fortune Journals

Research Article

ARCHIVES OF INTERNAL MEDICINE RESEARCH

ISSN: 2688-5654

Differences by Country-Level Income in COVID-19 Cases, Deaths, Case-Fatality Rates, and Rates Per Million Population in the First Five Months of the Pandemic

Wrishmeen Sabawoon[1-4]*

Abstract

Objective: To describe differences by country-level income in COVID-19 cases, deaths, case-fatality rates, incidence rates, and death rates per million population.

Methods: Publicly available data on COVID-19 cases and deaths from December 31, 2019 to June 3, 2020 were analyzed. Kruskal-Wallis tests were used to examine associations of country-level income with COVID-19 cases, deaths, case-fatality rates, incidence rates, and death rates.

Results: A total of 380,803 deaths out of 6,348,204 COVID-19 cases were reported from 210 countries and territories globally in the period under study, and the global case-fatality rate was 6.0%. Of the total globally reported cases and deaths, the percentages of cases and deaths were 59.9% and 75.0% for high-income countries, and 30.9% and 20.7% for upper-middle-income countries. Countries in higher income categories had higher incidence rates and death rates. Between April and May, the incidence rates in higher-income groups of countries decreased, but in other groups it increased.

Conclusions: In the first five months of the COVID-19 pandemic, most cases and deaths were reported from high-income and upper-middle-income countries, and those countries had higher incidence rates and death rates per million population than did lower-middle and low-income countries.

Keywords: COVID-19; Incidence Rate; Death Rate; Case Fatality Rate; Income; Country

Introduction

The disease caused by a coronavirus that recently emerged in Wuhan, China [1] is now known as COVID-19. Most patients with COVID-19 have a respiratory illness with flu-like symptoms including cough, fever, fatigue, and shortness of breath. Some have pneumonia, acute respiratory distress syndrome, respiratory failure, and multiple organ failure, and a few die [2]. The causative agent is a previously unknown coronavirus: Severe Acute Respiratory Syndrome (SARS)-CoV-2 [3-9].

The COVID-19 outbreak started a few weeks before the Chinese Spring Festival, which usually occurs in January or February on the Gregorian calendar. In 2020 it was celebrated January 24-30. Each year around the time of that festival, many Chinese people visit their ancestral homes and some people from outside China visit the country for sightseeing and to celebrate

Affiliation:

[1]Senior advisor, LIAISON, Japan

[2]Adjunct researcher, Center for Decision Research, Waseda University, Tokyo, Japan

[3]Ex. Visiting researcher, Department of Public Health, Graduate School of Medicine, the University of Tokyo, Tokyo, Japan

[4]Ex-epidemiologist, Office of Senior Advisor to President in Political Affairs and the President's Focal Point for Polio Eradication, Kabul, Afghanistan

***Corresponding author:**
Wrishmeen Sabawoon, Senior advisor, LIAISON, Adjunct researcher, Center for Decision Research, Waseda University, Tokyo, Japan

Citation: Vanamail Perumal. Epidemiological Aspects of COVID-19 Disease in India during Nationwide Lockdown Phase- An Empirical Data-Based Analysis and its Implications on Interrupting the Transmission. Archives of Internal Medicine Research 5 (2022): 385-396.

Received: May 25, 2022
Accepted: June 22, 2022
Published: August 09, 2022

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

the start of the lunar year. In 2020, that seasonal increase in travel exacerbated the spread of SARS-CoV-2 within China and also to countries and territories outside China. The worldwide pandemic was recognized as such on March 11, 2020, after more than 118,000 cases had been reported in 110 countries and there was judged to be a sustained risk of further global spread [10]. As of mid-March, 146 countries were affected, 154,000 people had been infected, and 5,700 fatalities had been recorded. In absolute terms, the number of cases was very high in China (81,048 cases), followed by Italy (21,157), Iran (12,729), the Republic of Korea (8162), Spain (5753), France (4469), Germany (3795), the US (1678), Switzerland (1359), and the UK (1144). On March 23, 2020, the WHO reported that little had changed in China (81,601 cases), but Italy had already recorded 59,138 cases, Spain 28,572, Germany 24,774, and France 15,821 [11]. By the end of March 2020, COVID-19 cases had occurred in all 50 states of the US. At the time of this writing (May 24, 2020), 210 countries and territories had reported cases of SARS-CoV-2 infection, and the US had the most confirmed active cases and deaths in the world (Data from Our World in Data).

The numbers of cases and deaths from COVID-19 differ both among countries [12] and within countries [13]. These differences might be caused by differences in the timing and early transmission of the virus, by countries' response patterns, by the numbers of tests conducted, by sociodemographic conditions, by connectivity and trade patterns, and by environmental factors. Pandemics generally have their greatest effects on lower-middle-income and low-income countries and on socially disadvantaged populations, because they intensify existing health inequalities. During the 1918 "Spanish" influenza pandemic, racial minorities had higher all-cause mortality and influenza mortality rates than did Caucasians [14]. In the 2009 H1N1 influenza pandemic, minority groups had higher rates of serious infection requiring hospitalizations than did non-minority groups [15]. Nonetheless, so far during the COVID-19 pandemic, more cases and deaths have been reported from high-income and upper-middle income countries. In the absence of a vaccine, given that responses differ between countries, and given the fact that information regarding transmission is still insufficient, it is difficult to confidently predict the course of the pandemic as it applies to individual countries. The virus has also reached almost all low-income and middle-income countries, where community transmission has started. Most of those countries have also closed their borders to prevent travel-related dissemination of the virus. Those include countries with large populations living in overcrowded conditions where "social distancing" is impossible to maintain, and with health systems that are unlikely to be able to meet the challenges of this pandemic.

