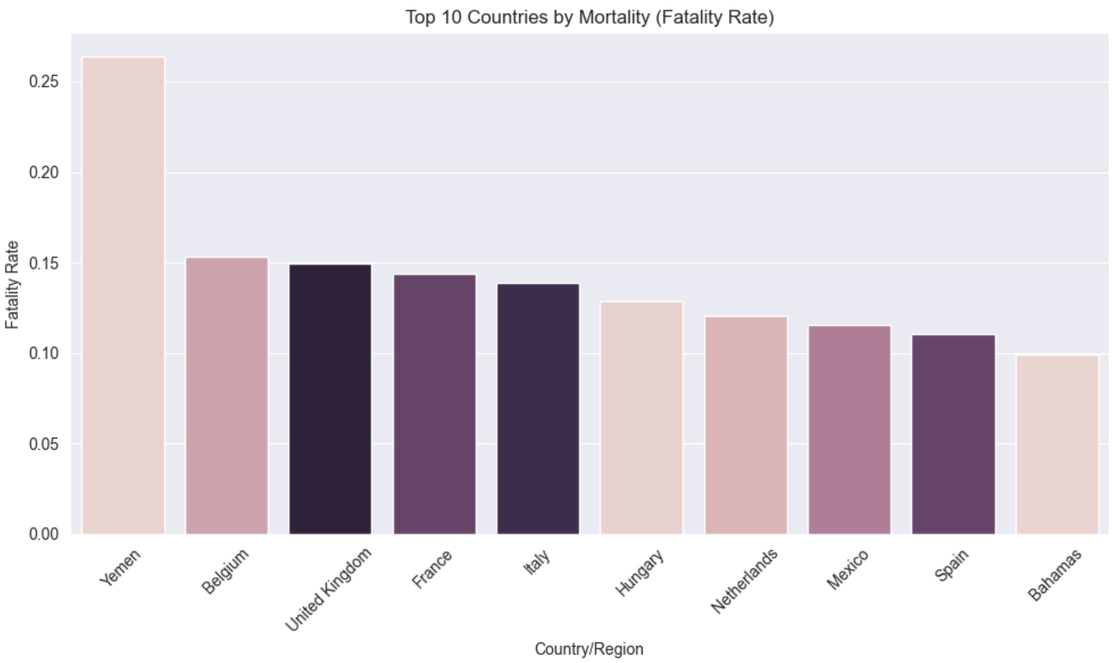
Mortality for America

[228]:
```
america_sm = america_covid[["Confirmed", "Deaths", "Recovered", "Active"]].
  ↪sum().copy()
fatal_america = america_sm["Deaths"] / america_sm["Confirmed"]
fatal_america
```

[228]:
```
np.float64(0.04812617346330454)
```

Top 10 Countries by Mortality

[229]:
```
top_fatal = sm_all.sort_values("Fatality Rate", ascending=False).head(10).
  ↪reset_index()
plt.figure(figsize=(10,6))
sns.barplot(data=top_fatal, x="Country/Region", y="Fatality Rate", hue =␣
  ↪"Deaths" , legend=False)
plt.title("Top 10 Countries by Mortality (Fatality Rate)")
plt.xticks(rotation=45)
plt.tight_layout()
plt.show()
```



Top 10 Countries by Mortality (Fatality Rate)

Percentage of recovered

```
[230]: sm_all["Recovery Rate"] = sm_all["Recovered"] / sm_all["Confirmed"]
       sm_all["Recovery Rate"]
```

```
[230]: Country/Region
       Afghanistan           0.412231
       Albania               0.604351
       Algeria               0.640724
       Andorra               0.731685
       Angola                0.290045
                               …
       West Bank and Gaza    0.261817
       Western Sahara        0.719201
       Yemen                 0.353960
       Zambia                0.646039
       Zimbabwe              0.240324
       Name: Recovery Rate, Length: 187, dtype: float64
```

