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State fragility and the coronavirus disease 2019 (COVID-19) pandemic: an ecologic analysis of data from 146 countries

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\textbf{ABSTRACT}

\textbf{Background:} Global spread and impact of the coronavirus disease 2019 (COVID-19) pandemic are determined to a large extent, by resistance to the pandemic and public response of all countries in the world; while a country’s resistance and response are in turn determined by its political and socio economic conditions. To inform future disease prevention and control, we analyzed global data to examine the relationship between state vulnerabilities and COVID-19 incidences and deaths.

\textbf{Methods:} Vulnerability was measured using the Fragile States Index (FSI). FSI is created by the Fund for Peace to assess levels of fragility for individual countries. Total FSI score and scores for 12 specific indicators were used as the predictor variables. Outcome variables were national cumulative COVID-19 cases and deaths up to September 16, 2020, derived from the World Health Organization. Cumulative incidence rates were computed using 2019 National population derived from the World Bank, and case fatality rates were computed as the ratio of deaths/COVID-19 cases. Countries with incomplete data were excluded, yielding a final sample of 146 countries. Multivariate regression was used to examine the association between the predictor and the outcome measures.

\textbf{Results:} There were dramatic cross-country variations in both FSI and COVID-19 epidemiological measurements. FSI total scores were negatively associated with both COVID-19 cumulative incidence rates ($\beta = -0.0135, P < 0.001$) and case fatality rates ($\beta = -0.0147, P < 0.05$). Of the 12 FSI indicators, three negatively associated with COVID-19 incidences were E1(Economic Decline and Poverty), E3 (Human Flight and Brain Drain), and S2 (Refugees and Internally Displaced Persons); two positively associated were P1 (State Legitimacy) and X1 (External Intervention). With regard to association with case fatality rates, C1 (Security Apparatus) was positive, and P3 (Human Rights and Rule of Law) and X1 was negative.

\textbf{Conclusion:} With FSI measures by the Fund of Peace, overall, more fragile countries are less likely to be affected by the COVID-19 pandemic, and even if affected, death rates were lower. However, poor in state legitimacy and lack of external intervention are risk for COVID-19 infection and lack of security apparatus is risky for COVID-19 death. Implications of the study findings are discussed and additional studies are needed to examine the mechanisms underpinning these relationships.

1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has resulted in over 57 million cases and approximately 1.4 million deaths worldwide, as of November 20, 2020.\textsuperscript{1} Despite extensive efforts from individual countries and the international community, the pandemic has not been subdued, as evidenced by the rising death toll.\textsuperscript{2} It is imperative to augment our understanding of key factors that fuel the pandemic and its life-threatening impact as well as to develop more effective measures and strategies for prevention and control.

Although several factors may play a role in the spread of COVID-19, we cannot ignore the role of individual countries’ capacities to deal with such public health emergencies as COVID-19, in terms of preparedness and responsiveness. Studies on many risk factors for the COVID-19 have been reported in the literature; however, few studies have examined the matter using national-level data. Furthermore, from these published

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studies, we noted that anti-epidemic measures at the national level often performed inadequately in predicting disease burdens emanating from the COVID-19 pandemic.\textsuperscript{3,4} State fragility is a concept that reflects a country’s responsiveness to dangerous events. According to the Organization for Economic Cooperation and Development, fragile states are considered those that lack the ability to develop mutually constructive relations with society and often have a weak capacity to perform basic governance functions.\textsuperscript{5} Consequently, fragile states tend to be vulnerable at multiple levels, including political, socioeconomic, and others.\textsuperscript{6-7} With regard to health, vulnerability may include population susceptibility and barriers to healthcare access,\textsuperscript{8,9} manifesting as outbreaks of epidemics, high incidence, and high mortality.\textsuperscript{10}

The Fragile States Index (FSI), established by the Fund for Peace, is a measure used to quantify the degree of state fragility. It has served as a tool for monitoring all countries worldwide in order to earmark those located in the alert zone for assistance,\textsuperscript{11} promote global peace and development, and identify countries in need of developmental assistance.\textsuperscript{12} In this study, we used FSI as a measure of national vulnerability to the COVID-19 pandemic. The FSI consists of 12 indicators organized in four measurement dimensions with three sub-indexes per domain. The four domains are as follows: (1) the Cohesion Indicators; (2) the Economic Indicators; (3) the Political Indicators; and (4) the Social and Cross-Cutting Indicators, each of which contains three measurements. Previous studies have used relevant indicators to predict population health. Typical examples include studies on the impact of violence and insecurity on the risk of infectious disease transmission,\textsuperscript{13} the inverted U-shaped relationship between economy and health,\textsuperscript{14} and the importance of politics and social welfare in health outcomes.\textsuperscript{15} to name a few.

