SHORT RESEARCH COMMUNICATION | COVID-19

Global Ranking of COVID-19-Related Mortality by Country using a Novel Pandemic Efficiency Index (PEI)

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ABSTRACT

The world is currently witnessing a dramatic disruption of everyday life owing to the rapid progression of the coronavirus disease 2019 (COVID-19) pandemic. As the pandemic evolves, there is an urgent need to better understand its epidemiology, characterize its potential impact, and identify mitigatory strategies to avert pandemic-related mortality. There is a need for a tool or algorithm to evaluate the extent to which public health policy and/or economic preparedness measures are effectively averting COVID-19 related mortality. We present a simple and yet practical epidemiological tool, the Pandemic Efficiency Index (PEI), that can be utilized globally to test the relative efficiency of measures put in place to avert death resulting from COVID-19 infection. Using the PEI and current COVID-19-related mortality, we determined that so far Germany demonstrates the highest PEI (5.1) among countries with more than 5,000 recorded cases of the infection, indicating high quality measures instituted by the country to avert death during the pandemic. Italy and France currently have the lowest COVID-19-related PEIs. Epidemics and pandemics come and go, but local, national, and global abilities to determine the efficiency of their efforts in averting deaths is critical.

Key words: • COVID-19 • Pandemic Efficiency Index • PEI • Coronavirus • Mortality • Pandemic • Epidemic • Global health

1. Introduction

Towards the end of 2019, a novel respiratory infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2), was first reported from Wuhan, the capital of Hubei province in the People's Republic of China. This illness has already been assigned the name coronavirus disease-19 (COVID-19) by the World Health Organization (WHO).[1] SARS-CoV-2 belongs to a family of viruses that cause a variety of symptoms that range in severity from mild cold symptoms to more severe infections, which disproportionately account for a high mortality rate among the elderly and individuals that are immunocompromised. The

pandemic has now reached almost every country on the globe (at least 199 countries at the time of writing). The epidemiological variability and lethality of COVID-19 in general and specific populations have been reported.[2,3] The world is currently witnessing substantial disruption of daily lives socially, psychologically and economically as a result of the progression of the COVID-19 pandemic.

As the pandemic rumbles through nations leaving behind considerable death and damaged economies, no effective treatment seems to be in sight as of now.[4] Preventive measures, enveloped in public health advocacy both at the individual and societal levels, and reinforced by national regulations seem to be our best bet of shortening the life span of the pandemic. Various countries have instituted diverse policies and laws to protect their citizens as the natural history of the disease progresses. However, just as we witness differences in the degree of public health preparedness across nations, we are also subdued by the lack of simple epidemiological tools that could capture, in broad terms, the comparative effectiveness of measures put in place by different countries to mitigate the impact of the pandemic on human lives. In this paper, we present a simple epidemiological tool that could be utilized globally to test the relative efficiency of measures put in place to avert death resulting from COVID-19 infection. For simplicity, we refer to this assessment tool as the Pandemic Efficiency Index or PEI. The PEI could be used to potentially rank countries and assist in distilling best practices from those countries with optimal outcomes in a pandemic. The higher the PEI, the greater the efficiency of the country in protecting its citizens from death resulting from the COVID-19 pandemic. Using PEI, nations can learn and adapt best practices in pandemic control from each other. Nations can systematically reverse-engineer the practices that countries with higher PEI used to achieve lower Covid-19-related mortality.

2. Methods

We collected information on current details of COVID-19 cases across the globe from Worldometer.[5] Worldometer is an independent company that operates a reference website acknowledged by the American Library Association as one of the best free online reference sources in the world. The website has been providing live updates on COVID-19 related total cases, new cases, deaths, recoveries and critical cases by country, territory or conveyance. Worldometer gathers and compiles the information from various sources, including newspapers, government websites, and social media such as Twitter, etc. The countries with more than 5,000 cases of Coronavirus, as of March 29, 2020 were included in this study and were classified as 'high impact countries.'

We calculated the mortality rate by dividing the total deaths by total number of cases associated with the disease, for each high impact territory. As the disease originated in China, we used China's mortality rate as the reference. The formula for COVID-19 Pandemic Efficiency Index (PEI) for a country X was derived as: $PEI_X = \dfrac{Mortality\ Rate_{China}}{Mortality\ Rate_X}$. For example, China had a total of 81,439 cases and 3,300 deaths, yielding a mortality rate of 0.0405 or 4.05%. Italy had 97,689 cases and 10,779 deaths, corresponding to a mortality rate of 0.1103 or 11.03%. Therefore, $PEI_{Italy} = \dfrac{0.0405}{0.1103} = 0.3672$. PEI is a comparative tool which uses the mortality rate of the pandemic's country of origin as the 'reference case.' Lastly, we ranked the countries based on their PEIs.

