**INTRODUCTION**

The unexpected emergence and expansion of SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus-2) have changed much of the present world in the beginning few months of the year 2020. This is an unprecedented pandemic the world has ever faced when no country across the globe remained unaffected by the disease. SARS-CoV-2 or simply known as COVID-19 is a viral and infectious disease which is newly discovered in China (Wuhan city) in December of 2019. The Government of China officially reported it to WHO on December 31, 2019. Later, the WHO declared the COVID-19 outbreak is a global health emergency on January 30, 2020, and subsequently it was declared as a global pandemic on March 11, 2020. After the H1N1 influenza pandemic of 2009, COVID-19 has been given such tag by WHO. According to WHO, there have been 22,256,219 confirmed cases of COVID-19 including 782,456 deaths (fatality rate of 3.5%) reported as of 20 August 2020 globally.\(^1\) Hence, COVID-19 has become a greater threat to the existence of entire humanity and posed a major cause of ongoing economic depression across the globe. However, the major brunt of the pandemic will be borne by the poor countries like sub-Saharan African countries where the medical facilities are not easily available for the poor people and these lower-income or lower-middle-income countries neither have many resources nor have the scientific capacity to contain the spread of COVID-19.\(^2\)
According to WHO, most of the COVID-19 infected patients will experience mild to moderate respiratory illness and recover without requiring special treatment. But COVID-19 can be manifested fatal with the presence of co-morbidities and higher risk for aged people or older section of population those with underlying medical problems like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness.\(^3\) Currently, there are no proven treatments for COVID-19. However, the whole scientific community especially virologists are busy with many clinical trials and researches evaluating potential treatments of the pandemic. A slew of such studies already has shared the facts and findings of their ongoing researches and clinical trials. Within such a short period, scientists and researchers have found several facts and findings of the emergence and pathogenicity of COVID-19. According to WHO, the COVID-19 virus spreads primarily through tiny droplets and aerosols from the nose when an infected and inattentive person coughs or sneezes.\(^4\) The spread of this zoonotic disease can be reduced on certain weather conditions like high temperature and humidity which may help to contain the spread of COVID-19 some countries with these weather conditions.\(^5\) The select preliminary studies while attempting to estimate the pattern of the spread of COVID-19 finds that this virus replicates very fast as like the SARS-CoV-1 (Severe Acute Respiratory Syndrome Coronavirus-1) and the Middle East Respiratory Syndrome coronavirus (MERS-CoV).\(^6\)

However, there is a much debate about the growing incidence and fatality of COVID-19 in the entire globe that whether this incidence and fatality of the pandemic are significantly varying among the countries particularly with different health status and economic development. Seeking the answer to this question, the paper investigates the variations in average death, infection rate, fatality rate and mortality rate of 178 countries.

**MATERIALS AND METHODS**

**Data and Sources**

The data on total confirmed cases and the total number of death for 178 countries used in this research has been collected from the WHO Coronavirus Disease (COVID-19) Dashboard.\(^7\) However, the various country classifications of these countries have been carried out based on WHO region, income classification, HDI classification and GHS classification provided by WHO, World Bank, United Nations Development Program, and Global Health Security Index respectively. The Global Health Security (GHS) Index is a comprehensive assessment of health security and related capabilities and it is a jointly developed by the Nuclear Threat Initiative (NTI) and the Johns Hopkins Center for Health Security (JHU) with the help of the Economist Intelligence Unit (EIU).

