The Global Health Security Index is not predictive of vaccine rollout responses among OECD countries

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ABSTRACT

Objective: This study sought to evaluate the utility of the Global Health Security (GHS) index in predicting the launch of COVID-19 vaccine rollout by Organization for Economic Cooperation and Development (OECD) member countries.

Methods: Country-level data on the preparedness to respond to infectious disease threats through vaccination rollout were collected using the GHS index. OECD member countries were rank-ordered based on the percentage of their populations fully vaccinated against COVID-19. Rank-ordering was conducted from the lowest to the highest, with each country assigned a score ranging from 1 to 33. Spearman's rank correlation between the GHS index and the percentage of the population that is fully vaccinated was also performed.

Results: Israel, ranked 34th in the world on the GHS index for pandemic preparedness, had the highest percentage of the population that was fully vaccinated against COVID-19 within 2 months of the global vaccine rollout. The Spearman rank correlation coefficient between GHS index and the percentage of population fully vaccinated was -0.1378, with a p-value of 0.43.

Conclusion: The findings suggest an absence of correlation between the GHS index rating and the COVID-19 vaccine rollout of OECD countries, indicating that the preparedness of OECD countries for infectious disease threats may not be accurately reflected by the GHS index.

Background

The ongoing coronavirus disease 2019 (COVID-19) pandemic has revealed the ominous threat posed by emerging infectious diseases to human civilization. SARS-CoV-2 infection was first detected in Wuhan, China, in December, 2019 (WHO, 2020), and on March 11, 2020, the WHO declared COVID-19 a global pandemic (WHO, 2020). As of August 2021, SARS-CoV-2 has infected more than 200 million people and claimed more than 4.3 million lives, particularly in underserved populations (COVID-19 Map 2021). In addition to the heavy cost on human health, the COVID-19 pandemic has necessitated tight restrictions on movement and economic activities, discouraging investment and disrupting all levels of education. Global Economic Prospects of the World Bank envisions a 5.2% contraction in global gross domestic product (GDP), with a historic reduction in per capita income (World Bank, 2020). The bleak economic outlook and the magnitude of the crisis caused by COVID-19 call for urgent steps to revive global economies, save lives and protect underserved populations.

Beyond temporizing interventions – such as masking, social distancing and hand hygiene – the most effective measure to end the pandemic is the development of herd immunity through mass

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vaccination. Through astounding scientific progress and robust financial backing, over 150 COVID-19 vaccines have entered clinical trials, with eight gaining approval for clinical use (Zimmer et al., 2021). A coordinated strategy is now needed to mass-produce and distribute vaccines to ensure that at least 75%–90% of the target population is properly immunized to achieve herd immunity (Anderson et al., 2020). Inequalities in vaccine distribution have resulted in faster vaccination rates in high-income countries relative to low-income countries (Bloomberg, 2021). The highest proportion of vaccine utilization is by members of the Organization for Economic Cooperation Development (OECD), a 38-member organization primarily consisting of wealthy nations with increased energy expenditure and high GDP (OECD, 2021). More robust economic recovery among OECD countries has been tightly linked with their ability to speed up the COVID-19 vaccine rollout. The projected economic growth among member nations is expected to markedly differ among OECD countries (OECD, 2021).

The Global Health Security (GHS) index, released prior to the COVID-19 pandemic in 2019, was designed to provide a framework to assess the ability of countries to prevent and mitigate emerging outbreaks, such as COVID-19 (Global Health Security Index, 2019). A 21-member panel of international experts, in collaboration with the Johns Hopkins Center for Health Security, the Economist Intelligence Unit, and the Nuclear Threat Initiative ranked 195 countries based on their preparedness level, from most prepared to least prepared (Global Health Security Index, 2019). The 140-question assessment is based on 34 indicators, 85 sub-indicators, and six categories related to prevention, detection, rapid response, health system, risk environment, and international norms compliance. Although the results revealed that none of the countries were adequately prepared for a major infectious disease outbreak, the United States (US), United Kingdom (UK), and Australia were ranked as the top three countries in preparedness (Global Health Security Index, 2019).

