Sheet

Assignment 2 Karim Aboudaoud 900212779

Part 2: Covid-19 Cases

Abstract

For this part of the assignment, I chose one country from the data set which is France to analyze its daily reported number of confirmed cases and deaths, and I compared the ratio between confirmed cases and deaths in 2020 and 2021. I plotted the necessary graphs for France such as the confidence interval graphs, line graphs and line graphs with error bars.

Then, I made a comparison between the data in terms of several factors like regions, income, and continents.

The chosen regions to compare between each other were East Asia and Pacific, and Europe and Central Asia.

The chosen income levels to compare between each other were low income and high income.

The chosen continents to compare between each other were Oceania and North America.

The analysis for each factor made it easier to understand which countries, regions, continents and which socio economic level were really affected by COVID.

For each of the above factors I plotted a line graph with error bars to show the comparison between 2020 and 2021 in terms of either confirmed cases or confirmed deaths.

The description of each graph can be found under the graph.

The conclusion can be found at the end of the notebook.

Preparing Data for Manipulation

```
import scipy
```

```
import numpy as np
```

```
!pip install matplotlib
```

```
Requirement already satisfied: matplotlib in /opt/python/envs/default/lib/python3.8/site-packages (3.5.1)
Requirement already satisfied: numpy>=1.17 in /opt/python/envs/default/lib/python3.8/site-packages (from matplotlib) (1.21.5)
Requirement already satisfied: packaging>=20.0 in /opt/python/envs/default/lib/python3.8/site-packages (from matplotlib) (21.3)
Requirement already satisfied: pyparsing>=2.2.1 in /opt/python/envs/default/lib/python3.8/site-packages (from matplotlib) (3.0.7)
Requirement already satisfied: fonttools>=4.22.0 in /opt/python/envs/default/lib/python3.8/site-packages (from matplotlib) (4.31.2)
Requirement already satisfied: kiwisolver>=1.0.1 in /opt/python/envs/default/lib/python3.8/site-packages (from matplotlib) (1.4.2)
Requirement already satisfied: python-dateutil>=2.7 in /opt/python/envs/default/lib/python3.8/site-packages (from matplotlib) (2.8.2
Requirement already satisfied: pillow>=6.2.0 in /opt/python/envs/default/lib/python3.8/site-packages (from matplotlib) (9.1.0)
Requirement already satisfied: cycler>=0.10 in /opt/python/envs/default/lib/python3.8/site-packages (from matplotlib) (0.11.0)
Requirement already satisfied: six>=1.5 in /opt/python/envs/default/lib/python3.8/site-packages (from python-dateutil>=2.7->matplotl
WARNING: You are using pip version 21.3.1; however, version 22.0.4 is available.
You should consider upgrading via the '/opt/python/envs/default/bin/python -m pip install --upgrade pip' command.
```

```
import matplotlib.pyplot as plt
```

```
import pandas as pd
```

```
import statsmodels.api as sm
from statsmodels.stats.proportion import proportion_confint
```

```
import scipy.stats
```

```
from scipy.stats import norm,t
```

```
!pip3 install livewires
```

```
Requirement already satisfied: livewires in /opt/python/envs/default/lib/python3.8/site-packages (2.1)
Requirement already satisfied: pygame in /opt/python/envs/default/lib/python3.8/site-packages (from livewires) (2.1.2)
WARNING: You are using pip version 21.3.1; however, version 22.0.4 is available.
You should consider upgrading via the '/opt/python/envs/default/bin/python -m pip install --upgrade pip' command.
```

```
df=pd.read_csv('covid_data.csv',encoding='latin-1')
```

```
df.head()
```

	date	iso3c	country	income	region	continent	dcases	ddeaths	population	weekdays	month
0	2020-02-24	AFG	Afghanistan	Low income	South Asia	Asia	5	0	38041754	Mon	Feb
1	2020-02-25	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Tue	Feb
2	2020-02-26	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Wed	Feb
3	2020-02-27	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Thu	Feb
4	2020-02-28	AFG	Afghanistan	Low income	South Asia	Asia	0	0	38041754	Fri	Feb

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

```
from pandas.api.types import CategoricalDtype
cats=['Fri', 'Sat', 'Sun','Mon','Tue','Wed','Thu']
cat_type = CategoricalDtype(categories=cats, ordered=True)
df['weekdays'] = df['weekdays'].astype(cat_type)
```

```
from pandas.api.types import CategoricalDtype
cats=['Jan', 'Feb', 'Mar','Apr','May','Jun','Jul','Aug','Sep','Oct','Nov','Dec']
cat_type = CategoricalDtype(categories=cats, ordered=True)
df['month'] = df['month'].astype(cat_type)
```

Chosen country to analyze: France

```
dffr=df[df['country']=='France']
```

Analyzing the daily reported number of cases

```
statsfr=dffr.groupby("weekdays").agg({"dcases": [np.mean, np.std, np.size]})
```

```
statsfr
```

	dcases		
	mean	std	size
weekdays			
Fri	17148.127451	27347.227106	102
Sat	14975.475248	18070.217337	101
Sun	13456.702970	17602.649041	101
Mon	6090.405941	13046.142380	101
Tue	15780.643564	22840.055655	101
Wed	17793.029703	25894.416151	101
Thu	18558.029703	26434.156239	101

```
statsfr.index
```

```
CategoricalIndex(['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], categories=['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], or
```

```
statsfr.columns
```

```
MultiIndex([('dcases', 'mean'),
            ('dcases',  'std'),
            ('dcases', 'size')],
           )
```

```
statsfr.index
```

```
CategoricalIndex(['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], categories=['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], or
```

```
ci95_hi = []
ci95_lo = []
```

```
for i in statsfr.index:
    m, s, n = statsfr.loc[i]
    x=scipy.stats.t.interval(.95, n-1, m,s/np.sqrt(n-1))
    ci95_hi.append(x[1])
    ci95_lo.append(x[0])
```

```
ci95_hi
```

```
[22546.158660289526,
 18560.554900435036,
 16949.0184050158,
 8678.723431382872,
 20312.04555423757,
 22930.40811604733,
 23802.49101221734]
```

```
ci95_lo
```

```
[11750.096241671257,
 11390.39559461447,
 9964.387535578264,
 3502.0884498052474,
 11249.2415744753,
 12655.651289893263,
 13313.568393723253]
```

```
statsfr['ci95_hi'] = ci95_hi
statsfr['ci95_lo'] = ci95_lo
print(statsfr)
```

```
               dcases                          ci95_hi       ci95_lo
                 mean           std size
weekdays
Fri       17148.127451  27347.227106  102  22546.158660  11750.096242
Sat       14975.475248  18070.217337  101  18560.554900  11390.395595
Sun       13456.702970  17602.649041  101  16949.018405   9964.387536
Mon        6090.405941  13046.142380  101   8678.723431   3502.088450
Tue       15780.643564  22840.055655  101  20312.045554  11249.241574
Wed       17793.029703  25894.416151  101  22930.408116  12655.651290
Thu       18558.029703  26434.156239  101  23802.491012  13313.568394
```

```
df_ci= pd.DataFrame(statsfr)
```

```
df_ci
```

	dcases			ci95_hi	ci95_lo
	mean	std	size		
weekdays					
Fri	17148.127451	27347.227106	102	22546.158660	11750.096242
Sat	14975.475248	18070.217337	101	18560.554900	11390.395595
Sun	13456.702970	17602.649041	101	16949.018405	9964.387536
Mon	6090.405941	13046.142380	101	8678.723431	3502.088450
Tue	15780.643564	22840.055655	101	20312.045554	11249.241574
Wed	17793.029703	25894.416151	101	22930.408116	12655.651290
Thu	18558.029703	26434.156239	101	23802.491012	13313.568394

```
df_ci.index
```

```
CategoricalIndex(['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], categories=['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], or
```

```
df_ci['weekdays']=df_ci.index
```

```
df_ci
```

	dcases			ci95_hi	ci95_lo	weekdays
	mean	std	size			
weekdays						
Fri	17148.127451	27347.227106	102	22546.158660	11750.096242	Fri
Sat	14975.475248	18070.217337	101	18560.554900	11390.395595	Sat
Sun	13456.702970	17602.649041	101	16949.018405	9964.387536	Sun
Mon	6090.405941	13046.142380	101	8678.723431	3502.088450	Mon
Tue	15780.643564	22840.055655	101	20312.045554	11249.241574	Tue
Wed	17793.029703	25894.416151	101	22930.408116	12655.651290	Wed
Thu	18558.029703	26434.156239	101	23802.491012	13313.568394	Thu

```
df_ci.columns
```

```
MultiIndex([(  'dcases', 'mean'),
            (  'dcases',  'std'),
            (  'dcases', 'size'),
            ( 'ci95_hi',     ''),
            ( 'ci95_lo',     ''),
            ('weekdays',     '')],
           )
```

```
for lb,ub,y in zip(df_ci['ci95_lo'],df_ci['ci95_hi'],range(len(df_ci))):
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(df_ci)),list(df_ci['weekdays']))
```

```
([<matplotlib.axis.YTick at 0x7f9642720370>,
  <matplotlib.axis.YTick at 0x7f964270c1f0>,
  <matplotlib.axis.YTick at 0x7f9642705670>,
  <matplotlib.axis.YTick at 0x7f96435449d0>,
  <matplotlib.axis.YTick at 0x7f9643544ca0>,
  <matplotlib.axis.YTick at 0x7f96435384c0>,
  <matplotlib.axis.YTick at 0x7f9643538c10>],
 [Text(0, 0, 'Fri'),
  Text(0, 1, 'Sat'),
  Text(0, 2, 'Sun'),
  Text(0, 3, 'Mon'),
  Text(0, 4, 'Tue'),
  Text(0, 5, 'Wed'),
  Text(0, 6, 'Thu')])
```

