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The impact of COVID-19 on globalization

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ABSTRACT

Globalization has altered the way we live and earn a livelihood. Consequently, trade and travel have been recognized as significant determinants of the spread of disease. Additionally, the rise in urbanization and the closer integration of the world economy have facilitated global interconnectedness. Therefore, globalization has emerged as an essential mechanism of disease transmission. This paper aims to examine the potential impact of COVID-19 on globalization and global health in terms of mobility, trade, travel, and countries most impacted.

The effect of globalization were operationalized in terms of mobility, economy, and healthcare systems. The mobility of individuals and its magnitude was assessed using airline and seaport trade data and travel information. The economic impact was measured based on the workforce, event cancellations, food and agriculture, academic institutions, and supply chain. The healthcare capacity was assessed by considering healthcare system indicators and preparedness of countries. Utilizing a technique for order of preference by similarity to ideal solution (TOPSIS), we calculated a pandemic vulnerability index (PVI) by creating a quantitative measure of the potential global health. The pandemic has placed an unprecedented burden on the world economy, healthcare, and globalization through travel, events cancellation, employment workforce, food chain, academia, and healthcare capacity. Based on PVI results, certain countries were more vulnerable than others. In Africa, more vulnerable countries included South Africa and Egypt; in Europe, they were Russia, Germany, and Italy; in Asia and Oceania, they were India, Iran, Pakistan, Saudi Arabia, and Turkey; and for the Americas, they were Brazil, USA, Chile, Mexico, and Peru. The impact on mobility, economy, and healthcare systems has only started to manifest. The findings of this study may help in the planning and implementation of strategies at the country level to help ease this emerging burden.

1. Background

Globalization has emerged as a means to ensure economic and cultural growth of individuals [1]. The rise in urbanization and the closer integration of the world economy has facilitated global interconnectedness [2]. Yet, trade and travel, essential components of globalization, are significant contributors to the spread of infectious diseases. Historically, pandemics have been observed throughout the history of human movement and communication [3]. The bubonic plague caused by *Yersinia pestis* was transmitted from China to Europe through trade routes [4].

Abbreviations: WHO, World Health Organization; TOPSIS, Technique for Order of Preference by Similarity to Ideal Solution; IMF, International Monetary Fund; PVI, Pandemic Vulnerability Index; GLM, Generalized Linear Model; GHI, Global Health Index; TEU, Twenty-foot Equivalent Unit; GDP, Gross Domestic Product; LMIC, Low-and-middle-income countries.

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Similarly, following the movement of armies in the first world war, the influenza pandemic of 1918 led to over 50 million deaths worldwide [5]. More recently, the Asian flu of 1957 (influenza A H2N2) was reported in 20 countries and primarily spread via land and sea travel [6,7]. The Hong Kong flu pandemic (influenza A H3N2) spread extensively through air travel [8,9]. Over the years, globalization has amplified global disease transmission and has had significant economic implications. The close integration of the economy in modern times has, therefore, emerged as an essential mechanism of disease transmission [10].

The consequences of a pandemic are not only defined in terms of mortality but also by their impact on our daily livelihood and the economy, with globalization accelerating this loss and costing billions (US dollars) in expenditures. Pandemics affect the economy in terms of demand and supply. First, consumers and investors tend to lose confidence in marketplaces affected by the pandemic, depreciating the demand side of the market [11]. Second, absenteeism and reduction in the workforce negate the supply side [11]. Lastly, public health and international response to pandemics affect economics and development policies in trade, travel, and health response [11].

A pandemic can also affect the economy in terms of decelerating the economic growth of affected countries, leading to a reduction in trade and increase in poverty [11,12]. For example, the 1918 influenza pandemic presented financial loss in the form of decreased education, increased disabilities, and lower socioeconomic status [13]. Another significant impact of pandemics emerges in the form of workforce reduction. Absenteeism in schools and the workforce were considered as a direct economic impact of the Hong Kong flu in the 70s [13]. Likewise, flu pandemics have led to a notable reduction of human and economic capital, as illustrated by the SARS pandemic, which had an estimated economic impact of $18 billion in East Asia [14].