Given that the vaccine supply chain and infrastructure for administering vaccine doses are critical components of the COVID-19 pandemic response, the current study sought to evaluate the utility of the GHS index in predicting the launch of the COVID-19 vaccine rollout (i.e., during the first two months of vaccine availability) of OECD member countries for which data are available.

Methodology

Study Population

Participating countries used for this analysis included OECD member countries, each of which was assessed for inclusion. COVID-19 vaccine data are reported on a daily basis for all countries by Our World in Data (https://ourworldindata.org/). Four OECD member countries (South Korea, Japan, New Zealand, and Colombia) were omitted from the analysis due to unavailability of the start date for their COVID-19 vaccination programs. The latest country to join the OECD - Costa Rica (38th member) - was also not included in the analysis, since its membership status was formally recognized on May 25,2021.

Data Collection

Country-level data on the preparedness to respond to infectious disease threats by way of vaccination rollout were collected using the GHS index available from http://www.ghsindex.org/. Data relating to the cumulative COVID-19 vaccine doses and the percent population fully vaccinated per hundred were collected up to March 23,2021 from https://ourworldindata.org/coronavirus-testing (a collaborative effort between the researchers at the University of Oxford and a non-profit organization,

Global Change Data Lab) and https://github.com/CSSEGISandData/COVID-19 (a COVID-19 data repository by the Center for Systems Science and Engineering at Johns Hopkins University). Vaccination data for the Netherlands were collected up to March 21,2021.

Statistical Analysis

Variables collected in this study included the total number of COVID-19 cases/million persons, cumulative COVID-19 vaccines/hundred, and the percentage of the population fully vaccinated (i.e., who received both doses of a two-dose vaccine, or a single dose of a one-dose vaccine) at 2 months after initiation of the vaccination program in each country. The percentage of the population fully vaccinated in each OECD country was the main variable of interest as an indicator of the success of each vaccination program. The OECD member countries were rank-ordered based on the percentage of their populations that had completed vaccination against COVID-19. Rank-ordering was conducted from the lowest to the highest, with each country assigned a score ranging from 1 to 33. The country (Israel) with the highest percentage (53%) of fully vaccinated population was assigned a score of 1, and that with the lowest percentage (0.6%) of fully vaccinated population was assigned a score of 33. By this approach, a lower score reflected relatively better performance, and a higher rating reflected poor performance. To determine the predictability of the GHS index for successful COVID-19 vaccination rollout, a Spearman's rank correlation was performed between the GHS index and the percentage of the population that was fully vaccinated. All statistical analyses were performed using STATA (Statistical Data Package version 16.0 IC, College Station, TX-USA).

Results

According to the GHS index, the US ranks highest in preparedness, with a score of 83.5, a five-point difference from the next country, the UK. Specifically, the US ranks highest in four out of six areas: prevention, detection, health system capacity, and compliance with international norms. Luxembourg ranks at the 67th position in the global ranking, with an overall score of 43.8. The 20 highest ranked countries are mostly OECD members, except for Thailand (sixth) and Malaysia (18th) (Table 1). Israel, which is ranked 34th in the world on the GHS index for pandemic preparedness, had the highest percentage of the population that was fully vaccinated against COVID-19 within 2 months of the global vaccine rollout, indicating a highly successful COVID-19 vaccination program (Table 2). On the other hand, the UK, which is ranked second on the GHS index, is ranked 23rd among OECD countries with respect to percentage of the population that was fully vaccinated in the initial phase of vaccine rollout. It is worth noting that some of the high-ranking countries on the GHS index also ranked highly with respect to percentage of the population that was fully vaccinated (Figure 1).

The Spearman rank correlation coefficient between GHS index and the percentage of population that was fully vaccinated was -0.1378, with a p-value of 0.43. Also, the Spearman rank correlation between rapid response to and mitigation of the spread of an epidemic (both components of the GHS index scoring system) and percentage of the population that was fully vaccinated was -0.0190, with a p-value of 0.91. The Spearman correlation affirmed that, although there was a negative trend, it was not statistically significant; as such, there was no monotonic relationship between the GHS index, or the rapid response to and mitigation of the spread of an epidemic, and the percentage of the population that was fully vaccinated within two months of the global vaccine rollout.