In this study, we used the FSI as a predictor to assess the association of state vulnerability with the COVID-19 pandemic and its health impact at national level, using data from countries in the world. Our selection of FSI is based on its validity and widely used in empirical research, including health-related research studies.\textsuperscript{11-13} Findings from these studies suggest FSI as a relevant tool for assessing the resistance and responsiveness of a nation to the COVID-19 pandemic, and its consequences. Furthermore, using FSI will facilitate communication of research findings to people and countries worldwide.

2. Methods

2.1. Data sources and variables

State fragility was measured using the 2020 FSI data acquired from the Fund for Peace.\textsuperscript{16} As previously described, the FSI consists of 12 specific indicators arranged in four domain indexes (Table 1). The scores of the 12 specific indicators range from 0 to 10, with 0 representing the lowest vulnerability and 10 the highest vulnerability. Total FSI scores for individual countries (ranging from 0 to 120) were computed by summing the 12 individual scores. The total FSI scores were used to rank individual countries by fragility. In this study, we used it to assess the vulnerability to COVID-19 for individual countries.

The outcome variables for individual countries were the cumulative incidence rates and case fatality rates of COVID-19 from the first reported case up to September 16, 2020, when the analysis was completed for this study. Data for COVID-19 cases and deaths were accessible from various sources, and we used data reported by the World Health Organization (WHO). In particular, data used in this analysis were acquired from the WHO Coronavirus Disease (COVID-19) Dashboard.\textsuperscript{1}

To compute the cumulative incidence rates by country, national population data are needed for individual countries in the world. Since 2020 population data were not available, we typically used 2019 population data instead. To ensure comparability, we acquired population data from the World Bank,\textsuperscript{17} the most reliable population data source for global health research.\textsuperscript{18} Of the 216 countries/territories in the world, countries with incomplete data on the key variables (i.e., FSI, COVID-19 cases and deaths, and total population) were excluded, yielding a final sample of 146 countries that were included in the analysis.

2.2. Data analysis and statistical models

First, cumulative incidence rates (/1 000) for individual countries were computed as the ratio of total COVID-19 cases to the 2019 population, and case fatality rates (/100) as the ratio of total COVID-19 deaths to total COVID-19 cases.

Second, descriptive statistical analysis was conducted to describe geographic variations in both the outcome measures and the predictor measure. To better describe the geographic pattern for comprehension, we used the following six world regions: Africa, the Americas, Eastern Mediterranean, Europe, Southeast Asia, and Western Pacific, as established by the WHO, rather than individual countries. Therefore, we computed our predictor and outcome measures by these regions and conducted an analysis to assess cross-regional differences.

One-way ANOVA tests were used to compare the predictor and outcome measures across the six global regions. An XY plot with simple linear regression was initially used to demonstrate the overall association of total FSI scores with COVID-19 cumulative incidence rates and case fatality rates. Multiple linear regression was used to analyze the relationship between different FSI measures and the two outcome measures. COVID-19 cumulative incidence rates and case fatality rates were analyzed separately. Type I error was set at \( P < 0.05 \) level (two-sided) for statistical inferences. All statistical analyses were conducted using the open-source software R (version 3.6.3; R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Variations in FSI scores and COVID-19 burdens across WHO regions

The results in Table 2 indicate that of the 146 countries included in this study, 39 were in the Africa Region (AFR), 27 in the Americas Region (AMR), 17 in the Eastern Mediterranean Region (EMR), 41 in the Europe Region (EUR), 10 in the Southeast Asia Region (SEAR), and 12 in the Western Pacific Region (WPR). All predictor and outcome measures differed significantly across the six WHO regions (\( P < 0.01 \) for all). Evidently, these results provide adequate information justifying further assessment of the relationship between these predictors and outcomes in future studies.

