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World one-hundred days after COVID-19 outbreak: Incidence, case fatality rate, and trend

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Abstract:

BACKGROUND: The prevalence of viral diseases is on the rise and has caused many problems for public health. COVID-19 is a new viral outbreak in the world. This study aimed to investigate the trends of incidence and case fatality rate (CFR) of COVID-19 in the world by April 30, 2020.

METHODS: This was a descriptive-analytical study. We investigated the number of cases and deaths in 35 selected countries and regions of the WHO that had at least 10,000 cases by the time of the study. In addition, the incidence and CFR of COVID-19 were investigated. Finally, time trends of the number of cases, deaths, and CFR were investigated using ordinary least squares regression models.

RESULTS: The total number of confirmed cases of COVID-19 was 3,090,184. The European region had the highest number of COVID-19 patients (1,434,649 [46.43%]). Ukraine with 10,406 and the USA with 1,003,974 cases have reported the lowest and highest confirmed cases, respectively. In addition, the European region and the African region with 157.13 and 2.50 patients per 100,000 population had the highest and the lowest incidence rate, respectively. India (2.44) and Spain (455.69) had the lowest and the highest incidence rate per 100,000 population, respectively. In the world, 217,759 deaths have happened, of which 135,961 (62.44%) were reported in the European region. Furthermore, the USA had the highest number of deaths (52,428) due to COVID-19. CFR was 7.05% in the world, which ranged from 3.74% in the African region and 9.48% in the European region. The number of patients and deaths due to COVID-19 had increasing trends in all countries, and the trend of CFR just for Iran and Ukraine was negative.

CONCLUSION: The countries had different trends in the morbidity and mortality of COVID-19. However, regarding the increasing trend of the disease in the world, it will be more important to rely on public prevention strategies. It is necessary to apply and continue public health policies at national and global levels till the control of the disease.

Keywords:

Case fatality rate, COVID-19, incidence, outbreak, trend

Introduction

According to WHO reports, the prevalence of viral diseases is on the rise and has caused many problems for public health. In the two recent decades, several viral epidemics such as SARS-CoV (2002–2003) and H1N1 Influenza (2009) have been reported.^[1] In

December 2019, a number of patients with pneumonia symptoms caused by a newly identified β -coronavirus were discovered in Wuhan, China.^[2] Within a month, the disease spread rapidly; the coincidence of the virus with the start of the new year and increase in travels increased the speed of its spread and transmission between cities and different countries.^[3] This coronavirus was first named as the

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2019-novel coronavirus (2019-nCoV) on January 12, 2020, by the World Health Organization (WHO). Then, the WHO introduced it as “COVID-19,” and some researchers have named it as SARS-CoV-2. Chinese scientists quickly isolated a SARS-CoV-2 virus from a patient on January 7, 2020, to extract the genetic structure of SARS-CoV-2.^[4] On January 30, 2020, the WHO announced the coronavirus outbreak as the sixth public health emergency after influenza (2009), polio (2014), Ebola in the west of Africa (2014), Zika (2016), and Ebola in Congo (2019).^[5] Despite considerable efforts made to control the disease by the Chinese government, the disease spread rapidly and then it affected people in other countries of the world^[6,7] until finally it was introduced as a pandemic disease on March 11, 2020.^[8]

Based on the present epidemiological information, the disease incubation period varies from 1 to 14 days, usually 3–7 days. It is also contagious during the latency period.^[7,9] Disease symptoms have a range of moderate to severe that include fever, cough, shortness of breath, and pneumonia. In severe cases, neurological, gastrointestinal, hepatic, and respiratory complications may occur. The disease is transmitted through respiratory droplets or direct contact with the infected person.^[4,10] Another comprehensive study has reported that fever in 88.7% of patients, cough in 67.8% of patients, fatigue in 38.1% of patients, sputum in 33.4% of patients, shortness of breath in 18.6% of patients, sore throat in 13.9% of patients, and headache in 13.6% of patients are known as common symptoms.^[4]

COVID-19 is highly contagious in the elderly and people with underlying diseases, and the mean age of the patients varies from 47 to 59 years.^[4] Its crude case fatality rate (CFR) has been reported as 2.3%, and the highest crude CFR (14.8%) is observed in the age group of above 80 years. The crude CFR for males and females is reported as 2.8% and 1.7%, respectively. The crude CFR has been approximately 0.9% in people without comorbidity.^[11] The hospital transfer rate has been reported as 41%,^[7] and the basic reproduction number or R_0 has been estimated as 2.2 (90% interval: 1.4–3.8).^[12] Others reported R_0 to be 3.28 and it ranged from 1.4 to 6.5 with a mean of 2.79.^[13]

