COVID-19 Pandemic Initial Case-Fatality Risk

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Abstract

Background

Coronavirus disease 2019 (COVID-19) pandemic continues to expand at alarming rates. We aimed to identify the effect of various health, economic and demographic indicators on the spread case fatality of COVID-19 during the initial pandemic phase.

Methods

Pearson's chi-squared (χ2) test and Wilcoxon rank-sum test were used compare categorical and continuous variables respectively.

Results

A total of 182 countries were included. The globally confirmed COVID-19 cases on March 21, 2020 were 266,073; with 11,183deaths. Countries with high COVID-19 case volumes had higher health expenditure, higher prevalence of smoking and alcohol use, more access to basic sanitation services and higher volume of tourists. Countries with high COVID-19 fatality had significantly lower number of nurses/midwives per 1000 people 2.6 vs 6.4, p = 0.028, higher prevalence of undernourishment 4.5 vs 2.5, p = 0.019, lower access to basic sanitation services 94.2 vs 98.7, p = 0.034 and higher mortality rates due to unsafe water, limited sanitation and lack of hygiene 0.6% vs 0.2%, p = 0.004 and higher number of total tourists' departures 9.5 vs 5.9 million, p = 0.042.

Conclusion

Countries with primitive health structure and low income are at high risk for increased mortality. Additional measures to increase nurse staffing and address undernourishment and availability of easy access to basic sanitation services and good hygiene are crucial for pandemic control during initial phase.

Background:

Coronaviruses are pathogens that have been known to cause diseases within humans and animals since the 1960s. The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was identified as a novel coronavirus that caused pneumonia in Wuhan, China in December 2019 [1]. On February 2020, the World Health Organization (WHO) officially referred to the disease as "COVID-19," or coronavirus disease 2019 [2]. In China, the epidemic peaked between late January 2020 and early February 2020, when more than 80,000 COVID-19 cases were reported [2]. Globally, by March 21, 2020, more than 266,073 confirmed

cases of COVID-19 have been reported by the WHO, including an estimated 11,183 deaths in 197 countries [3].

On March 11, 2020, the WHO officially changed their classification of COVID-19 from a public health emergency of international concern to a pandemic [3]. Initial data from China, published in February 2020, suggested an overall COVID-19 case fatality rate of 2.3%, with 80% of deaths occurring among adults aged ≥ 60 and among persons with serious underlying health conditions. Only one death (0.1%) occurred among a person aged ≤ 19 [4]. Alternatively, in the United States, as of March 2020, only 53% of COVID-19 intensive care unit admissions and 80% of deaths were among adults ≥ 65 years [5].

Against this backdrop, the two parameters that are used to understand the basic epidemiological features of an outbreak include the basic reproduction number (R_0) and best estimates of case fatality rates (CFR) [6]. During the early phase of COVID-19 outbreaks, several studies were conducted to estimate the (R_0); however reliable estimates of CFR for COVID-19 are lacking [7][8]. Therefore, it is of great importance for clinicians and public health professionals to implement efficient and effective disease control interventions, including social distancing and more resource allocation for health system. To that end, our objective in this study was to identify the effect of various health, economic, and demographic indicators on the spread of COVID-19 and to evaluate factors that correlate with increased risk of fatality.

Methods:

Study variables

Variables that were readily accessible on the world wide web, and having a possible impact on COVID-19 spread and fatality were selected. The variables included were general health indicators, population density, health care system indicators, and socioeconomic status. These indicators included median age of population, life expectancy at birth, life expectancy at age 60, population density, world bank income classification, number of hospital beds (per 1,000 people), physicians (per 1,000 people), nurses and midwives (per 1,000 people). Health indicators included prevalence of smoking and alcohol use, prevalence of undernourishment, access to basic sanitation services. Additional indicators considered were, crude mortality measures related to communicable and non-communicable disease as well as mortality related to the water and air pollution and lack of hygiene. Finally, measures related to tourism including total number of arrivals and departures were also included. A complete description of the study variables is available at world bank data page. [9]

Data Source

The data on COVDI-19 prevalence was derived from the WHO based on the reported number of cases on March 21st of the year 2020. Other data were extracted from the most recent data on the World Bank website (http://data.worldbank.org/). If data was not available from the most recent year, available data

from the most recent previous year was used. The World Bank database is an open-access free database that provides a collection of the most current and accurate global development data. It includes collections of national, regional and global estimates for development indicators, gathered from officially-recognized international sources.

