Epidemiological Indices of COVID-19 Viruses in Countries with High-incidence: A Descriptive and Comparative Analysis

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Abstract

Background: Coronavirus disease 2019 (COVID-19) has posed an unusual threat to global health. Up to May 26, 2021, according to a report by the World Health Organization (WHO), 167.01 million cases, and 3.47 million deaths were reported. This study aimed to estimate and compare epidemiological indices of COVID-19 in high-incidence countries.

Methods: We conducted a descriptive and comparative analysis intending to examine the epidemiological indices of COVID-19 in high-incidence countries, using the data published by the WHO until May 17, 2021. We calculated the incidence and mortality rate per 1,000,000 inhabitant-day at risk daily, weekly, and overall, using person-day as the denominator.

Results: The fatality rate in 14 countries was about 1.94%. The highest fatality rate was acquired in Italy (2.99%), followed by the United Kingdom (2.86%) and Iran (2.79%). The lowest value on the fatality rate was in Turkey and India, at 0.88% and 1.1%. The highest incidence rate was reported in the USA (207 cases per 1,000,000 person-day), followed by France (190), Poland (171), and Argentina (167). The highest mortality rate for the whole period was extracted in Brazil (4.60 death per 1,000,000 population-day), and the lowest rate happened in India (0.42).

Conclusion: Until May 17, 2021, COVID-19 has affected about 117.6 million patients and caused 2.3 million deaths in 14 high-incidence countries. This study shows that a specific pattern of COVID-19 has been observed in every country.

Introduction

The coronavirus disease 2019 (COVID-19), known in China at the end of 2019, has high potential transmission, and its incidence has grown exponentially.[1] Due to the extensive transmission of COVID-19 the World Health Organization (WHO) identified it as a pandemic.[2] Two major outbreaks of the beta coronaviruses family, including severe acute respiratory syndrome coronavirus (SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV), had occurred worldwide over the past two decades. These outbreaks have generated more than 10,000 cases, including fatality rates of 10% for SARS-CoV and 37% for MERS-CoV.[3, 4] In contrast, studies reported different rates of epidemiological indices for COVID-19.[5-7] For example, Rodriguez-Villamizar et al. estimated the mortality rate of COVID-19 per 100,000 person-day to be 0 to 38.5 in the municipals of Colombia.[8] In OECD countries, the mean incidence of COVID-19 was reported at 2474 cases per million, ranging from 136 to 7413 cases per million.[9]

The ongoing pandemic of COVID-19 has posed an unusual threat to global health.[10] On December 31, 2019, this infection was reported in China and spread

globally in more than 188 countries. Up to May 26, 2021, according to a report by WHO, there were 167.01 million cases, and 3.47 million deaths were reported.[11, 12]

Not only has COVID-19 caused problems in health, but it has also created changes in the world's economy, such that these changes would create the distance between countries depending on their approaches following the disease, the type of interventions, diagnostic programs, and control machines.[13] The forecast by the International Monetary Fund (IMF) estimated that the economic growth decreased from 2.9% in 2019 to -3% in 2020 at the global level.[14]

The research aims to study the epidemiological indices of COVID-19 in high-incidence countries based on two key arguments; First, studying the epidemiological indices by a disease can be a guide in preventing and controlling that disease, especially in unknown pandemics such as COVID-19. In addition, more data are required to demonstrate the full spectrum of the epidemiological features of the outbreak. Second, studies associated with COVID-19 epidemiology have been done globally, but these studies have been carried out in one country or a particular region.[15-17] Additionally, studying some specificcountries is more important than othersbecause nearly 70% of reported cases belonged to 14 countries.

Methods

We conducted a descriptive and comparative analysis intending to examine the epidemiological indices of COVID-19 in high-incidence countries. For this reason, we selected 14 countries with the highest incidence of cases on May 17, 2021. In other words, countries with the highest rank in terms of the cumulative number of COVID-19 cases until May 17, 2021, were selected. These countries are listed in order of cumulative disease cases, respectively: United States of America, India, Brazil, France, Turkey, Russian Federation, United Kingdom, Italy, Spain, Germany, Argentina, Colombia, Poland, and Iran.