The emergence of new epidemics has always had a heavy financial burden on the economies of the involved countries. The interference of an estimate indicated that the influenza pandemic could impose 700,000 deaths and 570 billion USD cost on countries.^[14] It was also estimated that the Zika outbreak cost 2 billion dollars for the USA,^[15,16] and the Ebola outbreak has imposed 53.19 billion dollars in the year 2014 on West Africa.^[17] The epidemics of SARS in the year 2003 and influenza in the year 2013 have cost 30–100 billion and 40 billion

dollars for China, respectively.^[18] Other effects of the epidemics included effects on the pharmaceutical demand of countries, import and export, and impact on tourism. The results of studies have indicated that the final demand has increased 12% for pharmaceutical products and 13% for health care and has decreased 10% for wholesale trade, 10% for traveling by plane and train, 18% for food and beverages, 18% for accommodation, 14% for retail trade, and 38% for amusement and recreation activities.^[19] The firms that have been most affected included those relating to transportation, tourism, fashion, and agro-food.^[20] According to the OECD, gross domestic product will decrease by a half percent in the year 2020 and will reach 2.4%, and it may also be reduced and reach 1.5% if the COVID-19 outbreak continues a higher time period.^[20]

Countries of the world are trying to cope with the possible devastating effects of COVID-19. Health organizations of countries through information flows and disease guidelines are trying to reduce the effect of this threat. Meanwhile, scientists around the world are researching tirelessly. Hence, the information on transmission, disease mechanism, clinical symptoms of the disease, methods of diagnosis, and appropriate strategies for the prevention and treatment of the disease are being developed.^[1] In this situation, the rapid response of governments to overcome COVID-19 has an increasing importance.^[20] Despite the actions taken, the disease is not yet controlled.

The number of confirmed cases and deaths has been variable from the beginning of the disease until April 30, 2020. According to the reports, by March 16, 2020, 174,961 patients with COVID 19 have been identified and 6,705 people have died from the disease.^[21] In another study, it was reported that the total number of confirmed cases and total number of deaths until March 26, 2020, were 460,611 and 20,842, respectively.^[22] The total number of confirmed cases in all the six regions is 3,089,733 cases, of which 71,839 cases have been newly approved. In addition, the total number of deaths in all regions is 217,756 cases, of which 9797 cases of it are new.^[23] These statistics would help policymakers to make better decisions for resource allocation in health sector.^[22] Although there are statistics regarding COVID-19, its morbidity and mortality trends have not been completely studied worldwide. This study aims to investigate the incidence of COVID-19 infections and deaths in the regions of WHO focusing on countries with a higher burden to obtain a complete picture of it, globally. In addition, we investigated CFR and its trend in the world to show the changes of this index during disease progress among the countries.

Methods

Data source

This was a descriptive-analytical and cross-sectional study performed in 2020 on the incidence and prevalence of COVID-19 morbidity and mortality until April 30, 2020. The data were extracted from the World Health Organization (WHO) reports which itself is on the basis of the countries members' reports. These reports are continuous daily statistical reports related to total confirmed cases, total confirmed new cases, total deaths, and total new deaths, separated for countries and six regions of the WHO from January 20, 2020.

Analysis

As the COVID-19 incidence in the study time was very low in some countries, those countries were entered into the study which have reported more than 10,000 disease cases. Therefore, 34 countries were included in the final analysis. The mean and standard deviation (SD) of total cases and deaths were calculated. In addition, the incidence rate of COVID-19 was calculated per 100,000 populations for the WHO regions and the selected countries in the study period. The following formula was used to calculate the incidence:

Incidence rate: The number of patients during the study period/population during the study period \times 100,000.

Furthermore, the CFR was obtained for the world, WHO regions, and the selected countries in the study period using the following formula:

CFR = Number of deaths in the study period/number of cases in the study period \times 100.

One of the other aims of this study was estimating the trends of total cases, total deaths, and CFR during the study time. The following regression formula was used to determine the trend of outcome variables in the different WHO regions and the selected countries.

$$Y = \beta_0 + \beta_1 T.$$

Here, Y is the outcome variable (number of cases/deaths/CFR), β_0 is the intercept, β_1 is b-coefficient, and T is time (days). Indeed, β_1 shows the time trend of cases and deaths. We fitted two models for each country, one model for confirmed cases and another model for deaths. In addition, two models were fitted for the globe.

