

**Population Growth Rates and Pattern of COVID-19 Deaths per  
Million**

**Abstract**

**Background:** Population growth rate (PGR) gives an idea about two parameters: birth rate and mortality rate. It is well known that aging – as an indicator of community structure- carries a risk factor for Corona Virus Disease 2019 (COVID-19) mortality but little is known about the population growth rate (PGR) and COVID-19 mortality. PGR can reflect the age group structure of the community because low PGR usually indicates low birth rate and old age structure of the community. As PGR is a single figure for each year and can be easily recalled and obtained from public sources (unlike the age distribution), we designed this study to look for any relation between PGR's impact on COVID-19 mortality and looking for a new indicator for COVID-19 mortality risk assessment. The importance of this study is to study the relation between Covid -19 pandemic and the universal trend in decreasing PGRs and continual change in population structure.

**Methods:** Ninety-two countries with a total population of more than ten million people were chosen as a sample for this study. We used publically available data for PGRs and COVID-19 deaths per one million populations. These countries were classified into three groups according to COVID-19 death rate per million people as follows: < 1000 / (62 Countries), COVID-19 death rate 1000-2000 (11 Countries), and > 2000 (19 Countries).

Analysis of variance (ANOVA) was used as a statistical method to provide information about levels of variability within a regression model and form a basis for testing the fitted logarithmic model for significance.

**Results:** PGR was inversely related to COVID-19 mortality in a too highly significant association (p-value 0.000)

**Conclusions:** We described a novel method to predict countries at increased risk for COVID-19 death through PGR estimation. Low PGR is correlated with the increased COVID-19 mortality rate for COVID-19 and vice versa.

**Keywords:** COVID-19; population growth rate; COVID-19 deaths per one million.

## **Introduction**

The global population has grown from 1 billion in 1800 to 7.9 billion in 2020.<sup>1,2</sup>

The absolute increase of the population per year peaked in 1988 with almost 93 million, while it was 80 million in last year (2021). Annual additions are projected to continue declining by around 1 million every year, reaching 48 million by 2050 and 3 million by 2100.<sup>2</sup> The world population growth rate (PGR) declined from 2.2% per year 50 years ago to 1.05% per year

Demographic transition refers to the shift from high birth rates and high death rates to low birth rates and low death rates, as well as the stages between these two scenarios.<sup>3</sup> Contemporary societies are now at very different stages of their demographic transitions. Most regions and countries in the world are experiencing unprecedentedly rapid demographic change. Extraordinary change is women's fertility which dropped rapidly and life expectancy has risen to new highs in the developed countries. This leads to an increase in older populations in these countries.<sup>4</sup> Fertility and mortality trends in developing countries have led to very young populations in these countries.<sup>4</sup>

Population growth is determined by births and deaths and every country has seen very substantial changes in both. Universally, a dramatic decline in child mortality has been achieved throughout the world.

Soon after Corona Virus Disease 2019 (COVID-19) was first reported in December 2019 in the Wuhan city of China, the disease got spread to the entire world and the world starts to

suffer a current COVID-19 pandemic. As of 30 January 2022 over 370 million COVID-19 confirmed cases and over 5.6 million deaths have been reported globally.<sup>5</sup> Since early times in this pandemic, COVID-19 have been examined according to age groups contexts. High incidence was recognized among older adults.<sup>6</sup> Furthermore, it is known that the distribution of the cases varied widely between countries.

Evidence indicates that children seldom develop a severe clinical presentation of severe acute respiratory syndrome coronavirus 2 ( SARS-COV 2 )infection and are less prone to transmit it than adults .<sup>7,8,9,10</sup>

The age structure of the cases dramatically impacts the differences in the fatality rates between countries. Adjusting for age reduces the variances. After an age-adjustments variance still exists.<sup>11</sup> Adjustments are specifically difficult when the data about age structure and age distribution of cases are not easily accessible or lacking or scarce<sup>12,13</sup> especially in middle-income countries and low-income countries .<sup>13</sup>

COVID-19 has been examined in the context of age structure, but has not been examined in contexts of PGR.

