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Is it possible to prepare for a pandemic?

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Abstract: How effective were investments in pandemic preparation? We use a comprehensive and detailed measure of pandemic preparedness, the Global Health Security (GHS) Index produced by the Johns Hopkins Center for Health Security (JHU), to measure which investments in pandemic preparedness reduced infections, deaths, excess deaths, or otherwise ameliorated or shortened the pandemic. We also look at whether values or attitudinal factors such as individualism, willingness to sacrifice, or trust in government—which might be considered a form of cultural pandemic preparedness—influenced the course of the pandemic. Our primary finding is that almost no form of pandemic preparedness helped to ameliorate or shorten the pandemic. Compared to other countries, the United States did not perform poorly because of cultural values such as individualism, collectivism, selfishness, or lack of trust. General state capacity, as opposed to specific pandemic investments, is one of the few factors which appears to improve pandemic performance. Understanding the most effective forms of pandemic preparedness can help guide future investments. Our results may also suggest that either we aren't measuring what is important or that pandemic preparedness is a global public good.

Keywords: public health, Covid-19, health policy

JEL classification: I10, I18, H12

I. Introduction

The global SARS-CoV-II pandemic has killed in the order of 18 million people including approximately 1 million Americans. World GDP was reduced by at least $10–12 trillion dollars and potentially much more taking into account future losses due to reductions in education and increases in morbidity.[1] The tremendous losses from the pandemic suggest that much of the world responded inadequately and it's widely argued that almost all nations should invest more heavily in pandemic preparation. The G20 High Level Independent Panel (2021), for example, argues that 'The world does not lack the capacity to limit pandemic risks and to respond much more effectively than

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[1] Excess mortality calculations from *The Economist* (2021*a*), GDP losses from *The Economist* (2021*b*) and Castillo *et al.* (2021).

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it has responded to COVID-19.' The report then outlines a series of measures to better prevent, detect, and respond to a pandemic.[2]

The world, however, was not completely unprepared for the pandemic, at least on paper. Indeed, hundreds of billions of dollars were spent preparing for a pandemic or biological attack, especially since the 9/11 terror attacks, the anthrax attack in the US in 2001, and the London bombings in July 2005, as well as the SARS, MERS, and H1NI pandemics. If we are to invest more, it would be useful to know which of our previous investments were most effective in preventing, detecting, and responding to a pandemic.

The Johns Hopkins Center for Health Security (JHU) and the Nuclear Threat Initiative (NTI) working with The Economist Intelligence Unit (EIU) developed an index of pandemic preparation which was completed in 2019, just prior to the SARS-CoV-II pandemic. The JHU is one of the leading centres on biosecurity and pandemics in the world. The JHU, for example, with the participation of the US military and senior US politicians designed and ran the Dark Winter and Event 201 pandemic simulations (Perry, 2020). In addition to advising the United States, the JHU is also an important advisor to the World Health Organization (WHO) and the United Nations.[3]

The Global Health Security (GHS) Index was designed by a panel of 21 experts in virology, public health, and bio-security from 13 countries who created a detailed framework of 140 questions, organized across six categories, 34 indicators, and 85 sub-indicators to assess a country's capability to prevent and mitigate epidemics and pandemics. A team of more than 100 researchers then gathered data from 195 countries. Each country's items were validated for accuracy and consistency and each country had the opportunity to review the data (JHU, 2019). Notably, a goal of the index was to measure and rank not just paper 'capacity', but the ability to 'marshal and effectively use capacities to prevent, detect, and respond to a high-consequence biological threat' (JHU, 2019).

In this paper we use the GHS Index as a measure of pandemic preparedness and, using a wide variety of indicators, we ask whether being prepared ameliorated or shortened the pandemic. Note that *we are not evaluating pandemic policy*, that is we are not evaluating whether lockdowns, masks, public health messaging, or other such pandemic policies were effective. We are evaluating the effectiveness of pandemic *preparation*. Assume, for example, that lockdowns are an effective means of controlling a pandemic but that lockdowns require very little in the way of preparation. In this case, we would find that pandemic preparedness was ineffective even though the pandemic policy of lockdowns was effective. But if pandemic preparedness helped to prepare for quicker or better lockdowns, then pandemic preparedness would be effective. We investigate these mechanisms further below.

Pandemic policy is inherently difficult to evaluate because policy is endogenous—policy influences the pandemic and the state of the pandemic influences policy—so it's difficult to disentangle cause and effect. An advantage of studying pandemic preparedness is that preparedness is relatively exogenous in comparison to pandemic policy. Preparedness happens before a pandemic, perhaps years or decades before a pandemic.

[2] The WHO Independent Panel for Pandemic Preparedness & Response (2021) offers similar recommendations. See also former FDA commissioner, Scott Gottlieb (2021).

