COVID-19 Response Across Various Countries

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Background of the Study

In October 2019 the Global Health Security Index (GHSI) was published. It represents the efforts of an international advisory panel of 21 experts from 13 countries to create a framework to assess every country's capability to prevent/mitigate epidemics and pandemics like COVID. The index looks at each country through 34 indicators that measure Prevention, Detection and Reporting, Rapid Response, Health Systems, Compliance with International Norms, and the Risk Environment. Using the GHSI, we will look at seven countries, evaluating their varied approaches to the COVID 19 pandemic and outcomes. Some relevant baseline demographics are shown below.

Country	Population	GDP	Healthcare Spending	Healthcare Capacity	Healthy Life Exp.
USA	330,112,816	62,918	16.89%	60.4	66.1
Italy	62,300,000	34,485	8.67%	44.5	71.9
New Zealand	4,900,000	43,836	9.21%	45.7	70.2
Singapore	5,800,000	63,247	4.46%	28.4	73.6
South Korea	51,600,000	28,605	11.82%	73.2	65
Sweden	10,200,000	54,886	10.90%	48.4	71.9
Brazil	212,000,000	8,918	9.51%	55.6	65.4

Figure 1: Demographics of countries in this study. Healthcare spending is presented as a percentage of GDP, which is in USD. Healthcare capacity is a score taken from the GHSI. Healthy life expectancy reflects WHO data for 2019.

Hypothesis

We hypothesize, that a higher indicator score of pandemic preparation and response prior to COVID 19 will correlate with lower deaths per capita and infections per capita.

Material and Methods

Statistical data from aggregate sources including the Global Health Security Index (GHSI), World Health Organization (WHO), Centers for Disease Control (CDC), and John Hopkins University was collected. From Oxford University, the Government Response Index as well as the OWID (Our World in Data) dataset was used.

A correlation analysis was completed in Microsoft Excel across multiple datasets collected from the GHSI and OWID database. A Pearson Product-Moment Correlation function was run on paired datasets evaluating the strength of correlation between various pairings of GHSI scores (overall, response and mitigation) and outcome measures identified as cumulative infections (cases) per capita and deaths per capita for each country as reported by the OWID database for 3/2/21. We derived correlation coefficients (R value) for the worldwide dataset as well as the subset of our 7 countries. The world dataset measures 186 countries, the remainder were removed due to incomplete data. There is no correction or weighting of countries for population. P values were calculated in Excel with a 2-tailed test.

Data from the Oxford COVID-19 Government Response Tracker's "Stringency Index" is presented graphically over time for the 7 countries evaluated.

Results

Country	Infections/1000	Deaths/1000	Lockdown Date	Tests/1000	Vaccines/1000
USA	86.83	1.56	3/15/2020-4/2/2020	1024.25	232.95
Italy	47.16	1.57	3/9/2020	672.15	69.89
New Zealand	0.49	0.01	3/23/2020	356.87	0.31
Singapore	10.34	0.01	4/7/2020	1289.49	62.07
South Korea	1.75	0.03	No hard lockdown	128.9	N/A
Sweden	64.44	1.26	No hard lockdown	N/A	70.65
Brazil	49.94	1.21	No hard lockdown	N/A	39.93

Figure 2: Statistics of the study countries as of 3/2/21, taken from the OWID dataset.[3] No data was available for total tests administered from our dataset for Sweden or Brazil. At the data freeze date 3/2/21, South Korea had just started its vaccination program a few days prior, and minimal data was available. Lockdown dates obtained from multiple news sources and aggregated by Wikipedia[4].

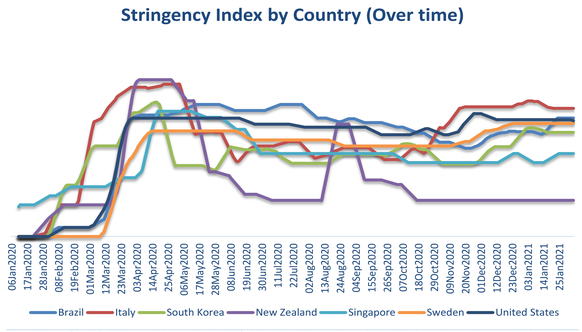

Figure 3: Graph of the Oxford Stringency Index over time. The Oxford Government Response Tracker looks at 19 indicators to evaluate a government's response to COVID, specifically "containment and closure", "economic policies", and "health systems policies". The "Stringency Index" more specifically incorporates indicators associated with containment and closure, and loosely reflects "lockdown" within a country.[1]

The figures above are intended to give a broad overview of the actual response and outcomes of COVID in the studied countries during the pandemic. There is heterogeneity among these countries in both their response and outcomes. Each country made different decisions regarding whether these movement and business restrictions were necessary, with Italy instituting local and then nationwide lockdowns early following their initial outbreaks. As the largest country studied, the USA had significant heterogeneity in its internal response with no national lockdowns, but statewide or localized lockdowns at the discretion of these governments. Despite the lack of a national lockdown, most of the US population was under significant restriction for parts of the pandemic.[6] Three of the countries reviewed, Brazil, Sweden, and South Korea, did not impose significant movement restrictions on their citizens. Regarding outcomes, New Zealand, Singapore, and South Korea have seen very low numbers of infection and death during the pandemic, despite differences in response and testing. There are no visible correlations between containment responses and the outcomes of this set of countries during the pandemic.