We look through this study to find a correlation of the PGR to the COVID-19 deaths per one million populations as crude mortality rate which is a ratio of the number of people that die from a disease divided by the total number of individuals in a population.<sup>14</sup>

This study can look for age structure and age distribution of the disease by other prospective i.e. the growth rate. This methodology does not require data concerning the age distribution of the disease.

## Methods

Patient and public were not involved. This study analyzed data from a public database, so no informed consent was required for this type of study and there was no need for ethics committee approval.

## Study Design

We chose all countries with a total population of more than ten million people as a sample for this study. As North Korea did not register any COVID-19 case till the time of the study, it was excluded. We used publically available data for 2016-2021 PGRs and COVID-19 deaths per one million populations as they were on February 6, 2022 to perform the study.

The selected countries were ninety-two countries furtherly classified into three groups according to COVID-19 death rate /Million people into < 1000 / (62 Countries), COVID-19 death rate 1000-2000 (11 Countries), and > 2000 (19 Countries). We used publically available data through:

1-Countries by population growth rate 2021 - StatisticsTimes.com

<https://www.statisticstimes.com/demographics/countries-by-population-growth-rate>.

2-UN (World Population Prospects 2019)

<https://population.un.org/wpp/>

3-World Population Prospects - Population Division - United Nations

<https://population.un.org/wpp/>

4- COVID Live - Coronavirus Statistics - Worldometer (worldometers.info)

## **Statistical Methods**

The statistical data analysis approaches were used under the application of the Statistical Package for the Social Sciences (SPSS) ver. (22.0). Descriptive data analyses predicted equation estimates for high fitted regression, and analysis of variance (ANOVA) were used.

An optimum model of high fitted regression was checked among several assumed linear and non-linear equations (Table 1). The most fitted model was the logarithmic model.

## Results

Table (2) shows a summary statistic for studied selected countries who were classified in three groups according to their numbers of covid-19 death per million populations.

Figure (1) represents the selected studied countries who were classified in three groups according to their numbers of COVID-19 deaths per one million population.

Table (4) shows a meaningful logarithmic model tested in a two-tailed alternative statistical hypothesis. Slope value indicates that with increasing one unit of the COVID-19 death / million, there is a negative impact on the unit of 2016-2021 PGR, and estimated by (-2.026032), which records too highly significant impact at  $P\text{-value} < 0.001$ , as well as the coefficient of relationship which is accounted (0.63030). The determination coefficient  $R^2$  (r-squared) was meaningful and significant (39.728%). The corrected coefficient of determination coefficient also confirms a large convergence of the estimated value of the coefficient, which reflects the strength of the fitted logarithmic model. Another source of variations that were not included in model (intercept) shows a too highly significant level at  $P < 0.001$  are accounted, and indicating that there are other sources of variations that have an actual effect explaining the variations that have been observed in the studied function.

## Discussion

Population growth is calculated by subtracting the death rate from the birth rate. Over the last two decades, we have seen declining PGRs in nearly all countries. PGRs are lowest in the most developed regions. In contrast, less developed regions have a higher growth rate which declined more slowly. High birth rate is a contributing factor for high GR in developing countries while birth rates are characteristically low in developed countries.

There is a dramatic decline in child mortality that has been achieved in all parts of the world <sup>1</sup> but there is no universal decline in adult deaths in this stage of global demographic transition. For this reason, adult mortality contributes to a substantial portion of death rates varies among countries. Since older people are the most-at-risk group in many developed countries, the high COVID-19 mortality rate was attributed to a higher rate of elderly people (a characteristic age structure of the developed countries). The largest increase in mortality risk for COVID-19 was observed in patients aged >50 years

especially patients aged 60 to 69 years<sup>15</sup>. Findings of low COVID-19 deaths per one million population and high adult death rates in certain countries with high birth rates (high growth rates countries) is partly attributed to substantial low proportions of the older age group.

Although we found a very high significant negative association between COVID-19 deaths per one million population and PGR, outliers were identified among three COVID-19 category groups as follows (Appendix 1 and Table 3):

**1-Low COVID-19 deaths per million (<1000)** was found in China, Japan, South Korea, Taiwan, Cuba, Venezuela, and Mauritius. These countries had PGR values 1-2 SD below the mean value except Venezuela which recorded a PGR value < 2 SD. The death rates for these countries in 2020 was equal to 8.20, 10.2, 8.2, 7.90, 9.10, 7.50, 7.3 respectively.<sup>16</sup> The death rates for these countries were relatively high and were above 7 (the whole world's death rate was 7.7 in 2020)<sup>16</sup>. This reflects a community structure which is consistent with a high adult death in these communities. This leads to a decrease in old age proportion.