The confidence interval for the daily COVID cases in France shows that there is no certain day that has the most COVID confirmed cases because there are many days that overlap each other. There are some confidence intervals for days that are wider than others, but at the end all days have nearly the same numbers with the difference of the size of the interval. The big size shows that there is a varied probability of getting this certain amount such as for Friday, which is the biggest interval, the interval goes from 12500 to 22500 which is a really high which shows that it is not accurate. Then, if we look at the confidence interval od Monday, it is narrower compared to the rest and this makes it more accurate because the difference between the interval is less which makes it more reliable.

```
statsfr
```

	dcases			ci95_hi	ci95_lo	weekdays
	mean	std	size			
weekdays						
Fri	17148.127451	27347.227106	102	22546.158660	11750.096242	Fri
Sat	14975.475248	18070.217337	101	18560.554900	11390.395595	Sat
Sun	13456.702970	17602.649041	101	16949.018405	9964.387536	Sun
Mon	6090.405941	13046.142380	101	8678.723431	3502.088450	Mon
Tue	15780.643564	22840.055655	101	20312.045554	11249.241574	Tue
Wed	17793.029703	25894.416151	101	22930.408116	12655.651290	Wed
Thu	18558.029703	26434.156239	101	23802.491012	13313.568394	Thu

```
statsfr.columns
```

```
MultiIndex([(  'dcases', 'mean'),
            (  'dcases',  'std'),
            (  'dcases', 'size'),
            ( 'ci95_hi',     ''),
            ( 'ci95_lo',     ''),
            ('weekdays',     '')],
           )
```

```
statsfr.index
```

```
CategoricalIndex(['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], categories=['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], or
```

```
statsfr['weekdays']=statsfr.index
```

```
statsfr.columns=['mean','std','size','ci95_hi','ci95_lo','weekdays']
```

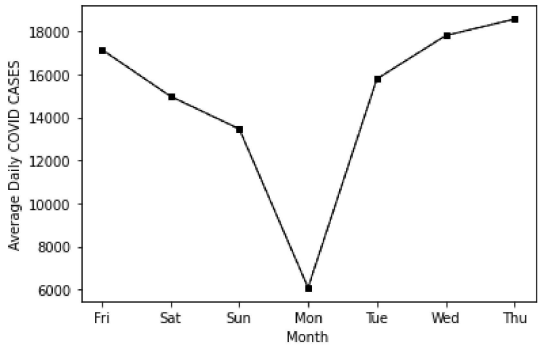
```
statsfr.columns
```

```
Index(['mean', 'std', 'size', 'ci95_hi', 'ci95_lo', 'weekdays'], dtype='object')
```

```
statsfr
```

	mean	std	size	ci95_hi	ci95_lo	weekdays
weekdays						
Fri	17148.127451	27347.227106	102	22546.158660	11750.096242	Fri
Sat	14975.475248	18070.217337	101	18560.554900	11390.395595	Sat
Sun	13456.702970	17602.649041	101	16949.018405	9964.387536	Sun
Mon	6090.405941	13046.142380	101	8678.723431	3502.088450	Mon
Tue	15780.643564	22840.055655	101	20312.045554	11249.241574	Tue
Wed	17793.029703	25894.416151	101	22930.408116	12655.651290	Wed
Thu	18558.029703	26434.156239	101	23802.491012	13313.568394	Thu

```
plt.plot( 'weekdays', 'mean', data=statsfr, marker='s', color='black', markersize=4,     linewidth=1, linestyle='--')
plt.plot( 'weekdays', 'mean', data=statsfr, marker='o', color='black',  markersize=4, linewidth=1,linestyle='-')
plt.xlabel("Month")
plt.ylabel("Average Daily COVID CASES")
plt.show()
```



The above line graph of the daily COVID cases shows that the numbers are all near each other for all weekdays except for Monday where it shows a massive drop in the number of cases and it then shows a massive increase in the number of cases. This is really something strange because how can a day cause a massive decrease in COVID cases then cause a massive increase in COVID cases. The only interpretation for this is that the data for Monday is not reliable because compared to the other data, it does not make sense.

Now analyzing the daily number of confirmed death cases

```
statsfr2=dffr.groupby("weekdays").agg({"ddeaths": [np.mean, np.std, np.size]})
```

```
statsfr2
```

	ddeaths		
	mean	std	size
weekdays			
Fri	240.294118	294.708333	102
Mon	190.603960	181.585907	101
Sat	111.643564	151.810908	101
Sun	87.277228	113.236842	101
Thu	160.712871	191.063358	101
Tue	277.980198	331.414845	101
Wed	167.871287	217.813620	101

```
statsfr2.index
```

```
Index(['Fri', 'Mon', 'Sat', 'Sun', 'Thu', 'Tue', 'Wed'], dtype='object', name='weekdays')
```

```
ci95_hi2 = []
ci95_lo2 = []
```

```
for i in statsfr2.index:
    m, s, n = statsfr2.loc[i]
    x=scipy.stats.t.interval(.95, n-1, m,s/np.sqrt(n-1))
    ci95_hi2.append(x[1])
    ci95_lo2.append(x[0])
```

```
ci95_hi2
```

```
[298.4661866078697,
 226.63008713989092,
 141.76241605427353,
 109.7430946508218,
 198.61929731676094,
 343.73195938213775,
 211.08488906531312]
```

```
ci95_lo2
```

```
[182.12204868624792,
 154.5778336521883,
 81.52471265859776,
 64.81136079472276,
 122.80644525749648,
 212.22843665746626,
 124.65768519211262]
```

```
statsfr2['ci95_hi2'] = ci95_hi2
statsfr2['ci95_lo2'] = ci95_lo2
print(statsfr2)
```

```
             ddeaths                     ci95_hi2    ci95_lo2
                mean         std size
weekdays
Fri        240.294118  294.708333  102  298.466187  182.122049
Mon        190.603960  181.585907  101  226.630087  154.577834
Sat        111.643564  151.810908  101  141.762416   81.524713
Sun         87.277228  113.236842  101  109.743095   64.811361
Thu        160.712871  191.063358  101  198.619297  122.806445
Tue        277.980198  331.414845  101  343.731959  212.228437
Wed        167.871287  217.813620  101  211.084889  124.657685
```

```
df_ci2= pd.DataFrame(statsfr2)
```

```
df_ci2
```

	ddeaths			ci95_hi2	ci95_lo2
	mean	std	size		
weekdays					
Fri	240.294118	294.708333	102	298.466187	182.122049
Mon	190.603960	181.585907	101	226.630087	154.577834
Sat	111.643564	151.810908	101	141.762416	81.524713
Sun	87.277228	113.236842	101	109.743095	64.811361
Thu	160.712871	191.063358	101	198.619297	122.806445
Tue	277.980198	331.414845	101	343.731959	212.228437
Wed	167.871287	217.813620	101	211.084889	124.657685

```
df_ci2= pd.DataFrame(statsfr2)
```

```
df_ci2['weekdays']=df_ci2.index
```

```
df_ci2
```

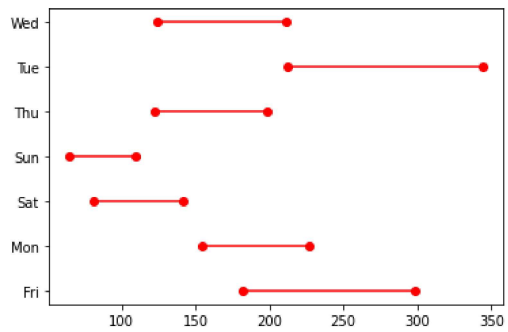
	ddeaths			ci95_hi2	ci95_lo2	weekdays
	mean	std	size			
weekdays						
Fri	240.294118	294.708333	102	298.466187	182.122049	Fri
Mon	190.603960	181.585907	101	226.630087	154.577834	Mon
Sat	111.643564	151.810908	101	141.762416	81.524713	Sat
Sun	87.277228	113.236842	101	109.743095	64.811361	Sun
Thu	160.712871	191.063358	101	198.619297	122.806445	Thu
Tue	277.980198	331.414845	101	343.731959	212.228437	Tue
Wed	167.871287	217.813620	101	211.084889	124.657685	Wed

```
df_ci2.columns
```

```
MultiIndex([( 'ddeaths', 'mean'),
            ( 'ddeaths',  'std'),
            ( 'ddeaths', 'size'),
            ('ci95_hi2',     ''),
            ('ci95_lo2',     ''),
            ('weekdays',     '')],
           )
```

```
for lb,ub,y in zip(df_ci2['ci95_lo2'],df_ci2['ci95_hi2'],range(len(df_ci2))):
    plt.plot((lb,ub),(y,y),'ro-')
plt.yticks(range(len(df_ci2)),list(df_ci2['weekdays']))
```

```
([<matplotlib.axis.YTick at 0x7f8dc2490430>,
  <matplotlib.axis.YTick at 0x7f8dc2e64f10>,
  <matplotlib.axis.YTick at 0x7f8dc2498a00>,
  <matplotlib.axis.YTick at 0x7f8dc28b1880>,
  <matplotlib.axis.YTick at 0x7f8dc28bb760>,
  <matplotlib.axis.YTick at 0x7f8dc28a2670>,
  <matplotlib.axis.YTick at 0x7f8dc2e7bf70>],
 [Text(0, 0, 'Fri'),
  Text(0, 1, 'Mon'),
  Text(0, 2, 'Sat'),
  Text(0, 3, 'Sun'),
  Text(0, 4, 'Thu'),
  Text(0, 5, 'Tue'),
  Text(0, 6, 'Wed')])
```



The confidence interval for the daily COVID deaths in France shows that the most occurring day of confirmed deaths is Tuesday, but its interval is big which shows that it is varied. There are some confidence intervals for days that are wider than others. Some days such as Saturday and Sunday have narrow confidence intervals which show that it is more accurate because the differences between the intervals are small;therefore they are more reliable. Then, other weekdays such as Tuesday and Friday have wide confidence intervals which show that they are less reliable because the values are more varied which means that a it can happpen but at a wide scale.

```
statsfr2
```

	ddeaths			ci95_hi2	ci95_lo2	weekdays
	mean	std	size			
weekdays						
Fri	240.294118	294.708333	102	22546.158660	11750.096242	Fri
Sat	111.643564	151.810908	101	18560.554900	11390.395595	Sat
Sun	87.277228	113.236842	101	16949.018405	9964.387536	Sun
Mon	190.603960	181.585907	101	8678.723431	3502.088450	Mon
Tue	277.980198	331.414845	101	20312.045554	11249.241574	Tue
Wed	167.871287	217.813620	101	22930.408116	12655.651290	Wed
Thu	160.712871	191.063358	101	23802.491012	13313.568394	Thu

```
statsfr2.columns
```

```
MultiIndex([( 'ddeaths', 'mean'),
            ( 'ddeaths',  'std'),
            ( 'ddeaths', 'size'),
            ('ci95_hi2',     ''),
            ('ci95_lo2',     ''),
            ('weekdays',     '')],
           )
```

```
statsfr2.index
```

```
CategoricalIndex(['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], categories=['Fri', 'Sat', 'Sun', 'Mon', 'Tue', 'Wed', 'Thu'], or
```