Results

All confirmed cases of COVID-19 disease until April 30, 2020, was 3,090,184 persons, and the mean (SD) of patient number in the countries of the world was

15,222.58 (76,180.64). The European region had the highest number of COVID-19 patients so that 1,434,649 (46.43%) patients were related to this region of the WHO. The lowest proportion of patients (0.82%) was reported in the African region, and the second-lowest reported cases of infection were reported in the South-East Asian Region. The highest and lowest mean of patients with 599.76 and 24,434.71 were related to countries covered by the African region and the region of the Americas, respectively. The COVID-19 incidence calculation indicated that the European region with 157.13 patients per 100,000 population had the highest and the African region with 2.50 patients per 100,000 population had the lowest incidence rate during the study period.

In terms of the number of deaths due to COVID-19 in the world, 217,759 deaths have happened, of which 135,961 (62.44%) were reported in the European region. In addition, the mean (SD) of deaths in the countries of the world was 1072.70 (5142.81). CFR of disease was 7.05% in the world, which ranged from 3.74% in the African region and 9.48% in the European region. Table 1 shows the total confirmed cases, incidence, total deaths, and CFR of coronaviruses in different regions of the WHO until April 30, 2020.

The comparison of selected countries indicated that Ukraine with 10,406 and the USA with 1,003,974 cases have reported the lowest and highest diagnosed cases of COVID-19, respectively. In this regard, Spain, Italy, Germany, the United Kingdom, and France were located in the next ranks. In terms of disease incidence, India (2.44) had the lowest and the Spain (455.69) had the highest incidence rate per 100,000 people. After Spain, Qatar, Belgium, Ireland, Switzerland, Italy, and the USA had the highest incidence rate.

Qatar and Singapore have reported 10 and 14 deaths, respectively. The highest number of deaths were reported from the USA (52,428), and then Italy, the United Kingdom, Spain, France, Belgium, Germany, and Iran. In terms of mortality, France had the highest CFR with 18.93 deaths per 100 COVID-19 confirmed cases. In the next ranks, CFRs in the United Kingdom, Belgium, Italy, and the Netherlands were 15.79%, 15.67%, 13.60%, and 12.14%, respectively. Qatar had the lowest CFR, and this rate in Singapore, Belarus, Saudi Arabia, and the United Arab Emirates was less than 1%. Table 2 indicates the total confirmed cases, incidence, total deaths, and CFR of coronaviruses in the selected countries.

Time trend assessment of the number of patients indicated that on an average, 27,003.95 cases have been identified on a daily basis, globally. The United Arab Emirates with 90.76 cases per day had the lowest increasing trend among the countries. After this country,

Table 1: Total confirmed cases and deaths of coronaviruses in World Health Organization regions until April 30, 2020

Country	Total confirmed cases		Incidence (per 100,000)	Total deaths		CFR (%)
	n (%)	Mean (SD)		n (%)	Mean (SD)	
Western Pacific region	147,743 (4.78)	7775.94 (18,748.55)	7.87	6094 (2.80)	320.74 (1030.23)	4.12
European region	1,434,649 (46.43)	23,910.82 (50,654.47)	157.13	135,961 (62.44)	2266.02 (6387.50)	9.48
South-East Asian region	54,021 (1.75)	5402.10 (9775.68)	2.76	2088 (0.96)	208.80 (369.02)	3.87
Eastern Mediterranean region	182,411 (5.90)	4070.50 (5904.34)	27.21	7447 (3.42)	354.62 (1257.14)	4.08
Region of the Americas	1,246,170 (40.33)	24,434.71 (13,914.23)	123.92	65228 (29.95)	1278.98 (7280.30)	5.23
African region	25,190 (0.82)	599.76 (1024.01)	2.50	941 (0.43)	22.40 (68.70)	3.74
Globe	3,090,184 (100)	15,222.58 (76,180.64)	39.71	217,759 (100)	1072.70 (5142.81)	7.05

CFR=Case fatality rate, SD=Standard deviation

Table 2: Total confirmed cases, incidence, total deaths, and case fatality rate of coronaviruses by April 30, 2020

