



Original Article

Cross-Country Comparison of Case Fatality Rates of COVID-19/SARS-COV-2



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ABSTRACT

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Objectives: Case fatality rates (CFR) and recovery rates are important readouts during epidemics and pandemics. In this article, an international analysis was performed on the ongoing coronavirus disease 2019 (COVID-19) pandemic.

Methods: Data were retrieved from accurate databases according to the user's guide of data sources for patient registries, CFR and recovery rates were calculated for each country. A comparison of CFR between countries with total cases $\geq 1,000$ was observed for 12th and 23rd March.

Results: Italy's CFR was the highest of all countries studied for both time points (12th March, 6.22% versus 23rd March, 9.26%). The data showed that even though Italy was the only European country reported on 12th March, Spain and France had the highest CFR of 6.16 and 4.21%, respectively, on 23rd March, which was strikingly higher than the overall CFR of 3.61%.

Conclusion: Obtaining detailed and accurate medical history from COVID-19 patients, and analyzing CFR alongside the recovery rate, may enable the identification of the highest risk areas so that efficient medical care may be provided. This may lead to the development of point-of-care tools to help clinicians in stratifying patients based on possible requirements in the level of care, to increase the probabilities of survival from COVID-19 disease.

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Introduction

A novel coronavirus has spread through China, originating from the city of Wuhan and has caused many deaths so far. It is a highly contagious virus that has spread rapidly and efficiently. Coronavirus disease 2019 (COVID-19) is caused by a virus (SARS-CoV-2) from the same family as the lethal coronaviruses that caused severe acute respiratory syndrome (SARS-CoV) and Middle East respiratory syndrome (MERS-CoV). COVID-19 is a relatively large virus (120 nm) and is enveloped, containing a positive-sense single-stranded RNA

[1]. The virus is transmitted through direct contact with the infected person's respiratory droplets (coughing and sneezing), as well as contact with infected surfaces. COVID-19 virus can survive for days on surfaces, but a simple disinfectant can eliminate this [2]. COVID-19 signs and symptoms include fever, cough, and shortness of breath. In more severe cases, infection can lead to pneumonia, serious respiratory problems and ultimately, fatalities. Thousands of people have been reported to have been infected with the virus so far [3]. Apart from China, other cases of the disease, also known as COVID-2, have been reported in several countries, including Thailand, South

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Korea, Japan, Taiwan, Australia, Iran, and the United States. According to the Worldometer, as of 10th March 2020, there are over 114,430 identified cases of COVID-19 worldwide in 115 countries and territories [1].

Of these 115 countries, South Korea and Iran (outside of China) have the largest epidemic of COVID-19 and Italy, France and Spain are the countries with a major epidemic of COVID-19 in Europe [2]. COVID-19 spreads mainly from person-to-person during the latency period before the symptoms appear [4]. There is much more to learn about the spread and severity of COVID-19. COVID-19 can cause mild flu-like symptoms, including fever, cough, dyspnea, myalgia, and fatigue, while more serious forms can cause severe pneumonia, acute respiratory distress syndrome, septic shock, and organ failure, which can lead to death [5]. Without a vaccine for COVID-19, transmission of the virus can be reduced with early detection and patient quarantine [6]. There is epidemiological and clinical evidence to suggest a number of novel compounds, as well as medicines licensed for other conditions, that appear to have potential efficacy against COVID-19 [7,8]. However, in the absence of a safe and effective vaccine or medicine, reducing viral transmission is the only strategy available where general education, and implementing the appropriate prevention and control is key. Precautions can help suppress the risk of infection, such as washing the hands frequently with soap and water or an alcohol-based disinfectant gel, coughing into the elbow or a folded napkin/tissue, avoiding close contact with those who have symptoms, and self-isolating, but medical help must be sought if difficulty in breathing is experienced [5].

COVID-19 can be diagnosed with diagnostic test kits [9] and imaging techniques such as chest X-ray and pulmonary CT scans that facilitate early diagnosis of pneumonia in patients with COVID-19 [10-12].