The end of 2019 challenged the world with an epidemic of a novel coronavirus (SARS-CoV-2), first observed in Wuhan, China [15]. COVID-19, the disease caused by SARS-CoV 2, presents with a spectrum of symptoms ranging from mild to severe with asymptomatic presentation also described [16]. On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a pandemic, [15] and as of October 21, 2020, over 41 million confirmed cases of COVID-19 and 1.13 million deaths have been reported worldwide [17].

This unprecedented time of COVID-19 and the implemented lockdown measures have influenced uncertainties regarding economic growth. The uncertainty on the global growth forecast by the International Monetary Fund (IMF) in 2020 is expected to decline by 3%, and by 6.1% for advanced economies [18]. Additionally, China, the second-largest economy, reported a reduction of 6.8% in the first quarter [19]. The lockdown measures have also increased telework and telecommuting, canceled operations, and restricted supply and demand.

The impact that COVID-19 can exert on health systems of the world varies. Low- and middle-income countries with less developed health systems are likely to face more significant challenges and remain vulnerable in controlling COVID-19 compared to the high-income countries [20]. Thus, determining the vulnerability indices at the national level is crucial in helping policymakers and the WHO to better control and mitigate the impact of the pandemic more efficiently.

The purpose of the current study is to investigate the impact of COVID-19 on globalization in terms of mobility, economy, and healthcare systems by utilizing data obtained for 1) mobility and travel resources, 2) economy and workforce, 3) healthcare capacity, and 4) country-level health vulnerability. Health vulnerability was examined through the calculation of a Pandemic Vulnerability Index (PVI).

2. Methods

2.1. Mobility and travel resources

The mobility of individuals and the respective magnitude was assessed using airlines and seaport trade and travel information. Major airlines were selected based on the number of countries traveled to and from by each airline throughout Asia, the Americas, and Europe. To understand the situation before the introduction of COVID-19 in January 2020 [21–26], detailed information related to travel history was obtained from the airlines' 2018–2019 annual reports. Similarly, major cruise companies were selected and their 2018–2019 yearly reports were studied [27–29]. Furthermore, significant seaports and trade volumes in areas with major shipping routes were examined by investigating the world shipping council website [30]. Current responses to COVID-19 were studied by following the official notices and websites of the travel companies [31–37].

2.2. Economy and workforce

Economic impact was explored through trade volumes, event cancellation, and workforce impact based on the 2018–2019 database [38–59]. Additional information was collected by examining the changes in the workforce, stock market, and major industries since the introduction of COVID-19 in January 2020 compared to 2019. Stocks were studied to investigate the stock value difference through the course of the pandemic.

2.3. Food and agriculture

The impact on food and agriculture was examined in terms of supply, agricultural contribution to GDP, food expenditures, agricultural imports, global food chains, business closures, food insecurity, supply disruptions, and response to COVID-19 [60–67].

2.4. Academic institutions

The impact on academic institutions was explored by studying the measures taken by universities to handle COVID-19. Furthermore, university reopening plans and future enrollment impact, particularly among international students, were also examined [68–70].

2.5. Healthcare capacity

Healthcare capacity (diagnosis, ICU, hospital beds) was examined by studying the healthcare systems and preparedness of countries. Additional information regarding healthcare responses and workforce impact were analyzed by following news articles, health department websites, WHO situation reports, and published peer-reviewed articles. Search engines such as PubMed, Google Scholar, and the websites of the Ministry of Health, and WHO's country office were used [71–76]. Detailed information regarding healthcare responses was collected by corresponding with the WHO country representative. The reported cases were studied from multiple sources, namely WHO situation reports, John Hopkins University interactive dashboard, and the Worldometers website [17,71–85]. The health indicators were reviewed and extracted from the global health security index website [86]. Furthermore, the COVID-19 disease prevalence, impacted population, and other country-specific information were studied and derived from the World Bank open data websites and Index Mundi [87–89].