3. Results

As of March 29, 2020, there were a total of 704,401 COVID-19 cases globally, 33,226 of which resulted in death, yielding a worldwide mortality rate of 4.72%. A total of 16 countries reported more than 5,000 cases of COVID-19 infections. The United States of America (USA) had the highest number of reported cases of 133,039, followed by Italy, which reported more than 97,000 cases so far. However, Italy had the highest number of reported deaths (10,779) with a PEI of 0.37. Other countries with a PEI lower than that of China included the Islamic Republic of Iran (0.59), the United Kingdom (0.64), Spain (0.48), and Netherlands (0.57).

The global ranking of high-impact countries based on COVID -19 PEI is illustrated in Figure 1.
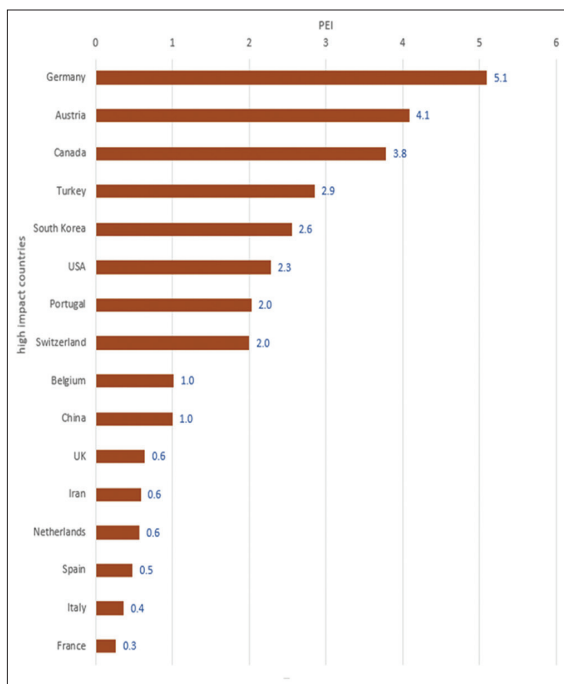
Figure 1: Global Ranking of high-impact countries based on COVID-19 Pandemic Efficiency Index (PEI)

Germany, a country with the fifth largest number of cases (60,659) has so far experienced 482 deaths resulting from COVID-19 infection, and had the highest PEI (5.09) among the high impact countries. Austria with 5,672 cases had the second highest PEI of 4.09, followed by Canada (3.79) and Turkey (2.85). The USA was 6th on the list, with a PEI of 2.28. Italy and France were the countries with the lowest PEI of 0.4 and 0.3, respectively.

4. Discussion and Global Health Implications

COVID-19 is the latest global health threat confronting nations, research and medical communities, with national and global efforts applauded and criticized.[6] Almost 3 months after the first confirmed case of the virus was identified in China, WHO declared the disease as a pandemic, making it the first such declaration since the 2009 H1N1 swine flu outbreak. The WHO had estimated COVID-19 mortality rate to be 3.4% about three weeks ago[7]. However, due to the rapid progression of the disease and differential efficiency in disease and mortality prevention across affected countries, the mortality rate had risen to 4.72% as of March 29, 2020. COVID-19 has been more deadly than the 2009 H1N1 swine flu pandemic, which registered a case fatality rate of 0.2%. For the first time since the outbreak, Wuhan in China reported no new cases on March 19th 2020, while the USA acquired the status of the country reporting the largest number of new COVID-19 infections worldwide. According to various analyses by the U.S. Centers for Disease Control and Prevention (CDC), older adults and those with underlying comorbidities like heart disease, lung disease or diabetes are more vulnerable to the severe forms of COVID-19 and to die from the disease.[8] From our results, we observed that citizens of countries that performed worse on our PEI scale (i.e., had low PEI) such as Italy, Spain, UK etc. had a higher median age than their counterparts from other parts of the world. What was most surprising was the low mortality rate (0.79%) and the highest PEI (5.09) of Germany, in spite of the fact that it ranks 4th in the world for the highest median age.[9] Austria and Portugal were the other two countries with a high PEI and median age above 44 years.

PEI is an innovative tool to compare countries in terms of the impact of their disaster preparedness and management protocols. Although COVID-19 is a global affliction, different countries have adopted different approaches to confronting the pandemic. PEI represents a simple and intuitive epidemiologic tool to compare the efficiency of policies and strategies that various countries have been adopting to curtail the impact of the COVID-19 pandemic. Lessons learned from these natural experiments would allow us to identify effective measures against mortality from countries with high PEI. Due to pandemic dynamics with numbers constantly changing, it is possible that the final PEI will only be available by the end of the current pandemic.

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