Analysis

All 193 United Nations member states were considered eligible for the analysis. Countries with a minimal of one COVID-19 case were included in analysis. Countries were divided into quartiles based on total COVID-19 reported cases. A low COVID-19 volume was defined by the lowest quartiles, the intermediate volume was defined by the second and third quartiles, and the high volume was defined by the highest quartile. This formula resulted in the formation of three cut points (low, intermediate and high COVID-19 case volume groups). COVID-19 fatality rate (CFR) was calculated by dividing the total confirmed COVID-19 related death by the total cases of COVID-19 reported per affected country using the formula:

$$\text{Case Fatality Rate (CFR, in \%)} = \frac{Number\ of\ death\ from\ disease}{Number\ of\ diagnosed\ cases\ of\ the\ disease} X100$$

To avoid the disproportionate impact of countries with low number of COVID-19 cases on the analysis, only countries with a minimum of 50 documented COVID-19 cases were included in the calculation of the COVID-19 fatality rate. COVID-19 fatality was defined as high when COVID-19 fatality rate was ≥ 75th percentile and low if below 75th percentile. For analysis, categorical variables were compared using Pearson's chi-squared ($\chi 2$) test and presented as percentages. Continuous variables had skewed distribution; they were expressed as median with interquartile ranges and compared by using the Wilcoxon rank-sum test. Multiple imputations by chained equations were used to deal with missing data using 20 imputations and using quantile regression to estimate the 25th, 50th and 75th percentile. Following multiple imputations for the missing values, similar results were obtained (Sup. Table 1,2) thus original data set was used. All p-values < 0.05 were considered statistically significant. Statistical analysis was performed using STATA 15. World map and Graphic production of map effects were produced using Tableau Desktop software.

Results:

Overall a total of 182 countries and territories were included in the analysis. The confirmed COVID-19 cases on March 21, 2020 were 266,073; with 11,183 deaths. Countries with low, intermediate, and high COVID-19 cases had a median case, interquartile range (IQR) of 1.5 (1–2), 44 (14–91) and 712 (409–2649) respectively. Table 1 summarizes the clinical indicators among countries stratified based on COVID-19 case volume. Overall, for countries with high COVID-19 case volume, majority were in Europe (57.8%) and were of high income (73.3%) (Supp. Figure 1,2). The median age, life expectancy at birth and at age of 60 were significantly in higher in countries with high COVID-19 cases (Fig. 1). Generally,

countries with high COVID-19 case volumes had higher health expenditure (% of Gross Domestic Product (GDP)) with a higher number of nurses, physicians and hospital beds per 1000 people. Among health indicators tested, countries with high COVID-19 volume had higher prevalence of smoking and alcohol use, more access to basic sanitation services. As per annual mortality, high COVID-19 countries had an overall, lower mortality related to communicable and non-communicable disease and lower mortality related to air pollution or unsafe water access. With regards to tourism industry, high COVID-19 countries had higher number of tourist's movement.

Table 1
Demographics and health parameters for countries according to COVID-19 case volume. (from Jan-21 to March-21 / 2020).

	Total	Low volume	Intermediate volume	High volume	p-value
	N = 182	N = 46	N = 91	N = 45	
Total confirmed COVID-19 cases	44.0 (4.0-234.0)	1.5 (1.0–2.0)	44.0 (14.0–91.0)	712.0 (409.0-2649.0)	< 0.001
Total confirmed COVID-19 deaths	0.0 (0.0–2.0)	0.0 (0.0–0.0)	0.0 (0.0–1.0)	6.0 (1.0–37.0)	< 0.001
Population count (millions)*	8.5 (1.4–29.8)	1.3 (0.2–8.6)	7.0 (2.8–28.9)	19.5 (8.5–69.4)	< 0.001
Population density (people per sq. km land)*	92.8 (37.3-236.9)	50.3 (18.4-246.3)	90.3 (53.3-232.2)	107.2 (35.8-237.4)	0.19
Region					< 0.001
Western Pacific	9.4%	6.5%	8.9%	13.3%	
Europe	32.0%	8.7%	31.1%	57.8%	
South-East Asia	5.0%	6.5%	4.4%	4.4%	
Eastern Mediterranean	10.5%	6.5%	11.1%	13.3%	
America	24.3%	34.8%	25.6%	11.1%	
Africa	18.8%	37.0%	18.9%	0.0%	
World Bank income group					< 0.001
High income	36.4%	6.2%	27.3%	73.3%	
Low income	12.3%	34.4%	10.4%	0.0%	
Lower middle income	23.4%	37.5%	27.3%	6.7%	
Upper middle income	27.9%	21.9%	35.1%	20.0%	
Health resources					

Data are presented as median (IQR) for continuous measures, and % for categorical measures.