Specifically, regarding FSI indicators, countries in the AFR, EMR, and SEAR generally had a higher overall FSI score; they also scored higher on the four subdomain indexes. Countries in the EUR scored low overall and on the four individual domains. As regards the COVID-19 indicators, the cumulative incidence rates were high for countries in the EMR and AMR. The cumulative incidence rates in these two regions were more than five times higher than those in the AFR. As regards case fatality rates, rates in the EUR and AMR were approximately three times higher than those in the SEAR.

3.2. Relationship between total FSI scores and COVID-19 burdens

Fig. 1 indicates a significantly negative relation between the total FSI score and the log (COVID-19 cases) for all 146 countries included in the analysis. The negative relation was quantified using a linear regression with a \( \beta \) coefficient of \(-0.0135 \) (\( P < 0.001 \)) and \( R^2 \) of 0.19. Likewise, Fig. 2 presents the relationship between total FSI scores and case fatality rates (no log transformation). Results from simple linear regression indicated a \( \beta \) coefficient of \(-0.0147 \) (\( P < 0.05 \)) and \( R^2 \) of 0.02.
Table 1
Categories and indicators of Fragile States Index (FSI).

| Category                        | Indicator                          | Content                                                                 | Meaning                                                                 |
|---------------------------------|------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------|
| Cohesion indicators             | C1: Security Apparatus             | Monopoly on the use of force Relationship between security and citizenry | The Security Apparatus indicator considers the security threats to a state |
|                                 | C2: Fractionalized Elites          | Representative leadership Identity Resource distribution Equality and equity Post-Conflict response Equality Divisions Communal violence | The Fractionalized Elites indicator considers the fragmentation of state institutions along ethnic, class, clan, racial or religious lines, as well as and brinkmanship and gridlock between ruling elites |
|                                 | C3: Group Grievance                |                                                                         | The Group Grievance Indicator focuses on divisions and schisms between different groups in society–particularly divisions based on social or political characteristics–and their role in access to services or resources. |
| Economic indicators             | E1: Economic Decline and Poverty   | Public finances Economic conditions Economic climate Economic diversification | The Economic Decline Indicator considers factors related to economic decline within a country |
|                                 | E2: Uneven Economic Development    | Economic equality Economic opportunity Socio-Economic dynamics Economics | The Uneven Economic Development Indicator considers inequality within the economy |
|                                 | E3: Human Flight and Brain Drain   | Retention of technical and intellectual capital Economics | The Human Flight and Brain Drain Indicator considers the economic impact of human displacement (for economic or political reasons) and the consequences this may have on a country’s development |
| Political indicators            | P1: State Legitimacy               | Confidence in the political process Political opposition Transparency Openness and fairness of the political process Political violence | The State Legitimacy Indicator considers the representativeness and openness of government and its relationship with its citizenry |
|                                 | P2: Public Services                | General provision of public services Health Education Shelter Infrastructure | The Public Services Indicator refers to the presence of basic state functions that serve the people |
|                                 | P3: Human Rights and Rule of Law   | Civil and political rights Civil and political freedoms Violation of rights Openness Justice Equality | The Human Rights and Rule of Law Indicator considers the relationship between the state and its population insofar as fundamental human rights are protected and freedoms are observed and respected |
| Social and cross-cutting indicators | S1: Demographic Pressures      | Population Public health Food and nutrition Environment Resources | The Demographic Pressures Indicator considers pressures upon the state deriving from the population itself or the environment around it |
|                                 | S2: Refugees and Internally        | Refugees Internally displaced persons Response to displacement            | The Refugees and Internally Displaced Persons Indicator measures the pressure upon states caused by the forced displacement of large communities as a result of social, political, environmental or other causes |
|                                 | X1: External Intervention          | Political intervention Force intervention Economic intervention | The External Intervention Indicator considers the influence and impact of external actors in the functioning – particularly security and economic – of a state. |

3.3. Relationship between individual FSI measures and COVID-19 burdens

Informed by simple linear regression, Table 3 presents the results from multivariate regression models revealing ecologic linkages between specific FSI measures and COVID-19 cumulative incidence rates and case fatality rates. First, three FSI indicators negatively correlated with COVID-19 cumulative incidence rates, namely, E1 (Economic Decline and Poverty, \( \beta = -1.392, P < 0.05 \)), E3 (Human Flight and Brain Drain, \( \beta = -1.482, P < 0.01 \)), and S2 (Refugees and Internally Displaced Persons, \( \beta = -1.202, P < 0.01 \)), and two positively correlated with COVID-19 cumulative incidence rates, namely, P1 (State Legitimacy, \( \beta = 1.276, P < 0.01 \)), and X1 (External Intervention, \( \beta = 1.094, P < 0.01 \)).