The initial lockdown of each country does not paint a full picture of the continued response. The time-graph of the Oxford Stringency Index above shows the ongoing level of restrictions placed on citizens in each country. New Zealand and Singapore had similar strategies, locking down early when cases presented, with a focus on international travel restrictions followed by a reduction in internal measures. With exceptions, the level of lockdown generally follows the levels of cases and deaths in each country, evidenced by the 2nd or 3rd peaks in later 2020.

The correlation data is more interesting, showing a positive correlation between each set of variables and outcome that we tested (Figure 5). This indicates that a higher pandemic preparedness score (GHSI) is correlated with subjectively worse outcomes in the pandemic (infections or deaths per capita). When this analysis was done using available data for all countries, the correlations were statistically significant, however, the correlation for the 7-country subset was not significant, though it showed similar patterns.

Figure 4 is a graphical representation of this analysis using the correlation of "Overall GHSI score" and the outcome of "deaths" (per capita). It shows significant variation in GHSI scores among countries with lower per-capita deaths, however, as the number of deaths increases, there is a clear trend towards those countries having higher initial GHSI scores, represented by the trendline.

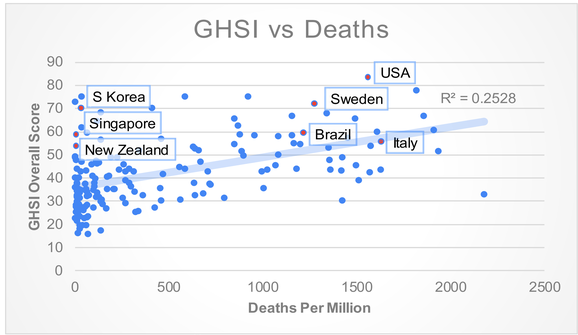

Figure 4: Histogram of GHSI score and deaths/million[2,6]. This graph is included to visually illustrate the findings of the correlation equations, wherein visualizing this graph the slope of the trendline represents correlation in the data.

Looking at Correlations in Data: Comparing GHSI scores to measured outcomes

	Correlation (R-value)	P Value
All countries		
GHSI Overall/Deaths	0.5028	<0.00001
GHSI Response and Mitigation/Deaths	0.3346	<0.00001
GHSI Overall/Cases	0.4609	<0.00001
GHSI Response and Mitigation/Cases	0.3086	0.00002
Brazil, Italy, New Zealand, Singapore, South Korea, Sweden, USA		
GHSI 7 Overall/Deaths	0.3246	0.47749
GHSI 7 Response and Mitigation/	0.5733	0.17848
GHSI 7 Overall/Cases	0.5940	0.15964
GHSI 7 Response and Mitigation/Cases	0.2697	0.55866

Figure 5: Correlation analysis. Calculated for world and study specific countries. P values are note to be significant for the global dataset only, however, data is still suggestive of correlation between the variables, which in this case is a positive correlation between "preparedness" and "infections" or "deaths".

Conclusion

The results from our analysis refute our initial hypothesis. We suspected that countries with prior experience with disaster preparation and management would have led to less infections and ultimately less deaths. Furthermore, these countries differ in population size, GDP, healthcare spending and healthcare capacity, but have similar healthy life expectancies. None of these factors have any obvious correlation with case/death numbers during COVID-19.

This discrepancy raises questions regarding our conventional beliefs regarding what is important in pandemic preparation. It may be that various indicators were not weighed appropriately. It may be that the key factors in pandemic preparation and response lie outside of conventional wisdom, with less tangible factors such as cultural or societal beliefs, or economic considerations having the largest impact on how people respond to a pandemic, and ultimately, each country's outcomes.

A major limitation in the datasets used here for outcome measures is that they depend on each country's self-reporting of data. This introduces possible sources of error in the data itself, including testing volumes for each country, as well as methods of reporting cases and deaths, which vary by country.

Future Research

The information gathered and learned from this comparative review of various countries disaster preparation and response plans indicate that more research needs to be done not only on disaster preparation and response but also on public perceptions in terms of leading a coordinated team approach. We intend to take this information to reflect on how we as global health physicians and educators can improve pandemic planning and response. Furthermore, funding toward public health education, language barriers, health inequities, and socio-political factors warrant further investigation in terms of their relationship to carrying out a coordinated pandemic response.

Acknowledgement

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