*<10% missing, **11–20% missing, ***23–38 missing

	Total	Low volume	Intermediate volume	High volume	p-value
Current health expenditure (% of GDP)**	6.3 (4.4–8.4)	4.6 (3.9–6.3)	6.3 (4.4–7.4)	8.4 (5.3–10.4)	< 0.001
Nurses and midwives (per 1,000 people)**	2.9 (1.2–6.6)	1.5 (0.5–2.3)	2.9 (1.1–5.7)	7.2 (4.1–11.1)	< 0.001
Physicians (per 1,000 people)*	1.8 (0.7-3.0)	0.4 (0.1–1.1)	1.8 (0.8–2.9)	3.0 (2.0–4.0)	< 0.001
Hospital beds (per 1,000 people)**	2.6 (1.3–4.3)	1.7 (0.9–2.9)	2.5 (1.2–4.3)	3.2 (2.4–4.8)	< 0.001
Population health					
Median age**	29.2 (22.4–37.6)	20.6 (18.6–24.1)	27.7 (23.0-34.6)	39.0 (31.7–41.4)	< 0.001
Life expectancy at birth**	75.0 (68.8–78.0)	64.1 (61.3–71.2)	74.5 (69.8–76.4)	81.2 (76.4–82.4)	< 0.001
Life expectancy at sixty	20.1 (17.6–22.5)	17.5 (16.4–18.9)	19.8 (18.0-21.4)	23.8 (21.7–24.7)	< 0.001
Smoking prevalence***	22.1 (13.8–28.2)	13.8 (9.8–22.8)	21.6 (12.5–28.8)	23.5 (20.1–28.2)	0.015
Total alcohol consumption per capita	6.8 (2.7–9.9)	4.1 (1.5–6.4)	6.5 (2.9-9.0)	9.3 (4.4–11.6)	< 0.001
Prevalence of undernourishment (%)***	5.6 (2.5–12.8)	16.8 (10.1–37.2)	6.4 (3.4–13.1)	2.5 (2.5–2.5)	< 0.001
Use of at least basic sanitation services (%)*	93.6 (69.3–99.1)	62.1 (34.5–87.5)	93.4 (76.3–97.8)	99.1 (97.6–99.9)	< 0.001
Mortality rate					
Attributed to communicable diseases and maternal, prenatal and nutrition**	10.7 (5.2–25.6)	47.4 (18.2–55.2)	10.6 (4.8–25.1)	5.6 (4.9–10.2)	< 0.001

Data are presented as median (IQR) for continuous measures, and % for categorical measures.

*<10% missing, **11–20% missing, ***23–38 missing

	Total	Low volume	Intermediate volume	High volume	p-value
Attributed to CVD, cancer, diabetes or CRD between exact ages 30 and 70**	17.6 (14.0-21.9)	20.8 (18.0-23.2)	18.2 (16.4–22.5)	11.4 (9.9–16.1)	< 0.001
Attributed to household and ambient air pollution**	56.1 (25.9-127.2)	142.4 (87.5-189.4)	63.2 (38.6-107.8)	20.5 (11.9–46.6)	< 0.001
Attributed to unsafe water, unsafe sanitation and lack of hygiene**	0.8 (0.2–11.9)	21.5 (3.4–38.7)	0.9 (0.2–5.6)	0.2 (0.1–0.4)	< 0.001
International tourism					
Number of departures (millions)**	3.0 (0.9–10.1)	0.2 (0.1–1.1)	1.6 (0.8–3.9)	10.6 (7.4–22.1)	< 0.001
Number of arrivals (millions)***	2.3 (0.7–9.2)	0.3 (0.1–0.8)	2.0 (0.9–5.3)	12.7 (6.6–30.1)	< 0.001
Data are presented as median (IQR) for continuous measures, and % for categorical measures.					
*<10% missing, **11–20% missing, ***23–38 missing					

In terms of COVID-19 case fatality. Table 2 summarizes the clinical indicators among countries with high versus low COVID-19 fatality rate. No significant regional difference in case fatality rates (Fig. 2). The number of nurses/midwives per 1000 people were significant lower in countries with high fatality rate 2.6 vs 6.4, p = 0.028 while physician and hospital bed number per 1000 people had no significant association with fatality rate (Fig. 3). Countries with high COVID-19 fatality had higher prevalence of undernourishment 4.5% vs 2.5%, p = 0.019, lower access to basic sanitation services 94.2% vs 98.7%, p = 0.034 and higher mortality rates due to unsafe water, limited sanitation and lack of hygiene 0.6% vs 0.2%, p = 0.004, higher number of total tourists' departures 11.1 vs 8 million, p = 004. No significant association was seen between other tested indicators and COVID-19 case fatality.

Table 2
Demographics and health parameters for countries according to COVID-19 fatality rate. (Jan-21 to March-21 / 2020).

	Total	Low fatality	High fatality	p-value
	N = 88	N = 66	N = 22	
Total confirmed COVID-19 cases	254.5 (94.0-779.0)	278.5 (91.0-670.0)	212.5 (127.0-3983.0)	0.29
Total confirmed COVID-19 deaths	2.0 (0.0-8.5)	1.0 (0.0–5.0)	14.0 (4.0-177.0)	< 0.001
Population count (millions) *	10.7 (4.2–49.6)	9.6 (3.5–31.8)	45.6 (10.6–98.4)	0.001
Population density (people per sq. km land) *	100.8 (44.7-215.5)	88.3 (32.9-137.8)	135.0 (88.5-347.1)	0.035
Region				0.48
Western Pacific	13%	12%	14%	
Europe	49%	52%	41%	
South-East Asia	5%	3%	9%	
America	15%	12%	23%	
Africa	16%	18%	9%	
World Bank income group				0.13
High income	58%	63%	41%	
Lower middle income	13%	10%	23%	
Upper middle income	29%	27%	36%	
Health resources				
Current health expenditure (% of GDP) *	7.1 (5.5–9.1)	7.1 (5.5–9.2)	7.0 (5.0-8.9)	0.76
Nurses and midwives (per 1,000 people) *	5.6 (2.5–8.8)	6.4 (3.0-9.7)	2.6 (1.9–6.6)	0.028
Physicians (per 1,000 people) *	2.6 (1.6–3.5)	2.6 (1.8–3.6)	2.1 (1.1–3.5)	0.22

Data are presented as median (IQR) for continuous measures, and % for categorical measures.