2.6. Pandemic vulnerability index (PVI)

We focused on the multiple-criteria decision-making (MCDM) approach for the COVID-19 vulnerability assessment, as countries adopt different strategies to control the COVID-19 pandemic according to their means and resources. We used the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), which takes into consideration uncertainty as well as positivity or negativity of various criteria and their related weights in ranking one country compared with others [90]. The TOPSIS method reduces the difference in the rankings which uses a crisp or fuzzy data set [91]. We used the national data reported on

September 4, 2020 regarding COVID-19 morbidity and mortality rates, tests per million population, number of active cases, and the total number of those who recovered from COVID-19, from the Worldometers website (https://www.worldometers.info/coronavirus/). We also considered population density per sq. km, Global Health Index (GHI), diabetes prevalence, and date of the first case (COVID 19) reported for each country. More details are provided in the supplement.

Further, this technique also considers the reduction of the difference of rankings inherent in ranking data sets (see Supplement). We used coefficients from a generalized linear model (GLM) for the weights of the ranking criteria and the explanatory factors, such as population density, days since the first case was reported, GHI, diabetic prevalence index, number of active cases, total cases reported, total tests conducted, and total tests per million [86]. This technique results in a ranking criterion that is computed from how far apart or close a country is from the highest as well as lowest vulnerable position, considering its weight. A high score indicates high vulnerability to the widespread transmission of COVID-19.

3. Results

3.1. Impact on mobility

3.1.1. Air Travel

Ten significant airlines covering over 50 countries presented large coverage in terms of passengers carried. Table 1 (appendix) includes relevant information regarding airlines. As the table shows, airlines such as Turkish, Delta, and Lufthansa Group each carried more than 5 million passengers per month in 2018–2019. Most airliner countries have responded to COVID-19 by implementing international travel bans from affected countries. On average, about a 30% reduction in stock prices has been observed among major airlines.

3.1.2. Sea travel and trade

Table 2 (appendix) outlines the three major cruise lines and their status during the pandemic. The Carnival Corporation is one of the largest cruise line companies with over 100 vessels carrying about one million passengers monthly across its multiple cruise lines. The corporation responded to the COVID-19 pandemic by suspending cruises from March 13–April 9, 2020. This cruise line has observed over a 60% reduction in stock prices.

Table 3 (appendix) includes information related to trade and travel through seaports. Los Angeles [92,93] saw a reduction in total trade volume by over 22% while Shanghai seaport observed a reduction in weekly vessel calls by 20% since January of 2020 [54,55], resulting in increased spillover in nearby Singapore and South Korea [57,58]. In the United States (US), Los Angeles handled 9.46 million TEU in 2018, and since the pandemic, a reduction in trade volume by over 22% has been observed. Similarly, in Long Beach, where over 8 million TEU vessels have been handled, a 17% decrease in imports has been reported [46,93,94].

3.1.3. Travel restrictions

Table 4 (appendix) includes continent-specific data on the travel restrictions implemented worldwide. Almost all (99.7%) of the individuals in South America and 92.5% in North America are living under travel restrictions. Only 62% of individuals are living under travel restrictions in Africa.

3.2. Impact on major industries

3.2.1. Event cancellation

Social distancing has been implemented since the pandemic broke out, which led to the cancellations of numerous events across the world. For instance, the 2020 Summer Olympics to be held in Japan was rescheduled for 2021. Sports events such as athletics, cycling, soccer, golf, auto racing, tennis, cricket, badminton, rugby, and basketball have been canceled or postponed (Table 5, appendix).

3.2.2. Impact on workforce

With lockdowns and travel restrictions, the workforce has been affected universally. About 62% of the global employment constitutes of an informal economy characterized by a lack of social security, benefits, healthcare access, income security, or the possibility of working remotely; thus exposing the most vulnerable group. Among the most vulnerable in the labor market, almost 1.6 billion informal economy workers are significantly impacted by the lockdown measures [59].

The most affected industries such as manufacturing, accommodation, food services, and retail include about 54% of employers worldwide and account for 30% of average GDP. It is estimated that a considerable amount of time and effort is needed for these sectors to recover [59].

Working hours are expected to decline by 10.5% compared to the quarter prior to the pandemic, which accounts for 305 million full-time jobs. The Americas, Europe, and Central Asia are expected to observe a significant loss in working hours. The highest loss in working hours is expected in low- and middle-income countries [59].

