



## The Validity of Global Rankings in a Global Epidemic

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### Introduction

Countries are compared to each other by a variety of ranking systems. Some rankings are based on simple facts or easily calculable values such as population or Gross Domestic Product [1,2]. Other rankings are more complex and contentious like the happiness or press freedom index [3,4]. World Health Organization (WHO) rankings are probably the most popular in global health. Ranking countries by overall health system performance is thought to be controversial [5]. There is no clear evidence that country rankings can predict performance in any major health care problem and some authors have challenged the validity of such rankings. [6] Corona Virus Disease 2019, also known as COVID-19, is a global pandemic that was first reported to WHO's Country Office in the People's Republic of China on December 31, 2020 [7]. At the time of writing this article, more than 73 million cases were reported globally [8]. This pandemic gained the public notoriety of being as one of the worst global health crises in the last 100 years [9]. The purpose of this research is to investigate the relationship between country global ranking in public health parameters (obesity, population density and endemic diseases like malaria and tuberculosis) and country global ranking for COVID-19 prevalence and mortality rates. It is our hypothesis that a statistically significant correlation will be found.

### Methodology

Country rankings were obtained from the following sources that were accessed on May 29, 2020: infections per country and death rate per capita per country from Johns Hopkins website, International arrival per country from World Bank data, country population from United Nation population data, country size from

Central Intelligence Agency (CIA) fact book, Gross Domestic Product from World Bank data, Malaria, Obesity, and Safe sanitation from World Health Statistics 2020, population density from World Bank data, incidence of Tuberculosis from WHO and World Bank, Gini coefficient per country from CIA book and World Bank and BCG per country from BCG atlas [10-20]. COVID-19 infection per capita was measured by dividing the total number of infection recorded at the Johns Hopkins website accessed on May 29, 2020 divided by total number of population obtained as described above then multiplied by 100,000. Rank correlations were tested using Spearman's rank correlation coefficient for rankings taken as ordinal variables and Pearson correlation coefficient to evaluate the linear relationship between rankings' data taken as continuous variables. For a statistical significance level of 0.05 or less, a two-tailed testing was conducted. IRB was not needed because no patient data was reviewed, obtained or utilized.

### Results

Total number of COVID -19 infections per country ranking was found to have statistically significant positive correlation with median age, GDP, sanitation, obesity, international arrivals and WHO country ranking; while it has statistically significant negative correlations with TB and GINI (Table 1). Likewise, Infection per 100,000 per country ranking correlates, with statistical significance, positively with median age, GDP, sanitation, population density, obesity and international arrivals. It has negative correlation with TB, GINI, WHO ranking and malaria (Table 2). However, death rate per capita per country has only one positive correlation with median age but two negative correlations with TB and with WHO country ranking. The rest of correlations were found to have no statistical significance (Table 3).

X vs Total Infection Per Country				
X	Pearson Correlation	Spearman's rho	Sig (2 tailed)	N
C19 Infection Rank	0.713	0.713	p<0.001	177
COVID Infection by Median Age	0.374	0.373	p<0.001	178
GDP	0.398	0.397	p<0.001	181
GINI	-0.317	-0.317	p<0.001	156
International Rank	0.713	1	p<0.001	177
Malaria	-0.216	-0.214	0.052	83
Obesity	0.278	0.278	p<0.001	176
Population Density	0.42	0.43	0.572	183
Sanitation	0.296	0.3	0.005	86
TB	-0.212	-0.212	0.004	180
WHO	-0.999	-1	p<0.001	167

Table 1

X vs Death Rate Per capital Per Country				
X	Pearson Correlation	Spearman's rho	Sig (2 tailed)	N
C19 Infection Rank	0.029	0.029	0.721	150
COVID Infection by Median Age	0.195	0.198	0.016	147
COVID Infection per 100k	-0.026	-0.024	0.771	144
GDP	0.105	0.107	0.203	150
GINI	-0.062	-0.064	0.463	132
International Arrival	0.118	0.12	0.15	145
Malaria	0.074	0.074	0.564	63
Obesity	0.024	0.023	0.779	146
Population Density	-0.006	-0.002	0.983	150
Sanitation	0.052	0.055	0.616	85
TB	-0.204	-0.207	0.011	149
WHO	-0.996	-1	p<0.001	145

Table 2

X vs Infection Per 100K Per Country				
X	Pearson Correlation	Spearman's rho	Sig (2 tailed)	N
Case Fatality	-0.026	-0.024	0.771	144
COVID Infection by Median Age	0.668	0.668	p<0.001	171
GDP	0.72	0.716	p<0.001	147
GINI	-0.349	-0.347	p<0.001	153
International Arrivsl	0.418	0.417	p<0.001	174
Malaria	-0.311	-0.306	0.01	67
Obesity	0.497	0.498	p<0.001	169
Population Density	0.15	0.15	0.049	174
Sanitation	0.566	0.566	p<0.001	86
TB	-0.593	-0.593	p<0.001	172
WHO	0.427	0.43	p<0.001	173