**Statistical Tools**

To analyze the data, I have used simple statistical tools like infection rate, fatality rate, mortality rate, compound monthly growth rate and ANOVA (Analysis of Variance).\(^8\) Infection, fatality and mortality rates indicate total confirmed cases per million populations, total deaths per million confirmed cases and total deaths per million populations respectively calculated using the following formulas.

\[
\text{i) Infection rate} = \frac{\text{Total confirmed cases of COVID-19}}{\text{Total populations of the country}} \times 1,000,000
\]

\[
\text{ii) Fatality rate} = \frac{\text{Total deaths in COVID19}}{\text{Total confirmed cases in the country}} \times 1,000,000
\]

\[
\text{iii) Mortality rate} = \frac{\text{Total deaths in COVID19}}{\text{Total populations of the country}} \times 1,000,000
\]

\[
\text{iv) The compound monthly growth rate (CMGR)} = \left(\frac{\text{Value of current month}}{\text{Value of the base month}}\right)^{\frac{1}{n}} - 1
\]

Also, ANOVA (Analysis of Variance) has been applied to test variation of the infection rate, fatality rate, mortality rate among the various country groups.

**RESULTS AND DISCUSSION**

**Spread and Status**

The spreading out of COVID-19 and current status of the pandemic has been discussed with the help of an average number of death, infection rate (number of confirmed cases per million populations), fatality rate (number of deaths per million confirmed cases) and mortality rate (number of deaths per million populations) as defined in the methodology.\(^9\)

Table-1 displays the average death, infection, fatality and mortality rates of COVID-19 pandemic in different geographical regions.\(^10\) This table shows that infection rate and mortality rate are highest in South American countries whereas the fatality rate is very high in European countries. In contrast, more specifically as per World Bank classification, East and South Asian countries show having very less infection, fatality and mortality rates compared to European and North American countries.
Table 1: Infection, Fatality and Mortality rates of COVID-19 by Geographical Regions

| Region/Country            | Average Death | Infection Rate | Fatality Rate | Mortality Rate | N  |
|---------------------------|---------------|----------------|---------------|----------------|----|
| **By Continent**          |               |                |               |                |    |
| Asia                      | 2710          | 4511           | 16106         | 40             | 41 |
| Europe                    | 4746          | 4082           | 44845         | 186            | 44 |
| Africa                    | 457           | 1064           | 28102         | 18             | 53 |
| North America             | 10376         | 3233           | 25345         | 99             | 23 |
| South America             | 14283         | 7263           | 29929         | 251            | 12 |
| Oceania                   | 81            | 240            | 17190         | 4              | 5  |
| **By World Bank Classification** |            |                |               |                |    |
| East Asia & Pacific       | 800           | 746            | 17181         | 5              | 19 |
| Europe & Central Asia     | 4338          | 3984           | 41947         | 175            | 49 |
| South Asia                | 7536          | 2151           | 12767         | 21             |  8 |
| Latin America & Caribbean | 7122          | 4321           | 25328         | 138            | 33 |
| Middle East & North Africa| 1941          | 7393           | 32312         | 60             | 20 |
| Sub-Saharan Africa        | 376           | 1015           | 22950         | 17             | 47 |
| North America             | 87505         | 9459           | 53131         | 370            |  2 |
| **By WHO Classification** |               |                |               |                |    |
| South East Asian Region   | 5884          | 1551           | 12226         | 12             | 10 |
| Eastern Mediterranean Region | 2258       | 6863           | 35927         | 58             | 20 |
| African Region            | 388           | 1027           | 22326         | 17             | 47 |
| American Region           | 1715          | 2499           | 26917         | 151            | 35 |
| European Region           | 4180          | 4069           | 40594         | 170            | 51 |
| Western Pacific Region    | 608           | 907            | 16563         | 5              | 15 |
| Total                     | 4239          | 3279           | 28938         | 90             | 178|

Notes: 'Average Death shows absolute number (rounded off).
1 Infection rates indicate Cases per million populations. 
2 Fatality rates show Deaths per million cases.
3 Mortality rates indicate Deaths per million populations.
N is total number of observations (i.e. countries)
Source: Author’s Calculation based on 178 countries collected from WHO.