Table 1
Country rankings and scores based on the Global Health Survey Index.

Country (ranked)	Overall score rank (score)	Prevention of the emergence or release of pathogens, rank (score)	Early detection & reporting for epidemics of potential international concern, rank (score)	Rapid response to and mitigation of the spread of an epidemic, rank (score)	Sufficient & robust health system to treat the sick and protect health workers, rank (score)	Commitments to improving national capacity, financing and adherence to norms, rank (score)	Overall risk environment and country vulnerability to biological threats, rank (score)
United States	1 (83.5)	1 (83.1)	1 (98.2)	2 (79.7)	1 (73.8)	1 (85.3)	19 (78.2)
United Kingdom	2 (77.9)	10 (68.3)	6 (87.3)	1 (91.9)	11 (59.8)	2 (81.2)	26 (74.7)
Netherlands	3 (75.6)	4 (73.7)	7 (86.0)	4 (79.1)	3 (70.2)	32 (61.1)	12 (81.7)
Australia	4 (75.5)	8 (68.9)	2 (97.3)	10 (65.9)	6 (63.5)	3 (77.0)	18 (79.4)
Canada	5 (75.3)	7 (70.0)	4 (96.4)	17 (60.7)	4 (67.7)	5 (74.7)	10 (82.7)
Sweden	7 (72.1)	2 (81.1)	7 (86.0)	14 (62.8)	20 (49.3)	11 (71.3)	6 (84.5)
Denmark	8 (70.4)	5 (72.9)	7 (86.0)	19 (58.4)	5 (63.8)	28 (62.6)	17 (80.3)
South Korea	9 (70.2)	19 (57.3)	5 (92.1)	6 (71.5)	13 (58.7)	23 (64.3)	27 (74.1)
Finland	10 (68.7)	9 (68.5)	45 (61.6)	7 (69.2)	9 (60.8)	4 (75.4)	14 (81.1)
France	11 (68.2)	6 (71.2)	21 (75.3)	13 (62.9)	8 (60.9)	44 (58.6)	9 (83.0)
Slovenia	12 (67.2)	12 (67.0)	27 (73.7)	12 (63.3)	18 (54.9)	8 (72.1)	29 (73.7)
Switzerland	13 (67.0)	34 (52.7)	48 (59.1)	3 (79.3)	7 (62.5)	18 (65.6)	3 (86.2)
Germany	14 (66.0)	13 (66.5)	10 (84.6)	28 (54.8)	22 (48.2)	29 (61.9)	11 (82.3)
Spain	15 (65.9)	32 (52.9)	11 (83.0)	15 (61.9)	12 (59.6)	32 (61.1)	24 (77.1)
Norway	16 (64.6)	11 (68.2)	49 (58.6)	20 (58.2)	14 (58.5)	22 (64.4)	2 (87.1)
Latvia	17 (62.9)	25 (56.0)	2 (97.3)	29 (54.7)	23 (47.3)	79 (51.1)	48 (67.2)
Belgium	19 (61.0)	15 (63.5)	42 (62.5)	53 (47.3)	10 (60.5)	38 (59.7)	19 (78.2)
Portugal	20 (60.3)	33 (52.8)	61 (50.5)	8 (67.7)	17 (55.0)	26 (63.0)	22 (77.3)
Japan	21 (59.8)	40 (49.3)	35 (70.1)	31 (53.6)	25 (46.6)	13 (70.0)	34 (71.7)
Ireland	23 (59.0)	14 (63.9)	18 (78.0)	62 (45.1)	41 (40.2)	66 (52.8)	21 (77.4)
Austria	26 (58.5)	18 (57.4)	28 (73.2)	76 (42.3)	25 (46.6)	66 (52.8)	5 (84.6)
Chile	27 (58.3)	23 (56.2)	30 (72.7)	18 (60.2)	43 (39.3)	78 (51.5)	38 (70.1)
Mexico	28 (57.6)	49 (45.5)	32 (71.2)	39 (50.8)	24 (46.9)	6 (73.9)	89 (57.0)
Estonia	29 (57.0)	44 (47.6)	19 (77.6)	56 (47.0)	66 (31.6)	15 (67.6)	30 (73.3)
Italy	31 (56.2)	45 (47.5)	16 (78.5)	51 (47.5)	54 (36.8)	29 (61.9)	55 (65.5)
Poland	32 (55.4)	37 (50.9)	44 (61.7)	51 (47.5)	21 (48.9)	41 (58.9)	45 (67.9)
Lithuania	33 (55.0)	59 (43.5)	13 (81.5)	107 (33.9)	63 (34.4)	8 (72.1)	46 (67.8)
Hungary	35 (54.0)	22 (56.4)	55 (55.5)	33 (52.2)	56 (36.6)	41 (58.9)	42 (68.2)
New Zealand	35 (54.0)	27 (55.0)	107 (36.7)	21 (58.1)	32 (45.2)	39 (59.4)	23 (77.2)
Greece	37 (53.8)	28 (54.2)	17 (78.4)	66 (44.0)	50 (37.6)	92 (49.1)	80 (58.2)
Turkey	40 (52.4)	20 (56.9)	74 (45.6)	46 (49.0)	30 (45.7)	23 (64.3)	92 (56.5)
Czech Republic	42 (52.0)	36 (51.1)	60 (50.7)	57 (46.6)	52 (37.4)	41 (58.9)	28 (74.0)
Slovakia	52 (47.9)	30 (53.5)	70 (46.0)	105 (34.1)	48 (37.9)	66 (52.8)	36 (71.5)
Israel	54 (47.3)	54 (44.0)	58 (52.4)	84 (39.9)	37 (42.2)	138 (41.5)	41 (68.8)
Iceland	58 (46.3)	84 (35.3)	104 (37.2)	66 (44.0)	28 (46.4)	128 (43.2)	13 (81.2)
Colombia	65 (44.2)	75 (37.2)	91 (41.7)	70 (43.5)	64 (34.3)	35 (60.1)	116 (51.0)
Luxembourg	67 (43.8)	102 (31.0)	91 (41.7)	139 (27.3)	48 (37.9)	66 (52.8)	4 (84.7)