In some previous studies, data on COVID-19 cases and deaths were analyzed to detect and predict seasonality of the disease [16, 17] and to describe cases and deaths by continent and by country [18]. To the best of our knowledge, no previous study has described the distribution of cases and deaths by country-level income. Such an analysis has analytical and practical purposes. Looking at countries as members of income-defined groups can highlight trans-national phenomena regarding how economic activity is associated with the spread of the disease and with the resulting burdens on healthcare systems. The findings from such analysis can also be used by policy makers, international organizations, and bilateral agencies to allocate resources for the control of the epidemic according to income-defined groups. We therefore describe the worldwide distribution of the numbers of cases and deaths by country and by country-level income status; describe trends in the numbers of cases and deaths; and examine how country-level income status is associated with COVID-19 case-fatality rate and with the numbers of cases and deaths per million population in the first five months of the pandemic. For that purpose we consider each country's income status, using the World Bank's approach, classifying countries into high-income, upper-middle-income, lower-middle-income, and low-income groups [19].

Methods

Two sources of publicly available data were used. First, data on COVID-19 cases and deaths in all affected countries were downloaded from the Our World in Data (OWID) website. The OWID's data on cases and deaths come from the European Centre for Disease Prevention and Control; data on testing were collected from formal reports of countries by the data team of OWID; data on other variables came from the United Nations, the World Bank, the Global Burden of Disease Collaborative Network, global burden of disease study 2017 results, the Blavatnik School of Government, the Oxford COVID-19 Government Response Tracker, and national governmental reports. The data are updated daily, and they contain the dates of daily reported data, the country or territory name, the numbers of total and new cases and deaths, the numbers of total and new cases and deaths per million population, and the numbers of total and new tests and their rates per 1,000 population, among other variables [20].

Second, data classifying countries by their income status were downloaded from the World Bank website and incorporated into the master dataset. The countries were classified according to the World Bank classification of countries by income, which has been used since 1989. It divides countries into four groups — low income, lower-middle income, upper-middle income, and high income — using gross national income per capita valued annually in US dollars using a three-year average exchange rate.

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

The classification is published at http://data.worldbank.org and revised versions are published each year on July 1 [19]. The World Bank did not provide data on income for seven small areas, all of which reported cases of COVID-19: Jersey, Guernsey, the Falkland Islands, Vatican City State, Montserrat, Bonaire Sint Eus, and Anguilla. Therefore, those seven were categorized as "small areas with unknown income status". The data were exported to STATA 2012 for analysis.

Cases on international conveyances (e.g. cruise ships) were excluded from the analysis, because the patients were from many countries, and therefore as groups they could not be linked with any of the World Bank's income categories. Descriptive statistics regarding cases, deaths, case-fatality rates (as percentages), cases per million population, and deaths per million population for each country and for income-defined groups of countries were calculated. Kruskal-Wallis one-way analysis of variance on ranks was used to examine associations of country-level income category with the variables listed above. Data from the small areas with unknown income status were excluded from the Kruskal-Wallis analysis because there was no information on country-level income status, and because the numbers of cases were much smaller than in the other income-groups. One-way analysis of variance (ANOVA) was used to examine associations of country-level income category with the time since the onset of the pandemic. Changes over time in the indices mentioned above were also examined for trends during the period for which data were available.

Results

Expansion period of the pandemic

The first cases of COVID-19 were reported to the WHO on December 31, 2019. By June 3rd, 2020, the disease had spread to 210 countries and territories (Table 1). The mean number of days from the time that the first case was reported to the WHO until June 3, 2020 differed widely among income-defined groups: 100.5 (SD 19.6) days for high-income countries; 94.8 (SD 18.6) for upper-middle-income countries; 89.5 (SD 20.1) for lower-middle-income countries; and 79.1 (SD 17.2) for low-income countries ($F= 870.36$, $df = 3$, $p < 0.001$).

Table1: Numbers of COVID-19 total and daily cases and deaths; their rates per million population, and case-fatality rates from the onset of the pandemic until June 3rd, 2020, by c.

	Days since reporting of index case (s) (N)	Cases							Deaths									
		Total (N)	Per day (N)			Per million population			Total (N)	Per day (N)			Case-fatality rate (%)			Per million population		
			Median	25th %	75th %	Median	25th %	75th %		Median	25th %	75th %	Median	25th %	75th %	Median	25th %	75th %
High income																		
United States	135	1831821	17,588	1	25,023	53	0	76	1,06,181	318	0	1,510	4	1	6	4	1	6
United Kingdom	125	2,77,985	1,936	4	4,244	29	0	63	39,369	186	0	568	10	5	16	10	5	16
Spain	123	239932	847	19	3,416	18	0	73	27,940	110	0	440	13	1	18	13	1	18
Italy	125	2,33,515	1,083	250	3,370	18	4	56	33,530	174	8	473	14	10	20	14	10	20
Germany	128	1,82,370	682	7	2,340	8	0	28	8,551	27	0	125	4	0	9	4	0	9
France	131	1,51,325	461	3	1,827	7	0	28	28,940	70	0	348	18	3	30	18	3	30
Chile	91	1,08,686	445	220	1,647	23	12	86	1,188	7	1	12	1	0	1	1	0	1
Canada	130	92,399	758	2	1,274	20	0	34	7,395	11	0	116	5	0	10	5	0	10
Saudi Arabia	90	89,011	1,105	112	1,704	32	3	49	549	6	0	9	0	0	1	0	0	1
Qatar	91	60,259	440	38	1,189	153	13	413	43	0	0	1	0	0	0	0	0	0
Belgium	121	58,615	276	10	809	24	1	70	9,505	30	0	113	13	4	20	13	4	20
Netherlands	97	46,647	317	171	845	19	10	49	5,967	43	11	101	10	5	16	10	5	16
Sweden	124	38,589	291	5	563	29	0	56	4,468	10	0	67	7	1	13	7	1	13
Singapore	132	35,836	48	3	539	8	1	92	24	0	0	0	0	0	0	0	0	0
United Arab Emir	123	35,788	85	0	552	9	0	56	269	0	0	3	0	0	1	0	0	1
Portugal	93	32,895	285	165	533	28	16	52	1,436	14	6	23	4	2	6	4	2	6
Switzerland	99	30,791	119	30	552	14	3	64	1,656	7	1	27	5	1	13	5	1	13
Kuwait	98	28,649	102	11	598	24	3	140	226	1	0	3	0	0	1	0	0	1
Ireland	93	25,066	204	61	377	41	12	76	1,658	12	1	25	5	1	11	5	1	11
Poland	90	24,395	308	170	380	8	4	10	1,092	11	2	20	3	2	6	3	2	6
Israel	100	17,342	70	16	270	8	2	31	290	2	0	5	1	0	4	1	0	4