**2-Medium COVID-19 deaths per one million (1000-2000):** in this group we found Portugal which had a PGR value of -1.53 (just below 1SD). Relatively high death rate which was 10.80 in 2020<sup>16</sup> might explain relatively low COVID-19 deaths. High elderly deaths in Portugal minimize elderly proportion again.

**3-High COVID-19 deaths per one million >2000:** Countries with outliers in this group have relatively low death rates and were below the whole world death rate (7.7 in 2020). This group includes Colombia with a death rate of 5.60 and Peru with a death rate of 6.20<sup>16</sup>. PGR was just > 1 SD for both of these countries. Low adult deaths increase elderly proportions among these countries. This might explain the increase in COVID-19 deaths per one million populations among these relatively high PGR countries.

In the context of scarce of COVID-19 age distribution data, we think that this observational data analyses provide the best available source for public health and decision making.

Our results confirm (in this large representative sample) that COVID-19 deaths per one million populations is negatively correlated to PGR in a very high significant association with a p-value of 0.000. PGR reflects the age structure of a community in one way or another. As far as we know, this is the first to study in this aspect. This study might consolidate findings of the high COVID-19 mortality rates among countries structurally characterized by high old age people and vice versa.<sup>12,13</sup>

Demographic adjustments do not necessarily explain COVID-19 indices variances across regions.<sup>12</sup>

Despite the demographic adjustments in Italy (2016-2020 PGR value of -0.49), the distribution of both cases and fatalities across ages shows a striking anomaly which has a high case fatality rate for ages above 60 years in respect to other countries.<sup>17</sup>

We can conclude that COVID-19 mortality rates among low PGR countries can be driven to levels beyond usual adjustment levels. Possibly, countries with high predominant young age people have lower risk for infection increasing herd immunity level acting as a barrier for the spread of disease thus, slowing or preventing the transmission of disease to others.

On the other hand, high infection rates among adults leads to higher infection rates among countries characterized by high older age demographics. High rate of infection is simply a contributing factor to increased mortality rate per million and may furtherly increase the mortality rate through increasing the case fatality rate.<sup>19,20,21,22</sup>

Some limitations might include the accuracy of data estimates and the potential of ecological bias due to confounding by country-level estimates. Of special importance, countries already used different methods to count mortalities, and they sometimes changed these methods.<sup>18</sup>

## Conclusions

This study showed that PGR is negatively correlated to COVID-19 mortality. There is a very high significant negative association between PGR and COVID-19 mortality rate. Low PGR is correlated with the increased COVID-19 mortality rate for COVID-19 and vice versa.

This is the first study that addresses such correlation. This novel finding can help to identify countries at increased risk for COVID-19 death. Furthermore, PGR might be added as factor during risk factors assessments for future epidemics.

### Recommendation

PGR can be considered as an indicator for any disease risk assessment specially for infections with various predilections among different age groups especially when disease – age distribution data are missing or scarce. This novel finding can help policy makers to tight or loose restrictions during epidemic.

### Abbreviations:

ANOVA: analysis of variance

COVID-19: Corona Virus Disease 2019

PGR: population growth rate

SARS-COV 2: Severe acute respiratory syndrome coronavirus 2

SPSS: Statistical Package for the Social Sciences

Table 1: Predicated Equations for fitness

Predicated Equations	Models
Model whose equation is $Y = b_0 + (b_1 * x)$ .	Linear
Model whose equation is $Y = b_0 + (b_1 * \ln(x))$ .	Logarithmic
Model whose equation is $Y = b_0 + (b_1 / x)$ .	Inverse
Model whose equation is $Y = b_0 + (b_1 * x) + (b_2 * x^{**2})$ .	Quadratic
Model defined by the equation $Y = b_0 + (b_1 * x) + (b_2 * x^{**2}) + (b_3 * x^{**3})$ .	Cubic

Predicated Equations for an optimal model is shaded.