Discussion

These findings demonstrate that the GHS index is a poor predictor of vaccine rollout or the general response to the COVID-19 pandemic by OECD countries. Overall, there was no correlation between the GHS index rankings and the vaccine rollout, based on the percentage of the population that was fully vaccinated. The US and the UK, which rank first and second on the GHS index, respectively, also represented two of the three countries with the highest number of vaccine doses administered/hundred population. Of these two countries, the US also accounted for the largest number of persons that have been fully vaccinated (i.e., who received both doses of a two-dose vaccine, or a single dose of a one-dose vaccine). In contrast, the UK was ranked 23rd among OECD countries for percentage of the population that was fully vaccinated in the early phase of the global COVID-19 vaccine rollout.

This discrepancy has been explained by the differing vaccination strategies adopted by each country. Whereas the US prioritized the vaccination of groups with the highest risk and poorest COVID-19 outcomes (healthcare workers and the elderly) and emphasized the completion of vaccine doses (two doses of the Pfizer-Biotech and Moderna vaccines) in its rollout process (Bubar et al., 2021), the UK adopted a mass vaccination strategy, primarily focusing on the administration of at least a single vaccine dose to as many people and as quickly as possible (Baraniuk, 2021; Harnden and Earnshaw, 2021). It is important to note that this ap-

proach "penalized" the UK in the current study, since the receipt of two doses of a two-dose vaccine was the definition of full vaccination that was utilized. Israel, which is ranked in the 54th position globally and 34th among OECD countries by the GHS, has had the most effective COVID-19 vaccine rollout globally: as of March 2021, more than 60% of the Israeli population had been fully vaccinated, nearly double the rate of vaccination in the next country. The success of vaccination in Israel is attributed to its comparatively advantageous population size of 9.3 million people, a viable healthcare structure, and a solid vaccine rollout plan (McKee and Rajan, 2021).