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

Japan	141	16,986	43	5	150	0	0	1	900	2	0	10	3	0	11	3	0	11
Austria	99	16,674	62	28	241	7	3	27	669	2	0	12	3	0	8	3	0	8
Panama	86	14,095	162	102	202	38	24	47	258	4	2	6	2	1	4	2	1	4
Oman	94	12,799	54	4	168	11	1	33	59	0	0	1	0	0	0	0	0	0
Bahrain	100	12,311	56	14	212	33	8	125	19	0	0	0	0	0	0	0	0	0
Denmark	98	11,734	107	48	169	18	8	29	580	4	0	10	5	0	7	5	0	7
South Korea	136	11,590	26	5	89	0	0	2	273	1	0	3	2	0	9	2	0	9
Czech Republic	94	9,364	70	43	130	6	4	12	323	2	0	5	3	0	6	3	0	6
Norway	98	8,446	50	18	129	9	3	24	237	1	0	4	1	0	5	1	0	5
Australia	131	7,221	12	2	42	0	0	2	102	0	0	1	0	0	4	0	0	4
Finland	122	6,887	49	1	90	9	0	16	320	1	0	4	3	0	6	3	0	6
Luxembourg	88	4,020	12	6	68	19	10	109	110	1	0	2	1	0	8	1	0	8
Puerto Rico	68	3,935	58	34	71	20	12	25	138	2	1	3	3	2	5	3	2	5
Hungary	90	3,931	38	21	60	4	2	6	534	5	1	10	13	4	20	13	4	20
Greece	96	2,918	19	6	47	2	1	5	179	1	0	3	5	0	10	5	0	10
Croatia	96	2,246	10	2	40	2	0	10	103	1	0	2	1	0	11	1	0	11
Estonia	92	1,870	10	5	33	8	4	25	68	0	0	1	0	0	9	0	0	9
Iceland	96	1,806	4	0	26	10	0	75	10	0	0	0	0	0	0	0	0	0
Lithuania	88	1,682	11	5	32	4	2	12	71	0	0	1	0	0	8	0	0	8
Slovakia	88	1,522	9	2	22	2	0	4	28	0	0	0	0	0	0	0	0	0
Slovenia	90	1,475	9	1	33	4	0	16	108	1	0	2	5	0	18	5	0	18
New Zealand	88	1,154	2	0	14	0	0	3	22	0	0	0	0	0	0	0	0	0
Latvia	89	1,079	9	4	17	5	2	9	24	0	0	0	0	0	0	0	0	0
Cyprus	84	952	7	2	17	8	2	19	17	0	0	0	0	0	0	0	0	0
Andorra	82	844	2	0	18	26	0	233	51	0	0	1	0	0	11	0	0	11
Uruguay	81	826	8	5	13	2	1	4	23	0	0	0	0	0	0	0	0	0
San Marino	96	687	5	1	12	147	29	339	42	0	0	1	0	0	4	0	0	4
Malta	89	620	5	1	10	11	2	23	9	0	0	0	0	0	0	0	0	0
Taiwan	133	443	1	0	2	0	0	0	7	0	0	0	0	0	0	0	0	0
Isle of Man	75	336	1	0	6	12	0	71	24	0	0	0	0	0	0	0	0	0
Faeroe Islands	76	187	0	0	1	0	0	20	0	0	0	0	0	0	0	0	0	0
Guam	77	177	1	0	3	6	0	18	5	0	0	0	0	0	0	0	0	0
Gibraltar	76	172	0	0	3	0	0	89	0	0	0	0	0	0	0	0	0	0
Cayman Islands	76	151	0	0	3	0	0	46	1	0	0	0	0	0	0	0	0	0
Bermuda	76	141	0	0	2	0	0	32	9	0	0	0	0	0	0	0	0	0
Brunei	85	141	0	0	2	0	0	5	2	0	0	0	0	0	0	0	0	0
Trinidad and Tob	83	117	0	0	1	0	0	1	8	0	0	0	0	0	0	0	0	0
Bahamas	78	102	1	0	2	3	0	5	11	0	0	0	0	0	0	0	0	0
Aruba	73	101	0	0	2	0	0	19	3	0	0	0	0	0	0	0	0	0
Monaco	84	99	0	0	2	0	0	51	5	0	0	0	0	0	0	0	0	0
Barbados	78	92	0	0	1	0	0	3	7	0	0	0	0	0	0	0	0	0
Liechtenstein	85	83	0	0	1	0	0	26	1	0	0	0	0	0	0	0	0	0
Sint Maarten (Du	70	77	0	0	1	0	0	23	15	0	0	0	0	0	27	0	0	27
United States Vi	71	70	0	0	1	0	0	10	6	0	0	0	0	0	0	0	0	0
French Polynesia	77	60	0	0	1	0	0	4	0	0	0	0	0	0	0	0	0	0
Antigua and Barb	76	25	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
Northern Mariana	65	23	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Curacao	72	20	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
New Caledonia	75	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