Table (2): Descriptive statistics for studied countries

		COVID-19 deaths / million		
Statistics		< 1000	1000 - 2000	> 2000
Mean		231.68	1535.17	2716.72
95% C.I. for mean	L.b.	165.97	1316.48	2247.98

U.b.	297.39	1753.86	3185.47
Standerd. deviation	258.75	344.19	942.6
Std. error	32.86	99.36	222.17
Minimum	3	1034	2014
Maximum	970	2014	6138
Range	967	980	4124

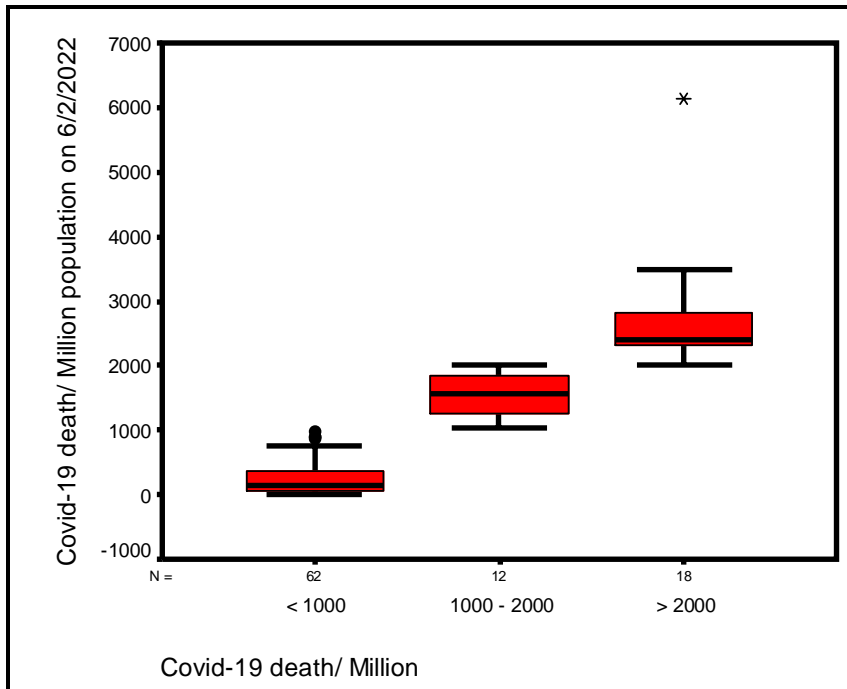
**Table (3): Descriptive statistics for 2016-2021 population growth rate (%) classified in three groups according to COVID-19 deaths per one million population**

Pop. Growth Rate (%) 2016-2021in light of Covid-19 death/ million			
Statistics	Covid-19 Death/ Million		
	< 1000	1000 - 2000	> 2000
Mean	9.398	4.767	2.287
95% C.I. for Mean	L.b.	7.949	0.619
	U.b.	10.847	3.954
Std. Deviation	5.707	3.517	3.353
Std. Error	0.725	1.015	0.790
Minimum	-3.840	-1.530	-3.380
Maximum	20.89	8.55	7.87
Range	24.73	10.08	11.25