Countries	WHO region	Total confirmed cases	Incidence (per 100,000)	Total deaths	CFR (%)
Austria	EURO	15,364	173.66	580	3.78
Belarus	EURO	13,181	138.96	84	0.64
Belgium	EURO	47,859	419.00	7501	15.67
Brazil	AMRO	71,886	34.32	5017	6.98
Canada	AMRO	50,363	135.90	2904	5.77
Chile	AMRO	14,885	79.48	216	1.45
China	WPRO	84,373	6.06	4643	5.50
Ecuador	AMRO	24,675	144.43	883	3.58
France	EURO	127,066	189.69	24054	18.93
Germany	EURO	159,119	191.88	6288	3.95
India	SEARO	33,050	2.44	1074	3.25
Iran	EMRO	93,657	114.49	5957	6.36
Ireland	EURO	20,253	417.29	1190	5.88
Italy	EURO	203,591	336.90	27682	13.60
Japan	WPRO	14,088	11.13	415	2.95
Mexico	AMRO	16,752	13.28	1569	9.37
The Netherlands	EURO	38,802	225.19	4711	12.14
Pakistan	EMRO	15,759	7.43	346	2.20
Peru	AMRO	31,190	97.50	854	2.74
Poland	EURO	12,640	33.28	624	4.94
Portugal	EURO	24,505	238.33	973	3.97
Qatar	EMRO	12,564	451.67	10	0.08
The Republic of Korea	WPRO	10,765	20.85	247	2.29
Romania	EURO	11,978	61.51	675	5.64
Russian Federation	EURO	106,498	73.71	1073	1.01
Saudi Arabia	EMRO	21,402	63.51	157	0.73
Singapore	WPRO	15,641	277.39	14	0.09
Spain	EURO	212,917	455.69	24275	11.40
Sweden	EURO	20,302	199.37	2462	12.13
Switzerland	EURO	29,324	344.32	1407	4.80
The United Kingdom	EURO	165,225	248.50	26097	15.79
Turkey	EURO	117,589	142.84	3081	2.62
Ukraine	EURO	10,406	23.32	261	2.51
The United Arab Emirates	EMRO	11,929	123.86	98	0.82
The United States of America	AMRO	1,003,974	306.87	52428	5.22

AMRO=Region of the Americas, EURO=European Region, WPRO=Western Pacific Region, SEARO=South-East Asian Region, EMRO=Eastern Mediterranean Region, CFR=Case fatality rate, WHO=World Health Organization

Singapore, Japan, and the Republic of Korea, on an average, have been reported 94.94, 116.81, and 148.08 new cases per day from the onset of the disease. On the other hand, the USA with a diagnosis of 8491.39 new cases in a day had the highest increasing trend. After

that, Spain, Turkey, Italy, and Germany had the highest trend of confirmed cases.

Furthermore, the time trend of deaths due to COVID-19 indicated that all countries have had an increasing trend,

and an average of more than 1903 deaths have happened in the world each day. Some countries such as Singapore, Qatar, the United Arab Emirates, Belarus, and Japan have had fewer deaths over time, but on the other hand, the USA has had the highest rate of increase in death trend so that the average of 385.05 deaths daily due to COVID-19 disease has happened in this country. After the USA, Italy, Spain, France, the United Kingdom, and Iran had the highest slope of death since the beginning of the disease. The disease and death trend in all countries was statistically significant at the level of 0.001.

The time trend of CFR indicates that this rate has had an increasing trend in globe and on an average, every day 0.06 has been added to this index. Iran and Ukraine had a decreasing trend in CFR, but the trends were not statistically significant ($P > 0.05$). Singapore and Qatar had the lowest positive trends ($\beta = 0.004$). The highest increasing trend in CFR had happened in the Netherlands, Belgium, and the United Kingdom so that they had more than 0.2 increase in this index from the onset of the disease in these countries. Table 3 indicates the time trends of the total confirmed cases, the total deaths, and CFR of coronaviruses in the countries.

Figures of the confirmed cases, total deaths, and case fatality rate in the selected countries

Assessment of the figures related to COVID-19 infection in the selected countries indicates that at the beginning of the period, China, as the first country involved in the disease, has had an increasing trend and at the end of the period, the slope of the disease has closed to zero. This indicates that the increasing trend of the disease has been controlled. In the following, with the infection of people from other countries, the USA, Spain, Italy, the United Kingdom, and Germany have had a more ascending trend compared to other countries. Totally, the USA has had the highest positive slope in the reported cases in the globe. Figure 1 indicates the trend of infection to disease in the selected countries.