Saint Kitts and	70	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greenland	76	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Turks and Caicos	71	12	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Seychelles	81	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
British Virgin I	69	8	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Upper-middle income																		
Brazil	99	5,55,383	1,930	224	9,258	9	1	44	31,199	133	5	600	6	3	7	1	0	3
Russia	124	4,23,741	471	0	8,136	3	0	56	5,037	3	0	81	1	0	1	0	0	1
Peru	88	1,70,039	1,177	72	3,556	36	2	108	4,634	38	2	96	3	2	4	1	0	3
Turkey	82	1,65,555	1,704	983	3,013	20	12	36	4,585	52	25	92	3	2	3	1	0	1
Iran	105	1,57,562	1,383	1,006	2,080	16	12	25	7,942	69	48	117	6	3	7	1	1	1
Mexico	88	97,326	676	126	1,960	5	1	15	10,637	67	4	195	8	3	11	1	0	2
China	156	84,159	46	7	212	0	0	0	4,645	2	0	27	2	0	9	0	0	0
Belarus	89	44,255	495	9	913	52	1	97	243	3	0	5	0	0	1	0	0	1
Ecuador	90	40,414	238	53	498	13	3	28	3,438	17	1	38	5	2	11	1	0	2
South Africa	88	35,812	174	51	656	3	1	11	755	3	0	11	2	0	3	0	0	0
Colombia	85	31,833	218	92	635	4	2	12	1,009	10	2	18	3	2	4	0	0	0
Romania	96	19,517	197	93	311	10	5	16	1,279	12	1	24	5	2	8	1	0	1
Argentina	89	18,306	112	35	245	2	1	5	569	6	2	10	3	1	5	0	0	0
Dominican Republ	85	17,752	206	90	296	19	8	27	515	6	2	9	3	1	5	1	0	1
Kazakhstan	81	11,796	139	38	218	7	2	12	44	0	0	1	0	0	1	0	0	0
Serbia	86	11,454	89	34	224	13	5	33	245	3	0	5	2	0	3	0	0	1
Armenia	86	10,009	64	30	146	21	10	49	158	1	0	3	1	0	2	0	0	1
Algeria	94	9,626	106	38	165	2	1	4	667	6	2	8	5	3	10	0	0	0
Malaysia	130	7,877	39	2	110	1	0	3	115	0	0	1	0	0	2	0	0	0
Iraq	98	7,387	48	11	83	1	0	2	235	2	0	4	3	1	6	0	0	0
Azerbaijan	89	5,935	49	25	101	5	2	10	71	0	0	1	1	0	2	0	0	0
Guatemala	81	5,586	27	5	89	2	0	5	123	0	0	2	0	0	3	0	0	0
Thailand	136	3,083	3	0	23	0	0	0	58	0	0	0	0	0	2	0	0	0
Gabon	82	2,803	5	0	42	2	0	19	20	0	0	0	0	0	1	0	0	0
Bulgaria	86	2,538	26	14	38	4	2	5	144	1	0	3	5	0	10	0	0	0
Bosnia and Herze	83	2,534	27	15	46	8	5	14	156	1	0	3	5	2	10	0	0	1
Macedonia	89	2,391	22	12	36	11	6	17	141	1	0	2	5	0	11	0	0	1
Cuba	81	2,092	20	10	40	2	1	4	83	1	0	2	2	0	6	0	0	0
Maldives	86	1,841	5	0	30	9	0	56	7	0	0	0	0	0	0	0	0	0
Venezuela	81	1,819	7	2	23	0	0	1	18	0	0	0	0	0	0	0	0	0
Sri Lanka	119	1,683	7	0	16	0	0	1	11	0	0	0	0	0	0	0	0	0
Equatorial Guine	81	1,306	0	0	2	0	0	1	12	0	0	0	0	0	0	0	0	0
Lebanon	99	1,242	8	4	18	1	1	3	27	0	0	0	0	0	0	0	0	0
Albania	87	1,164	12	7	19	4	2	7	33	0	0	1	0	0	4	0	0	0
Costa Rica	88	1,105	10	6	19	2	1	4	10	0	0	0	0	0	0	0	0	0
Kosovo	80	1,067	8	1	22	4	1	11	30	0	0	0	0	0	3	0	0	0
Paraguay	84	1,013	5	2	13	1	0	2	11	0	0	0	0	0	0	0	0	0
Georgia	95	800	6	3	11	2	1	3	13	0	0	0	0	0	0	0	0	0
Jordan	83	755	6	3	14	1	0	1	9	0	0	0	0	0	0	0	0	0
Jamaica	83	590	4	2	9	1	1	3	9	0	0	0	0	0	0	0	0	0
Mauritius	76	335	0	0	6	0	0	4	10	0	0	0	0	0	0	0	0	0
Montenegro	78	324	1	0	6	2	0	10	9	0	0	0	0	0	0	0	0	0
Libya	71	182	0	0	2	0	0	0	5	0	0	0	0	0	0	0	0	0
Guyana	81	153	1	0	3	1	0	4	12	0	0	0	0	0	0	0	0	0
Suriname	76	54	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Botswana	64	38	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Saint Vincent an	72	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