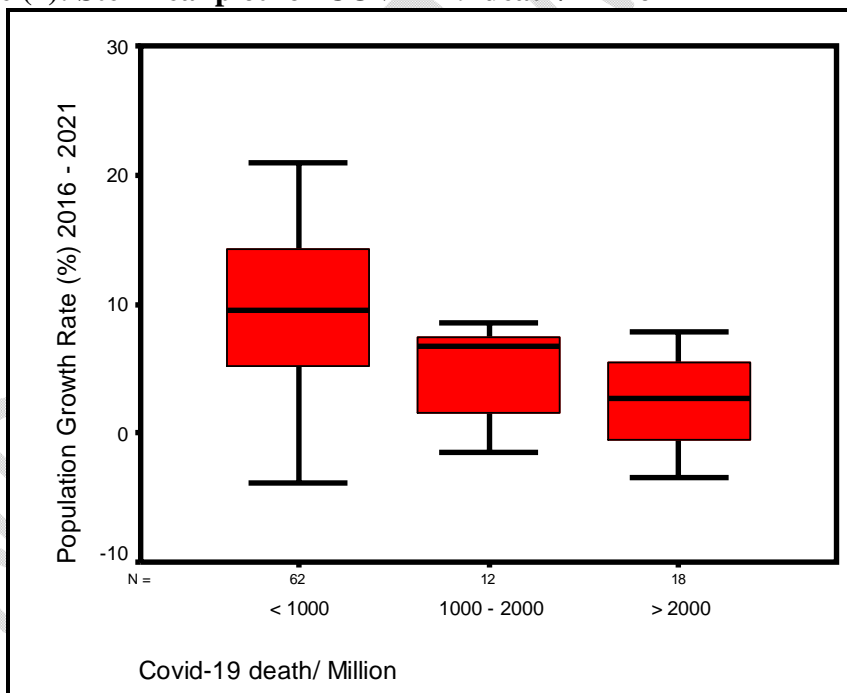
**Table (4): Regression Analysis for the influence of COVID-19 death per one million population on 2016-2021 PGR.**

Dependent variable: " 2016-2021 Pop. Growth Rate (%)"					
List wise Deletion of Missing Data					
Correlation Coefficient	0.63030 (THS)	Meaningful nonl-linear regression tested in two tailed alternative statistical hypothesis			
R- Squared	0.39728				
Adjusted R squared	0.39059				
F statistic of reg. ANOVA	59.32398	Sign. F =	0.0000 (VHS) <sup>(*)</sup>		
Variables in the Equation					
Variable	B	SE.B	Beta	t-test	Sig. level <sup>(*)</sup>
Covid-19 death per one million	-2.026032	0.263046	-0.630304	-7.702	0.0000
(Constant)	18.873429	1.563576	-	12.071	0.0000
Predicted equation - logarithmic model					
$(\widehat{\text{Pop. Growth Rate}}\%) = (18.873429) + \text{Ln}(-2.026032 * \text{Covid} - 19 \text{ Death/ Million})$					

<sup>(\*)</sup> VHS: very highly Sig. at P<0.001; Testing Non Linear Regression (Logarithmic Model): Model whose equation is  $Y = b_0 + (b_1 * \text{Ln}(x))$ .



**Figure (1): Stem-leaf plot for COVID-19 death/ million**



**Figure (2): Stem-leaf plot for 2016-2021 population growth rate (%) according to COVID-19 death per one million population groups.**

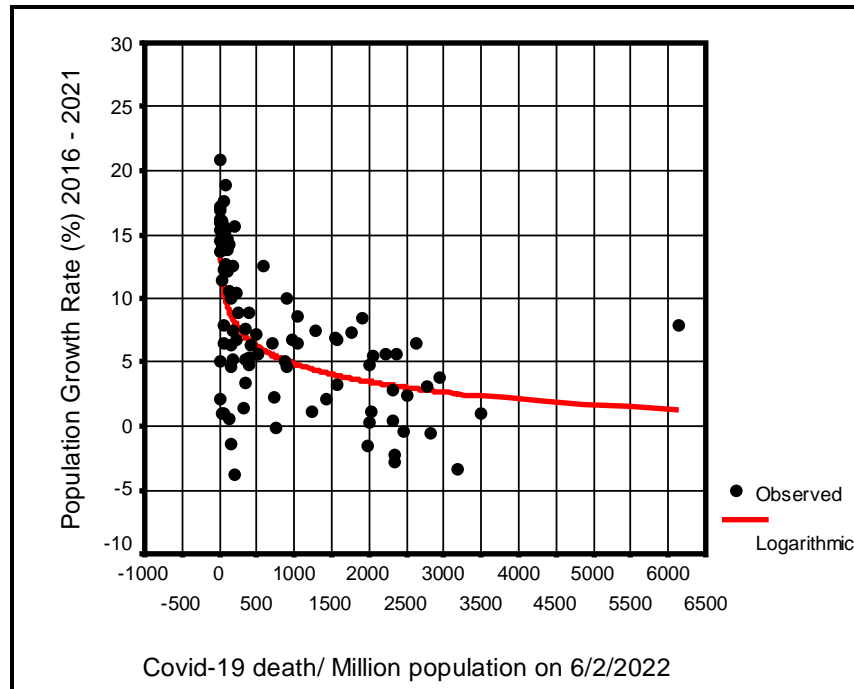


Figure (3): Long term trend of the scatter diagram concerning influence of COVID-19 deaths per one million people in 2016-2021 PGR.