3.3. Impact on the healthcare capacity

The unforeseen pandemic has challenged the healthcare systems worldwide. Some nations are impacted less than others, as demonstrated by country-specific fatality rates. Table 6 (appendix) illustrates the cases, recovery, and fatality rates from COVID-19 in countries with developed healthcare systems. The United Kingdom has the highest fatality rate followed by the Netherlands. Canada has high number of cases in this list of the top 10 developed health systems and a low fatality rate of 2.46%. The lowest fatality was reported in Australia.

The current confirmed cases in major countries that were affected as of June 20, 2020, and the current healthcare capacities are listed in Table 7 (appendix). As of November 7, 2020 the US has conducted over 157 million COVID-19 diagnostic tests and reported over 10 million cases and 0.23 million deaths. Currently, there are 2.9 hospital beds per 1000 people and 34.7 ICU beds per 100,000 population. The number of ventilators available in the US is 177,000.

3.4. Food and agriculture

The impact of COVID-19 on the food and agriculture industries is presented in Table 8 (appendix). As shown in Table 9 (appendix), the United Kingdom, United States, Australia, Canada, and New Zealand have reported a high impact from production and supply disruptions [65]. Interestingly, these countries have a low impact on the demand shock due to COVID-19 [65]. Countries with higher GDP from agriculture, such as Bangladesh, have presented low exposure to supply but high exposure to the demand shocks (Table 9, appendix) [65].

In addition, an initial slump in services and consumption at leading food chains contributed greatly to the disruptions in the food industry. This has been attributed to the many closures due to lockdowns. Although limited disruptions in supply have been reported, numerous franchises have been closed in European markets.

3.4.1. Academic institutions

Academic institutions have observed major disruptions similar to disruptions in other major industries. Most institutions have resorted to moving classes online and cancelling in-person classes [95]. Transitioning to online classes brought many logistical problems. Results from a survey showed that almost 10% of institutions do not have the facilities and infrastructures in place to conduct online classes, and most of these institutions are in Africa [69]. Furthermore, the majority of the institutions have indicated a significant impact on enrollment of both new international and local students, with negative financial