Namibia	81	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Grenada	73	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Belize	72	18	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Dominica	73	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fiji	76	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saint Lucia	81	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lower-middle income																		
India	125	2,07,615	336	1	2,553	0	0	2	5,815	6	0	73	3	2	4	0	0	0
Pakistan	93	80,463	517	104	1,446	2	0	7	1,688	15	1	31	2	1	2	0	0	0
Bangladesh	81	52,445	418	9	1,034	3	0	6	709	5	1	14	1	1	3	0	0	0
Indonesia	87	27,549	325	114	479	1	0	2	1,663	16	8	26	6	3	9	0	0	0
Egypt	106	27,536	126	9	388	1	0	4	1,052	7	0	15	4	2	8	0	0	0
Ukraine	82	24,823	332	68	476	8	2	11	735	8	1	14	3	2	4	0	0	0
Philippines	122	18,997	116	0	258	1	0	2	966	6	0	13	5	2	8	0	0	0
Bolivia	83	10,991	44	9	205	4	1	18	376	3	1	6	3	1	6	0	0	1
Nigeria	86	10,819	75	12	229	0	0	1	314	2	0	6	3	0	4	0	0	0
Moldova	86	8,548	105	35	148	26	9	37	307	3	0	6	3	0	5	1	0	1
Ghana	82	8,297	10	0	152	0	0	5	38	0	0	1	0	0	1	0	0	0
Morocco	86	7,866	86	33	139	2	1	4	206	1	0	3	2	0	4	0	0	0
Cameroon	83	6,585	16	0	146	1	0	6	200	0	0	3	1	0	3	0	0	0
Honduras	82	5,527	33	7	111	3	1	11	225	1	0	5	3	0	10	0	0	1
Sudan	82	5,310	5	0	137	0	0	3	307	0	0	5	4	0	8	0	0	0
Senegal	86	3,836	26	9	83	2	1	5	43	0	0	1	0	0	2	0	0	0
Djibouti	77	3,779	12	2	54	12	2	55	25	0	0	0	0	0	0	0	0	0
Uzbekistan	80	3,769	41	20	67	1	1	2	15	0	0	0	0	0	0	0	0	0
Cote d'Ivoire	82	3,024	35	14	54	1	1	2	33	0	0	1	0	0	2	0	0	0
El Salvador	77	2,653	13	2	68	2	0	10	49	0	0	1	0	0	3	0	0	0
Kenya	82	2,093	14	7	28	0	0	1	71	0	0	1	0	0	8	0	0	0
Kyrgyzstan	77	1,871	21	12	30	3	2	5	20	0	0	0	0	0	0	0	0	0
Nicaragua	77	1,118	0	0	0	0	0	0	46	0	0	0	0	0	4	0	0	0
Zambia	77	1,089	2	0	9	0	0	0	7	0	0	0	0	0	0	0	0	0
Tunisia	87	1,086	5	1	18	0	0	2	48	0	0	1	0	0	5	0	0	0
Mauritania	81	668	0	0	1	0	0	0	31	0	0	0	2	0	6	0	0	0
Palestine	87	630	3	0	7	1	0	1	5	0	0	0	0	0	0	0	0	0
Congo	80	611	0	0	12	0	0	2	20	0	0	0	0	0	4	0	0	0
Sao Tome and Pri	56	484	0	0	4	0	0	18	12	0	0	0	0	0	6	0	0	0
Cape Verde	75	466	2	0	10	4	0	18	5	0	0	0	0	0	0	0	0	0
Vietnam	128	328	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Swaziland	81	293	2	0	6	2	0	5	3	0	0	0	0	0	0	0	0	0
Myanmar	72	233	1	0	5	0	0	0	6	0	0	0	0	0	0	0	0	0
Zimbabwe	75	206	0	0	2	0	0	0	4	0	0	0	0	0	0	0	0	0
Mongolia	80	185	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Comoros	33	132	0	0	1	0	0	1	2	0	0	0	0	0	0	0	0	0
Cambodia	119	125	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Angola	74	86	0	0	2	0	0	0	4	0	0	0	0	0	0	0	0	0
Bhutan	82	47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Timor	74	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Western Sahara	39	23	0	0	0	0	0	0	1	0	0	0	3	0	6	0	0	0
Laos	71	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Papua New Guinea	75	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lesotho	20	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Low income																		
Afghanistan	90	16,509	61	8	259	2	0	7	270	2	0	4	1	0	3	0	0	0
Tajikistan	34	4,013	85	17	204	9	2	21	47	0	0	2	1	0	3	0	0	0
Guinea	81	3,844	41	0	82	3	0	6	23	0	0	0	0	0	1	0	0	0

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

Democratic Repub	83	3,325	19	3	70	0	0	1	72	0	0	1	0	0	6	0	0	0
Haiti	76	2,507	3	0	34	0	0	3	48	0	0	1	0	0	2	0	0	0
Nepal	118	2,099	0	0	3	0	0	0	8	0	0	0	0	0	0	0	0	0
Somalia	79	2,089	19	0	49	1	0	3	79	0	0	2	2	0	5	0	0	0
Mali	70	1,351	18	8	27	1	0	1	78	1	0	2	3	0	12	0	0	0
Ethiopia	82	1,344	4	1	13	0	0	0	14	0	0	0	0	0	0	0	0	0
Guinea-Bissau	69	1,339	1	0	30	1	0	15	8	0	0	0	0	0	0	0	0	0
Central African	80	1,173	0	0	22	0	0	5	4	0	0	0	0	0	0	0	0	0
South Sudan	59	994	0	0	10	0	0	1	10	0	0	0	0	0	0	0	0	0
Niger	75	960	7	2	15	0	0	1	65	1	0	1	5	0	20	0	0	0
Sierra Leone	64	896	11	2	21	1	0	3	46	0	0	1	1	0	7	0	0	0
Burkina Faso	83	883	7	3	15	0	0	1	53	0	0	1	0	0	13	0	0	0
Madagascar	75	845	4	0	14	0	0	1	6	0	0	0	0	0	0	0	0	0
Chad	76	803	1	0	16	0	0	1	66	0	0	1	4	0	11	0	0	0
Tanzania	79	509	0	0	1	0	0	0	21	0	0	0	0	0	2	0	0	0
Uganda	74	489	2	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0
Togo	82	445	3	1	7	0	0	1	13	0	0	0	0	0	0	0	0	0
Yemen	55	399	3	0	12	0	0	0	87	0	0	3	18	6	31	0	0	0
Rwanda	81	384	4	2	7	0	0	1	2	0	0	0	0	0	0	0	0	0
Malawi	62	358	1	0	3	0	0	0	4	0	0	0	0	0	0	0	0	0
Liberia	79	311	3	0	8	1	0	2	28	0	0	0	0	0	11	0	0	0
Mozambique	73	307	1	0	5	0	0	0	2	0	0	0	0	0	0	0	0	0
Benin	79	244	0	0	5	0	0	0	3	0	0	0	0	0	0	0	0	0
Syria	73	123	0	0	1	0	0	0	6	0	0	0	0	0	0	0	0	0
Burundi	64	63	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Eritrea	74	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gambia	78	26	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Small areas																		
Jersey	76	308	1	0	5	10	0	45	30	0	0	1	0	0	7	0	0	10
Guernsey	76	252	0	0	4	0	0	60	13	0	0	0	0	0	6	0	0	0
Falkland Islands	61	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vatican City State	81	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Montserrat	74	11	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Bonaire Sint Eus	63	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anguilla	69	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Numbers of reported cases and deaths

In five months, 6,804,286 cases were reported globally. About 90% were reported from high-income or upper-middle-income countries (Table 2). The number of reported cases within each income-defined group varied. The top-10 high-income countries accounted for 48.0% of all COVID-19 cases globally. The top-10 upper-middle-income countries accounted for 26.1% of the cases globally. In contrast, the top-10 lower-middle-income countries accounted for only 6.9%, and the top-10 low-income countries accounted for only 0.6%. The remaining 170 countries and territories reported only 18.4% of all COVID 19 cases globally (Table 1). Countries in higher income categories reported more cases per day ($\chi2 = 514.79$, df = 3, $p < 0.001$) (Table 2). The high-income and upper-middle-income countries also accounted for most of the reported deaths. In five months, 380,803 deaths were reported, and thus the global case-fatality rate was 6.0%. Three quarters of all deaths were reported from high-income countries and one fifth were reported from upper-middle-income countries. Countries in higher income categories reported more deaths per day ($\chi2= 349.92$, df = 3, $p < 0.001$) (Table 2).

