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Dynamics of Infectivity and Fatality of COVID-19 Pandemic

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ABSTRACT

Introduction: There is 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 really and statistically varying among the countries particularly with different health status and economic development.

Objective: Based on the above research problem, the paper investigates the variations in average death, infection rate, fatality rate and mortality rate and looks into the statistical significance of their growth trends among different group of countries.

Methods: The data on total confirmed cases and the total number of death for 178 countries used in this research has been collected from the World Health Organization (WHO) Coronavirus Disease (COVID-19) Dashboard. The paper explains the current status estimating of average death, incidence rate, fatality rate and mortality rate. Moreover, the paper also investigates the statistical significance of average death, incidence rate, fatality rate and mortality rate applying compound monthly growth rate and one-way ANOVA.

Results: The paper reveals that average death and infection rate of COVID-19 in all countries are increasing irrespective of economic and other categories. However, the fatality rate is found to be very low in relatively low level-income countries as well as low human developed countries. Moreover, one-way ANOVA results also show that infection and mortality rates are significantly very high among high-income countries and high Human Development Index (HDI) level countries. But fatality rate which is significantly high among low-income countries and very low among Global Health Security (GHS) least-prepared countries.

Conclusion: The average death and infection rate of COVID-19 in all countries are increasing irrespective of economic and other categories but the fatality rate is found to be very low in relatively low level-income as well as low HDI level countries.

Key Words: COVID-19, Fatality rate, Mortality rate, Compound monthly growth rate

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 de-

clared as a global pandemic on March 11, 2020. After the H1N1 influenza pandemic of 2019, 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

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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 ca-

pabilities 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.

$$i) \text{ Infection rate} = \frac{\text{Total confirmed cases of COVID19}}{\text{Total populations of the country}} \times 1,000,000$$

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

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

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

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 ¹	Infection Rate ²	Fatality Rate ³	Mortality Rate ⁴	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	11715	4615	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: ¹Average Death shows absolute number (rounded off).

²Infection rates indicate Cases per million populations.

³Fatality rates show Deaths per million cases.

⁴Mortality 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. Moreo-

ver, 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.¹¹ 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 (3,996 US\$-12,375 US\$)	5956	3827	22981	103	49

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)					
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)					
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 displays that average death and infection rate of COVID-19 in all continents are increasing at an alarming rate but unlike in other continents, the fatality rate in Asia and Africa registers a decreasing trend. In a similar vein, average death and infection rate of COVID-19 in all countries irrespective of economic and other categories are increasing whereas the fatality rate in relatively low-level income countries (lower-middle and low-income countries) and or low human development countries, it is declining. Moreover, the least prepared countries in GHS index also shows declining fatality rate.

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.

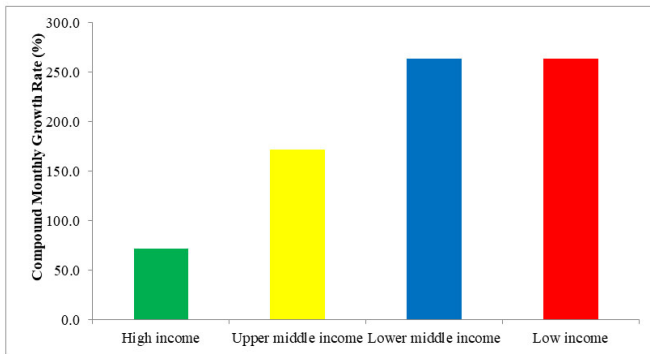


Figure 1: Growth of Infection in different Income countries (During February-July 2020).

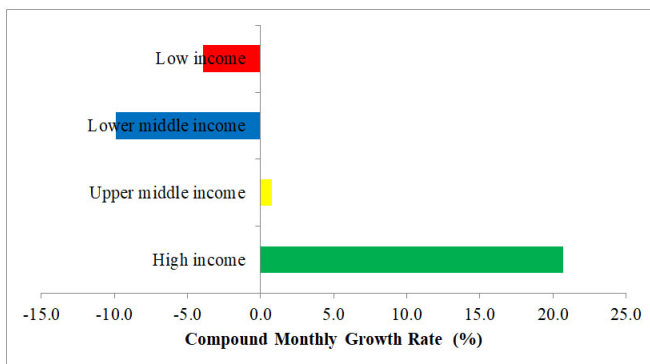


Figure 2: Fatality in different Income countries (During February-July 2020).

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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