We retrieved the data in this study from the WHO website.[12] The WHO reports COVID-19 data on diagnosed and death cases in all counties and regions. To make a more logical comparison, we calculated person-time at risk (person-day) as a product of the total population multiplied by the day number since the first symptom for the first confirmed case in every country.

We examined the epidemiological indices of COVID-19 in the selected countries in two stages. We first obtained the confirmed incidence cases and the death number in the selected countries until May 17, 2021, daily. Then, we calculated the cumulative rates of incidence and death. Finally, we estimated the incidence and mortality rate per 1,000,000 inhabitant-day at risk daily, weekly, and overall, using person-day calculated as the denominator. For this reason, we employed the population of each country in 2020, using the United Nations reports.[18] In addition, the following formulas were used for incidence and mortality rates;

A: Incidence rate=

$$\frac{\text{The number of confirmed cases}}{\text{The population (person}-\text{day) in 2020}} \times 1{,}000{,}000$$

B: Mortality rate=

$$\frac{\text{The number of death due to COVID}-19}{\text{The population (person}-\text{day) in 2020}} \times 1{,}000{,}000$$

Besides, we calculated the fatality rate by dividing the death number from COVID-19 disease by the total number of the infected population. All the analyses were performed using Stata 14 (Stata Corp, College Station, Tex) software.

Results

Table 1 shows the total case, death, and fatality rate by COVID-19 in 14 high-incidence countries until May 17, 2021. At the follow-up time, the United States had the highest total instances of COVID-19 (approximately

Table 1: COVID-19 infection and mortality rates in specified nations as of May 17, 2021

Countries	Total case reported	Total death reported	Fatality rate (%)
United States of America	32,994,339	586,359	1.78
India	25,008,447	275,187	1.10
Brazil	15,657,391	436,537	2.79
France	5,942,370	107,973	1.82
Turkey	5,127,548	44,983	0.88
Russian Federation	4,892,938	114,263	2.34
United Kingdom	4,468,582	127,946	2.86
Italy	4,162,576	124,296	2.99
Spain	3,615,860	79,432	2.20
Germany	3,608,320	86,386	2.39
Argentina	3,335,965	71,027	2.13
Colombia	3,131,410	81,809	2.61
Poland	2,855,190	71,675	2.51
Iran	2,765,485	77,222	2.79
All countries	117,566,421	2,285,095	1.94

33 million), whereas the Islamic Republic of Iran had the lowest (about 2.76 million). COVID-19 caused 2.28 million deaths in 14 nations. The United States had the highest deaths (586.3 thousand), while Argentina had the lowest number (71 thousand). However, Italy (2.99 percent) and Turkey (0.88 percent) had the highest and lowest fatality rates, respectively.

Table 2 shows the incidence rate per 1,000,000 person-day in the selected countries. The average incidence rate for cases of COVID-19 ranged from 0.08 per 1,000,000 inhabitants-day for India to 0.43 for the USA. The mean incidence rate per 1,000,000 person-day was 93.11 for the whole period in the selected countries. The highest incidence rate for the whole period was reported in the USA (207.23), and the lowest incidence rate happened in India (38.31).

Table 3 presents the selected countries' COVID-19 mortality rate for the day, week, and overall period. Until May 17, 2021, the mortality rate was estimated at 0.007 per 1,000,000 person-day daily, 0.046 weekly, and 1.81 for the entire period. The average daily mortality rate varied from 0.001 per 1,000,000 inhabitants-day for India to 0.011 for Brazil.

Discussion

Our descriptive and comparative study reveals that the

top 14 countries with a high incidence of COVID-19 are responsible for 72% of total cases and 67% of total deaths worldwide. There were approximately 163.41 million cases and 3.38 million COVID-19 deaths in the world until May 17, 2021, of which 117.56 million cases and 2.28 million deaths occurred in 14 countries. In addition, COVID-19 has a fatality rate of approximately 1.94 percent in 14 countries with significant prevalence, according to the study.