The case fatality rate (CFR), is a measure of the ability of a pathogen or virus to infect or damage a host in infectious disease and is described as the proportion of deaths within a defined population of interest, i.e. the percentage of cases that result in death [13]. CFRs confers the extent of disease severity and CFR is necessary for setting priorities for public health in targeted interventions to reduce the severity of risk [14]. Initial studies reported an estimation of 3% for the global CFR of COVID-19 [15]. Estimating CFR from country-level data requires assessment of information about the delay between the report of the country-specific cases and death from COVID-19, as well as underestimating and under-reporting of death-related cases, which may not be known. Given the importance of CFR and recovery rate (RR), in this current study the CFR and RR of different countries during a COVID-19 ongoing pandemic was observed using up-to-date country-level data.

Materials and Methods

1. Source of data and procedure

The data were retrieved from accurate databases including Worldometer 2, WHO 3, the Center of Disease Control and Prevention [16], and the Morbidity and Mortality Weekly Report series (provided from Center of Disease Control and Prevention), according to the user's guide of data sources for patient registries [17]. Due to the rapid increase in data, the analysis in this study was performed on the 12th and 23rd of March 2020.

Raw data was mapped according to countries and CFR and RR were compared for countries with $\geq 1,000$ cases. All countries with $< 1,000$ cases are presented in supplementary Table 1. A comparison of CFR with different known viral diseases was performed.

2. Measuring the CFR and RR

The formulas below were used to measure CFR and RR.

$$\text{CFR (\%)} = (\text{Number of deaths due to COVID-19} / \text{Number of closed cases of COVID-19}) \times 100$$

$$\text{RR (\%)} = (\text{Number of cases recovered from COVID-19} / \text{Number of closed cases of COVID-19}) \times 100$$

Results

The total number of confirmed cases of COVID-19 was highest in China, followed by Italy and Iran on 12th March, but on 23rd March 2020, total COVID-19 confirmed cases was the highest in China, followed by Italy, USA, and Spain (Table 1). However, Italy's CFR was the highest on both time points (12th March, 6.22% versus 23rd March, 9.26%). The data showed that Italy was the only European country reported on 12th March, but by the 23rd March 2020, Spain and France had the highest CFR of 6.16 and 4.21%, respectively, which was strikingly higher than the overall CFR of 3.61%. The highest RR was observed in China, with RR values of 76.12% and 89.85% in both analysis time points, respectively, compared with the overall RR of 55.83% and 29.3% on the 12th and 23rd March 2020, respectively.

The highest CFR was observed in Italy, followed by China, Iran, and USA on 12th March, which changed to Italy, Spain, France, Iran, and China on 23rd March (Figure 1). Among European countries, Spain and France also faced an increasing rate of CFR. Although Morocco, Panama, and Iraq showed higher CFR values, there was only a small number of total cases, therefore the results of countries with highest outbreak and total cases of COVID-19 were preferentially reported.

China showed encouraging recovery rates from COVID-19

Table 1. The comparison of case fatality rate (CFR) and recovery rate (RR) between different countries ($n = 116$). Only countries with total cases over 1,000 cases depicted (population in million and GDP in trillion USD; $n = 116$).