* <5% missing, ** 5–10% missing, ***15% missing

	Total	Low fatality	High fatality	p-value
Hospital beds (per 1,000 people) *	2.9 (2.0-4.8)	2.9 (2.2-5.0)	2.9 (1.5–4.7)	0.41
Population health				
Median age **	35.5 (29.2–40.6)	36.3 (29.8–40.1)	31.1 (26.9–40.6)	0.44
Life expectancy at birth **	76.9 (75.1–81.4)	77.8 (75.2–81.4)	76.3 (73.5–81.4)	0.27
Life expectancy at sixty **	21.8 (19.9–24.1)	22.2 (20.2–24.1)	20.5 (19.7–24.0)	0.23
Smoking prevalence **	23.5 (17.2–28.9)	22.8 (16.9–28.8)	24.8 (22.0–30.0)	0.38
Total alcohol consumption per capita *	8.4 (4.4–11.4)	9.1 (4.8–11.5)	7.2 (1.0-9.8)	0.067
Prevalence of undernourishment (%)	2.5 (2.5–5.6)	2.5 (2.5–4.3)	4.5 (2.5–8.6)	0.019
Us of at least basic sanitation services (%) *	97.9 (90.9–99.5)	98.7 (91.7–99.6)	94.2 (86.0-98.7)	0.034
Mortality rate				
Attributed to communicable diseases and maternal, prenatal and nutrition **	6.5 (4.5–11.5)	6.4 (4.5–10.2)	7.9 (4.9–15.8)	0.27
Attributed to CVD, cancer, diabetes or CRD between exact ages 30 and 70 **	15.7 (11.2–19.0)	15.1 (11.3–17.4)	17.0 (11.2–23.0)	0.25
Attributed to household and ambient air pollution**	35.5 (15.3–60.7)	29.8 (15.4–54.8)	49.7 (15.0-75.1)	0.089
Attributed to unsafe water, unsafe sanitation and lack of hygiene **	0.2 (0.1-1.0)	0.2 (0.1–0.6)	0.6 (0.2-2.0)	0.004
International tourism				
Number of departures (millions)***	7.5 (2.1–18.9)	5.9 (2.0-12.3)	9.5 (5.7–26.3)	0.042

Data are presented as median (IQR) for continuous measures, and % for categorical measures.

* <5% missing, ** 5–10% missing, ***15% missing

	Total	Low fatality	High fatality	p-value
Number of arrivals (millions)*	8.5 (3.2–16.6)	7.4 (3.0-15.3)	11.7 (6.6–31.2)	0.083
Data are presented as median (IQR) for continuous measures, and % for categorical measures.				
* <5% missing, ** 5–10% missing, ***15% missing				

Discussion

In this ecological study, instances of COVID-19 were more prevalent in European and high-income countries whose characteristics include an overall higher expenditure on the healthcare system, more health resources, longer life expectancy, better sanitation services, and higher tourism expenditures. Factors that were linked to increased COVID-19 fatalities included lower numbers of nurses per 1000 members of the population, under-nourishment, lower access to basic sanitation services, and lack of hygiene, as well as higher numbers of total tourist departures.

While the initial outbreak occurred in China, as of March 2020 the epicenter moved to Italy and is expected to move to the USA [10]. As of March 21, 2020, the countries with the highest number of COVID-19 cases were China, Italy, Spain, Iran, Germany and United States of America (USA), (Supp. Figure 2). It is worth noting that the ranking of these countries fluctuates due to the nature of the measures that were adopted to stop the disease progression and the variation on strategies for testing and early case detection [11]. Overall, the countries with the greatest prevalence of COVID-19 have higher incomes and higher health expenditures. These countries have a higher number of nurses/midwives, physicians, and hospital beds per population ratios (Table 1, Fig. 1). According to the WHO, the year 2020 was designated as the International Year of the Nurse and Midwife [12]. Based on the study findings, the most influential indicators for decreasing the case fatality is the overall income level as well as the number of nurses/midwives per 1000 people (Table 2, Supp. Figure 2). Such findings demonstrate the importance of nursing staff, particularly in pandemic settings, to achieve optimal health outcomes.

Despite the fact that the economy and overall healthcare expenditures are key measures for logistics and operations, such systems can become crippled in a pandemic situation. This is due to exponential doubling of the number of cases within short time periods, as we saw in Italy when the healthcare system was flooded with a large number of COVID-19 cases [13]. Based on the Italian experience, many countries, imposed restrictions and activated social distancing orders to “flatten the curve” of the epidemic and buy time for their health systems to build capacity [14].