However, Table-2 exhibits the infection, fatality and mortality rates of COVID-19 among countries with different level of economic development. The table demonstrates that infection, fatality and mortality rates are significantly very lofty among high and upper-middle-income countries (i.e. countries with GNI per capita greater than US$3996) whereas low-income countries (i.e. countries with GNI per capita less than US$1026) register low infection and mortality. Moreover, classification by HDI (Human Development Index) shows that countries with very high and high human development are having the soaring infection, fatality and mortality rates. Similarly, the countries with high Global Health Security Index (GSHI) grouped as most prepared countries (i.e. countries with overall GHS Index of 66 or greater out of 100) are also register high infection, fatality and mortality rates compared to more and least prepared countries.

Table 2: Infection, Fatality and Mortality rates of COVID-19 by Economic Category

| Region/Country          | Average Death | Infection rate | Fatality rate | Mortality rate | N  |
|-------------------------|---------------|----------------|---------------|----------------|----|
| **By Income Classification (based on GNI per capita)** |               |                |               |                |    |
| High income (>12,375 US$) | 6582          | 5550           | 37460         | 160            | 57 |
| Upper middle income     | 5956          | 3827           | 22981         | 103            | 49 |
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Table 2: (Continued)

| Region/Country                                    | Average Death | Infection rate | Fatality rate | Mortality rate | N  |
|--------------------------------------------------|---------------|----------------|---------------|----------------|----|
| Lower middle income (1,026 US$-3,996 US$)        | 1837          | 1576           | 19651         | 38             | 45 |
| Low income (<1,026 US$)                         | 179           | 330            | 37237         | 8              | 27 |

By Human Development Classification (based on HDI Score)

| Region/Country                                    | Average Death | Infection rate | Fatality rate | Mortality rate | N  |
|--------------------------------------------------|---------------|----------------|---------------|----------------|----|
| Very High Human Development (> =0.800)           | 6719          | 5568           | 36342         | 155            | 60 |
| High Human Development (0.700-0.799)             | 5328          | 3505           | 23226         | 102            | 51 |
| Medium Human Development (0.550-0.699)           | 2364          | 1719           | 19041         | 40             | 31 |
| Low Human Development (<0.550)                   | 178           | 488            | 33212         | 10             | 36 |

By Global Health Security Classification (based on GHS Index Score)

| Region/Country                                    | Average Death | Infection rate | Fatality rate | Mortality rate | N  |
|--------------------------------------------------|---------------|----------------|---------------|----------------|----|
| Most Prepared (>66.6)                            | 20163         | 3794           | 61003         | 245            | 13 |
| More Prepared (33.4-66.6)                         | 4614          | 4323           | 26888         | 106            | 103|
| Least Prepared (<33.4)                           | 277           | 1437           | 25620         | 32             | 62 |
| Total                                            | 4239          | 3279           | 28938         | 90             | 178|

Source: Author’s Calculation based on 178 countries collected from WHO.

Growth of infection and fatality

The current status discussed in the above tables is silence about the trend of the COVID-19 i.e. whether it is growing or shrinking in the different regions. Hence, to capture the aspects I have applied compound monthly growth rate (using a similar method of calculating compound annual growth rate, CAGR). The compound monthly growth rate (CMGR), estimated for February-July of 2020, will help us to track the growth of COVID-19 pandemic in terms the average number of death, infection rate, fatality rate and mortality rates among the countries with different level of health-related and economic development has been shown in the following table and panels.12,13

Table 3: Compound monthly growth rate (CMGR) of Average Death, Infection, Fatality and Mortality rates (Estimated for February-July 2020 period)

| Region/Country | Average Death | Infection rate | Fatality rate | Mortality rate |
|----------------|---------------|----------------|---------------|----------------|
| **By Continent**                       |               |                |               |                |
| Asia           | 89.8          | 172.3          | -7.1          | 122.4          |
| Africa         | 244.7         | 227.6          | -5.5          | 210.3          |
| Europe         | 61.4          | 51.8           | 17.3          | 67.5           |
| North America  | 201.2         | 143.4          | 7.8           | 204.8          |
| South America  | 411.1         | 250.3          | 3.0           | 377.6          |
| Oceania        | 81.5          | 32.3           | 68.3          | 90.7           |
Table 3: (Continued)