COVID-19 incidence and mortality rates per million population

The overall median daily incidence rate of COVID-19 for all affected countries in the period was 0.9 per million population (interquartile range: 0.0 to 9.3). The incidence rate of the disease varied across countries (Table 1), and it was higher in countries with higher incomes ($\chi2 = 1440.98$, df = 3, $p < 0.001$) (Table 3). The overall median daily death rate per million population was 0.0 (interquartile range: 0.00 to 0.01), which also differed between income-defined groups

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

of countries. The 75th percentile of the death rates for high-income, upper-middle-income, lower-middle-income, and low-income groups were 0.5, 0.2, 0.0, and 0.0, respectively ($\chi 2 = 479$, df = 3, $p < 0.001$) (Table 3).

Trend in the numbers of cases, deaths, and their rates per million population

From the onset of the pandemic until June 3, 2020, the total number of cases increased globally. In the high-income countries, of the total 3,804,286 reported cases, 0.1%, 16.2%, 45.9%, and 34.8% were reported in February, March, April, and May, respectively. A decline in cases was recorded between April and May. In the upper-middle-income group, over the same four months the number of cases increased. Of the total reported cases (1,962,382), 3.6%, 4.2%, 24.4%, and 60.1% were reported in February, March, April, and May, respectively. In the-lower middle-income group, that month-over-month increase in the percentage of cases increased substantially in May. Of the total cases in this income group (532,259), 2.0% were reported in February and 67.1% in May. In low-income countries, the percentage of cases increased between February and May from 0.0% to 71.1%. Similarly, the median (interquartile range) of the daily incidence rates per million population in high-income countries declined between April and May. It was 0.0 (0.0 to 0.1), 5.6 (0.8 to 23.3), 13.0 (0.3 to 45.0), and 2.9 (0.0 to 20.9) per million population in February, March, April, and May, respectively. However, during the same time period, the daily incidence rates per million population increased in all other groups: from 0.0 (0.0 to 0.1) to 2.9 (0.0 to 14.0) in upper-middle-income countries, from 0.0 (0.0 to 0.0) to 1.5 (0.0 to 6.0) in lower-middle-income countries, and from 0.0 (0.0 to 0.0) to 0.4 (0.0 to 1.9) in low-income countries.

In high-income countries the number of deaths also declined between April and May. Among all deaths (285,666), 0.0% were reported in February. That rose to 57.9% in April but then declined to 29.5% in May. In contrast, between February and May the number of cases in upper-middle-income, lower-middle-income, and low-income countries

Table 2: Contribution of countries by income group to global numbers of COVID-19 cases and deaths and their daily reported cases, deaths, and case-fatality ratios from the onset of the pandemic until June 3rd, 2020.

Variable	Income category	Total	% Global	Daily reported data		
				Median	25th percentile	75th percentile
Total cases						p<0.001
	High	3,804,286	59.9	10.0	0.0	147.0
	Upper-Middle	1,962,382	30.9	14.0	1.0	111.0
	Lower-Middle	532,259	8.4	5.0	0.0	67.0
	Low	48,671	0.8	2.0	0.0	15.0
	Small areas with unknown income status		0.0			
		606		Excluded		
	Global	6,348,204	100.0	7.0	0.0	75.0
Total deaths						p < 0.001
	High	285,666	75.0	0.0	0.0	3.0
	Upper-Middle	78,977	20.7	0.0	0.0	3.0
	Lower-Middle	15,051	4.0	0.0	0.0	1.0
	Low	1,065	0.3	0.0	0.0	0.0
	Small areas with unknown income status		0.0			
		44		Excluded		
	Global	380,803	100.0	0.0	0.0	2.0
Case-fatality rate						p < 0.001
	High	NA	NA	0.6	0.0	7.0
	Upper-Middle	NA	NA	0.7	0.0	4.2
	Lower-Middle	NA	NA	0.0	0.0	3.4
	Low	NA	NA	0.0	0.0	2.3
	Small areas with unknown income status	NA	NA	Excluded		
	All of the above	NA	NA	0.0	0.0	4.8

P-value for Kruskall-Wallis test (small areas excluded).

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

Table 3: Association of country-level category with COVID-19 incidence and death rates per million population from the onset of the pandemic until June 3rd, 2020.

Variable	Income category	Median	25th percentile	75th percentile
Cases per million population				p < 0.001
	High	4.2	0.0	26.2
	Upper-Middle	1.5	0.0	8.6
	Lower-Middle	0.3	0.0	2.6
	Low	0.1	0.0	0.8
	Small areas with unknown income status	Excluded		
	All above	0.9	0.0	9.3
Deaths per million population				p < 0.001
	High	0.0	0.0	0.5
	Upper-Middle	0.0	0.0	0.2
	Lower-Middle	0.0	0.0	0.0
	Low	0.0	0.0	0.0
	Small areas with unknown income status	Excluded		
	All above	0.0	0.0	0.1

P-value for Kruskall-Wallis test (small areas excluded).

increased. Among all deaths in the upper-middle-income group (78,977), 3.4% were reported in February, 25.1% in March, and 60.1% in May. Among all deaths in the lower-middle-income group (15,051), 0.0% were reported in February, 25.7% in March, and 61.8% in May. Among all deaths in the low-income group (1,065), 0.0% were reported in February, 24.3% in April, and 66.5% in May. Similarly, the death rate per million population declined in high-income countries and was approximately constant in the remaining three income groups. In the small areas with no income data, both cases and deaths declined after April.