In terms of demographic differences, even though all age groups can be affected by COVD-19, the population characteristics of countries that have been heavily affected by COVID-19 showed an overall increase in the median age of the population, with the highest life expectancy at birth and at age 60 years. Countries with high numbers of COVID-19 cases had a life expectancy of 81.2 years compared

to 64.1 years in countries with lower volumes of COVID-19 cases. In general, elderly people – particularly those with comorbidities – are at higher risk for severe disease and death [15]. With the exception of Italy, where the case fatality is holding at 7.2%, the sum of countries with a higher proportion of elderly people have no significant increased risk for higher case fatality. [16] Perhaps that is because the majority of patients who become infected fall into the middle age group. In addition, the majority of countries with longer life expectancies also have a more robust healthcare system, with resources that allow for better healthcare delivery.

The case fatality rate for COVID-19 is estimated to range from 2 to 3% [17]. The severity and case fatality vary according to the geographic location. [5] Possible explanations include variations in a host's susceptibility to the virus. [18] In addition, selection bias – with over-reporting of severe cases – might have contributed to an over-estimation of fatality rates in different regions [19]. Other explanations include variations in the genomic structure of the virus due to continuous genetic mutation, resulting in less virulent strains affecting different geographic locations [20].

According to this study, during the initial stages of the pandemic period, countries with higher rates of under-nourishment, and less access to basic sanitation services had an increased case fatality. General measures for mortality, including mortality related to communicable and non-communicable diseases, as well as mortality related to household and Ambient air pollution did not have any significant association with fatality rates. On the other hand, countries with higher mortality rates, due to unsafe drinking water and a lack of hygiene, had higher COVID-19 case fatality rates. These findings suggest that poor countries are at a higher risk for increased fatality. While African countries are currently the least affected by the spread of COVID-19, worse outcomes would be expected there with the spread of the disease due to low incomes, poorer health practices and less resources allocated to health system.

More broadly, the tourism sector has contributed widely to the spread of COVID-19 [21]. From this study, the number of tourists (both arrivals and departures) – correlated with an increase in COVID-19 case numbers. Similarly, countries with higher numbers of departing tourists had a higher COVID-19 fatality rate. From this data, it is likely that current travel restrictions will help in limiting the spread of the virus to countries without prior exposure, particularly in Africa by lowering the number of tourists moving across countries.

This study has a number of limitations that must be considered. The measures of exposure are based on population averages, meaning prudence is required to apply grouped results at the individual level. The data used was based on nationwide vital statistics, wherein coding errors are known to occur. Importantly, the study was based on measurements of association at the univariate level, hence the association might be explained by other unmeasured confounders. On the setting of pandemic, events including new case diagnosis and mortality records are changing at exponential rates. Thus, as times goes, new data are expected to come with new results. Our goal from this paper was focused on analyzing the events during the initial phase of the Pandemic thus further studies will be needed to study the trend of these findings on later stages.

The study also has a number of strengths. It is the first to investigate the association between various demographic, health, and economic indicators with the spread and case fatality of COVID-19. A large multinational sample of all countries affected by the COVID-19 pandemic were included, with adequate representation from wide geographical areas. The large sample also allowed for sufficient statistical power to draw conclusions from null results. The data are publicly available, thus there is no concern over confidentiality or reproducibility.

In summary, COVID-19 is more prevalent in European and high-income countries. Along with ongoing measures for disease control and the widespread adoption of social distancing practices, measures to increase nursing staff, address under-nourishment, access basic sanitation services and good hygiene, together with strict regulations of the tourism industry to cope with pandemics are essential for disease control and decreased fatalities during the initial phase of pandemic. Poor countries, particularly in Africa, are at a higher risk for devastating outcomes and increased mortality. Economic support measurements for such countries are warranted.

Abbreviations

COVID-19
Corona Virus Disease of 2019
SARS-CoV-2
Severe Acute Respiratory Syndrome Coronavirus 2
CFR
Case Fatality Rate
WHO
World Health Organization
GDP
Gross Domestic Product

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material

The data and study tools that support the findings of this study are available from the World bank and WHO database and will be made available by the main and corresponding author on reasonable request.

Competing interests:

Non

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Authors' contributions:

All Authors read and approved the manuscript. A. A was responsible for concept and study design; acquisition, analysis, and interpretation of the data; drafting and critical revision of the manuscript. F.A was responsible for concept and study design, drafting, and critical revision of the manuscript. K.D, M.O and P.P contributed to the drafting and critical revision of the manuscript. M.A was responsible for concept and study design, data analysis and critical revision of the manuscript. M.A was responsible for study design, data interpretation, drafting, and critical revision of the manuscript.