Share of recovered cases in Europe

```
[231]: europe_r = europe_covid[["Confirmed", "Deaths", "Recovered", "Active"]].sum().
        ↪copy()
       rec_europe = europe_r["Recovered"] / europe_r["Confirmed"]
```

```
rec_europe
```

```
[231]: np.float64(0.49502642828057963)
```

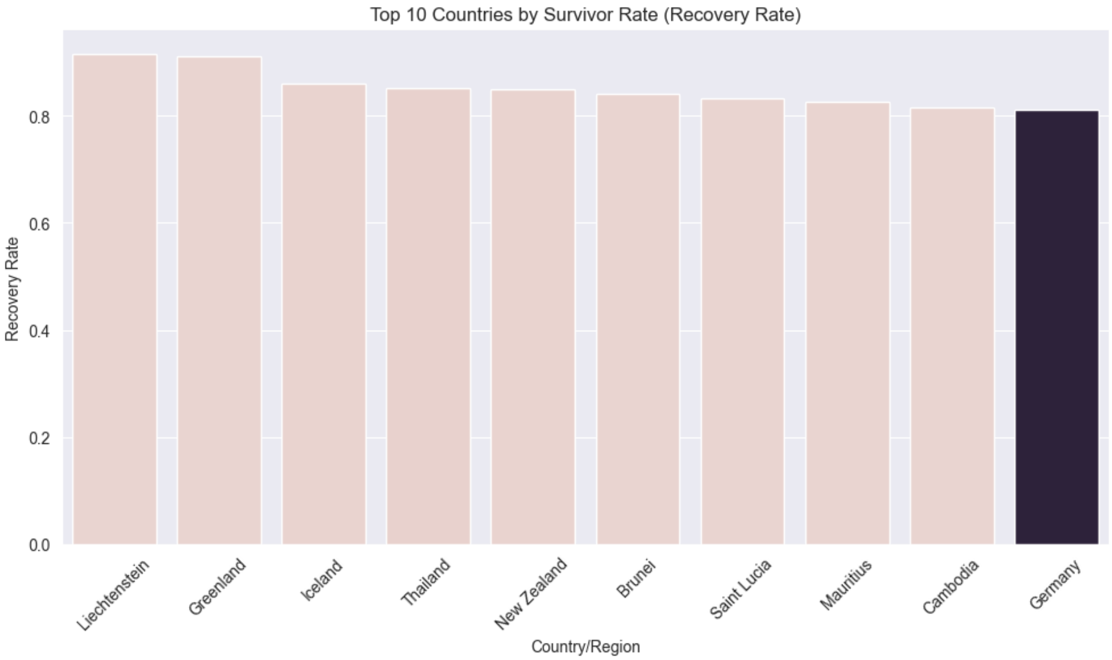
The share of recovered people in America

```
[232]: america_r = america_covid[["Confirmed", "Deaths", "Recovered", "Active"]].sum().
          ↪copy()
        rec_america = america_r["Recovered"] / america_r["Confirmed"]
        rec_america
```

```
[232]: np.float64(0.390466309807652)
```

Top 10 Countries by Survivor Rate

```
[233]: top_rec = sm_all.sort_values("Recovery Rate", ascending=False).head(10).
          ↪reset_index()
        plt.figure(figsize=(10,6))
        sns.barplot(data=top_rec, x="Country/Region", y="Recovery Rate", hue =␣
          ↪"Recovered" , legend=False)
        plt.title("Top 10 Countries by Survivor Rate (Recovery Rate)")
        plt.xticks(rotation=45)
        plt.tight_layout()
        plt.show()
```



Top 10 Countries by Survivor Rate

Conclusion: At the end of the project, it is clear that America was late in taking measures to prevent the spread of the virus. The US and Brazil have the highest mortality rate and the highest spread of infection. European countries dealt with the infection faster and it began to decline.

The project was completed with partial use of open sources (Kaggle/ChatGPT/StackOverflow) and my own analysis.