Country	Population	GDP	ICU beds per capita	Total cases	Total deaths	Total recovered	Active cases	Serious, critical	Total cases/ 10 ⁶ population	Case fatality rate	Recovery response
12 th March 2020											
China	1,386	12.24	3.6	80,783	3,158	61,493	16,132	4,492	56.1	3.91	76.12
Italy	60.48	1.935	12.5	10,149	631	1,004	8,514	877	167.9	6.22	9.89
Iran	81.16	0.4395	4.2	8,042	291	2,731	5,020		95.7	3.62	33.96
S. Korea	51.47	1.531	10.6	7,755	61	288	7,406	54	151.3	0.79	3.71
France	66.99	2.583	11.6	1,784	33	12	1,739	86	27.3	1.85	0.67
Spain	46.66	1.311	9.7	1,695	36	135	1,524	101	36.3	2.12	7.96
Germany	82.79	3.677	29.2	1,565	2	18	1,545	9	18.7	0.13	1.15
USA	327.2	19.39	34.7	1,010	31	15	964	10	3.1	3.07	1.49
All countries < 1,000 cases	---	---	---	6,442	56	872	5,514	118	---	---	---
Total	---	---	---	119,225	4,299	66,568	48,358	5,747	15.3	3.61	55.83
23 rd March 2020											
China	1386	12.24	3.6	81,093	3,270	72,703	5,120	1,749	56	4/03	89/65
Italy	60.48	1.935	12.5	59,138	5,476	7,024	46,638	3,000	978	9/26	11/88
USA	327.2	19.39	34.7	33,563	420	178	32,965	795	101	1/25	0/53
Spain	46.66	1.311	9.7	28,768	1,772	2,575	24,421	1,785	615	6/16	8/95
Germany	82.79	3.677	29.2	24,873	94	266	24,513	23	297	0/38	1/07
Iran	81.16	0.4395	4.2	21,638	1,685	7,913	12,040		258	7/79	36/57
France	66.99	2.583	11.6	16,018	674	2,200	13,144	1,746	245	4/21	13/73
S. Korea	51.47	1.531	10.6	8,961	111	3,166	5,684	59	175	1/24	35/33
Switzerland	8.57	0.6789	11	7,474	98	131	7,245	141	864	1/31	1/75
UK	66.44	2.622	6.6	5,683	281	93	5,309	20	84	4/94	1/64
Netherlands	17.18	0.8262	6.4	4,204	179	2	4,023	354	245	4/26	0/05
Austria	8.822	0.4166	21.8	3,582	16	9	3,557	15	398	0/45	0/25
Belgium	11.4	0.4927	15.9	3,401	75	263	3,063	288	293	2/21	7/73
Norway	5.368	0.3988	8	2,385	7	6	2,372	28	440	0/29	0/25
Sweden	10.12	0.538	5.8	1,934	21	16	1,897	76	191	1/09	0/83
Australia	24.6	1.323	8	1,629	7	88	1,534	11	64	0/43	5/40
Portugal	10.29	0.2176	4.2	1,600	14	5	1,581	26	157	0/88	0/31
Brazil	209.3	2.056	6.7	1,546	25	2	1,519	18	7	1/62	0/13
Canada	37.59	1.653	13.5	1,470	20	14	1,436	1	39	1/36	0/95
Denmark	5.603	0.3249	6.7	1,395	13	1	1,381	42	241	1	0/07

Table 1. (Continued).

Country	Population	GDP	ICU beds per capita	Total cases	Total deaths	Total recovered	Active cases	Serious, critical	Total cases/10 ⁶ population	Case fatality rate	Recovery response
Malaysia	31.62	0.3145	3.7	1,306	10	139	1,157	26	40	1	10/64
Turkey	80.81	0.8511	2.9	1,236	30		1,206		15	2	0/00
Czechia	10.65	0.2157	11.6	1,120	1	6	1,113	19	105	0	0/54
Japan	126.8	4.872	7.3	1,101	41	235	825	49	9	4	21/34
Israel	8.712	0.3509	6.3	1,071	1	37	1,033	18	124	0	3/45
All countries with less than 1,000 cases	----	----	---	21,381	324	1,812	19,255	264	---	---	----
Total	----	----	---	337,570	14,665	98,884	224,031	10,553	43.4	4.34	29.29

Only countries with total cases over 1,000 are depicted (population in million and GDP in trillion US dollars). GDP = gross domestic product; ICU = intensive care unit.