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References

1. Phelan AL, Katz R, Gostin LO. The Novel Coronavirus Originating in Wuhan, China: Challenges for Global Health Governance. JAMA. 2020;323:709–10.
2. WHO Director-General's remarks at the media briefing on 2019-nCoV on 11. February 2020. https://www.who.int/dg/speeches/detail/who-director-general-s-remarks-at-the-media-briefing-on-2019-ncov-on-11-february-2020. Accessed 25 Mar 2020.
3. Novel Coronavirus. (2019-nCoV) situation reports. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports. Accessed 25 Mar 2020.
4. Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. [The epidemiological characteristics of an outbreak of 2019 novel coronavirus diseases (COVID-19) in China]. Zhonghua Liu Xing Bing Xue Za Zhi Zhonghua Liuxingbingxue Zazhi. 2020;41:145–51.
5. CDCMMWR. Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) — United States, February 12–March 16, 2020. MMWR Morb Mortal Wkly Rep. 2020;69.

doi:10.15585/mmwr.mm6912e2.

6. Wallinga J, Teunis P. Different epidemic curves for severe acute respiratory syndrome reveal similar impacts of control measures. Am J Epidemiol. 2004;160:509–16.
7. Wu JT, Leung K, Leung GM. Nowcasting and forecasting the potential domestic and international spread of the 2019-nCoV outbreak originating in Wuhan, China: a modelling study. Lancet Lond Engl. 2020;395:689–97.
8. Zhao S, Musa SS, Lin Q, Ran J, Yang G, Wang W, et al. Estimating the Unreported Number of Novel Coronavirus (2019-nCoV) Cases in China in the First Half of January 2020: A Data-Driven Modelling Analysis of the Early Outbreak. J Clin Med. 2020;9.
9. Indicators | Data. https://data.worldbank.org/indicator?tab=all. Accessed 26 Mar 2020.
10. Saglietto A, D'Ascenzo F, Zoccai GB, De Ferrari GM. COVID-19 in Europe: the Italian lesson. The Lancet. 2020;:S0140673620306905.
11. Jernigan DB, CDC COVID-19 Response Team. Update: Public Health Response to the Coronavirus Disease 2019 Outbreak - United States, February 24, 2020. MMWR Morb Mortal Wkly Rep. 2020;69:216–9.
12. Global challenges in health and health. care for nurses and midwives everywhere - Catton – 2020 - International Nursing Review - Wiley Online Library. https://onlinelibrary.wiley.com/doi/full/10.1111/inr.12578. Accessed 25 Mar 2020.
13. Analysis of the number growth of ICU patients with Covid-19 in Italy and Lombardy. ESA HQ. https://www.esahq.org/esa-news/analysis-of-the-number-growth-of-icu-patients-with-covid-19-in-italy-and-lombardy/. Accessed 25 Mar 2020.
14. Raoult D, Zumla A, Locatelli F, Ippolito G, Kroemer G. Coronavirus infections: Epidemiological, clinical and immunological features and hypotheses. Cell Stress. 2020. doi:10.15698/cst2020.04.216.
15. McMichael TM. COVID-19 in a Long-Term Care Facility — King County, Washington, February 27–March 9, 2020. MMWR Morb Mortal Wkly Rep. 2020;69. doi:10.15585/mmwr.mm6912e1.
16. Onder G, Rezza G, Brusaferro S. Case-Fatality Rate and Characteristics of Patients Dying in Relation to COVID-19 in Italy. JAMA. 2020. doi:10.1001/jama.2020.4683.
17. Singhal T. A Review of Coronavirus Disease-2019 (COVID-19). Indian J Pediatr. 2020;87:281–6.
18. Hanff TC, Harhay MO, Brown TS, Cohen JB, Mohareb AM. Is There an Association Between COVID-19 Mortality and the Renin-Angiotensin System-a Call for Epidemiologic Investigations. Clin Infect Dis Off Publ Infect Dis Soc Am. 2020.
19. 10.1007/s15010-020-01401-y
    Cheng ZJ, Shan J. 2019 Novel coronavirus: where we are and what we know. Infection. 2020. doi:10.1007/s15010-020-01401-y.
20. Sardar R, Satish D, Birla S, Gupta D. Comparative analyses of SAR-CoV2 genomes from different geographical locations and other coronavirus family genomes reveals unique features potentially consequential to host-virus interaction and pathogenesis. bioRxiv. 2020;:2020.03.21.001586.

21. Bernard Stoecklin S, Rolland P, Silue Y, Mailles A, Campese C, Simondon A, et al. First cases of coronavirus disease 2019 (COVID-19) in France: surveillance, investigations and control measures, January 2020. Eurosurveillance. 2020;25. doi:10.2807/1560-7917.ES.2020.25.6.2000094.