| Region/Country                  | Average Death | Infection rate | Fatality rate | Mortality rate |
|---------------------------------|---------------|----------------|---------------|---------------|
| By GHS Index Category           |               |                |               |               |
| Most Prepared                   | 127.7         | 63.4           | 22.5          | 92.9          |
| More Prepared                   | 89.7          | 100.3          | 2.6           | 91.3          |
| Least Prepared                  | 212.4         | 85.2           | -1.5          | 79.9          |
| By Income Category              |               |                |               |               |
| High income                     | 81.3          | 71.5           | 20.7          | 71.3          |
| Upper middle income             | 142.2         | 172.1          | 0.8           | 173.6         |
| Lower middle income             | 284.3         | 263.5          | -9.9          | 268.4         |
| Low income                      | 234.2         | 263.7          | -3.9          | 231.1         |
| By HDI Category                 |               |                |               |               |
| Very High Human Development     | 83.9          | 73.7           | 20.0          | 71.9          |
| High Human Development          | 138.6         | 166.3          | 1.6           | 174.1         |
| Medium Human Development        | 333.2         | 305.4          | -17.6         | 256.4         |
| Low Human Development           | 257.2         | 259.7          | 0.6           | 277.3         |

Source: Author’s Calculation based on 178 countries collected from WHO.

Results of one-way ANOVA

But the variations of the numbers observed in the above tables may be random and we can’t say with certainty and conviction that the variations are statistically significant in terms of infection, fatality and mortality rates among the countries/regions or countries with different level of economic development without formal confirmation with statistical analysis.

Table 4: One-way ANOVA Outputs

| Dependent Variable | Independent Variable (Group Variable) | F-Statistic | P-value |
|--------------------|---------------------------------------|-------------|---------|
| Infection rate     | Continents                            | 4.74***     | 0.0004  |
|                    | Income Group                          | 9.37***     | 0.0000  |
|                    | HDI Group                             | 9.34***     | 0.0000  |
|                    | GHS Index Group                       | 6.31***     | 0.0023  |
| Fatality rate      | Continents                            | 3.78***     | 0.0028  |
|                    | Income Group                          | 3.75**      | 0.0120  |
|                    | HDI Group                             | 2.75**      | 0.0444  |
|                    | GHS Index Group                       | 7.17***     | 0.0010  |
| Mortality rate     | Continents                            | 11.56***    | 0.0000  |
|                    | Income Group                          | 8.67***     | 0.0000  |
|                    | HDI Group                             | 8.35***     | 0.0000  |
|                    | GHS Index Group                       | 12.02***    | 0.0000  |

Notes: ***Very highly significant, ** Highly Significant & *Significant
Source: Author’s Calculation (see Appendix-2).
Hence, several one-way ANOVA taking infection rate, fatality rate and mortality rate as the dependent variable to test them among different continents, income group, HDI group and GHS index group as independent variables (as shown in Table-4). The results show that infection and mortality rates are significantly very high among countries with high-income as well as with high HDI level. But the fatality rate is significantly high among low-income countries (see Table-2). Besides, the fatality rate is also significantly low among the least-prepared countries as classified by the GHS index.14

CONCLUSION

The paper investigates that whether the incidence, fatality and mortality of COVID-19 pandemic are really and statistically varying among the countries particularly with different health status and economic development. The paper reveals that the variations in average death, infection rate, fatality rate and mortality rate irrespective of economic and other categories are increasing significantly. The results also corroborated by the one-way ANOVA analysis which confirms that infection and mortality rates are significantly very high among high-income and high HDI level countries. But, the results also show that the fatality rate is significantly low-income countries as well as among the GHS least-prepared countries. However, a host of scientists working on various preventive measures to reduce the fatality rate of COVID-19. But the potential gains from these upcoming preventive strategies should incorporate the necessary precautions of economic and health consequences of that future preventive measures.15

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