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## Appendix 1:

<b>Covid-19 death rate /Million population On 6/2/2022</b>	<b>Country</b>	<b>Pop. Growth rate 2016-2021 (%)</b>
<b>COVID-19 death rate &lt; 1000 (62 Countries)</b>		
<u>3</u>	<a href="#"><u>Burundi</u></a>	<b>16.85</b>
<u>3</u>	<a href="#"><u>China</u></a>	<b>2.13</b>
<u>11</u>	<a href="#"><u>Chad</u></a>	<b>16.16</b>

<u>12</u>	<a href="#">Niger</a>	<b>20.89</b>
<u>12</u>	<a href="#">South Sudan</a>	<b>5.07</b>
<u>13</u>	<a href="#">Tanzania</a>	<b>15.93</b>
<u>13</u>	<a href="#">Benin</a>	<b>14.52</b>
<u>14</u>	<a href="#">Congo, Democratic Republic Of The</a>	<b>17.25</b>
<u>15</u>	<a href="#">Nigeria</a>	<b>13.68</b>
<u>17</u>	<a href="#">Burkina Faso</a>	<b>15.29</b>
<u>31</u>	<a href="#">Guinea</a>	<b>14.98</b>
<u>34</u>	<a href="#">Mali</a>	<b>16.09</b>
<u>36</u>	<a href="#">Taiwan</a>	<b>1.00</b>
<u>44</u>	<a href="#">Ghana</a>	<b>11.41</b>
<u>45</u>	<a href="#">Madagascar</a>	<b>14.19</b>
<u>46</u>	<a href="#">Uzbekistan</a>	<b>7.93</b>
<u>55</u>	<a href="#">Angola</a>	<b>17.65</b>
<u>62</u>	<a href="#">Ethiopia</a>	<b>13.78</b>
<u>66</u>	<a href="#">Yemen</a>	<b>12.23</b>
<u>67</u>	<a href="#">Mozambique</a>	<b>15.57</b>
<u>68</u>	<a href="#">Cameroon</a>	<b>13.78</b>
<u>69</u>	<a href="#">Haiti</a>	<b>6.47</b>
<u>69</u>	<a href="#">Mauritius</a>	<b>0.92</b>
<u>74</u>	<a href="#">Uganda</a>	<b>18.85</b>
<u>79</u>	<a href="#">Sudan</a>	<b>12.70</b>
<u>80</u>	<a href="#">Somalia</a>	<b>15.32</b>

<u>101</u>	<a href="#">Kenya</a>	<b>12.10</b>
<u>107</u>	<a href="#">Rwanda</a>	<b>13.78</b>
<u>112</u>	<a href="#">Senegal</a>	<b>14.69</b>
<u>129</u>	<a href="#">Malawi</a>	<b>14.20</b>
<u>129</u>	<a href="#">Pakistan</a>	<b>10.59</b>
<b>134</b>	<a href="#">Korea, South</a>	<b>0.63</b>
<u>147</u>	<a href="#">Algeria</a>	<b>10.02</b>
<u>153</u>	<a href="#">Japan</a>	<b>-1.34</b>
<u>162</u>	<a href="#">Australia</a>	<b>6.29</b>
<u>165</u>	<a href="#">Syria</a>	<b>4.64</b>
<u>171</u>	<a href="#">Bangladesh</a>	<b>5.27</b>
<u>176</u>	<a href="#">Cambodia</a>	<b>7.49</b>
<u>184</u>	<a href="#">Afghanistan</a>	<b>12.58</b>
<u>194</u>	<a href="#">Venezuela</a>	<b>-3.84</b>
<u>205</u>	<a href="#">Zambia</a>	<b>15.63</b>
<u>217</u>	<a href="#">Egypt</a>	<b>10.39</b>
<u>225</u>	<a href="#">United Arab Emirates</a>	<b>6.73</b>
<u>251</u>	<a href="#">Saudi Arabia</a>	<b>8.93</b>
<u>318</u>	<a href="#">Thailand</a>	<b>1.42</b>
<u>351</u>	<a href="#">Burma (Myanmar)</a>	<b>3.32</b>
<u>353</u>	<a href="#">Zimbabwe</a>	<b>7.57</b>
<b>358</b>	<a href="#">India</a>	<b>5.20</b>
<u>388</u>	<a href="#">Vietnam</a>	<b>4.84</b>
<u>392</u>	<a href="#">Dominican Republic</a>	<b>5.35</b>
<u>394</u>	<a href="#">Nepal</a>	<b>8.85</b>
<u>415</u>	<a href="#">Morocco</a>	<b>6.32</b>