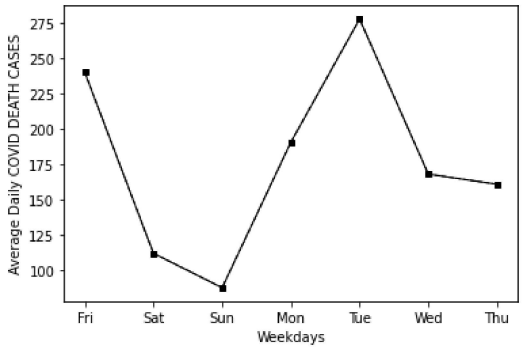
```
statsfr2.columns=['mean','std','size','ci95_hi2','ci95_lo2','weekdays']
```

```
statsfr2['weekdays']=statsfr2.index
```

```
statsfr2
```

	mean	std	size	ci95_hi2	ci95_lo2	weekdays
weekdays						
Fri	240.294118	294.708333	102	22546.158660	11750.096242	Fri
Sat	111.643564	151.810908	101	18560.554900	11390.395595	Sat
Sun	87.277228	113.236842	101	16949.018405	9964.387536	Sun
Mon	190.603960	181.585907	101	8678.723431	3502.088450	Mon
Tue	277.980198	331.414845	101	20312.045554	11249.241574	Tue
Wed	167.871287	217.813620	101	22930.408116	12655.651290	Wed
Thu	160.712871	191.063358	101	23802.491012	13313.568394	Thu

```
plt.plot( 'weekdays', 'mean', data=statsfr2, marker='s', color='black', markersize=4,     linewidth=1, linestyle='--')
plt.plot( 'weekdays', 'mean', data=statsfr2, marker='o', color='black',  markersize=4, linewidth=1,linestyle='-')
plt.xlabel("Weekdays")
plt.ylabel("Average Daily COVID DEATH CASES")
plt.show()
```



The above line graph of the daily COVID death shows that the numbers are fluctuating between all days. There are some days with very low death cases such as Sunday and Saturday, then there are days with very high death cases such as Tuesday and Friday. The other days have nearly the same amount of death cases.

Now comparing between 2020 and 2021 in terms of cases and death cases in France

1. In terms of cases

```
df['date'][0]
```

```
'2020-02-24'
```

```
df['date'] = pd.to_datetime(df['date'],format='%Y-%m-%d')
df['date'][0]
```

```
Timestamp('2020-02-24 00:00:00')
```

```
df['year'] = pd. DatetimeIndex(df['date']). year
```

```
df['year'][0]
```

```
2020
```

```
def ci_lb2(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean - margin_of_error
```

```
x=df['dcases']
```

```
ci_lb2(x)
```

```
2285.1835480837276
```

```
def ci_ub2(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean + margin_of_error
```

```
ci_ub2(x)
```

```
2422.2624439548904
```

```
statsdcases=df.groupby(['country','year','month']).agg({"dcases": [np.mean, np.std, np.size,ci_ub2,ci_lb2]})
```

```
statsdcases
```

			dcases				
			mean	std	size	ci_ub2	ci_lb2
country	year	month					
Afghanistan	2020	Jan	NaN	NaN	NaN	NaN	NaN
		Feb	0.833333	2.041241	6.0	2.975485	-1.308818
		Mar	5.258065	10.871883	31.0	9.245904	1.270225
		Apr	55.366667	40.385627	30.0	70.446908	40.286426
		May	430.741935	266.692078	31.0	528.565379	332.918491
...	...	...	...	...	...	...	...
Zimbabwe	2021	Aug	513.322581	386.841948	31.0	655.217353	371.427809
		Sep	201.566667	135.119789	30.0	252.021225	151.112108
		Oct	69.580645	58.035492	31.0	90.868235	48.293055
		Nov	54.933333	82.622087	30.0	85.784928	24.081739
		Dec	2536.548387	2572.199964	31.0	3480.038951	1593.057823

4488 rows × 5 columns

```
statsdcases=statsdcases.reset_index()
```

```
statsdcases
```

	index	country	year	month	dcases				
					mean	std	size	ci_ub2	ci_lb2
0	0	Afghanistan	2020	Jan	NaN	NaN	NaN	NaN	NaN
1	1	Afghanistan	2020	Feb	0.833333	2.041241	6.0	2.975485	-1.308818
2	2	Afghanistan	2020	Mar	5.258065	10.871883	31.0	9.245904	1.270225
3	3	Afghanistan	2020	Apr	55.366667	40.385627	30.0	70.446908	40.286426
4	4	Afghanistan	2020	May	430.741935	266.692078	31.0	528.565379	332.918491
...	...	...	...	...	...	...	...	...	...
4483	4483	Zimbabwe	2021	Aug	513.322581	386.841948	31.0	655.217353	371.427809
4484	4484	Zimbabwe	2021	Sep	201.566667	135.119789	30.0	252.021225	151.112108
4485	4485	Zimbabwe	2021	Oct	69.580645	58.035492	31.0	90.868235	48.293055
4486	4486	Zimbabwe	2021	Nov	54.933333	82.622087	30.0	85.784928	24.081739
4487	4487	Zimbabwe	2021	Dec	2536.548387	2572.199964	31.0	3480.038951	1593.057823

4488 rows × 9 columns

```
statsFR=statsdcases[(statsdcases['country']=='France') & (statsdcases['year']==2021)]
```

```
statsFR
```

	index	country	year	month	dcases				
					mean	std	size	ci_ub2	ci_lb2
1428	1428	France	2021	Jan	18655.935484	7238.793836	31.0	21311.146499	16000.724468
1429	1429	France	2021	Feb	19989.071429	9397.752308	28.0	23633.139352	16345.003505
1430	1430	France	2021	Mar	28693.483871	13879.207174	31.0	33784.418164	23602.549578
1431	1431	France	2021	Apr	32421.433333	27492.203564	30.0	42687.190857	22155.675810
1432	1432	France	2021	May	12900.645161	7670.719026	31.0	15714.287615	10087.002707
1433	1433	France	2021	Jun	3616.466667	3114.443823	30.0	4779.419103	2453.514231
1434	1434	France	2021	Jul	11394.129032	9338.220451	31.0	14819.415947	7968.842117
1435	1435	France	2021	Aug	20787.129032	9213.403131	31.0	24166.632585	17407.625480
1436	1436	France	2021	Sep	9033.533333	6421.571141	30.0	11431.387405	6635.679262
1437	1437	France	2021	Oct	5241.903226	2192.836996	31.0	6046.242330	4437.564122
1438	1438	France	2021	Nov	17001.600000	12090.447958	30.0	21516.247464	12486.952536
1439	1439	France	2021	Dec	74168.000000	56549.481173	31.0	94910.517156	53425.482844

```
statsFR.columns
```

```
MultiIndex([(  'index',       ''),
            ('country',       ''),
            (   'year',       ''),
            (  'month',       ''),
            ( 'dcases',   'mean'),
            ( 'dcases',    'std'),
            ( 'dcases',   'size'),
            ( 'dcases', 'ci_ub2'),
            ( 'dcases', 'ci_lb2')],
           )
```

```
statsFR21=statsdcases[(statsdcases['country']=='France')
  & (statsdcases['year']==2021)]
statsFR21
```

	index	country	year	month	dcases				
					mean	std	size	ci_ub2	ci_lb2
1428	1428	France	2021	Jan	18655.935484	7238.793836	31.0	21311.146499	16000.724468
1429	1429	France	2021	Feb	19989.071429	9397.752308	28.0	23633.139352	16345.003505
1430	1430	France	2021	Mar	28693.483871	13879.207174	31.0	33784.418164	23602.549578
1431	1431	France	2021	Apr	32421.433333	27492.203564	30.0	42687.190857	22155.675810
1432	1432	France	2021	May	12900.645161	7670.719026	31.0	15714.287615	10087.002707
1433	1433	France	2021	Jun	3616.466667	3114.443823	30.0	4779.419103	2453.514231
1434	1434	France	2021	Jul	11394.129032	9338.220451	31.0	14819.415947	7968.842117
1435	1435	France	2021	Aug	20787.129032	9213.403131	31.0	24166.632585	17407.625480
1436	1436	France	2021	Sep	9033.533333	6421.571141	30.0	11431.387405	6635.679262
1437	1437	France	2021	Oct	5241.903226	2192.836996	31.0	6046.242330	4437.564122
1438	1438	France	2021	Nov	17001.600000	12090.447958	30.0	21516.247464	12486.952536
1439	1439	France	2021	Dec	74168.000000	56549.481173	31.0	94910.517156	53425.482844

```
statsFR20=statsdcases[(statsdcases['country']=='France')
  & (statsdcases['year']==2020)]
statsFR20
```

	index	country	year	month	dcases				
					mean	std	size	ci_ub2	ci_lb2
1416	1416	France	2020	Jan	0.625000	0.744024	8.0	1.247019	0.002981
1417	1417	France	2020	Feb	3.275862	9.153050	29.0	6.757496	-0.205772
1418	1418	France	2020	Mar	1683.258065	1810.969832	31.0	2347.527162	1018.988967
1419	1419	France	2020	Apr	4676.966667	9414.028521	30.0	8192.222688	1161.710645
1420	1420	France	2020	May	727.516129	873.594905	31.0	1047.953327	407.078931
1421	1421	France	2020	Jun	584.966667	762.203045	30.0	869.577961	300.355372
1422	1422	France	2020	Jul	741.774194	600.058203	31.0	961.877319	521.671068
1423	1423	France	2020	Aug	3029.709677	2423.309434	31.0	3918.586754	2140.832601
1424	1424	France	2020	Sep	9491.100000	3343.298189	30.0	10739.508061	8242.691939
1425	1425	France	2020	Oct	26080.741935	15176.536825	31.0	31647.540586	20513.943285
1426	1426	France	2020	Nov	30285.166667	25170.760112	30.0	39684.082959	20886.250374
1427	1427	France	2020	Dec	12930.000000	5586.351206	31.0	14979.090166	10880.909834

```
statsFR20.columns=['index','country','year','month','mean','std','size','ci_lb2','ci_ub2']
```

```
statsFR21.columns=['index','country','year','month','mean','std','size','ci_lb2','ci_ub2']
```

```
x=statsFR20['month']
x
```

```
y1=statsFR20['mean']
y1
```

```
y2=statsFR21['mean']
y2
```