Table 3

## Discussion

Ranking systems for countries have been getting more popular since the inception and wide use of the internet that allowed greater segments of the global population access to knowledge that was previously available to small and more professional sectors. Google Page ranking algorithm has been its engine for global success [21]. An article published in the *Journal of Consumer Research* points to the importance of ranking in consumer decision making in Western Culture [22]. However, there is a paucity of data related to the validity of country, hospital, doctor, or medical school ranking on healthcare outcomes or quality. Furthermore, some popular healthcare related rankings are considered controversial. For example, the World Health Organization ranking of countries' overall healthcare performance places some small countries with small economies like Malta and Dominica higher than the United States. Meanwhile, some patients with financial means from countries ranked higher than the United States, like Saudi Arabia and United Arab Emirates; consider the United States as their destination of choice to receive complex health care. According to the *Newsweek's* ranking of best hospitals in the world 2020, only 10 hospitals in the top 50 are located in a country that is ranked in the top 10 by the WHO country ranking [23]. In this study we attempt to investigate whether the global rank of a country in certain public health parameters can predict its rank in COVID-19 prevalence and mortality. We chose COVID-19 pandemic since it is one of the worst global health care crises in the last century. We also tried to find if positive and negative statistically significant ranking correlations follow the existing proven scientific medical research of risk factors of the pandemic.

While infection per 100,000 per country correlates with statistical significance with 9 different rankings, death rate per capita per country correlates only with 3. It is difficult to point with certainty to the cause of this discrepancy between the number of statistically significant rankings correlating with death rate per capita per country and the ones correlating with infection per 100,000 per country. This may be due to flaws in the individual ranking systems, or to the flaws that may exist in this study. Another interesting finding is noticed upon looking on how correlations between total COVID 19 infections and global rankings have more similar patterns to those of infections per 100,000 per country compared to correlations between case death rate per capita per country and global rankings. We ran the correlation between the number of infections per 100,000 per country and the death rate per capita per country and that came out not significant. Looking at the aforementioned results, we tend to believe that there is some correlation between the total number of COVID 19 infection per country and infections per 100,000 per country. While this seems logical, we had to look at the data before making such suggestion. However, it seems that death rate per capita per country has much fewer statistically significant global rankings. Do these findings

point to two different sets of mechanisms in play: one affecting how many infections a country suffers and another set that influences death rates? Our study is not able to answer this question; however the next paragraph may be able to shine some light on an important factor that could partially explain the previous question.

We believe the most important finding in our study is the statistically significant negative correlation between WHO country ranking and both death rate per capita per country and infection per 100,000. What was even more interesting is the strength of the correlation (-0.996 - -1.000). This indicates direct relationship between a country ranking by the WHO and its performance in terms of lower death rates per 100,000 from COVID-19. Does that indicate validity of the WHO ranking in terms of performance? It is hard to say since there is limited number of publications that examine the hypothesis in question. In addition, our data was taken only a few months into the pandemic.

While this article is not intended to delve into the dispute between socialized medicine advocates and free market health care proponents, we believe the WHO ranking is more suited to address healthcare delivery and system performance than political systems. The dispute between free market and socialized medicine has been going on for decades and it attracted many authors to express their opinions about the topic [24-27]. Addressing the political and economical disputes between the two philosophies is beyond the scope of this article. However, the main question this article is attempting to answer is the validity of global rankings especially the one issued by the WHO. A strong statistically significant correlation between the WHO ranking and country performance in limiting mortality from COVID-19 pandemic may indicate scientific validity of the ranking and should be taken into consideration while planning for future pandemics. Another aspect of our study was to examine whether statistically significant correlations in global rankings follow any recognizable clinical patterns. Obesity has been considered one of the risk factors for severe COVID-19 infection [28-30]. In our study we found that obesity ranking correlates positively with total COVID-19 infection and COVID-19 infection per 100,000 per country. One report suggested that patients from African countries that are endemic with malaria are less likely to have severe COVID-19 course [31]. Our results indicate negative correlation between infection per 100,000 per country and malaria global ranking. Age was the only entity that correlates positively with death rate per capita per country in our study. Some reports from literature showed the same pattern [32,33]. We took the Gini coefficient which is designed to measure income inequality as an indicator for socioeconomic status. Our results indicates statistically significant negative correlation between the GINI global ranking and COVID-19 total infection and COVID-19 infection per 100,000 per country, meanwhile no correlation was found with case fatality rate. Some reports from literature echoed these findings [34,35].

Our data showed positive correlation between population density and COVID-10 infection per 100,000 per country. Many studies showed the same pattern [36-40] Air travel has been associated with spread of COVID-19 [41,42]. Our data showed statistically positive correlation of air travel with COVID-19 total infection and infection per 100,000 per country.

While the overall validity of global rankings in healthcare are not very well studied, our data may indicate beneficial aspects of the rankings in preparing for global pandemics. Accurate predications of the direction and the magnitude of the spread the infection should help allocate limited resources to places anticipated to be hit harder. While some of the published article already suggested that approach, none of them utilized global rankings as a measure of prediction or planning [39].

## Limitations

This study limitation includes taking the data only few months into the pandemic and dependence on non-medical sources like CIA and World Bank on data collection. We plan on repeating the study at the end of the pandemic. We elected to publish our findings before the end of the pandemic because we haven't found publications addressing our question. We hope by publishing our findings we stimulate further studies that may help utilizing ranking data to manage limited resources in this pandemic.

## Conclusion

There is statistically significant direct correlation between "The World Health Organization" ranking of countries by over all healthcare performance and (a) global country ranking of COVID 19 infection per 100,000 per country (b) death rate per capita per country. Further studies are needed to verify these findings and to investigate whether any practical conclusions can be drawn and implemented from these correlations.

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