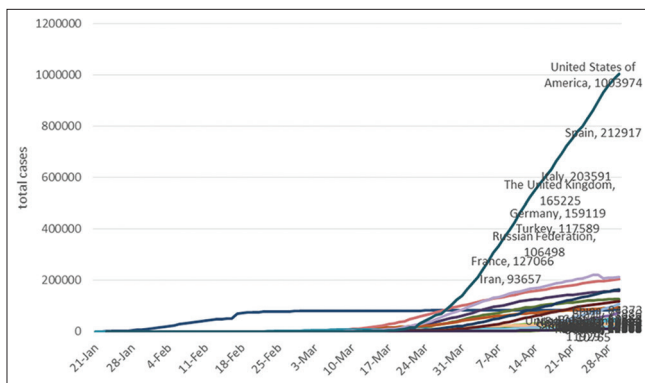


Figure 1: Trend of total confirmed cases of coronavirus in selected countries by April 30, 2020

The figure related to death due to COVID-19 indicates that China has been able to reduce the slope of the disease at the end of the study time, but the USA, which has reported the first case of COVID-19 in the middle of the period, has had the most positive mortality slope so that this country has significant higher increasing trend than other countries. After the USA, Italy has had the highest increasing slope of the deaths of the disease. In addition, Italy, the United Kingdom, Spain, and France are also placed in the next ranks of increasing slope of COVID-19-related deaths. Figure 2 indicates the trend of deaths due to COVID-19 in the countries.

Trend of CFR indicated that Iran had the highest CFR in the first days of disease. However, in the following days, the trend of CFR in this country has been decreasing. All countries in the end of the study period had an increasing trend. The United Kingdom, France, Sweden, Belgium, the Netherlands, and Spain had the higher CFR in the end of the period. Figure 3 displays the trend of CFR of COVID-19 in the countries.

Discussion

This study assessed the time trend of morbidity and mortality due to COVID-19 in all the six regions of the WHO from April 30, 2020, using the published data. The highest incidence rate of COVID-19 belonged to the European region and the lowest belonged to the African region. The reason for these differences between the regions may be differences in the demographic characteristics of population, restrictive policies, the disease epidemiologic status, and the last but not the least, preparedness of countries against disaster situations. One of the most effective probable reasons for high morbidity in the European region may be its high population density which has caused more people to become infected within a short time period.

The COVID-19 CFR was also different in WHO regions so that the lowest rate belonged to the African region with 3.74 and the highest belonged to the European region

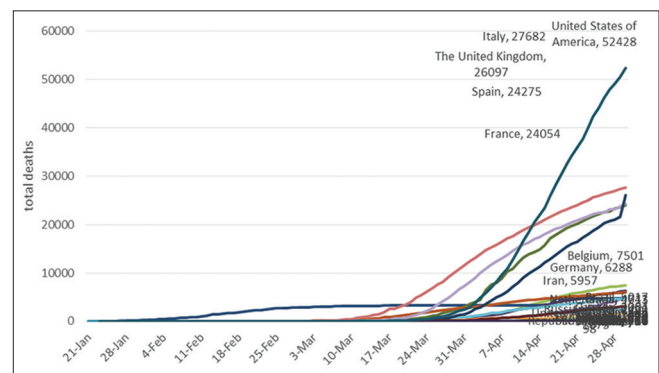


Figure 2: Trend of number of deaths due to coronavirus in selected countries by April 30, 2020

Table 3: Time trend of total confirmed case and total death of coronaviruses in selected countries, by March 29, 2020