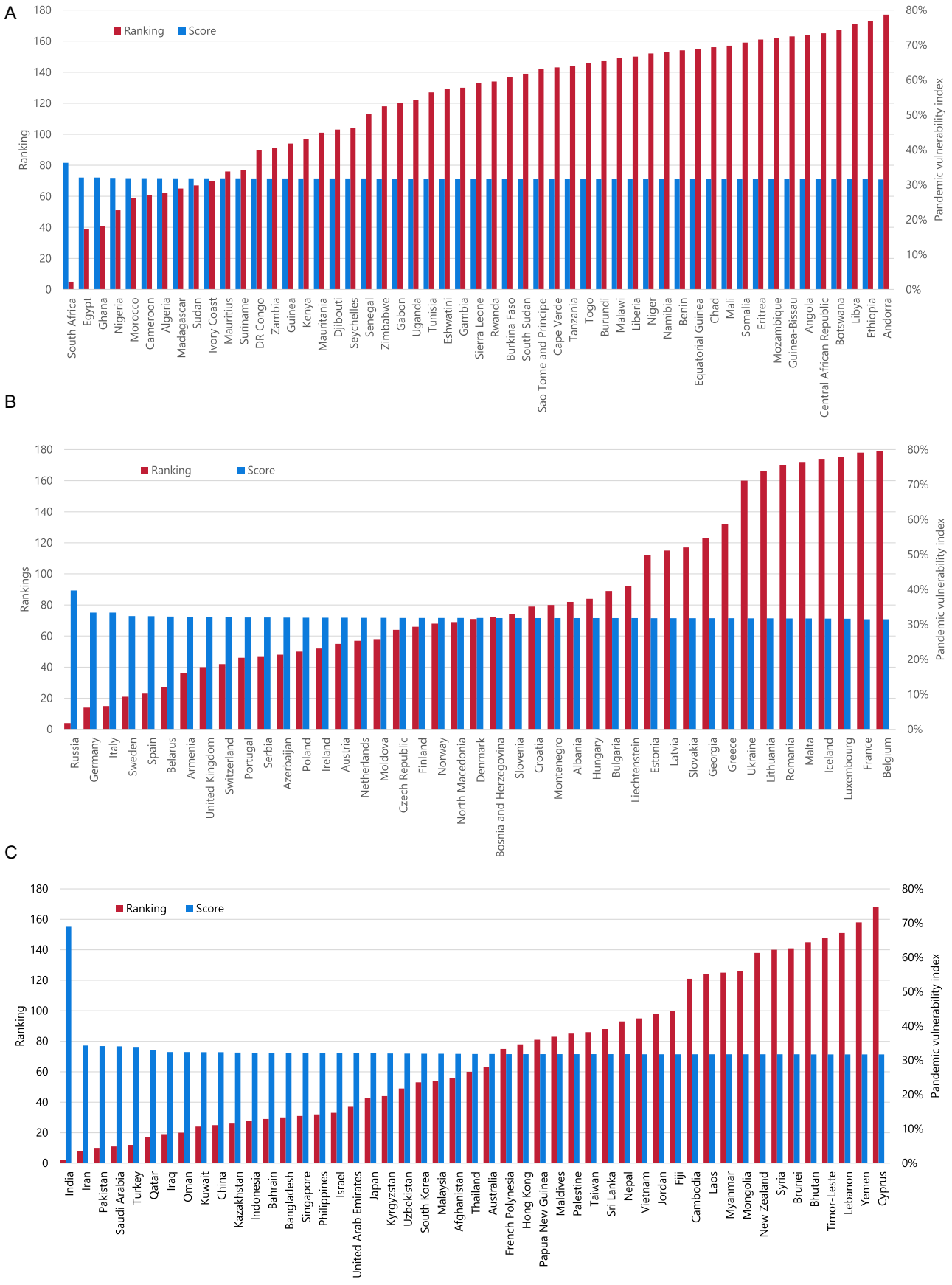

Fig. 1. A. COVID-19 risk and vulnerability index in Africa, B. Europe, C. Asia and Oceania, D. Americas (Red bars indicate ranking and the blue bar indicates vulnerability index score). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