Second, two FSI indicators negatively correlated with case fatality rates, P3 (Human Rights and Rule of Law, \( \beta = -0.447, P < 0.01 \)) and X1 (\( \beta = -0.418, P < 0.01 \)), and one positively correlated with case fatality rates, C1 (Security Apparatus, \( \beta = 0.595, P < 0.01 \)).

4. Discussion and conclusions

In this study, we analyzed data from 146 countries across six WHO regions worldwide. The goal was to explore the relationship between vulnerability/resistance at national level and the disease burden emanating from COVID-19. Data used for this study were derived from reliable sources, and an advanced multivariate regression method was used to examine the ecological relationship. To the best of our knowledge, this is one of the first studies to examine this relationship. The findings of this study provide time data that are prerequisite for establishing measures to control the current COVID-19 pandemic and that support future research and interventions against potential infectious disease pandemics.
Table 2
Differences in two COVID-19 outcome measures and 12 Fragile State Index indicators by World Health Organization (WHO) Region, 146 countries in 2020.

| Item                                      | AFR | AMR | EMR | EUR | SEAR | WPR | P       |
|-------------------------------------------|-----|-----|-----|-----|------|-----|---------|
| Number of countries                       | 39  | 27  | 17  | 41  | 10   | 12  |         |
| Cumulative incidence rates (/1 000)        | 1.15±1.99 | 7.28±7.59 | 9.80±13.19 | 4.80±3.56 | 2.68±5.37 | 1.29±2.86 | <0.001 |
| Case fatality rates (/100)                 | 2.18±1.67 | 3.16±2.30 | 1.72±1.50 | 3.27±2.58 | 1.12±1.19 | 2.04±1.97 | <0.01  |
| Cohesion                                  | 6.68±1.74 | 5.94±1.34 | 6.40±2.55 | 3.61±1.78 | 6.57±1.45 | 4.69±2.58 | <0.001 |
| indicators                                | 7.59±1.74 | 5.37±2.03 | 7.86±1.77 | 4.89±2.65 | 8.32±0.88 | 5.68±2.59 | <0.001 |
| Economic                                   | 6.26±2.09 | 4.95±1.87 | 7.01±2.51 | 4.96±2.26 | 7.87±1.87 | 4.83±1.99 | <0.001 |
| indicators                                | 7.04±1.25 | 4.87±1.35 | 5.65±2.40 | 3.90±1.57 | 5.16±1.01 | 3.75±1.65 | <0.001 |
| Political                                  | 7.01±1.24 | 4.90±2.23 | 7.75±1.19 | 3.85±3.07 | 6.10±1.70 | 4.99±3.05 | <0.001 |
| indicators                                | 7.66±1.64 | 4.88±1.76 | 5.10±2.89 | 2.42±1.21 | 5.89±1.57 | 3.85±2.73 | <0.001 |
| Social and cultural pressures               | 8.03±1.52 | 4.86±1.61 | 5.70±2.37 | 2.45±1.29 | 6.69±1.28 | 4.47±2.12 | <0.001 |
| cross-cutting                              | 6.53±2.03 | 3.59±1.63 | 5.87±3.05 | 3.80±1.90 | 6.18±1.69 | 3.15±1.66 | <0.001 |
| indicators                                | 6.67±1.62 | 4.83±1.95 | 6.74±2.32 | 3.05±2.51 | 5.90±1.72 | 3.91±2.61 | <0.001 |
| Total Fragile States Index                 | 84.07±15.41 | 60.06±16.41 | 76.32±22.48 | 43.14±20.27 | 77.64±9.09 | 53.81±24.24 | <0.001 |

All values were from data means of one-way ANOVA. AFR: Africa Region; AMR: Americas Region; EMR: Eastern Mediterranean Region; EUR: Europe Region; SEAR: South-East Asia Region; WPR: Western Pacific Region.