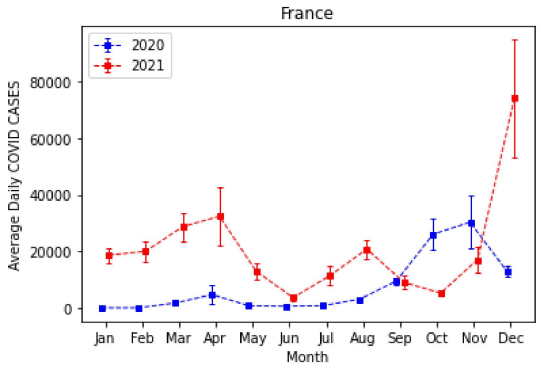
```
ci_lb_ub20=[statsFR20['ci_lb2'],statsFR20['ci_ub2']]
err20 = np.abs(ci_lb_ub20 - statsFR20['mean'].to_numpy())
```

```
ci_lb_ub21=[statsFR21['ci_lb2'],statsFR21['ci_ub2']]
err21 = np.abs(ci_lb_ub21 - statsFR21['mean'].to_numpy())
```

```
from matplotlib.transforms import Affine2D
```

```
fig, ax = plt.subplots()

trans1 = Affine2D().translate(-0.1, 0.0) + ax.transData
trans2 = Affine2D().translate(+0.1, 0.0) + ax.transData
plt.errorbar('month', 'mean',  yerr=err20, data=statsFR20,marker='s', capsize=2,
             color='blue', markersize=4, linewidth=1, linestyle='--',transform=trans1)
plt.errorbar('month', 'mean',  yerr=err21, data=statsFR21,marker='s', capsize=2,
             color='red', markersize=4, linewidth=1, linestyle='--',transform=trans2)
plt.legend(['2020','2021'])
plt.xlabel("Month")
plt.ylabel("Average Daily COVID CASES")
plt.title("France")
plt.show()
```



The line graph above is the average daily covid cases between 2020 and 2021 with error bars. The graph shows that France did not suffer from any covid cases until September 2020 and then it increased and then decreased again in December. Then, for 2021 the base rate was 20 thousand case then the number kept on increasing and decreasing. The error bar for the last point in December is very large from both sides which show that this number is not as reliable as the other number. This shows that it might be a false point because it does not match with the other data since it shows a drastic increase from November to December by nearly 60 thousand cases which does not make sense.

2. In terms of death

```
def ci_lb3(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean - margin_of_error
```

```
x=df['ddeaths']
```

```
ci_lb3(x)
```

```
43.18608989544058
```

```
def ci_ub3(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean + margin_of_error
```

```
ci_ub3(x)
```

```
45.39995896367227
```

```
statsddeaths=df.groupby(['country','year','month']).agg({"ddeaths": [np.mean, np.std, np.size,ci_ub3,ci_lb3]})
```

```
statsddeaths
```

			ddeaths				
			mean	std	size	ci_ub3	ci_lb3
country	year	month					
Afghanistan	2020	Apr	1.866667	2.285386	30	2.720044	1.013290
		Aug	4.225806	6.432779	31	6.585369	1.866244
		Dec	13.741935	6.717975	31	16.206108	11.277763
		Feb	0.000000	0.000000	6	0.000000	0.000000
		Jul	17.290323	15.064735	31	22.816112	11.764533
...	...	...	...	...	...	...	...
Zimbabwe	2021	Mar	1.935484	1.730809	31	2.570350	1.300618
		May	0.870968	1.087564	31	1.269889	0.472046
		Nov	0.966667	1.351457	30	1.471309	0.462024
		Oct	1.774194	1.909794	31	2.474712	1.073676
		Sep	6.800000	5.803685	30	8.967132	4.632868

4126 rows × 5 columns

```
statsddeaths=statsddeaths.reset_index()
```

```
statsFR2=statsddeaths[(statsddeaths['country']=='France') & (statsddeaths['year']==2021)]
```

```
statsFR2
```

	country	year	month	ddeaths				
				mean	std	size	ci_ub3	ci_lb3
1331	France	2021	Apr	295.933333	86.466630	30	328.220504	263.646163
1332	France	2021	Aug	92.419355	43.202449	31	108.266141	76.572569
1333	France	2021	Dec	148.935484	64.952770	31	172.760352	125.110615
1334	France	2021	Feb	370.678571	225.874113	28	458.263409	283.093734
1335	France	2021	Jan	369.096774	218.571324	31	449.269383	288.924165
1336	France	2021	Jul	25.870968	14.368349	31	31.141321	20.600615
1337	France	2021	Jun	52.200000	27.508494	30	62.471840	41.928160
1338	France	2021	Mar	297.387097	143.757128	31	350.117637	244.656557
1339	France	2021	May	161.838710	71.109351	31	187.921830	135.755589
1340	France	2021	Nov	49.566667	31.250582	30	61.235826	37.897508
1341	France	2021	Oct	37.129032	17.615792	31	43.590557	30.667508
1342	France	2021	Sep	84.933333	47.229399	30	102.569081	67.297586

```
statsFR221=statsddeaths[(statsddeaths['country']=='France')
  & (statsddeaths['year']==2021)]
statsFR221
```

	country	year	month	ddeaths				
				mean	std	size	ci_ub3	ci_lb3
1331	France	2021	Apr	295.933333	86.466630	30	328.220504	263.646163
1332	France	2021	Aug	92.419355	43.202449	31	108.266141	76.572569
1333	France	2021	Dec	148.935484	64.952770	31	172.760352	125.110615
1334	France	2021	Feb	370.678571	225.874113	28	458.263409	283.093734
1335	France	2021	Jan	369.096774	218.571324	31	449.269383	288.924165
1336	France	2021	Jul	25.870968	14.368349	31	31.141321	20.600615
1337	France	2021	Jun	52.200000	27.508494	30	62.471840	41.928160
1338	France	2021	Mar	297.387097	143.757128	31	350.117637	244.656557
1339	France	2021	May	161.838710	71.109351	31	187.921830	135.755589
1340	France	2021	Nov	49.566667	31.250582	30	61.235826	37.897508
1341	France	2021	Oct	37.129032	17.615792	31	43.590557	30.667508
1342	France	2021	Sep	84.933333	47.229399	30	102.569081	67.297586

```
statsFR220=statsddeaths[(statsddeaths['country']=='France')
  & (statsddeaths['year']==2020)]
statsFR220
```

	country	year	month	ddeaths				
				mean	std	size	ci_ub3	ci_lb3
1319	France	2020	Apr	694.100000	339.189841	30	820.755568	567.444432
1320	France	2020	Aug	12.193548	10.215737	31	15.940711	8.446386
1321	France	2020	Dec	385.161290	239.988902	31	473.189930	297.132650
1322	France	2020	Feb	0.068966	0.257881	29	0.167058	-0.029127
1323	France	2020	Jan	0.000000	0.000000	8	0.000000	0.000000
1324	France	2020	Jul	14.064516	16.621142	31	20.161200	7.967832
1325	France	2020	Jun	34.700000	28.675533	30	45.407620	23.992380
1326	France	2020	Mar	113.677419	148.476572	31	168.139066	59.215773
1327	France	2020	May	153.322581	120.334087	31	197.461480	109.183681
1328	France	2020	Nov	534.166667	358.686501	30	668.102407	400.230926
1329	France	2020	Oct	157.096774	135.182680	31	206.682182	107.511367
1330	France	2020	Sep	45.066667	37.734036	30	59.156787	30.976546

```
statsFR220.columns=['country','year','month','mean','std','size','ci_lb3','ci_ub3']
```

```
statsFR221.columns=['country','year','month','mean','std','size','ci_lb3','ci_ub3']
```

```
x=statsFR220['month']
x
```

```
y3=statsFR220['mean']
y3
```

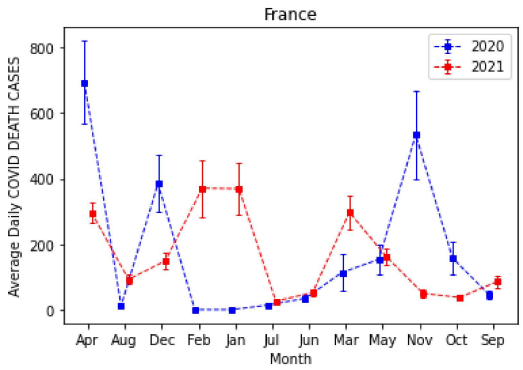
```
y4=statsFR221['mean']
y4
```

```
ci_lb_ub220=[statsFR220['ci_lb3'],statsFR220['ci_ub3']]
err220 = np.abs(ci_lb_ub220 - statsFR220['mean'].to_numpy())
```

```
ci_lb_ub221=[statsFR221['ci_lb3'],statsFR221['ci_ub3']]
err221 = np.abs(ci_lb_ub221 - statsFR221['mean'].to_numpy())
```

```
fig, ax = plt.subplots()

trans1 = Affine2D().translate(-0.1, 0.0) + ax.transData
trans2 = Affine2D().translate(+0.1, 0.0) + ax.transData
plt.errorbar('month', 'mean',  yerr=err220, data=statsFR220,marker='s', capsize=2,
             color='blue', markersize=4, linewidth=1, linestyle='--',transform=trans1)
plt.errorbar('month', 'mean',  yerr=err221, data=statsFR221,marker='s', capsize=2,
             color='red', markersize=4, linewidth=1, linestyle='--',transform=trans2)
plt.legend(['2020','2021'])
plt.xlabel("Month")
plt.ylabel("Average Daily COVID DEATH CASES")
plt.title("France")
plt.show()
```



The line graph above is the average daily covid deaths between 2020 and 2021 with error bars. The graph shows that France did not suffer from any covid deaths until September 2020 and then it increased and then decreased again in December. Then, for 2021 the base rate was 20 thousand deaths which is a massive rate, then the number kept on fluctuating. The error bar for the last point in December 2021 is very large that it takes the whole graph from both sides which show that this number is not as reliable as the other number. This shows that it might be a false point because it does not match with the other data since it shows a drastic increase from November to December by nearly 50 thousand cases which does not make sense.