Discussion

As of June 3, 2020, a total of 6,804,286 COVID-19 cases including 380,803 (6.0%) deaths had been reported globally. Income-defined groups of countries differed greatly in the numbers of cases and deaths and in their rates, as follows.

Income-related differences in cases and in incidence rates per million population

Among the main findings of this study are the income-related differences in COVID-19 cases and their incidence rates per million population. The income-defined category of a country was positively associated with the number of COVID-19 cases and with the daily incidence rate per million population. The large differences in daily incidence rates probably reflect differences in epidemiologic and population characteristics, and differences in clinical and public health practices. First, the most obvious of the epidemiological differences is in the timing of the introduction and early transmission of SARS-CoV-2 in the various countries. Among the income-defined groups, strong connections by air travel probably resulted in the relatively early and widespread transmission of the disease among high-income and upper-middle-income countries. The date on which a country reported its first case(s) to the WHO can be taken as indicator of the date on which the disease began to spread in that country. Given that indicator, it is clear that the temporal order of the introduction and the start of transmission among income-defined categories is exactly the same as the economic ranking of those categories In other words, overall, the disease has been spreading from higher-income countries to lower-income countries.

A second possible explanation for the observed differences in the number of cases by income-defined groups of countries involves differences in the availability of and approaches to SARS-CoV-2 testing, including testing patients with illness of various severities. In this context two indices of testing are often used: daily tests per capita and test-positivity rate (the number of positive tests as a percentage of the total number of tests done). High-income and upper-middle-income countries are more likely to test more people with illness of various severities than are lower-middle-income and low-income countries. Kobia and Gitaka [21] also attributed the low apparent incidence rate of COVID-19 in Africa to insufficient testing. In large parts of Africa and also in most low-income and middle-income countries elsewhere, shortages of test kits, lack of capacity to implement large-scale testing and contact tracing, and lack of capacity to roll out surveillance testing have been reported [21, 22], all of which can cause the true incidence rate of COVID-19 in those areas to be underestimated.

The test-positivity rate can be used to assess whether

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

enough testing is being done. High test-positivity rates can indicate that only the sickest patients are being tested, which may imply that more people should be tested. The WHO has issued guidance stating that the positivity rate should be below 5% for at least 14 days before social-distancing measures are relaxed. The actual percentage varied both within and among income-defined groups. As shown on the OWID website, testing was limited in lower-middle-income countries and possibly also in low-income countries, which probably resulted in underestimation of incidence rates [23]. Third, the income-related differences might also have been caused in part by differences in the timing, adherence to, and/or implementation of preventive and community and public-health measures among the countries. Such measures include frequent handwashing with soap and water, use of alcohol-based hand rub, wearing masks, social distancing, case detection, isolation, contact tracing, and quarantine of exposed persons, closure of schools, public libraries, cinemas, and clubs, and suspension of religious and social gatherings and events, etc. [13, 24-27]. Large-scale meta-analyses and reviews are required to quantify the impacts of those and other measures on the incidence rate of COVID-19 in different countries.

Income-related differences in COVID-19 case-fatality rate and death rate per million population

Also noteworthy are the differences in the COVID-19 case-fatality rate, in the daily reported numbers of COVID-19 cases, and in the numbers of deaths per million population, by income-defined group. Overall, higher-income countries were more severely affected in the time period under study. One contributing factor could be longer life expectancy, i.e. the presence of proportionally more elderly people. The spread of COVID-19 in nursing homes for elderly people has been documented [10, 28, 29] and older populations have higher prevalences of chronic medical conditions: hypertension, diabetes mellitus, coronary artery disease, chronic obstructive pulmonary diseases, etc. [30, 31]. Elderly patients are more likely to have serious and sometimes-fatal medical complications from COVID-19 [2]. Another possible contributor to the apparent income-related differences is under-reporting of cases and of deaths in lower-income countries due to insufficient surveillance. Nonetheless, the most likely explanation for the bulk of the difference between income-defined groups may still be the relatively late establishment of transmission of the virus in lower-income countries.

Opposite trends in higher-income and lower-income countries

Another main finding of this study is the fact that the COVID-19 incidence rate decreased in high-income countries from April to May 2020, while at the same time it increased in all other income-defined groups of countries. The impact of the pandemic will be large if the incidence rates already recorded in high-income countries eventually also occur in other countries. Some middle-income and low-income countries have large populations, with many people living in overcrowded conditions, where the virus can easily spread. Moreover, non-pharmaceutical public-health interventions may not be implemented due to a lack of public awareness of their importance. These conditions soon may adversely affect patients, health-care workers, already-weak health systems, and the economies of those countries [22, 32]. Already some impact of the pandemic has been observed in middle-income and low-income countries. For example, substantial increases in the numbers deaths have been reported from Ecuador, Brazil, Nigeria, Bangladesh, Pakistan, and Afghanistan [33]. In Guayaquil city of Ecuador, mortuaries were full of corpses of COVID-19 victims and some were even left in the street [34]. In the absence of new medical interventions, the result could be more loss of life than has occurred so far in high-income and upper-middle-income countries.

Limitations

The findings of this study are subject to some limitations. First, the numbers of cases of COVID-19 reported each day are likely to be underestimated, especially in the middle-income and low-income countries. For example, in Afghanistan, COVID-19 cases have been classified as typhoid fever cases and many symptomatic patients did not present themselves to public health services, due to limited testing services, poor quality of medical care, or stigma associated with COVID-19 [35-37]. Second, the numbers of deaths reported daily may also be underestimated, because of non-follow-up or incomplete follow-up of patients with COVID-19 who died, or because of deaths among people who were infected with SARS-CoV-2 but in whom COVID-19 was not diagnosed.