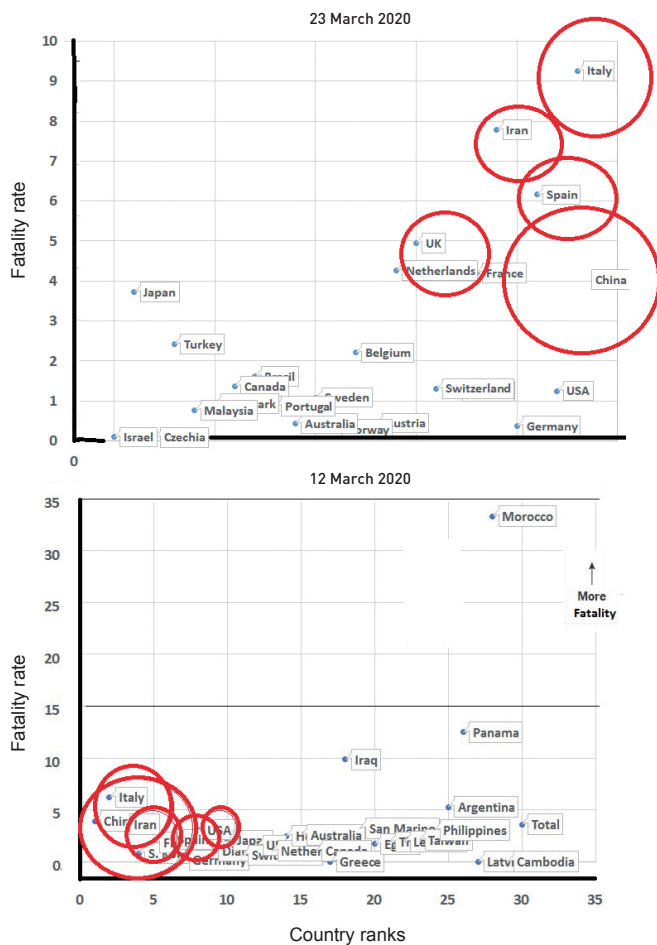


Figure 1. The cross-country comparison of case fatality rate (CFR) between different countries (n = 116). The circles showed the countries with highest outbreak and positive cases of COVID-19. Countries with CFR value zero has not been illustrated here.



Figure 2. The cross-country comparison of recovery rate (RR) between different countries (n = 116). The circles showed the countries with highest outbreak and positive cases of COVID-19. Countries with RR value zero has not been illustrated here.