Comparing between 2020 and 2021 in terms of several factors like regions, income, and continents.

1. In terms of region: confirmed COVID 19 cases

Region no.1 East Asia and Pacific

```
df['date'][0]
```

```
'2020-02-24'
```

```
df['date'] = pd.to_datetime(df['date'],format='%Y-%m-%d')
```

```
df['date'][0]
```

```
Timestamp('2020-02-24 00:00:00')
```

```
df['year'] = pd. DatetimeIndex(df['date']). year
```

```
df['year'][0]
```

```
2020
```

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

```
def ci_lb4(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean - margin_of_error
```

```
x=df['dcases']
```

```
ci_lb4(x)
```

```
2285.1835480837276
```

```
def ci_ub4(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean + margin_of_error
```

```
ci_ub4(x)
```

```
2422.2624439548904
```

```
rdcases=df.groupby(['region','year','month']).agg({"dcases": [np.mean, np.std, np.size,ci_ub4,ci_lb4]})
```

```
rdcases
```

			dcases				
			mean	std	size	ci_ub4	ci_lb4
region	year	month					
East Asia & Pacific	2020	Apr	92.700000	177.828711	570	107.329764	78.070236
		Aug	423.417657	1044.901057	589	507.976780	338.858534
		Dec	630.715288	1475.101424	713	739.173912	522.256663
		Feb	250.304795	1155.872616	292	383.435013	117.174576
		Jan	126.679487	436.945076	78	225.195380	28.163595
...	...	...	...	...	...	...	...
Sub-Saharan Africa	2021	Mar	161.274537	393.852860	1457	181.514676	141.034398
		May	128.577213	488.161505	1457	153.663883	103.490544
		Nov	89.737589	588.981229	1410	120.506577	58.968601
		Oct	87.528483	293.259577	1457	102.599123	72.457843
		Sep	247.950355	1021.166824	1410	301.297165	194.603545

166 rows × 5 columns

```
rdcases=rdcases.reset_index()
```

```
statsR=rdcases[(rdcases['region']=='East Asia & Pacific ') & (rdcases['year']==2020)]
```

```
statsR
```

	region	year	month	dcases				
				mean	std	size	ci_ub4	ci_lb4

```
statsR.columns
```

```
MultiIndex([('region',       ''),
            (  'year',       ''),
            ( 'month',       ''),
            ('dcases',   'mean'),
            ('dcases',    'std'),
            ('dcases',   'size'),
            ('dcases', 'ci_ub4'),
            ('dcases', 'ci_lb4')],
           )
```

```
statsR21=rdcases[(rdcases['region']=='East Asia & Pacific')
  & (rdcases['year']==2021)]
statsR21
```

	region	year	month	dcases				
				mean	std	size	ci_ub4	ci_lb4
12	East Asia & Pacific	2021	Apr	1060.565217	2329.091311	690	1234.655140	886.475295
13	East Asia & Pacific	2021	Aug	4614.985411	7931.303734	754	5182.014870	4047.955952
14	East Asia & Pacific	2021	Dec	1599.202581	3930.662042	775	1876.370268	1322.034893
15	East Asia & Pacific	2021	Feb	713.222050	1994.214109	644	867.532447	558.911653
16	East Asia & Pacific	2021	Jan	974.037868	2493.902759	713	1157.405099	790.670637
17	East Asia & Pacific	2021	Jul	3584.767473	8539.384316	744	4199.372652	2970.162294
18	East Asia & Pacific	2021	Jun	1386.216667	3044.425526	720	1608.967267	1163.466066
19	East Asia & Pacific	2021	Mar	654.294530	1684.235185	713	778.129969	530.459091
20	East Asia & Pacific	2021	May	1146.808803	2127.435975	727	1301.712581	991.905025
21	East Asia & Pacific	2021	Nov	1447.053333	2829.960769	750	1649.915113	1244.191554
22	East Asia & Pacific	2021	Oct	1877.485161	3075.700882	775	2094.365903	1660.604419
23	East Asia & Pacific	2021	Sep	3389.320000	5723.491086	750	3799.600453	2979.039547

```
statsR20=rdcases[(rdcases['region']=='East Asia & Pacific')
  & (rdcases['year']==2020)]
statsR20
```

	region	year	month	dcases				
				mean	std	size	ci_ub4	ci_lb4
0	East Asia & Pacific	2020	Apr	92.700000	177.828711	570	107.329764	78.070236
1	East Asia & Pacific	2020	Aug	423.417657	1044.901057	589	507.976780	338.858534
2	East Asia & Pacific	2020	Dec	630.715288	1475.101424	713	739.173912	522.256663
3	East Asia & Pacific	2020	Feb	250.304795	1155.872616	292	383.435013	117.174576
4	East Asia & Pacific	2020	Jan	126.679487	436.945076	78	225.195380	28.163595
5	East Asia & Pacific	2020	Jul	252.157895	571.667546	589	298.420367	205.895422
6	East Asia & Pacific	2020	Jun	112.329825	270.676176	570	134.598043	90.061606
7	East Asia & Pacific	2020	Mar	55.969828	102.512114	464	65.321753	46.617902
8	East Asia & Pacific	2020	May	86.125637	193.352744	589	101.772801	70.478472
9	East Asia & Pacific	2020	Nov	467.615964	1031.543735	664	546.220071	389.011857
10	East Asia & Pacific	2020	Oct	447.566069	1000.134807	613	526.895826	368.236311
11	East Asia & Pacific	2020	Sep	420.385965	1060.530412	570	507.634584	333.137346

```
statsR20.columns=['region','year','month','mean','std','size','ci_lb4','ci_ub4']
```

```
statsR21.columns=['region','year','month','mean','std','size','ci_lb4','ci_ub4']
```

```
x=statsR20['region']
x
```

```
y1=statsR20['mean']
y1
```

```
y2=statsR21['mean']
y2
```

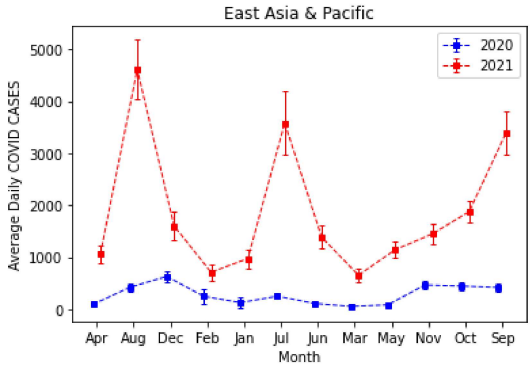
```
ci_lb_ubR20=[statsR20['ci_lb4'],statsR20['ci_ub4']]
errR20 = np.abs(ci_lb_ubR20 - statsR20['mean'].to_numpy())
```

```
ci_lb_ubR21=[statsR21['ci_lb4'],statsR21['ci_ub4']]
errR21 = np.abs(ci_lb_ubR21 - statsR21['mean'].to_numpy())
```

```
from matplotlib.transforms import Affine2D
```

```
fig, ax = plt.subplots()

trans1 = Affine2D().translate(-0.1, 0.0) + ax.transData
trans2 = Affine2D().translate(+0.1, 0.0) + ax.transData
plt.errorbar('month', 'mean',  yerr=errR20, data=statsR20,marker='s', capsize=2,
             color='blue', markersize=4, linewidth=1, linestyle='--',transform=trans1)
plt.errorbar('month', 'mean',  yerr=errR21, data=statsR21,marker='s', capsize=2,
             color='red', markersize=4, linewidth=1, linestyle='--',transform=trans2)
plt.legend(['2020','2021'])
plt.xlabel("Month")
plt.ylabel("Average Daily COVID CASES")
plt.title("East Asia & Pacific")
plt.show()
```



The line graph above is the average daily covid cases between 2020 and 2021 with error bars. The graph shows that the East Asia and Pacific region did not suffer from any cases deaths until August 2020 and then kept on increaing and decreasing but not significantly. Then, for 2021 the base rate was only 1 thousand cases which is a very small rate, then the number kept on fluctuating. Some error bars are bigger than others in the 2021 points which show that they may be inaccurate; therefore, not that reliable.