Fig. 1. Negative association of total Fragile States Index (FSI) scores and COVID-19 cumulative incidence rates (/1 000) in 146 countries in the world, up to September 16, 2020.
Data sources: COVID-19 cases were derived from WHO and population data from the World Bank.1,17

Fig. 2. Negative association between total Fragile States Index (FSI) scores and COVID-19 case fatality rates (/100) in 146 countries in the world, up to September 16, 2020.
Data source: Cases and deaths of COVID-19 were derived from WHO.1
Table 3
Results from multiple regression predicting COVID-19 cumulative incidence rates and case fatality rates with 12 Fragile States Index (FSI) indicators with data from 146 countries.

| 12 indicators of FSI | Cumulative incidence rates (/1 000) | Case fatality rates (/100) |
|----------------------|------------------------------------|---------------------------|
|                      | \( \beta \)  | \( t \)  | \( P \)  | \( \beta \)  | \( t \)  | \( P \)  |
| Cohesion indicators  |                                    |                           |                       |                           |                       |
| C1: Security Apparatus | 0.222  | 0.498  | >0.05  | 0.595  | 4.055  | <0.01  |
| C2: Factionalized Elites | -0.686  | -1.389  | >0.05  | 0.028  | 0.172  | >0.05  |
| C3: Group Grievance | 0.428  | 1.288  | >0.05  | 0.003  | 0.028  | >0.05  |
| E1: Economic Decline and Poverty | -1.392  | -2.422  | <0.05  | 0.211  | 1.115  | >0.05  |
| Economic indicators  |                                    |                           |                       |                           |                       |
| E2: Uneven Economic Development | 0.495  | 0.97  | >0.05  | 0.013  | 0.077  | >0.05  |
| E3: Human Flight and Brain Drain | -1.482  | -3.238  | <0.01  | -0.167  | -1.113  | >0.05  |
| P1: State Legitimacy | 1.276  | 2.624  | <0.01  | -0.008  | -0.047  | >0.05  |
| Political indicators  |                                    |                           |                       |                           |                       |
| P2: Public Services | -0.021  | -0.031  | >0.05  | 0.079  | 0.353  | >0.05  |
| P3: Human Rights and Rule of Law | -0.387  | -0.812  | >0.05  | -0.447  | -2.853  | <0.01  |
| S1: Demographic Pressures | 0.155  | 0.27  | >0.05  | -0.192  | -1.018  | >0.05  |
| Social and cross-cutting indicators  |                                    |                           |                       |                           |                       |
| S2: Refugees and Internally Displaced Persons | -1.202  | -3.204  | <0.01  | 0.193  | 1.566  | >0.05  |
| X1: External Intervention | 1.094  | 2.719  | <0.01  | -0.418  | -3.16  | <0.01  |

Results from our intensive ecological modeling analysis indicated that countries that were generally more vulnerable were less likely to be affected by COVID-19, whether in terms of incidence or fatality. This finding was rather unanticipated. In theory, or at least according to the Fund for Peace, more fragile and more vulnerable countries are more likely to be affected by any infectious disease, vice versa. We discuss these findings further in the following two sections.

4.1. Consistent findings and implications

Despite the overall inconsistency between the FSI and COVID-19 burden, in-depth analysis revealed three fragile measures that did lead to increased risk of COVID-19, consistent with our expectations. These three measures were C1, which was associated with the risk of death, as well as P1 and X1, which were associated with cumulative incidence rates.

As a cohesion measure, countries scoring higher on C1 scores may have less secure healthcare service delivery. This may explain the prediction of a higher risk of COVID-19 deaths by a higher C1 score in our study. This is consistent with the impact of conflict on maternal and child health services delivery.19 Countries with poor cohesion often face traditional security threats, such as political violence and armed resistance. The burden has been prevented by diverting extra attention and resources toward medical infrastructure. Fear and insecurity also lead to a shortage of health workers, which might have contributed to increased COVID-19 deaths.

Politically fragile P1 may increase the risk of COVID-19 infection. State legitimacy plays many roles in curbing the spread of infectious diseases, such as COVID-19. It reflects leadership and decision-making capacity as well as the ability to mobilize citizens to participate in coordinated action by political leaders and public health experts. Political and institutional legitimacy reflect whether a country has the functional and credible policy capacity to implement top-down governance.20,21 People in countries with poor state legitimacy are more likely to have negative views on political leaders and health experts, engage in self-centered behaviors, and are less likely to adopt protective measures, such as wearing masks, social distancing, and vaccination.22

Societally, fragile measure X1 is another risk factor for COVID-19 infection. The impact of this fragile measure is evident. Lack of mutual support and international assistance will certainly weaken a country’s resistance to a serious novel pandemic like the COVID-19.