In contrast, certain countries ranked highly by the GHS index have shown significant deficiencies in their vaccination campaigns. For example, although rated in the top five countries by the GHS index, Australia had a comparatively poor vaccine rollout. While the reasons for this discrepancy are unclear, it is possible that the comparatively small number of reported COVID-19 cases in Australia may have diminished enthusiasm for a vigorous vaccination campaign there. Nevertheless, many people in the highest risk category for COVID-19 infection have expressed an interest in receiving the vaccine, despite its relative inaccessibility within the country (Seale et al., 2021).

Given the obvious discrepancies between the GHS index ranking and the initial COVID-19 vaccine rollout among OECD member countries, its use in assessing country level vaccination efforts is limited. These shortcomings can be explained by the failure of the

Table 2
OECD countries and COVID-19 vaccine indices.

OECD countries	GHS index (overall ranking)	Total COVID-19 cases/million	COVID-19 vaccination start date	Cumulative COVID-19 vaccine doses/hundred	Ranking (percentage of population fully vaccinated /hundred)
US	1 (83.5)	41254.11	December 14, 2020	38.34	3 (13.6)
UK	2 (77.9)	24065.87	December 8, 2020	45.94	23 (3.7)
Netherlands	3 (75.6)	31043.71	January 6,2021	12.24	26 (3.5)
Australia	4 (75.5)	1094.59		1.21	-
Canada	5 (75.3)	10109.57	December 14, 2020	11.19	28 (1.7)
Sweden	6 (72.1)	24073.92	December 27, 2020	13.72	19 (4.1)
Denmark	7 (70.4)	13984.66	December 27, 2020	16.90	5 (5.7)
Finland	9 (68.7)	4496.17	December 27, 2020	14.99	29 (1.6)
France	10 (68.2)	34882.05	December 27, 2020	13.39	23 (3.7)
Slovenia	11 (67.2)	36467.76	December 27, 2020	14.23	8 (5.0)
Switzerland	12 (67.0)	37791.62	December 23, 2020	14.81	6 (5.5)
Germany	13 (66.0)	12769.89	December 26, 2020	13.75	18 (4.2)
Spain	14 (65.9)	35251.73	December 27, 2020	13.71	12 (4.6)
Norway	15 (64.6)	6668.21	December 27, 2020	14.50	10 (4.9)
Latvia	16 (62.9)	9052.58	December 28, 2020	5.88	30 (1.0)
Belgium	17 (61.0)	49815.71	December 28, 2020	13.40	20 (4.0)
Portugal	18 (60.3)	29231.1	December 27, 2020	13.43	14 (4.5)
Ireland	20 (59.0)	14691.57	December 29, 2020	14.37	21 (3.9)
Austria	21 (58.5)	31361.7	December 27, 2020	15.16	22 (3.8)
Chile	22 (58.3)	28862.57	December 24, 2020	47.03	2 (16.1)
Mexico	23 (57.6)	8636.62	December 24, 2020	4.60	31 (0.6)
Estonia	24 (57.0)	9278.28	December 27, 2020	17.11	16 (4.3)
Italy	25 (56.2)	26488.68	December 27, 2020	13.72	16 (4.3)
Poland	26 (55.4)	26179.65	December 27, 2020	13.72	11 (4.8)
Lithuania	27 (55.0)	22521.84	December 27, 2020	15.51	11 (4.8)
Hungary	28(54.0)	22475.58	December 26, 2020	22.68	7 (5.1)
Greece	30 (53.8)	10099.82	December 27, 2020	14.42	13 (4.7)
Turkey	31 (52.4)	7574.75	January 14,2021	16.11	4 (6.5)
Czech Republic	32 (52.0)	48865.34	December 27, 2020	13.31	25 (3.6)
Slovakia	33 (47.9)	19402.18	December 26, 2020	15.09	14 (4.5)
Israel	34 (47.3)	38956.66	December 19, 2020	113.28	1 (53.3)
Iceland	35 (46.3)	15800.73	December 29, 2020	16.08	8 (5.0)
Luxembourg	37 (43.8)	55398.29	December 28, 2020	12.46	27 (3.0)