The results demonstrated that the case fatality rate is about 1.94% in the selected countries, ranging from 0.88% for Turkey to 2.99% for Italy. Other studies have estimated the COVID-19 case fatality rate from 1% to 5%;[19-21] for example, a meta-analysis by Li et al. reported a 5% case fatality rate for patients with COVID-19.[19] Another study by He et al. reported the case fatality rate of 2.72% with a 95% confidence interval (1.29%-4.16%).[22] The average case fatality rate by COVID-19 was calculated at 2% to 3% globally.[23] There are some reasons why the case fatality rate of COVID-19 varies between studies. First, the population surveyed is different in these studies; some of these studies have used a general population, and others have been conducted on a specific population. Usually, the case fatality rate has a statistically significant relationship with age, sex, and the prevalence of cardiovascular diseases, diabetes,

Table 2: The incidence rate average per 1,000,000 population-time (day) in the specified nations till May 17, 2021

Countries	Daily		Weekly		Overall period
	Mean (CI 95%)	Standard Deviation	Mean (CI 95%)	Standard Deviation	Mean (CI 95%)
United states of America	0.43 (0.39-0.47)	0.40	3 (2.34-3.67)	2.80	207.23 (189.73-224.74)
India	0.08 (0.07-0.09)	0.13	0.56 (0.35-0.78)	0.89	38.31 (32.76-43.86)
Brazil	0.37 (0.35-0.39)	0.26	2.58 (2.20-2.96)	1.54	165.15 (154.23-176.08)
France	0.40 (0.35-0.44)	0.53	2.75 (2.07-3.44)	2.89	190.06 (167.28-212.84)
Turkey	0.27 (0.24-0.31)	0.39	1.91 (1.23-2.58)	2.69	118.14 (102.24-134.04)
Russian Federation	0.15 (0.14-0.16)	0.11	1.04 (0.85-1.24)	0.80	71.03 (66.13-75.94)
United Kingdom	0.29 (0.26-0.33)	0.41	2.05 (1.38-2.73)	2.83	139.46 (121.97-156.95)
Italy	0.31 (0.28-0.34)	0.33	2.15 (1.60-2.69)	2.31	145.86 (131.47-160.25)
Spain	0.35 (0.30-0.40)	0.58	2.41 (1.80-3.03)	2.6	164.20 (139.37-189.02)
Germany	0.19 (0.17-0.21)	0.23	1.31 (0.99-1.64)	1.37	90.48 (80.53-100.42)
Argentina	0.38 (0.35-0.41)	0.33	2.62 (2.08-3.16)	2.20	167.75 (154.01-181.50)
Colombia	0.32 (0.30-0.34)	0.23	2.24 (1.84-2.63)	1.61	140.82 (131.11-150.55)
Poland	0.39 (0.34-0.44)	0.49	2.73 (1.91-3.55)	3.3	171.85 (151.48-192.21)
Iran	0.16 (0.15-0.17)	0.14	1.12 (0. 87-1.37)	1.02	72.68 (66.55-78.82)
All countries	0.29 (0.28-0.30)	0.37	2.03 (1.88-2.18)	2.31	93.11

CI: Confidence Interval

Table 3: The average mortality rate per 1,000,000 population-time (day) until May 17, 2021, in the specified countries