Figures

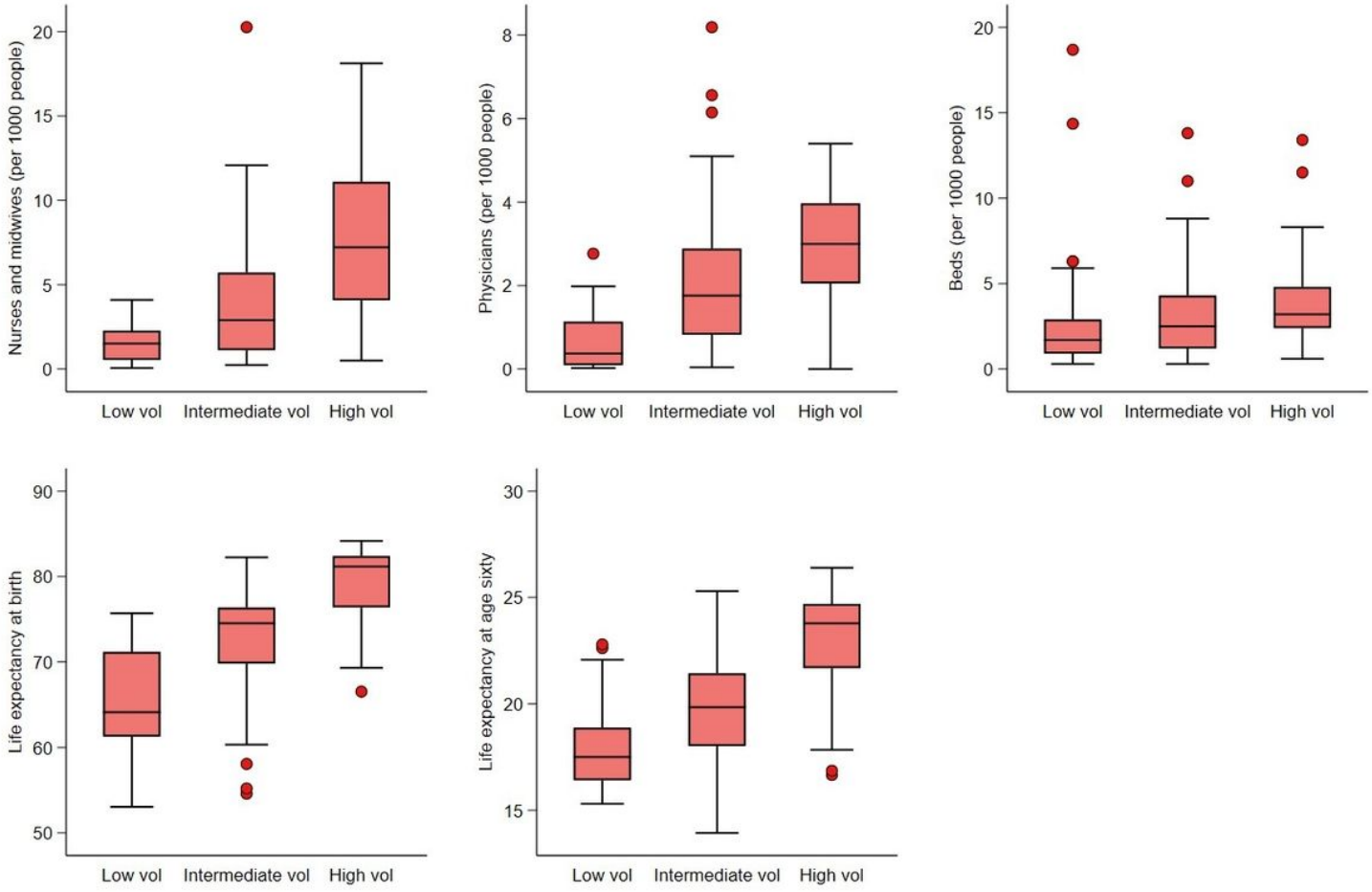

Figure 1

Distribution of health variables among countries according to the reported COVID-19 cases volume, March 21st 2020.