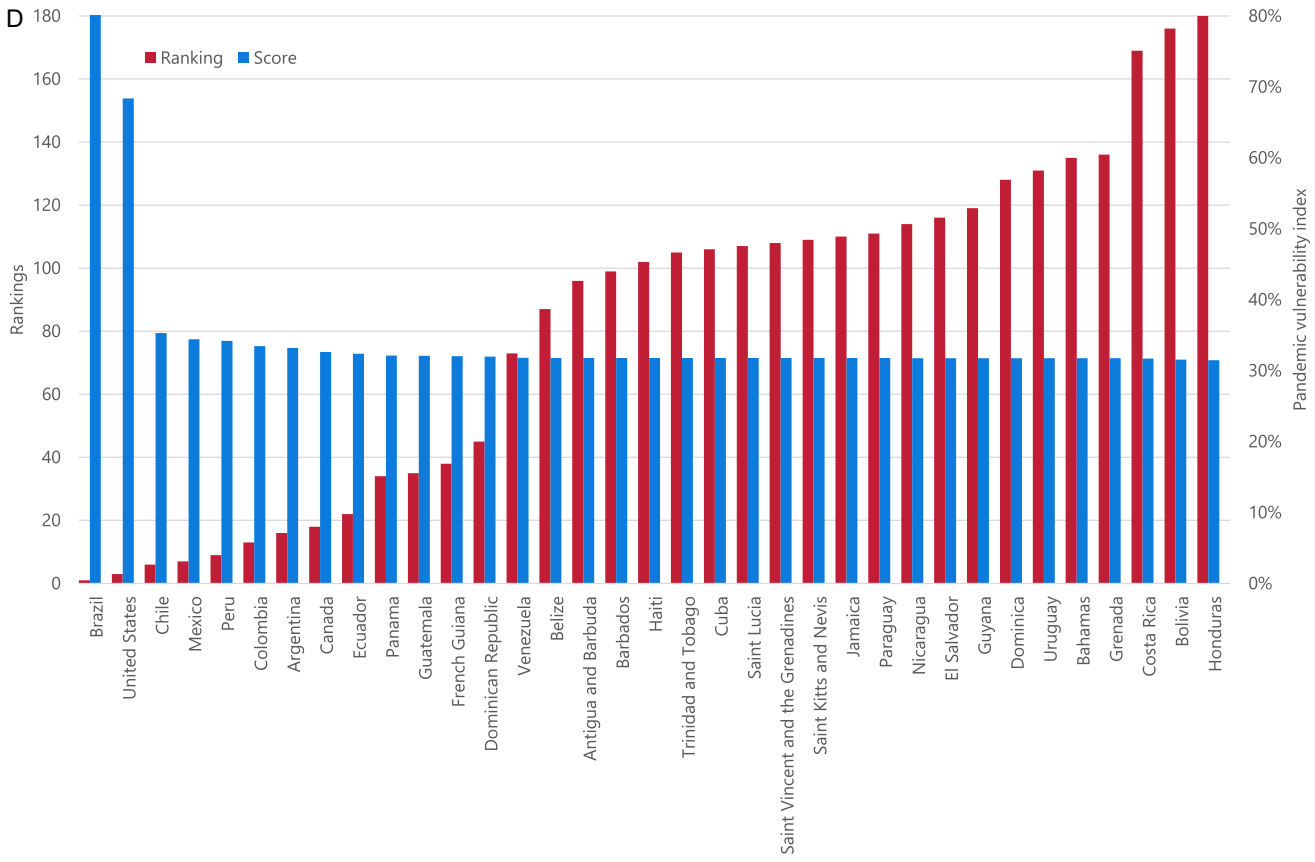

Fig. 1. (*continued*).

consequences [69]. Additionally, 80% of the institutions in the survey reported a negative impact on research at higher institutions owing to travel bans, cancellation of research events, and incomplete projects [69]. Moreover, limited flexibility has been observed in the United States from restricted use of grant funding to alleviate the impact of COVID-19 [96].

In an attempt to deal with the ongoing pandemic, many universities have been considering or adopting the following methods of reopening the new academic year: adopting online-only instructions, in-person with social distancing, or creating a hybrid model with components of both in-person and online elements [95]. Nevertheless, the economic impact of the pandemic on academic institutions is devastating. For example, the US institutions of higher education will lose an estimated one billion dollars due to the cancellation of study abroad programs, and new student enrollments are likely to suffer. Further, an estimated loss of three billion dollars will happen if future international students cannot be enrolled [68]. In Australia, major universities are estimated to lose a cumulative five billion AUD by 2024. According to a recent report, 38 universities would collectively lose 3.3 billion AUD due to the loss of international students alone [70]. In the UK, where most universities have moved online, 13 universities can potentially face bankruptcy due to COVID-19 [97]. With an approximate decrease in enrollment by 50% among incoming international and 10% among local students, an estimated loss of 11 billion pounds have been reported, including revenue from non-academic venues such as accommodation and services [97].

3.5. Pandemic vulnerability index (PVI)

Based on results calculated for the PVI (the higher the score, the more vulnerable), the top ten highly vulnerable countries include Brazil, India, the USA, Russia, South Africa, Chile, Mexico, Iran, Peru, and Pakistan. Fig. 1 A–D presents the PVI rankings among 180 countries. South Africa and Egypt are highly vulnerable countries in Africa (Fig. 1. A). Regarding the PVI rankings such that the lower the rank, the higher the vulnerability. The countries with high numbers of active cases (data not shown), such as Russia, Germany, and Italy (Fig. 1 B), are more vulnerable than other countries in Europe. Asia and Oceania include the majority of countries that are highly vulnerable to COVID-19, such as India, Iran, Pakistan, Saudi Arabia, Turkey, Qatar, Iraq, and Oman (Fig. 1 C). Countries such as Brazil, Chile, Peru, and Colombia are highly vulnerable in South America, although most of them have a moderate number of active cases (Fig. 1 D). Conversely, Honduras, Costa Rica, and Bolivia are less vulnerable than other countries in the American continents. The USA has the highest number of active cases and is ranked 3rd in the world and is considered highly vulnerable (Fig. 1 D).