Countries	Daily		Weekly		Overall period
	Mean (CI 95%)	Standard Deviation	Mean (CI 95%)	Standard Deviation	Mean (CI 95%)
United states of America	0.008 (0.007-0.009)	0.006	0.053 (0.044-0.063)	0.039	3.68 (3.43-3.93)
India	0.001 (0.0009-0.0011)	0.0012	0.006 (0.004-0.008)	0.008	0.42 (0.37-0.47)
Brazil	0.011 (0.010-0.012)	0.008	0.072 (0.0059-0.085)	0.053	4.60 (4.25-4.96)
France	0.007 (0.007-0.0083)	0.008	0.05 (0.039-0.061)	0.048	3.45 (3.09-3.82)
Turkey	0.003 (0.002-0.0031)	0.002	0.02 (0.016-0.024)	0.017	1.23 (1.13-1.34)
Russian Federation	0.004 (0.003-0.0041)	0.002	0.024 (0.02-0.029)	0.018	1.66 (1.56-1.76)
United Kingdom	0.009 (0.008-0.0102)	0.011	0.059 (0.041-0.076)	0.072	3.99 (3.52-4.46)
Italy	0.01 (0.009-0.0104)	0.008	0.064 (0.05-0.078)	0.058	4.36 (4.00-4.71)
Spain	0.008 (0.007-0.009)	0.011	0.053 (0.04-0.067)	0.057	3.61 (3.12-4.09)
Germany	0.005 (0.004-0.006)	0.006	0.031 (0.022-0.041)	0.04	2.17 (1.89-2.45)
Argentina	0.008 (0.007-0.009)	0.01	0.056 (0.043-0.068)	0.051	3.57 (3.14-4.00)
Colombia	0.009 (0.008-0.0091)	0.005	0.058 (0.048-0.069)	0.040	3.68 (3.44-3.92)
Poland	0.01 (0.009-0.011)	0.012	0.068 (0.051-0.086)	0.072	4.31 (3.81-4.82)
Iran	0.0045 (0.0042-0.0048)	0.003	0.031 (0.026-0.037)	0.022	2.03 (1.90-2.16)
All countries	0.007 (0.006-0.0072)	0.008	0.046 (0.043-0.049)	0.05	1.81

CI: Confidence Interval

and kidney and chronic obstructive pulmonary diseases.[8, 24, 25] Another explanation might be that in our analysis, the fatality rate for some nations was assessed with bias. Iran, for example, was predicted to have 2.79 percent. In this nation, most COVID-19 cases are likely undiagnosed, especially at the beginning of the outbreak, which faced shortcomings in diagnostic testing technology. In addition, because the incubation period for COVID-19 is unusually long, many cases of this disease go undetected. Third, changes in population structure may account for some of the variances in the COVID-19 mortality rate. For instance, Italy's high case fatality rate compared to other countries could be due to the aging population. Besides, COVID-19 has a considerably lower fatality rate than SARS and MERS. According to studies, SARS and MERS exhibit fatality rates of 9.6% and 36%, respectively.[26-28]

The incidence rate of COVID-19 was estimated at 0.29, 2.03, and 93.11 per 1,000,000 inhabitants-day for daily, weekly, and the entire period in countries with high incidence, respectively. Also, for every 1,000,000 person-day, the average mortality rate was 0.007 daily, 0.046 weekly, and 1.81 overall periods. Comparing epidemiology indicators by COVID-19 in the 14 countries shows much morbidity and mortality rate diversity. The USA had the highest rank in terms of incidence per 1,000,000 person-day for the overall period (207), followed by France (190) and Poland (171). However, the highest mortality rate was in Brazil (4.6), Italy (4.36), and Poland (4.31), respectively. Comparison of different studies associated with morbidity and mortality rates by COVID-19 shows that the time frame of estimation is a significant factor in determining these indices. Overall, the incidence rates are estimated to be lower in a short period than in a more extended period.

Conversely, the mortality rates are extracted to be higher in a short period. Lai et al. reported that the incidence rate of COVID-19 per 1,000,000 population was 0.45 in the USA, 0.03 in Brazil, and 63 in Italy as of March 6, 2020. Also, they reported a mortality rate of 0.03 for the USA and 2.45 for Italy.[29]

This study had some limitations. First, we used the whole data reported by WHO. Due to many concealed cases of COVID-19, these statistics may not accurately reflect real incidence cases. As a result, it's possible that our research underestimated the incidence rate in some nations. Furthermore, the fatality rate is likely to be exaggerated because the real cases of COVID-19 in these nations should be substantially greater than the reported cases. Second, the start of the COVID-19

pandemic differs depending on the country. Therefore, it's possible that comparing illness patterns at various times will provide skewed data. Finally, we adjusted the results using inhabitant-day for every country.

Conclusion

Despite the limitations highlighted, this is the first study that compares COVID-19 epidemiological indicators in countries with high prevalence. COVID-19 has impacted about 117.6 million people and caused 2.3 million fatalities in 14 high-intensity nations till May 17, 2021. This study demonstrates that each nation has its COVID-19 pattern, which various factors can influence. The results also suggest that more studies be designed on the epidemiological indices of COVID-19 over a more extended period.

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