Region no.2 Europe and Central Asia

```
statsR2=rdcases[(rdcases['region']=='Europe & Central Asia') & (rdcases['year']==2020)]
```

```
statsR2
```

	region	year	month	dcases				
				mean	std	size	ci_ub4	ci_lb4
24	Europe & Central Asia	2020	Apr	693.848667	1939.781037	1500	792.092653	595.604680
25	Europe & Central Asia	2020	Aug	557.484503	1427.035570	1581	627.880793	487.088214
26	Europe & Central Asia	2020	Dec	5276.588868	21992.213905	1581	6361.474414	4191.703322
27	Europe & Central Asia	2020	Feb	4.819936	24.944837	311	7.603155	2.036716
28	Europe & Central Asia	2020	Jan	0.894737	0.936586	19	1.346157	0.443317
29	Europe & Central Asia	2020	Jul	398.997470	1080.452784	1581	452.296679	345.698261
30	Europe & Central Asia	2020	Jun	351.989542	1137.680770	1530	409.040996	294.938089
31	Europe & Central Asia	2020	Mar	338.220733	1065.272767	1418	393.714208	282.727259
32	Europe & Central Asia	2020	May	424.242884	1403.684633	1581	493.487262	354.998506
33	Europe & Central Asia	2020	Nov	5183.352288	9110.089031	1530	5640.197332	4726.507243
34	Europe & Central Asia	2020	Oct	3193.193548	6395.982837	1581	3508.710184	2877.676913
35	Europe & Central Asia	2020	Sep	1008.238562	2527.394697	1530	1134.980215	881.496909

```
statsR2.columns
```

```
MultiIndex([('region',       ''),
            (  'year',       ''),
            ( 'month',       ''),
            ('dcases',   'mean'),
            ('dcases',    'std'),
            ('dcases',   'size'),
            ('dcases', 'ci_ub4'),
            ('dcases', 'ci_lb4')],
           )
```

```
statsR221=rdcases[(rdcases['region']=='Europe & Central Asia')
  & (rdcases['year']==2021)]
statsR221
```

	region	year	month	dcases				
				mean	std	size	ci_ub4	ci_lb4
36	Europe & Central Asia	2021	Apr	4400.757516	9911.409826	1530	4897.786519	3903.728514
37	Europe & Central Asia	2021	Aug	3180.007590	6844.920329	1581	3517.670508	2842.344672
38	Europe & Central Asia	2021	Dec	9411.908918	22368.523899	1581	10515.358001	8308.459836
39	Europe & Central Asia	2021	Feb	3034.478291	5547.740717	1428	3322.462489	2746.494094
40	Europe & Central Asia	2021	Jan	4423.700822	9236.689814	1581	4879.350777	3968.050868
41	Europe & Central Asia	2021	Jul	2646.413662	7396.965106	1581	3011.309191	2281.518133
42	Europe & Central Asia	2021	Jun	1075.566013	2875.930124	1530	1219.785726	931.346300
43	Europe & Central Asia	2021	Mar	4017.991145	6963.850364	1581	4361.520934	3674.461356
44	Europe & Central Asia	2021	May	1864.763441	3692.159287	1581	2046.899276	1682.627606
45	Europe & Central Asia	2021	Nov	6763.426144	11088.295989	1530	7319.472639	6207.379649
46	Europe & Central Asia	2021	Oct	4243.963947	8383.799608	1581	4657.540454	3830.387440
47	Europe & Central Asia	2021	Sep	3095.722222	6524.122498	1530	3422.888403	2768.556042

```
statsR220=rdcases[(rdcases['region']=='Europe & Central Asia')
  & (rdcases['year']==2020)]
statsR20
```

	region	year	month	mean	std	size	ci_lb4	ci_ub4
0	East Asia & Pacific	2020	Apr	92.700000	177.828711	570	107.329764	78.070236
1	East Asia & Pacific	2020	Aug	423.417657	1044.901057	589	507.976780	338.858534
2	East Asia & Pacific	2020	Dec	630.715288	1475.101424	713	739.173912	522.256663
3	East Asia & Pacific	2020	Feb	250.304795	1155.872616	292	383.435013	117.174576
4	East Asia & Pacific	2020	Jan	126.679487	436.945076	78	225.195380	28.163595
5	East Asia & Pacific	2020	Jul	252.157895	571.667546	589	298.420367	205.895422
6	East Asia & Pacific	2020	Jun	112.329825	270.676176	570	134.598043	90.061606
7	East Asia & Pacific	2020	Mar	55.969828	102.512114	464	65.321753	46.617902
8	East Asia & Pacific	2020	May	86.125637	193.352744	589	101.772801	70.478472
9	East Asia & Pacific	2020	Nov	467.615964	1031.543735	664	546.220071	389.011857
10	East Asia & Pacific	2020	Oct	447.566069	1000.134807	613	526.895826	368.236311
11	East Asia & Pacific	2020	Sep	420.385965	1060.530412	570	507.634584	333.137346

```
statsR220.columns=['region','year','month','mean','std','size','ci_lb4','ci_ub4']
```

```
statsR221.columns=['region','year','month','mean','std','size','ci_lb4','ci_ub4']
```

```
x=statsR220['region']
x
```

```
y1=statsR220['mean']
y1
```

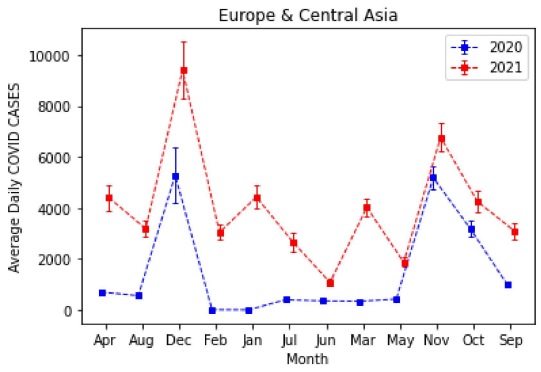
```
y2=statsR221['mean']
y2
```

```
ci_lb_ubR220=[statsR220['ci_lb4'],statsR220['ci_ub4']]
errR220 = np.abs(ci_lb_ubR220 - statsR220['mean'].to_numpy())
```

```
ci_lb_ubR221=[statsR221['ci_lb4'],statsR221['ci_ub4']]
errR221 = np.abs(ci_lb_ubR221 - statsR221['mean'].to_numpy())
```

```
fig, ax = plt.subplots()

trans1 = Affine2D().translate(-0.1, 0.0) + ax.transData
trans2 = Affine2D().translate(+0.1, 0.0) + ax.transData
plt.errorbar('month', 'mean',  yerr=errR220, data=statsR220,marker='s', capsize=2,
             color='blue', markersize=4, linewidth=1, linestyle='--',transform=trans1)
plt.errorbar('month', 'mean',  yerr=errR221, data=statsR221,marker='s', capsize=2,
             color='red', markersize=4, linewidth=1, linestyle='--',transform=trans2)
plt.legend(['2020','2021'])
plt.xlabel("Month")
plt.ylabel("Average Daily COVID CASES")
plt.title("Europe & Central Asia")
plt.show()
```



The line graph above is the average daily covid cases between 2020 and 2021 with error bars. The graph shows that the Europe and Central Asia region did not suffer from any cases deaths until August 2020 and then kept on increaing and decreasing but not significantly. Then, for 2021 the base rate was only 1 thousand cases which is a very small rate, then the number kept on fluctuating. Some error bars are bigger than others in the 2021 points which show that they may be inaccurate; therefore, not that reliable.

2. In terms of income: confirmed COVID 19 deaths

No.1 low income

```
df['date'][0]
```

```
'2020-02-24'
```

```
df['date'] = pd.to_datetime(df['date'],format='%Y-%m-%d')
```

```
df['date'][0]
```

```
Timestamp('2020-02-24 00:00:00')
```

```
df['year'] = pd. DatetimeIndex(df['date']). year
```

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

```
x=df['ddeaths']
```

```
def ci_lb5(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean - margin_of_error
```

```
ci_lb5(x)
```

```
43.18608989544058
```

```
def ci_ub5(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean + margin_of_error
```

```
ci_ub5(x)
```

```
45.39995896367227
```

```
incdeaths=df.groupby(['income','year','month']).agg({"ddeaths": [np.mean, np.std, np.size,ci_ub5,ci_lb5]})
```

```
incdeaths
```

			ddeaths				
			mean	std	size	ci_ub5	ci_lb5
income	year	month					
High income	2020	Apr	98.662573	318.565638	1710	113.772301	83.552845
		Aug	21.320883	132.611288	1767	27.508281	15.133485
		Dec	114.995473	379.800723	1767	132.716274	97.274671
		Feb	0.108268	0.597571	508	0.160356	0.056179
		Jan	0.000000	0.000000	75	0.000000	0.000000
...	...	...	...	...	...	...	...
Upper middle income	2021	Mar	93.728196	337.437017	1674	109.904429	77.551963
		May	96.706691	295.246678	1674	110.860381	82.553000
		Nov	56.883951	171.705193	1620	65.251510	48.516391
		Oct	61.903226	160.512807	1674	69.597973	54.208478
		Sep	81.536420	176.995456	1620	90.161785	72.911054

96 rows × 5 columns

```
incdeaths=incdeaths.reset_index()
```

```
incdeaths
```

	income	year	month	ddeaths				
				mean	std	size	ci_ub5	ci_lb5
0	High income	2020	Apr	98.662573	318.565638	1710	113.772301	83.552845
1	High income	2020	Aug	21.320883	132.611288	1767	27.508281	15.133485
2	High income	2020	Dec	114.995473	379.800723	1767	132.716274	97.274671
3	High income	2020	Feb	0.108268	0.597571	508	0.160356	0.056179
4	High income	2020	Jan	0.000000	0.000000	75	0.000000	0.000000
...	...	...	...	...	...	...	...	...
91	Upper middle income	2021	Mar	93.728196	337.437017	1674	109.904429	77.551963
92	Upper middle income	2021	May	96.706691	295.246678	1674	110.860381	82.553000
93	Upper middle income	2021	Nov	56.883951	171.705193	1620	65.251510	48.516391
94	Upper middle income	2021	Oct	61.903226	160.512807	1674	69.597973	54.208478
95	Upper middle income	2021	Sep	81.536420	176.995456	1620	90.161785	72.911054