4. Discussion

The world has drastically changed since the onset of the COVID-19 pandemic. The pandemic has had a devastating impact on the global economy and the health of communities across the world. This paper examined the effects on globalization in terms of mobility, trade, travel, global health, and the countries most impacted. In 2019, 4.5 billion passengers traveled by airlines and this number decreased to 2.2 billion during the pandemic [98]. Thus, globalization has led to the spread of the disease owing to mobility channels such as air and ship travel. Restricted travel, mobility regulations, and lockdown of economies and trade limited, and in some cases halted, globalization to reduce the rapidly rising number of COVID-19 cases. However, this strategy has put pressure on the airline and shipping industries, resulting in loss of income, disruption of global trading, and decimation of the tourism industry. Furthermore, event cancellations have affected the economy and tourism of various countries. The consequential impact on the workforce, supply chain, and consumer behavior is observed as a cascading

chain of events that has halted the global economy.

Major airlines have implemented travel bans and reported declining stock value. Similarly, cruise lines are well-established forms of international tourism presenting a steady annual increase with over 28 million passengers in 2018 [99]. Yet, cruise ships have been recognized as an epicenter for outbreaks. More than 800 cases of COVID-19 have been confirmed to have originated in a cruise ship settings [100]. The stocks of cruise line companies have been declining, resulting in layoffs and affecting the livelihood of the employees.

Restrictive lockdowns implemented as a response to the pandemic have led to a decrease in production, consumption, employment, and supply chain that affect the world economy at large [101]. It is estimated that the global economy and value chains are likely to create an economic depression more severe than the 2008 financial crisis [102]. Furthermore, only 34% of employment in the US can be performed from home, which accounts for 44% of all wages [48]. Individuals working in industries such as transportation, construction, retail, service, and hospitality may find it implausible to work remotely [48]. In the US alone, the unemployment rate has risen to 14.7% in April from 10.3% in March, indicating the highest monthly increase in unemployment in history.

Travel and tourism account for over 10% of the global GDP and is one of the industries affected directly by COVID-19 [39]. Numerous international and national sports, conferences, and concerts have been canceled due to the pandemic, causing massive losses in the host nation [103]. Tourism is expected to be immensely affected by this pandemic. Asia-pacific region of destinations such as Indonesia, Thailand, and Malaysia are expected to be significantly affected. Furthermore, unemployment is a major problem with an estimated 14% decline in jobs related to this industry [38]. Additionally, academic research and higher education have also been affected by the loss of international students and scholars, as well as research in basic, clinical, and population-based studies due to lockdowns and physical distancing requirements.

The pandemic has impacted the food and agriculture industry greatly. Developed countries are facing disruptions in production and supply chains due to the needs of advanced and capital-intensive agricultural systems, disruptions in local and international mobility, delays in customs, and disruptions in credit markets [65]. In addition, there have been major shortages in developed countries with high-demand supplies such as face masks, sanitizers, and paper products due to hoarding and lack of adequate supplies [104]. Nevertheless, the looming risk of food insecurity in developed nations lies in the impact of COVID-19 on people's employment, as demonstrated by the current economic recession, which stands at 6% on average in 2020 [105,106]. This situation is even worse for Low and Middle Income Countries (LMICs), which have shown a high risk to the demand-side of food insecurity due to low socio-economic status, access issues, and dependency on the importation of food [65]. Developing countries are estimated to observe at least a 3.6% decrease in GDP, with Africa, South Asia, and South America affected the most. Globally, over 140 million people are estimated to face extreme poverty, which would increase food insecurity severely [106]. Subsequently, the journey from farm to fork has been somewhat concerning in the service delivery of restaurants. While many global food chains have reported bankruptcy and closures in selected markets, delivery services by third-party vendors have been thriving [67,107–113]. Concerns regarding the food and agriculture industry have escalated all over the world with the progression of the pandemic, and with no end in sight.