GHS index scoring framework to collect relevant information explicitly related to vaccine rollout in the categories assessed (Global Policy Journal,2021). Furthermore, the GHS index does not take into consideration the important role of centralized health systems and the complex nature of political decisions regarding public health, particularly for country-wide vaccination programs (Lafortune, 2020). Additional reasons for the differences between vaccination matrices evaluated in the current study and the GHS index are related to the methodology of data collection and its sole dependence on data provided by the countries assessed without engaging the specific country level authorities and key stakeholders. This approach has the potential to mask any relevant existing weaknesses in a country's health system and overestimate the ability to efficiently conduct vaccination efforts. Additionally, relevant vaccination parameters, such as the cumulative number of vaccines administered in each country, are largely reflective of the complex interplay of socioeconomic determinants of health at a population level, which may not be completely captured by the GHS index. Countries with high vaccine hesitancy rates and government mistrust will inevitably report lower vaccination rates, irrespective of GHS index (Tjada,2021). As stated earlier, the GHS index inevitably fails to represent vaccination efforts in countries like Australia, with an early robust response to the COVID-19 pandemic and lower infection rates resulting in a less robust vaccine rollout.

This study had some limitations. The GHS index, a relatively new tool that provides a comprehensive assessment of global health security and level of preparedness of OECD member countries, uses only publicly available data sources from each country and published governmental information. There is a possibility of overestimation or underestimation of capabilities due to inaccurate data reported by each country. The variability in capacity of COVID-19 testing, number of deaths, number recovered, vaccine admin-

istered, and type of vaccine received by individuals might have an impact on the scoring system. Using aggregated and composite data in an ecological study can introduce collection bias. Furthermore, there is a concern that the international preparedness for epidemics and pandemics is collectively low but skewed towards the priorities of high-income countries. However, like any other cross-sectional study, it was difficult to establish a causal inference in this study. Of note, the GHS index is complex and does not account for all factors impacting global health security. As a result of continuously evolving knowledge from the pandemic, it is expected that variation in GHS index performance will be seen over time.