96 rows × 8 columns

```
statsI=incdeaths[(incdeaths['income']=='Low income ') & (incdeaths['year']==2020)]
```

```
statsI.columns
```

```
MultiIndex([( 'income',       ''),
            (   'year',       ''),
            (  'month',       ''),
            ('ddeaths',   'mean'),
            ('ddeaths',    'std'),
            ('ddeaths',   'size'),
            ('ddeaths', 'ci_ub5'),
            ('ddeaths', 'ci_lb5')],
           )
```

```
statsI21=incdeaths[(incdeaths['income']=='Low income')
  & (incdeaths['year']==2021)]
statsI21
```

	income	year	month	ddeaths				
				mean	std	size	ci_ub5	ci_lb5
36	Low income	2021	Apr	3.013793	6.546447	870	3.449405	2.578182
37	Low income	2021	Aug	4.560623	8.160108	899	5.094756	4.026489
38	Low income	2021	Dec	1.084538	3.506528	899	1.314064	0.855013
39	Low income	2021	Feb	2.721675	22.240838	812	4.253714	1.189636
40	Low income	2021	Jan	2.220245	5.373406	899	2.571970	1.868519
41	Low income	2021	Jul	6.929922	31.430352	899	8.987249	4.872596
42	Low income	2021	Jun	5.998851	17.450077	870	7.160008	4.837693
43	Low income	2021	Mar	2.449388	8.871544	899	3.030090	1.868686
44	Low income	2021	May	6.284761	27.044694	899	8.055017	4.514505
45	Low income	2021	Nov	1.322989	4.245656	870	1.605502	1.040475
46	Low income	2021	Oct	3.101224	23.121153	899	4.614658	1.587790
47	Low income	2021	Sep	3.171264	6.810055	870	3.624417	2.718112

```
statsI20=incdeaths[(incdeaths['income']=='Low income')
  & (incdeaths['year']==2020)]
statsI20
```

	income	year	month	ddeaths				
				mean	std	size	ci_ub5	ci_lb5
24	Low income	2020	Apr	0.322034	0.930519	826	0.385585	0.258483
25	Low income	2020	Aug	1.579533	3.871986	899	1.832980	1.326085
26	Low income	2020	Dec	2.105673	7.706689	899	2.610127	1.601219
27	Low income	2020	Feb	0.000000	0.000000	35	0.000000	0.000000
28	Low income	2020	Jan	0.000000	0.000000	7	0.000000	0.000000
29	Low income	2020	Jul	1.528365	4.874371	899	1.847425	1.209305
30	Low income	2020	Jun	1.425287	4.293148	870	1.710961	1.139614
31	Low income	2020	Mar	0.095238	0.394160	378	0.135101	0.055375
32	Low income	2020	May	0.796440	1.997144	899	0.927167	0.665714
33	Low income	2020	Nov	1.631034	4.266788	870	1.914954	1.347115
34	Low income	2020	Oct	1.209121	3.298222	899	1.425012	0.993231
35	Low income	2020	Sep	1.239080	3.103187	870	1.445572	1.032589

```
statsI20.columns=['income','year','month','mean','std','size','ci_lb5','ci_ub5']
```

```
statsI21.columns=['income','year','month','mean','std','size','ci_lb5','ci_ub5']
```

```
x=statsI20['income']
x
```

```
y1=statsI20['mean']
y1
```

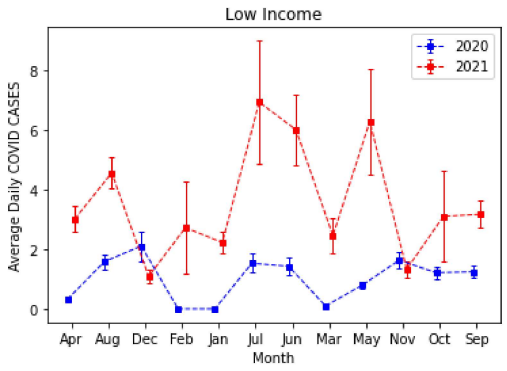
```
y2=statsI21['mean']
y2
```

```
ci_lb_ubI20=[statsI20['ci_lb5'],statsI20['ci_ub5']]
errI20 = np.abs(ci_lb_ubI20 - statsI20['mean'].to_numpy())
```

```
ci_lb_ubI21=[statsI21['ci_lb5'],statsI21['ci_ub5']]
errI21 = np.abs(ci_lb_ubI21 - statsI21['mean'].to_numpy())
```

```
fig, ax = plt.subplots()

trans1 = Affine2D().translate(-0.1, 0.0) + ax.transData
trans2 = Affine2D().translate(+0.1, 0.0) + ax.transData
plt.errorbar('month', 'mean',  yerr=errI20, data=statsI20,marker='s', capsize=2,
             color='blue', markersize=4, linewidth=1, linestyle='--',transform=trans1)
plt.errorbar('month', 'mean',  yerr=errI21, data=statsI21,marker='s', capsize=2,
             color='red', markersize=4, linewidth=1, linestyle='--',transform=trans2)
plt.legend(['2020','2021'])
plt.xlabel("Month")
plt.ylabel("Average Daily COVID CASES")
plt.title("Low Income")
plt.show()
```



The line graph above is the average daily covid cases between 2020 and 2021 with error bars. The graph shows that low income people suffered from covid 19 in 2021 more than in 2020 and this is definitely because of its spread.

No.2 high income

```
statsI220=incdeaths[(incdeaths['income']=='High income') & (incdeaths['year']==2020)]
```

```
statsI221=incdeaths[(incdeaths['income']=='High income')
  & (incdeaths['year']==2021)]
statsI221
```

	income	year	month	dcases				
				mean	std	size	ci_ub5	ci_lb5
12	High income	2021	Apr	3978.551462	10659.667441	1710	4484.144840	3472.958084
13	High income	2021	Aug	4689.092290	20751.092792	1777	5654.568160	3723.616421
14	High income	2021	Dec	11119.231368	37758.466932	1798	12865.697682	9372.765055
15	High income	2021	Feb	3901.845238	12490.965193	1596	4515.123160	3288.567316
16	High income	2021	Jan	7123.431239	27693.041493	1767	8415.537480	5831.324999
17	High income	2021	Jul	2578.013582	9520.992379	1767	3022.245527	2133.781638
18	High income	2021	Jun	1098.700000	2682.523739	1710	1225.933448	971.466552
19	High income	2021	Mar	3915.258065	9627.120804	1767	4364.441765	3466.074364
20	High income	2021	May	2068.009055	4985.409835	1767	2300.619083	1835.399027
21	High income	2021	Nov	5843.591379	15016.968768	1740	6549.678224	5137.504535
22	High income	2021	Oct	3422.258065	12665.341213	1798	4008.076123	2836.440006
23	High income	2021	Sep	4244.210345	20143.711503	1740	5191.352869	3297.067821

```
statsI220.columns=['income','year','month','mean','std','size','ci_lb5','ci_ub5']
```

```
statsI221.columns=['income','year','month','mean','std','size','ci_lb5','ci_ub5']
```

```
x=statsI220['income']
```

```
y1=statsI220['mean']
```

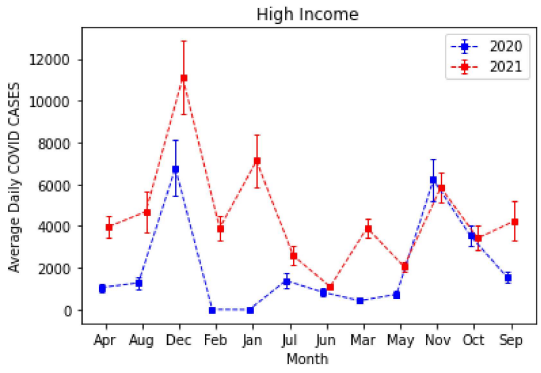
```
y2=statsI221['mean']
```

```
ci_lb_ubI220=[statsI220['ci_lb5'],statsI220['ci_ub5']]
errI220 = np.abs(ci_lb_ubI220 - statsI220['mean'].to_numpy())
```

```
ci_lb_ubI221=[statsI221['ci_lb5'],statsI221['ci_ub5']]
errI221 = np.abs(ci_lb_ubI221 - statsI221['mean'].to_numpy())
```

```
fig, ax = plt.subplots()

trans1 = Affine2D().translate(-0.1, 0.0) + ax.transData
trans2 = Affine2D().translate(+0.1, 0.0) + ax.transData
plt.errorbar('month', 'mean',  yerr=errI220, data=statsI220,marker='s', capsize=2,
             color='blue', markersize=4, linewidth=1, linestyle='--',transform=trans1)
plt.errorbar('month', 'mean',  yerr=errI221, data=statsI221,marker='s', capsize=2,
             color='red', markersize=4, linewidth=1, linestyle='--',transform=trans2)
plt.legend(['2020','2021'])
plt.xlabel("Month")
plt.ylabel("Average Daily COVID CASES")
plt.title("High Income")
plt.show()
```



The line graph above is the average daily covid cases between 2020 and 2021 with error bars. The high income people also suffered from covid 19 in 2021 more than in 2020. But, unexpectedly high income people suffered from more cases than low income. The data actually does not give a representative sample of the low income people which makes high income people look as if they suffered more from covid 19.

3. In terms of continent: confirmed COVID 19 cases

No.1 Oceania

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

```
x=df['dcases']
```

```
def ci_lb6(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean - margin_of_error
```

```
ci_lb6(x)
```

```
2285.1835480837276
```

```
def ci_ub6(x, alpha=0.05):
    sample_s=np.std(x)
    sample_mean=np.mean(x)
    sample_size=len(x)
    margin_of_error = t.ppf(1 - alpha/2,sample_size-1)*sample_s/np.sqrt(sample_size-1)
    return sample_mean + margin_of_error
```

```
ci_ub6(x)
```

```
2422.2624439548904
```

```
contcases=df.groupby(['continent','year','month']).agg({"dcases": [np.mean, np.std, np.size,ci_ub6,ci_lb6]})
```

```
contcases=contcases.reset_index()
```

```
statsC21=contcases[(contcases['continent']=='Oceania')
  & (contcases['year']==2021)]
statsC21
```

	continent	year	month	dcases				
				mean	std	size	ci_ub6	ci_lb6
107	Oceania	2021	Apr	23.579167	75.020011	240	33.118639	14.039694
108	Oceania	2021	Aug	133.093426	293.247232	289	167.045162	99.141689
109	Oceania	2021	Dec	703.383871	3321.515757	310	1074.583839	332.183903
110	Oceania	2021	Feb	2.964286	10.315584	224	4.322541	1.606031
111	Oceania	2021	Jan	2.475806	5.741339	248	3.193880	1.757733
112	Oceania	2021	Jul	107.000000	285.278092	279	140.620892	73.379108
113	Oceania	2021	Jun	21.340741	55.849794	270	28.032590	14.648892
114	Oceania	2021	Mar	20.943548	77.762204	248	30.669319	11.217778
115	Oceania	2021	May	21.393130	80.661739	262	31.205717	11.580542
116	Oceania	2021	Nov	168.610000	401.043819	300	214.175986	123.044014
117	Oceania	2021	Oct	250.867742	635.574188	310	321.897096	179.838388
118	Oceania	2021	Sep	198.343333	521.456096	300	257.590378	139.096288

```
statsC20=contcases[(contcases['continent']=='Oceania')
  & (contcases['year']==2020)]
statsC20
```

	continent	year	month	dcases				
				mean	std	size	ci_ub6	ci_lb6
95	Oceania	2020	Apr	25.500000	51.758327	120	34.855709	16.144291
96	Oceania	2020	Aug	73.653226	140.644743	124	98.654072	48.652379
97	Oceania	2020	Dec	3.012097	7.196199	248	3.912130	2.112063
98	Oceania	2020	Feb	0.548387	1.859009	31	1.230277	-0.133503
99	Oceania	2020	Jan	1.500000	1.643168	6	3.224399	-0.224399
100	Oceania	2020	Jul	76.322581	150.496120	124	103.074597	49.570565
101	Oceania	2020	Jun	6.208333	16.116642	120	9.121538	3.295128
102	Oceania	2020	Mar	59.609195	118.538715	87	84.873223	34.345167
103	Oceania	2020	May	3.725806	7.024161	124	4.974413	2.477200
104	Oceania	2020	Nov	2.369159	5.038740	214	3.048109	1.690209
105	Oceania	2020	Oct	4.574324	7.357805	148	5.769566	3.379083
106	Oceania	2020	Sep	12.100000	23.138022	120	16.282372	7.917628

```
statsC20.columns=['continent','year','month','mean','std','size','ci_lb6','ci_ub6']
```

```
statsC21.columns=['continent','year','month','mean','std','size','ci_lb6','ci_ub6']
```

```
x=statsC20['continent']
x
```

```
y1=statsC20['mean']
y1
```