These consistent findings have a significant role in the control and prevention of the current COVID-19 pandemic and in infectious disease control and prevention in the future. First, strategic plans and massive anti-pandemic interventions in any country must consider infrastructure for health security. Second, leadership development and evidence-based decision-making will be essential in inspiring confidence in people to take massive action against a pandemic. Ultimately, in fights against a pandemic, such as COVID-19, no single country can work in isolation to win the war; global health measures are paramount, such as mutual support and international assistance.

4.2. Unexpected or expected findings and implications

Most findings from this study were generally unexpected or consistent with our knowledge regarding infectious diseases, particularly COVID-19. Infectious diseases have long been used as markers of underdevelopment, poverty, and lack of hygiene. However, the findings of this study discovered that less fragile countries with high political, socioeconomic, and cohesion levels were at greater risk of COVID-19 infections and deaths. In other words, these countries are more vulnerable to infectious diseases than those that are more fragile based on FSI measures. For example, we identified a negative relationship between economic decline and COVID-19 infection, while poor countries often have higher tuberculosis prevalence.23-24

However, this seemingly contradictory finding appears to be reasonable based on a more precise measure of development. Two ecological studies, including one with provincial data from China25 as well as another with national data from 28 European countries and state data from the USA,26 demonstrated a significantly positive relationship between national gross domestic product (GDP) and cumulative COVID-19 cases. Results from these two studies are less likely to be affected by cross-entity differences in COVID-19 tests because each study focused on a considerably homogenous population. For example, the impact of the difference in COVID-19 tests between different provinces within China was minimal since all the tests were planned and delivered based on requirements.

With the strengths of the design and data, the researchers in these two studies argued that more developed countries have superior transportation systems shuttling people around. As revealed in another COVID-19 study using global data,27 more developed countries with large, highly metropolitan cities are characterized by high population densities, facilitating viral transmission; moreover, their inhabitants have surplus dispensable income and time to spend associating with others, further promoting transmission, and they place personal values and freedom above the common, a big barrier for protection measures. Corroborated by these studies, our findings support the notion that the impact of socioeconomic and political measures can be more
important than healthcare in protecting people from diseases and promoting health.  

This finding has significant implications for both political leaders and health professionals. It is prudent to balance economic development and human health. It is absolutely imperative to develop a country in order to protect its people from COVID-19 or any other pandemic. All measures must be considered in terms of political and socioeconomic development to enhance a nation’s resistance to infectious diseases, including high standards for modern transportation, prevention measures in infrastructure, and emphasis of individual and collective values, to name a few.

Finally, we propose revisions of the FSI measures. According to the current FSI measurements, countries that are more vulnerable to infectious diseases are classified as less fragile, while countries less vulnerable to infectious diseases are classified as more fragile. Apparently, this position seems untenable and lacks substantiation.

4.3. Limitations

This study has several limitations. First, although highly comprehensive, FSI measures may not capture the complexity of a nation’s fragility level. This is particularly true when these measures are used to assess the vulnerability/resistance of a country. Second, the COVID-19 pandemic continues to evolve. The data included in this study cannot reflect the entire pandemic. Additional research is required at the time when the pandemic has ended. Third, total COVID-19 cases and deaths are potentially affected by the testing and reporting capacity of individual countries. Although studies on GDP and COVID-19 revealed a rather limited impact of testing and reporting capabilities, the impact cannot be ruled out completely. Caution is obligatory when interpreting the findings of our study. Finally, this study is an ecological research; thus, no causal relationship can be derived.

4.4. Conclusions

Despite the foregoing limitations, this study provided data supporting a novel trend in infectious disease epidemiology. In modern society, high levels of development place people at increased risk of infections. In addition to medical care and personal behaviors, national measures must be applied to increase the resistance of a country and its people to infectious diseases. Such measures are also required to end the devastating COVID-19 pandemic. The findings of this study provide support data for further studies with individual-level data to examine the mechanisms underlying the relationship between national fragility and vulnerability to COVID-19 and other infectious diseases.

Credit author statement

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Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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