Conclusions

In the first five months of the COVID-19 pandemic, the vast majority of the cases and deaths reported worldwide were from high-income and upper-middle-income countries, with relatively high incidence rates and death rates. Between April and May, the numbers of cases and deaths decreased in high-income countries, but they continued to increase in upper-middle-income, lower-middle-income, and low-income countries.

Funding

None.

Conflict of Interest

The author declares that he has no conflict of interest.

Ethical Approval and Informed Consent

Not required.

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

Acknowledgement

The author is grateful to Joseph Green (retired from the Graduate School of Medicine at the University of Tokyo) for reading an earlier version of this article and providing comments and suggestions.

References

1. He F, Deng Y, Li W. Coronavirus disease 2019: What we know?. J Med Virol (2020).
2. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 395 (2020): 497-506.
3. Alexander EG, Susan CB, Ralph SB, et al. Severe acute respiratory syndrome-related coronavirus: The species and its viruses – a statement of the Coronavirus Study Group. bioRxiv (2020).
4. Andersen KG, Rambaut A, Lipkin WI, et al. The proximal origin of SARS-CoV-2. Nat Med. Nature Publishing Group 89 (2020): 44-48
5. Lu R, Zhao X, Li J, et al. Genomic Characterization and Epidemiology of 2019 Novel Coronavirus: Implications for Virus Origins and Receptor Binding. Lancet. Lancet Publishing Group 395 (2020): 565-574.
6. World Health Organization (2020a). Novel Coronavirus disease (2019-nCoV) situation report-1 (2020).
7. World Health Organization (2020b). Novel Coronavirus disease (2019-nCoV) situation report-22 (2020).
8. Zhou P, Yang XL, Wang XG, et al. A Pneumonia Outbreak Associated With a New Coronavirus of Probable Bat Origin. Nature. Nature Research 579 (2020): 270-273.
9. Zhu N, Zhang D, Wang W, et al. A Novel Coronavirus From Patients With Pneumonia in China, 2019. N Engl Med. Massachussetts Medical Society 382 (2020): 727-733.
10. Bedford J, Enria D, Giesecke J, et al. COVID-19: towards controlling of a pandemic. Lancet 395 (2020): 1015-1018.
11. Welfens PJJ. Macroeconomic and health care aspects of coronavirus epidemic: EU, US and global perspectives. International Economics and Economic Policy 17 (2020): 295-362.
12. Coronavirus COVID-19 Global Cases by Centre for Systems Science and Engineering, Johns Hopkins University (2020).
13. Centers for Disease Control and Prevention COVID-19 response team (2020) Geographic Differences in COVID-19 Cases, Deaths, and Incidence — United States, February 12–April 7, 2020. Morbidity and Mortality Weekly Report 69 (2020).
14. Hutchins SS, Fiscella K, Levine RS, et al. Protection of racial/ethnic minority populations during an influenza pandemic. Am J Public Health 99 (2009): S261-S270.
15. Centers for Disease Control and Prevention: Information on 2009 H1N1 impact by race and ethnicity (2020).
16. Bukhari Q, Jameel Y. Will coronavirus pandemic diminish by summer? (2020).
17. Sajadi MM, Habibzadeh P, Vintzileos A, et al. Temperature, humidity, and latitude analysis to predict potential spread and seasonality for COVID-19 (2020).
18. Lai CC, Wang CY, Wang YH, et al. Global coronavirus disease 2019: what has daily cumulative index taught us?. International Journal of Antimicrobial Agents (2020).
19. Fantom N, Umar S. The World Bank's Classification of Countries by Income. Policy Research Working Paper (2020).
20. Our World in Data (2020a) Data on COVID-19 (coronavirus) by Our World in Data. 2020a. Master Dataset (2020).
21. Kobia F, Gitaka J. COVID-19 (2020) Are Africa diagnostic challenges blunting response effectiveness?. AAS Open Research (2020).
22. Jaffer Shah, Sedighe K, Tareq MAA, et al. COVID-19: the current situation in Afghanistan. Lancet (2020).
23. Our World in Data (2020b) Are countries testing enough to monitor their outbreak? Tests conducted per new confirmed case of COVID-19 (2020).
24. Baharudin H. Software for Singapore contact tracing app to be free for global use (2020).
25. Khanna RC, Cicine MV, Gilbert SS, et al. COVID-19 pandemic: Lessons learned and future directions. Indian Journal of Ophthalmology 68 (2020): 703-710.
26. Lee VJ, Chiew CJ, Khong WX. Interrupting transmission of COVID-19: lessons from containment efforts in Singapore. J Travel Med (2020).
27. Qiu Yun, Chen X, Shi W. Impacts of social and economic factors on the transmission of coronavirus disease 2019 (COVID-19) in China. Journal of Population Economics (2020).
28. Davidson PM, Szanton SL. Nursing homes and COVID-19: we can and should do better. J Clin Nurs (2020).
29. Kemenesi G, Kornya L, Endre Tóth G, et al. Nursing homes and the elderly regarding the COVID-19 pandemic: situation report from Hungary. GeroScience (2020).

Sabawoon W., Arch Intern Med Res 2022
DOI:10.26502/a9mr.0121

30. Suzman R, Beard J. Global health and aging: preface. National Institute on Aging website (2011).

31. Zhao C, Wong L , Zhu Q, et al. Prevalence and correlates of chronic diseases in an elderly population: A community-based survey in Haikou. PLoS One 13 (2018): e0199006.

32. Bong CL, Brasher C, Chikumba E, et al. The COVID-19 pandemic: effects on low and middle-income countries. Anesth Analg (2020).

33. World Health Organization (2020c) WHO Coronavirus Disease (COVID-19) Dashboard (2020).

34. The Guardian (2020). They're Leaving us to die": Ecuadorians' Plead for Help as Virus Blazes Deadly Trail, World News, The Guardian (2020).

35. Arian news. Concerns over the typhoid outbreak in Afghanistan (2020).

36. CNA news: Afghan testing lapse suggests growing and hidden COVID-19 crisis (2020).

37. Sabawoon W. The influence of stigma associated with COVID-19 and ways for its prevention. Tannd website (2020).