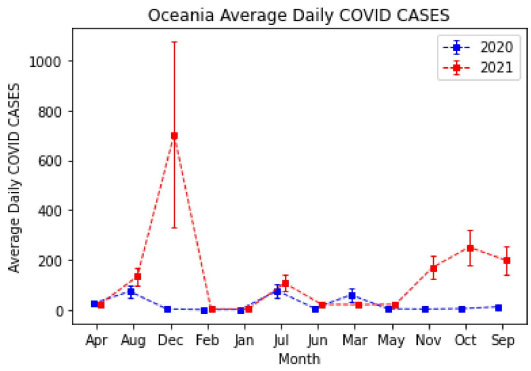
```
y2=statsC21['mean']
y2
```

```
ci_lb_ubC20=[statsC20['ci_lb6'],statsC20['ci_ub6']]
errC20 = np.abs(ci_lb_ubC20 - statsC20['mean'].to_numpy())
```

```
ci_lb_ubC21=[statsC21['ci_lb6'],statsC21['ci_ub6']]
errC21 = np.abs(ci_lb_ubC21 - statsC21['mean'].to_numpy())
```

```
fig, ax = plt.subplots()

trans1 = Affine2D().translate(-0.1, 0.0) + ax.transData
trans2 = Affine2D().translate(+0.1, 0.0) + ax.transData
plt.errorbar('month', 'mean',  yerr=errC20, data=statsC20,marker='s', capsize=2,
             color='blue', markersize=4, linewidth=1, linestyle='--',transform=trans1)
plt.errorbar('month', 'mean',  yerr=errC21, data=statsC21,marker='s', capsize=2,
             color='red', markersize=4, linewidth=1, linestyle='--',transform=trans2)
plt.legend(['2020','2021'])
plt.xlabel("Month")
plt.ylabel("Average Daily COVID CASES")
plt.title("Oceania Average Daily COVID CASES")
plt.show()
```



The line graph above is the average daily covid cases between 2020 and 2021 with error bars. The graph shows that Oceania barely suffered from Covid 19 in 2020 and in 2021 because the reported cases are really few compared to other continents. There is an error bar that is very long and this shows that it is not that reliable because it does not match the data.

No.2 North America

```
statsC221=contcases[(contcases['continent']=='North America(continent)')
  & (contcases['year']==2021)]
statsC221
```

	continent	year	month	dcases				
				mean	std	size	ci_ub6	ci_lb6
83	North America(continent)	2021	Apr	3474.511594	13109.117751	690	4454.363816	2494.659372
84	North America(continent)	2021	Aug	7564.781206	31441.137078	713	9876.529020	5253.033392
85	North America(continent)	2021	Dec	9583.346424	50657.183656	713	13307.977415	5858.715432
86	North America(continent)	2021	Feb	4435.069876	18203.779489	644	5843.661074	3026.478677
87	North America(continent)	2021	Jan	9823.566620	41609.030320	713	12882.921141	6764.212099
88	North America(continent)	2021	Jul	2912.256662	11901.748323	713	3787.347172	2037.166152
89	North America(continent)	2021	Jun	1128.489855	2985.964804	690	1351.678349	905.301361
90	North America(continent)	2021	Mar	3105.723703	12114.880329	713	3996.485002	2214.962403
91	North America(continent)	2021	May	1919.178121	6530.713898	713	2399.356797	1438.999445
92	North America(continent)	2021	Nov	4070.542029	19237.894355	690	5508.494902	2632.589156
93	North America(continent)	2021	Oct	4170.751753	18095.115446	713	5501.217107	2840.286399
94	North America(continent)	2021	Sep	7353.733333	30881.235514	690	9661.977703	5045.488964

```
statsC220=contcases[(contcases['continent']=='North America(continent)')
  & (contcases['year']==2020)]
statsC220
```

	continent	year	month	dcases				
				mean	std	size	ci_ub6	ci_lb6
71	North America(continent)	2020	Apr	1395.597101	6024.659889	690	1845.915459	945.278744
72	North America(continent)	2020	Aug	2558.939691	10048.562353	713	3297.772450	1820.106933
73	North America(continent)	2020	Dec	10196.102384	43624.334013	713	13403.634559	6988.570210
74	North America(continent)	2020	Feb	0.833333	1.542249	60	1.231738	0.434928
75	North America(continent)	2020	Jan	0.631579	0.895081	19	1.062994	0.200164
76	North America(continent)	2020	Jul	3172.765778	12561.816835	713	4096.388627	2249.142929
77	North America(continent)	2020	Jun	1566.520290	6157.750470	690	2026.786617	1106.253963
78	North America(continent)	2020	Mar	481.909302	2681.486820	430	736.074746	227.743859
79	North America(continent)	2020	May	1192.165498	4737.096601	713	1540.466282	843.864713
80	North America(continent)	2020	Nov	7133.234783	31079.078406	690	9456.267088	4810.202477
81	North America(continent)	2020	Oct	3220.123422	13059.619589	713	4180.347824	2259.899021
82	North America(continent)	2020	Sep	2166.363768	8222.473043	690	2780.959551	1551.767986

```
statsC220.columns=['continent','year','month','mean','std','size','ci_lb6','ci_ub6']
```

```
statsC221.columns=['continent','year','month','mean','std','size','ci_lb6','ci_ub6']
```

```
x=statsC220['continent']
x
```

```
y1=statsC220['mean']
y1
```

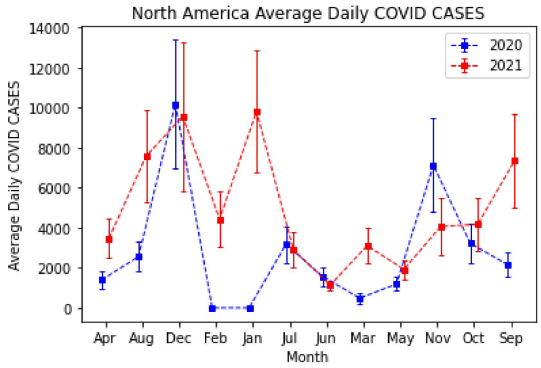
```
y2=statsC221['mean']
y2
```

```
ci_lb_ubC220=[statsC220['ci_lb6'],statsC220['ci_ub6']]
errC220 = np.abs(ci_lb_ubC220 - statsC220['mean'].to_numpy())
```

```
ci_lb_ubC221=[statsC221['ci_lb6'],statsC221['ci_ub6']]
errC221 = np.abs(ci_lb_ubC221 - statsC221['mean'].to_numpy())
```

```
fig, ax = plt.subplots()

trans1 = Affine2D().translate(-0.1, 0.0) + ax.transData
trans2 = Affine2D().translate(+0.1, 0.0) + ax.transData
plt.errorbar('month', 'mean',  yerr=errC220, data=statsC220,marker='s', capsize=2,
             color='blue', markersize=4, linewidth=1, linestyle='--',transform=trans1)
plt.errorbar('month', 'mean',  yerr=errC221, data=statsC221,marker='s', capsize=2,
             color='red', markersize=4, linewidth=1, linestyle='--',transform=trans2)
plt.legend(['2020','2021'])
plt.xlabel("Month")
plt.ylabel("Average Daily COVID CASES")
plt.title("North America Average Daily COVID CASES")
plt.show()
```



The line graph above is the average daily covid cases between 2020 and 2021 with error bars. The graph shows that North America r suffered from Covid 19 in 2020 and in 2021 equally because the numbers are near each other. There is are some error bar that are longer than others which show that these points are not as reliabe as the others.

Conclusion

The country that was taken as an example was France and the graphs and analysis show that it really suffered from covid 19 either in terms of confirmed cases or confirmed deaths. The data shows that France suffered from very high death cases rate and that most of the deaths happened in 2021.

For the continent comparison, the expected result happened which is that Europe and Central Asia are the ones who suffered more than East Asia and Pacific. This is because countries that mostly suffered from covid 19 such as France lies in the Europe and Central Asia sector. In general, for 2020 and 2021 countries of East Asia and Pacific suffered less confirmed cases and confirmed deaths than Europe and Central Asia.

For the income level comparison, something unexpected happened which is that the data shows that high income people suffered from covid 19 more than low income people but this does not make sense. This happened because the data did not give the necessary information about low income people in order to draw a suitable conclusion. This is because the sample size of low income people is very low compared to high income people which makes it seem that high income people suffered more.

For the region comparison, the graphs show that North America suffered more in terms of covid 19 confirmed cases and confirmed deaths than Oceania. This makes sense because the population size in North America is definitely much higher than in Oceania. Countries that lie in North America is the United States of America and Canada which have very big populations. But, countries in Oceania are New Zealand and Australia which have way more less population sizes than countries in North America.