Country	Total cases			Total death			CFR		
	Coefficient	Robust SE	P	Coefficient	Robust SE	P	Coefficient	Robust SE	P
Austria	320.49	10.89	<0.001	10.05	0.53	<0.001	0.07	0.00	<0.001
Belarus	154.81	19.59	<0.001	1.18	0.11	<0.001	0.02	0.00	<0.001
Belgium	570.81	37.06	<0.001	77.86	7.10	<0.001	0.21	0.01	<0.001
Brazil	909.42	87.51	<0.001	59.03	6.65	<0.001	0.14	0.00	<0.001
Canada	435.39	38.91	<0.001	18.91	2.59	<0.001	0.05	0.00	<0.001
Chile	269.60	14.16	<0.001	3.63	0.28	<0.001	0.03	0.00	<0.001
China	787.85	63.65	<0.001	45.81	1.48	<0.001	0.03	0.00	<0.001
Ecuador	330.21	38.69	<0.001	12.35	0.97	<0.001	0.09	0.01	<0.001
France	1420.38	83.09	<0.001	229.18	18.96	<0.001	0.19	0.01	<0.001
Germany	1905.56	102.62	<0.001	55.22	5.23	<0.001	0.04	0.00	<0.001
India	236.06	29.26	<0.001	7.49	0.94	<0.001	0.05	0.00	<0.001
Iran	1579.86	44.38	<0.001	100.24	2.88	<0.001	-0.21	0.11	0.06
Ireland	359.45	21.45	<0.001	17.20	1.66	<0.001	0.10	0.00	<0.001
Italy	2603.75	110.47	<0.001	339.00	16.82	<0.001	0.20	0.01	<0.001
Japan	116.81	10.47	<0.001	2.62	0.31	<0.001	0.03	0.00	<0.001
Mexico	214.50	22.60	<0.001	18.67	2.41	<0.001	0.19	0.01	<0.001
The Netherlands	731.22	28.32	<0.001	85.21	4.25	<0.001	0.25	0.01	<0.001
Pakistan	216.24	17.47	<0.001	4.44	0.44	<0.001	0.04	0.00	<0.001
Peru	470.06	48.99	<0.001	12.61	1.39	<0.001	0.07	0.00	<0.001
Poland	237.76	11.53	<0.001	10.24	0.79	<0.001	0.08	0.00	<0.001
Portugal	504.25	18.83	<0.001	18.22	0.98	<0.001	0.08	0.00	<0.001
Qatar	160.01	17.31	<0.001	0.20	0.01	<0.001	0.00	0.00	<0.001
The Republic of Korea	148.08	4.53	<0.001	3.04	0.10	<0.001	0.03	0.00	<0.001
Romania	199.26	11.22	<0.001	10.42	0.74	<0.001	0.12	0.00	<0.001
Russian Federation	680.04	101.56	<0.001	6.14	0.99	<0.001	0.01	0.00	<0.001
Saudi Arabia	288.99	31.55	<0.001	2.63	0.19	<0.001	0.03	0.00	<0.001
Singapore	94.94	14.22	<0.001	0.14	0.01	<0.001	0.00	0.00	<0.001
Spain	2785.50	145.80	<0.001	287.64	17.08	<0.001	0.16	0.01	<0.001
Sweden	203.56	14.85	<0.001	21.40	2.22	<0.001	0.15	0.01	<0.001
Switzerland	594.78	18.55	<0.001	25.09	1.18	<0.001	0.08	0.00	<0.001
The United Kingdom	1621.45	135.40	<0.001	213.60	20.66	<0.001	0.20	0.01	<0.001
Turkey	2717.91	133.58	<0.001	66.56	4.03	<0.001	0.04	0.01	<0.001
Ukraine	165.16	14.30	<0.001	4.25	0.34	<0.001	-0.11	0.06	0.093
The United Arab Emirates	90.76	10.15	<0.001	0.61	0.08	<0.001	0.01	0.00	<0.001
The United States of America	8491.39	747.34	<0.001	385.05	43.38	<0.001	0.05	0.00	<0.001
Selected countries	25012.33	1812.38	<0.001	1721.49	144.55	<0.001	0.06	0.00	<0.001
Globe	27003.95	1958.08	<0.001	1903.38	203.98	<0.001	0.06	0.01	<0.001

SE=Standard error, CFR=Case fatality rate

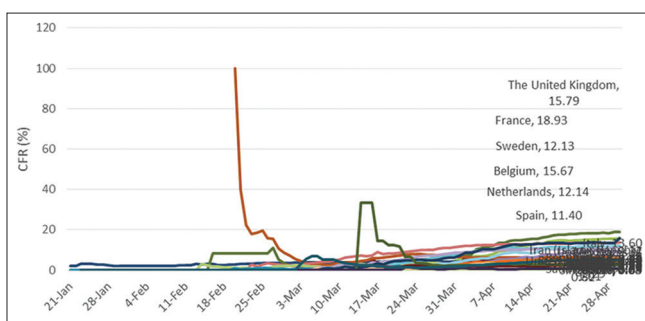


Figure 3: Trend of case fatality rate of coronavirus in selected countries by April 30, 2020

with 9.48. There are different probable reasons for this. Many infected people may indicate mild symptoms of

the disease and not be diagnosed as the confirmed cases of COVID-19. However, the real CFR of this disease is still ambiguous because many infected cases may have mild symptoms that did not undertake a diagnostic test. In order to reach a true estimate of CFR, it is necessary to conduct serology surveys in the large scale.^[24] Another reason may be the difference in population structure and their background diseases. Studies have indicated that background diseases,^[25] gender, and age^[25,26] are among the effective factors on the disease case fatality. These background diseases which are more prevalent among the elderly, increase COVID-19 severity.^[26,27] Furthermore, the duration after reporting the first case and the incidence of disease are different in the countries, and this factor can effect on disease epidemiology and

its CFR. The time distance between diagnosis and death may be another explanation for differences in CFR among these regions.^[28] The detection process of cases and attributable deaths also may have different accuracy in the selected countries. In addition, the result of our study indicates that CFR in almost all countries had a positive pattern that showed the variability of this rate during the disease progression.^[22] Finally, differences in treatment facilities in the surveyed regions may be another explanation for CFR variation.