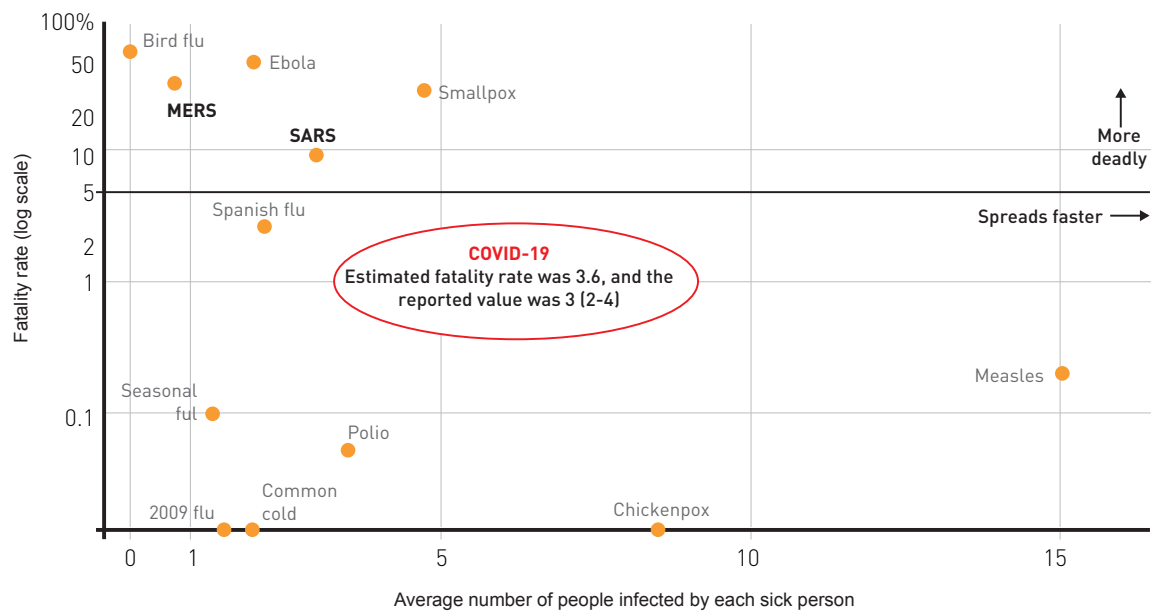


Figure 3. The cross-country comparison of case fatality rate (CFR) between different known infectious and viral diseases ($n = 116$). The circles showed the estimated value and the reported range of CFR of COVID-19.

at both time points (76.12% and 89.85% on 12th and 23rd March 2020, respectively; Figure 2). Although the COVID-19 outbreak has led to high rates of death in other Asian countries such as Iran, the recovery rate may be considered acceptable (34%).

The comparison of CFR between different known infectious and viral diseases was shown in Figure 3. This revealed that the overall clinical concerns of COVID-19 may eventually be more like those of a severe seasonal flu (CFR of approximately 0.1%) or a pandemic flu, rather than SARS or MERS, which have had CFR of approximately 10% and 36%, correspondingly.

Discussion

This study aimed to observe the CFR of different countries during an ongoing COVID-19 pandemic using recent country-level data, showing that alongside the outbreak of this virus, there is a frame-shift and transition from China (as the first country faced with the outbreak) to other countries in other continents.

The outbreak was declared a public health emergency of international concern on 30th January 2020 [18]. Confronting emerging diseases requires universal cooperation in identifying, controlling, and preventing these diseases. The Center for Disease Control obtained a number of factors

to establish a geographic risk assessment for the spread of COVID-19 (Supplementary Figure 1). This may be used for international guidelines for public health decisions and travel-related exposure. For instance, China and Iran were categorized as countries where there was widespread ongoing transmission, with restrictions on entry.

The data from this study supports the fact that the CFR of the COVID-19 pandemic seems to be less than Bird flu, Ebola, SARS, and MERS, but public health concerns remain due to its highly infectious nature, since a large proportion of cases are asymptomatic or mild, which promotes the spread of the disease worldwide. In such situations, the media plays a crucial role in promoting health literacy and advocating limited spread of the disease [19]. Cross-country comparisons of CFR and RR as important indicators of disease characteristics are vital for national and international priority setting and recognizing health system performance. However, many factors can confound the current estimation for CFR and RR of COVID-19, namely, undetected cases or delayed case reporting, which can significantly affect the 2 indicators which are linked with a degree of preparedness and mitigation of both the general public and politicians.

Since the number of cases in the world is increasing in a heterogeneous form, to obtain a better picture for cross-country comparison of medical care performance, we require

a limiting denominator of CFR and RR to be applied to cases under official medical care with final disease outcome (death/recovered or discharged).

Conclusion

Death and severity of COVID-19 are associated with age and comorbidities across the world. Especially in countries with the highest outbreaks, such as China, Italy, and Iran, strategies must be employed to ensure that high-risk groups, such as old people and those with other underlying diseases such as diabetes and cancer, received adequate protection from COVID-19. Therefore, early access to medical care when infected is vital for improving chances of survival. Improving medical supplies to countries such as Iran, which is significantly influenced by US punitive policies, can reduce the deterioration of this politically sensitive situation [20].

Furthermore, taking detailed and accurate medical history, and scoring CFR alongside RR, may highlight the highest risk areas, and more efficiently direct the intervention to decrease the spread of the virus globally. This may enable the development of point-of-care tools to help clinicians in stratifying patients, based on possible requirements in the level of care to improve probabilities of survival from COVID-19 disease.

Conflicts of Interest

The authors have no conflict of interest to declare.

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Supplementary Figure 1. Geographic risk assessment for spread of COVID-19.