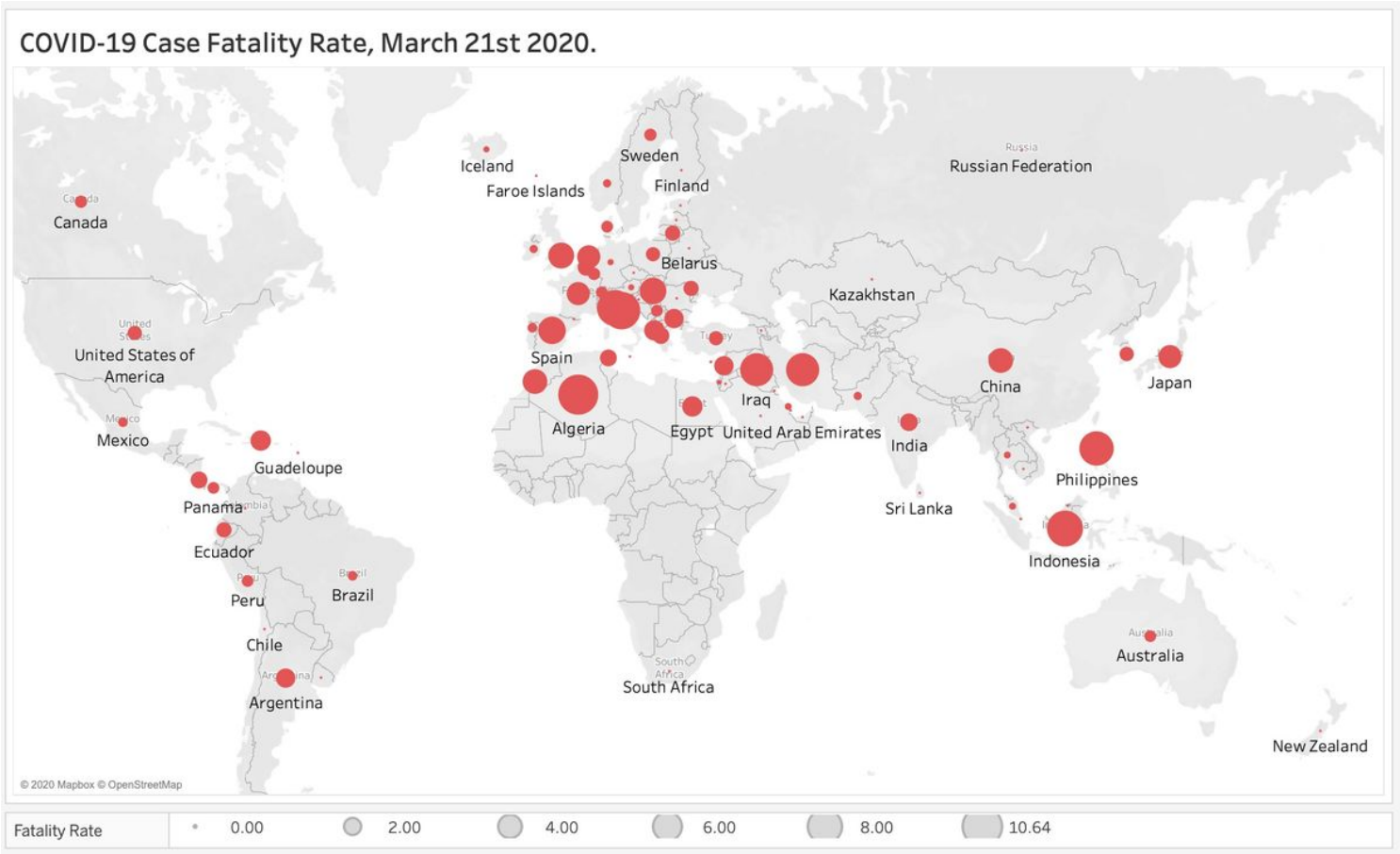

Figure 2

Countries, territories or areas with calculated COVID-19 fatality rate, March 21st 2020 (Countries with minimum case volume of 50) * Created using Tableau Desktop software, public edition 2020. Available for download at www.tableau.com. Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

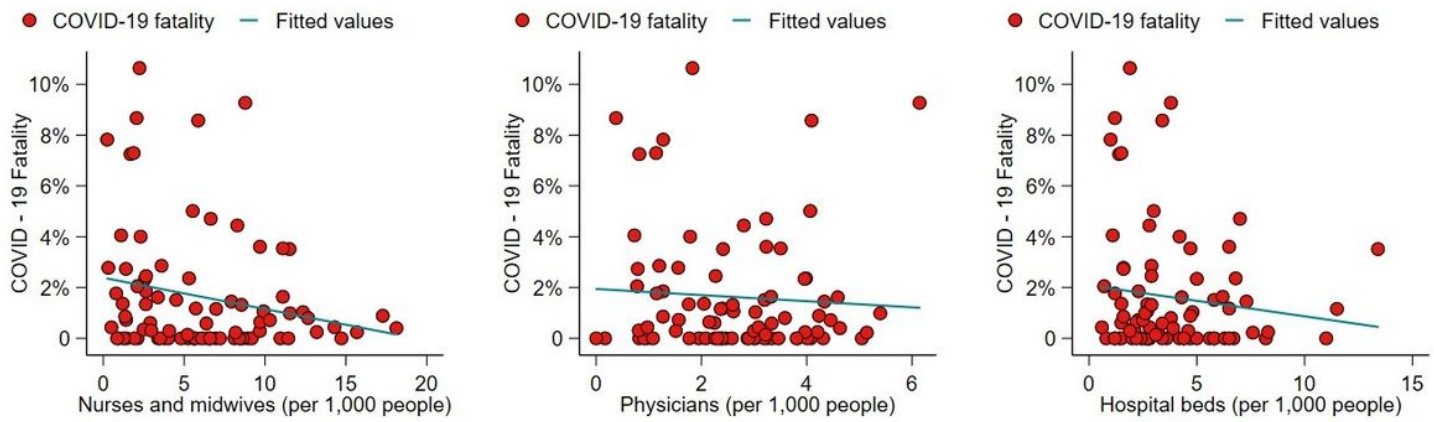

Figure 3

Correlation between COVID-19 fatality rate volume of nurses, physicians and beds per 1000 people, March 21st 2020.

Supplementary Files

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