China had the most total number of confirmed cases among the countries located in the Western Pacific Region (WPRO). However, regarding incidence rate, Singapore had the first rank in this region. The time trend analysis results indicated China had the most average infected individuals daily followed by the Republic of Korea, Japan, and Singapore. In China, the time trend analysis indicated that from January 30, 2020, three days after editing the guideline of COVID-19 diagnosis and treatment, the number of confirmed cases has increased with a steeper slope. It seems that more expanding this guideline has led to the diagnosis of more new cases.^[29] The results of the current study indicated that the ascending slope of new cases take a flat trend after February 8, 2020. It seems that policies such as travel restrictions, quarantine, and isolation of cases are among the probable reasons.^[30] Japan was the third infected country with COVID-19 in WPRO it has enjoyed a decreasing morbidity and mortality trend in comparison with other counties that have been involved after it. The Japanese government has considered numerous limitations on arrival from China to Japan on January 7, 2020. Moreover, formulating diagnostic guidelines, active surveillance, and contact tracing were among other measures. It seems that performing these measures was successful in controlling the disease. Regarding another surveyed variable in the WPRO, China had the most CFR and Singapore had the least one. The time trend of CFR showed that this country had the lowest CFR globally, too. It seems that the experiences of Singapore in previous infectious outbreaks and implementation early social and public health interventions were effective to control COVID-19 in this country.^[31]

Iran had a higher number of confirmed cases of COVID-19 infections (93,657 cases) and deaths (5957 death) among the countries located in the Eastern Mediterranean Region (EMRO). However, after adjusting for the population, Qatar had the first position (highest incidence rate). The time trend of incidence rate in the EMRO showed that Iran had the most increasing trend next to Saudi Arabia, Pakistan, Qatar, and the United Arab Emirates. Compared with other countries in the world, Qatar had the second place. Asymptomatic patients due to their role in spreading the disease are

among the most important probable causes of the increase in confirmed cases. The mortality trend also has an increasing slope in the following order: Pakistan, Saudi Arabia, the United Arab Emirates, and Qatar. CFR time trend analysis for Iran, showed that this rate had a negative trend that was not statistically significant at the level of 0.05. However, Iran's CFR from the beginning of the outbreak until April 30 was 6.36 that was first among EMRO countries and sixth in the world. Access to treatment facilities is an important factor in survival chance of patients, especially for older ones or patients with comorbidities.^[32] It seems that inadequate access to these facilities at the beginning of this outbreak may be the reason of this finding. As stated above, the result of regression analysis showed a negative trend in CFR ($P > 0.01$). In other words, the ascending trend of CFR started to descend, reaching to a real rate. This finding demonstrates that we cannot only judge on the information at the beginning of an outbreak.

Overall, the time distance between the confirmations of first cases may be the cause of difference between the countries located in the Eastern Mediterranean region. In other words, high number of confirmed cases and mortality of COVID-19 in Iran may be due to its sooner prevalence. On March 27, Iran tried to decrease the transmission chain through performing social distancing and limitation on traveling. It is necessary to point out that on the basis of a study assessing the effectiveness of interventions performed to control SARS disease, applying 90% travel restrictions would have a medium effect on the disease transmission chain when not accompanied by public health policies and behavioral change.^[33]

The highest morbidity rate in the European region belonged to Spain and Belgium. The trend analysis showed that Spain, Turkey, Italy, and Germany had the highest slope of morbidity (incidence rate) since the beginning of the disease. On the basis of one study's predictions on March 9, the number of infections in Italy, Spain, France, and Germany would continue to increase.^[34] The time trend of confirmed cases indicated that this prediction was true. The Spain government announced emergency status on March 14 and imposed country-level shutdown. Leaving the house was limited to providing food and medical supplies.^[35] It was expected that proper implementation of these policies decrease the disease slope. However, the disease reached to its peak on April 1; the trend of infected cases in Spain showed frequent up and down after its peak. The Italy government on March 8 tried to perform policies to restrict commuting in order to decrease the disease transmission to the healthy people.^[36] However, in this time we cannot evaluate the true impact of these public health interventions on control COVID-19.