Academic institutions also have been affected by the pandemic and emerged as a key concern due to mobility and socializing of students. While many universities have shifted to online, hybrid, or in-person classes with social distancing [95], universities have emerged as a new hotspot of COVID-19 after reopening [114,115]. Therefore, the implications of reopening universities have proven to be severe for public health. Moreover, universities are predicting a steep decline in new enrollments of both international and local students; the serious financial impact will have major economic consequences [69,97].

Healthcare systems across the world are exhausting themselves in the control of COVID-19. This study also calculated a country level PVI and assigned rankings. We identified that countries with high numbers of active cases are more vulnerable such as Ireland, the UK, and Italy in Europe, despite having good healthcare facilities. This again illustrates the globalization that may have precipitated the amplification of pandemic in these regions. The vulnerable countries in Asia are, Hong Kong, Singapore, and India in Asia. A plausible explanation may be the high population density in these areas. The US has the highest burden of COVID-19 and the health system is struggling to meet the demands of this pandemic. Most of the countries in Africa have a poor healthcare system and most of them fall to the bottom of GHI (data not provided). Although they have a low number of cases, a poor healthcare system and low GHI score [86] make them more vulnerable [86]. On the other hand, some countries have low prevalence of testing and some have high prevalence of active cases now. This illustrates multiple facets of handling the control and containment of COVID-19. Therefore, the control strategies taken by different countries to handle the pandemic can ease the vulnerability of countries to COVID-19. However, every control action has consequential effects on the economy and global health at large.

Although this study utilized multiple elements to characterize the effects of the pandemic on globalization and implemented an innovative technique that has not previously applied to assess a country's vulnerability to the pandemic, some limitations exist. Some information was extracted and taken from non-traditional sources such as news articles due to a lack of information from official sources. In addition, for the calculation of the PVI and rank, the selection of variables was influenced by the availability of country-level data. For example, only the diabetic prevalence was available for all countries; no other risk factors such as hypertension prevalence was available. Moreover, country-level data do not consider subject-level risk factors; thus, within the same country, people with different levels of the same risk factors may have different vulnerabilities to the transmission of COVID-19.

5. Conclusion

The pandemic has exposed the urgent need to revisit disaster preparedness and public health response to a health crisis such as COVID-19. Though much progress has been made in the nations' and the world's ability to respond to a public health emergency, the healthcare capacity of various powerful nations has been tested during this pandemic. Even developed countries with sophisticated infrastructure, sanitation, and hygiene that have undergone epidemiological transitions are facing difficulties controlling the epidemic. Less developed countries, however, have been overwhelmed, with many nations unable to adequately respond to and control the pandemic due to the lack of infrastructure, resources, fragile governments, and impoverished communities. The pandemic has exposed and exacerbated disparities between low- to middle-income countries and high-income and developed nations, and between the poor and the rich. The pandemic has also exposed inadequate surveillance systems worldwide, and the inability to detect and control the pandemic. The information presented in this paper can assist governments and policymakers to respond to COVID-19 faster and more efficiently by instituting control measures that limit the spread and alleviate the vulnerabilities to local and global economies.

Ethical approval and consent to participate

Not applicable.

Consent for publication

Not Applicable.

Availability of data and materials

Data and codes are accessible to researchers upon request for data sharing to the corresponding author.

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Authors' contributions

Nistha Shrestha and Ubydul Haque: Conceived the study design, collected data, conducted the experiments, analyzed, and interpreted the data, and drafted the manuscript. Muhammad Yousaf Shad: Analyzed and interpreted the data and contributed to writing. Osman Ulvi and Modasser Hossain Khan: Collected data and contributed to writing. Ajlina Karamehic-Muratovic, Uyen-Sa D. T. Nguyen, Mahdi Baghbanzadeh, Robert Wardrup, Nasrin Aghamohammadi, Diana Cervantes, Kh Md Nahiduzzaman, and Rafdzah Ahmad Zaki: Contributed to writing and reviewing of the manuscript. All authors approved the final version of the manuscript.

Declaration of Competing Interest

None declared.

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NA

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.onehlt.2020.100180.

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