Inequities in vaccine administration have the potential to impede global economic recovery and compromise global health security. The top five ranked OECD countries based on the GHS index have 65% of their population receiving at least one dose of the vaccine compared to about 7% of the population in the bottom five countries on the GHS index ranking, which are primarily in Africa. As of September 2, 2021, only 2.9% of the African population has been fully vaccinated compared with 48% and 42% of the population in Europe and North America, respectively (https://ourworldindata.org/covid-vaccinations). The world is highly interconnected, which is an important factor in pandemic preparedness, as infectious diseases know no boundaries. The GHS index considers the broader context for biological risks within each country, identifies considerable potential gaps in global health security capabilities, including financing in preparedness, and illuminates those gaps by providing recommendations to counter those threats. It also helps to understand the emergence and spread of pathogens at national and international levels, the use of existing resources to predict, prevent and promptly respond to public health emergencies, and take collective action to build stronger national and global
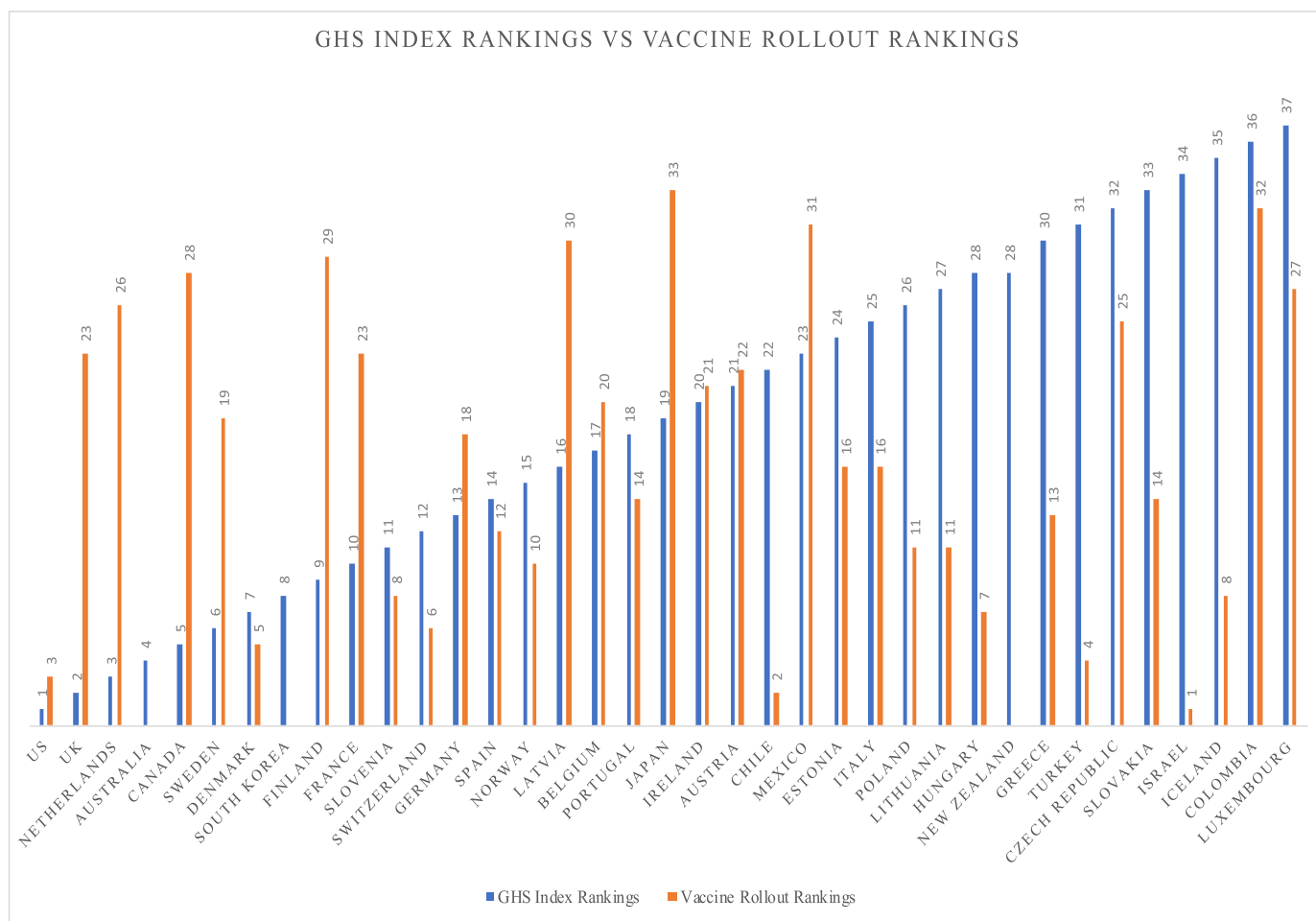
Figure 1. Comparison of GHS index rankings with rankings based on percentage of population vaccinated
GHS = Global Health Security. The above graph represents the OECD countries ranked by the GHS index (shown in blue) in ascending fashion from left to right, with a corresponding rank in vaccination rollout (shown in yellow).

health security. However, to better prepare for future events and consequences, it is important to broadly consider several other factors beyond the GHS index indicators such as social, political, economic, and environmental measures, public health services, universal health coverage, social inequities, clinical severity of infections, pre-existing comorbidities, and existing validated metrics. A more integrated global approach with international response protocols, coordinated global action and effective communication is crucial in pandemic preparedness and response.

Conclusion

This study underscores the lack of correlation between the GHS index ranking and the real-world response of OECD countries based on COVID-19 vaccine rollout. Future assessment of countries' preparedness should consider frequently reassessing the GHS index, including the potential incorporation of the effect of politico-cultural differences in countries' responses to national health emergencies. Finally, a country's vaccine hesitancy and the population's mistrust of governmental institutions should be taken into consideration when developing a framework of this nature.

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Supplementary materials

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