In EURO, the highest CFR was in France and next in the United Kingdom, Belgium, and Italy. Analysis of CFR time trend showed that Italy, Spain, France, and the United Kingdom had the highest trend of CFR in this region. The most important cause of higher mortality rates in these countries is related to the population demographics. The present statistics indicate that 23% of Italian population is composed of higher than 65-year-old population. The Other probable reasons for the higher mortality rate in Italy are an inaccurate definition of death due to COVID-19 and also the selected strategy to examine the suspected cases.^[37]

The USA has had the highest COVID-19 morbidity in the WHO American region. However, the time trend analysis showed that the average of CFR in Mexico was the most among other Region of the Americas countries. Among the probable causes of higher incidence rate in the USA, we can mention a high focus on people screening on the basis of symptoms such as cough, fever, and shortness of breath.^[38] However, not tracing health protocols of COVID-19 control caused high spreading rate of this disease in the USA.^[39]

India was the only country in SEARO that we included in our study. Compared with other selected countries, it had the lowest disease incidence. However, there is some debates regarding the true number of infected cases in India. There is some argument that India's diagnostic facilities for COVID-19 are limited.^[35]

The discovery of effective treatment and vaccine for COVID-19 is a time-consuming process which it has estimated that obtaining an effective treatment needs a 10 years' time.^[40] There is no specific treatment for COVID-19 treatment at the present time,^[41] so using other medicines used for similar diseases is an effective step.^[27] However, prevention of the disease through controlling its development is the best solution.^[40,42,43] The things that may be overlooked are cost-effectiveness and cost-benefit analysis of the probable vaccine discovered in future. Different countries place a vaccine in their national vaccination program on the basis of decision-making and budgeting presumptions and if possible vaccinations are not given publicly in future, their effectiveness will be greatly reduced.^[44]

Applying other countries' experiences is a recommended measure to get better results. China's experience indicates that quarantine, social distancing, and isolation could control these epidemics. It is obvious that cooperation and coherence between countries are among the most important components in the successful control of COVID-19. In other words, formulating transparent and comprehensive policies on COVID-19 surveillance and control requires a comprehensive approach that includes

local and international levels. Developing screening for all population and diagnosis of asymptomatic persons are the cornerstone in breaking the transmission chain. However, countries have not equal resources to prevention and to control the disease. In addition, countries with better surveillance systems probably have more valid data than other countries. Therefore, the reported cases in countries have not equal validity, and comparison of countries should be done with caution.

As stated above, it is necessary to determine disease epidemiology. Judging based on the current data should be with caution because many aspects of disease are still ambiguous. Tailoring successful prevention and treatment strategies is related to valid information regarding the nature of disease. Despite all these, differences in the morbidity and the mortality rates among selected countries could be attributed to various factors such as demographic differences of population structure, prevention actions, detection strategies, treatment facilities, and country's ability in disaster management.

We investigated the trends of morbidity and mortality of COVID-19 by WHO regions and by countries which had more reported cases at the time of the study. This study is a unique one that investigated the time trends of reported cases and CFR in the world. This study finding is helpful to understanding the epidemiological aspects of the disease. This study along with assessing the time trend changes in COVID-19 morbidity and mortality has encountered with some limitations. First of all, the effect of other influential variables has not been assessed. The second limitation is that the true calculation of the CFR needs diagnosis of all positive cases, this is while due to asymptomatic cases, calculated CFR is exaggerated. Therefore, the CFR is probably overestimated in this study. Then, the interpretation of the results should be done with caution. Third limitation is related to data. As data of all included countries have not equal validity, the comparison of them should be done with cautious.

Conclusion

According to the results of the present study, over time, the number of patients with COVID-19 and the number of deaths from this disease are increasing. As mentioned earlier, many epidemiological aspects of the disease are still unknown, and it is difficult to answer questions about these characteristics. In addition, access to effective medicines and vaccines is a time-consuming process that doubles the concerns about the spread of the disease. In this situation, it will be more important to rely on the prevention of the disease. COVID-19 further reminds the very close relationship between countries in the world. Obviously, until the control of the disease, it is

necessary to apply public health policies accompanied by other policies at the national and global levels, while it is suggested to use the experience of successful countries for others.

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Conflicts of interest

There are no conflicts of interest.

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