<u>487</u>	<a href="#">Philippines</a>	7.12
<u>520</u>	<a href="#">Indonesia</a>	5.66
<u>588</u>	<a href="#">Iraq</a>	12.48
<u>697</u>	<a href="#">Kazakhstan</a>	6.53
<u>723</u>	<a href="#">Sri Lanka</a>	2.26
<u>746</u>	<a href="#">Cuba</a>	-0.16
<u>863</u>	<a href="#">Azerbaijan</a>	5.01
<u>894</u>	<a href="#">Guatemala</a>	10.05
<u>907</u>	<a href="#">Canada</a>	4.63
<u>970</u>	<a href="#">Malaysia</a>	6.8
<b>COVID-19 death rate 1000-2000 (11 Countries)</b>		
<u>1,034</u>	<a href="#">Turkey</a>	6.53
<u>1,039</u>	<a href="#">Honduras</a>	8.55
<u>1,241</u>	<a href="#">Netherlands</a>	1.13
<u>1,283</u>	<a href="#">Jordan</a>	7.48
<u>1,417</u>	<a href="#">Germany</a>	2.08
<u>1,550</u>	<a href="#">Iran</a>	6.87
<u>1,583</u>	<a href="#">Sweden</a>	3.30
<u>1,584</u>	<a href="#">South Africa</a>	6.82
<u>1,772</u>	<a href="#">Bolivia</a>	7.26
<u>1,913</u>	<a href="#">Ecuador</a>	8.47
<u>1992</u>	<a href="#">Portugal</a>	-1.53
<b>COVID-19 death / million &gt; 2000 (19 Countries)</b>		
<u>2,014</u>	<a href="#">Spain</a>	0.24
<u>2,014</u>	<a href="#">Argentina</a>	4.82
<u>2,021</u>	<a href="#">France</a>	1.17
<u>2,064</u>	<a href="#">Chile</a>	5.51
<u>2,215</u>	<a href="#">Tunisia</a>	5.59

<u>2,313</u>	<a href="#">United Kingdom</a>	<b>2.88</b>
<u>2,313</u>	<a href="#">Russia</a>	<b>0.44</b>
<u>2330</u>	<a href="#">Greece</a>	<b>-2.30</b>
<u>2,338</u>	<a href="#">Ukraine</a>	<b>-2.79</b>
<u>2,360</u>	<a href="#">Mexico</a>	<b>5.62</b>
<u>2,466</u>	<a href="#">Italy</a>	<b>-0.49</b>
<u>2504</u>	<a href="#">Belgium</a>	<b>2.45</b>
<u>2,619</u>	<a href="#">Colombia</a>	<b>6.42</b>
<u>2,771</u>	<a href="#">United States</a>	<b>3.06</b>
<u>2,821</u>	<a href="#">Poland</a>	<b>-0.51</b>
<u>2,939</u>	<a href="#">Brazil</a>	<b>3.80</b>
<u>3,186</u>	<a href="#">Romania</a>	<b>-3.38</b>
<b>3,489</b>	<b>Czechia</b>	<b>1.00</b>
<u>6,138</u>	<a href="#">Peru</a>	<b>7.87</b>

Appendix 2 Data References :1- [Countries by population growth rate 2021 - StatisticsTimes.com](#)

2-[UN \(World Population Prospects 2019\)](#)

3-[World Population Prospects - Population Division - United Nations](#)

4-[COVID Live - Coronavirus Statistics - Worldometer \(worldometers.info\)](#)