[3] See The Johns Hopkins Center for Health Security Annual Reports, https://www.centerforhealthsecurity.org/who-we-are/annual_report/, for example, JHU (2020).

Preparedness is also influenced by many factors other than the expected state of a pandemic—factors such as income and scientific expertise and even luck or whim. George W. Bush, for example, famously demanded an increase in pandemic preparedness in the United States after reading John M. Barry's *The Great Influenza* (Biasco, 2020). The fact that the Covid-19 pandemic largely caught the world by surprise is also indicative of the exogeneity of preparation. Nonetheless, with those factors in mind, however, our analysis is primarily correlational.

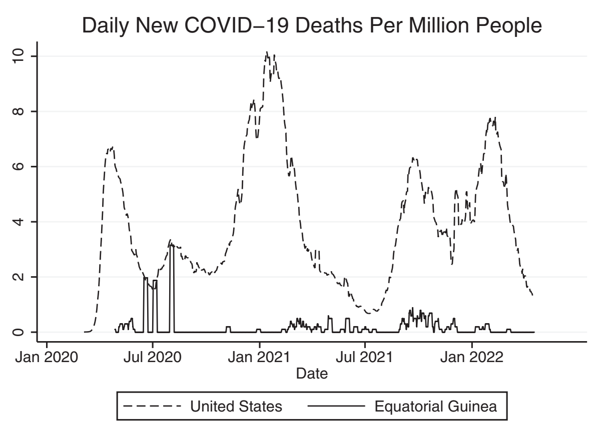
The country that ranked highest for pandemic preparedness in the GHS Overall Index was the United States, with a score of 83.5 out of a possible 100. The country that ranked lowest was Equatorial Guinea, with a score of 16.3. Figure 1 offers a simple but stark preview of our results. The United States, the country most prepared for a pandemic, had a much higher Covid death rate *per capita* than the country least prepared for a pandemic, Equatorial Guinea.

Of course, Figure 1 leaves out many other factors. The United States was more connected with the rest of the world. Deaths in Equatorial Guinea may be undercounted. The United States has a better medical system and so forth. After introducing the data, what we show in great detail in the sections below is that regardless of how we cut the data or adjust for other factors a similar story emerges—pandemic preparations had very little influence on the course of the pandemic.

II. Data

Our primary measure of preparedness is the Global Health Security Index (GHS). The basis of the Index are 96 qualitative and 44 quantitative country-level questions, such as 'Does the country have a national law requiring prescriptions for antibiotics?' or 'How many hospital beds per capita does the country have?' The answers to each of these questions are translated into a score for each country ranging from 0, meaning the least secure, to 100, meaning the most secure. A score of 100 on a question does not indicate

Figure 1: Dynamics of Covid-19 deaths in the most and least prepared countries



Note: 7-day rolling average.

that a country has perfect health security. A high score indicates a high degree of security relative to other countries, not relative to some ideal policy.

The scores for each question are then combined through a weighted sum to create 34 *indicators*, which are then aggregated into 6 *categories*, each measuring a different facet of health security. One final weighted sum of these six categories creates each country's overall GHS score of health security. Table 1 presents summary statistics and descriptions for the GHS Index and its six component categories, as well as examples of questions that are used to construct each category.

The GHS Index was created to measure a country's preparedness for all types of biological threats, not just respiratory viruses like SARS CoV-II. For example, several questions of the index concern the use of antibiotics and the management of antimicrobial-resistant (AMR) bacteria, while others evaluate how well a country maintains the confidentiality of patient health records, neither of which should matter much in mitigating the spread of Covid-19.

Table 1: GHS and categories

Variable	Description	Example questions	Mean	Std. Dev.
GHS	Overall health security	N/A	41.6	14.4
Prevention	Prevention of the emergence or release of pathogens	Does the country maintain surveillance systems for zoonotic diseases? Does the country have a national law requiring prescriptions for antibiotics?	36.3	16.7
Detection	Early detection and reporting for epidemics of potential international concern	Can the country's lab system conduct five or more WHO core tests? Does the country have an electronic real-time reporting system?	44.3	23.3
Response	Rapid response to and mitigation of the spread of an epidemic	Does the country have a national emergency response plan for a pandemic? Has the country completed a biological-focused IHR exercise with the WHO within the past year?	39.6	15.1
Health system	Sufficient and robust health system to treat the sick and protect health workers	Does the country mandate universal healthcare coverage? Does the country have a plan to address routine and emergency PPE supply issues?	27.8	17.1
Norms	Commitments to improving national capacity financing plans to address gaps, and adhering to global norms	Has the country submitted IHR reports to the WHO within the past year? Is the country a member of a global health security and/or biological weapons agreement?	49.5	12.5
Risk	Overall risk environment and country vulnerability to biological threats	What is the country's EIU score for government effectiveness? Does the country have an adequate road network?	55.5	16.6

Note: IHR is International Health Regulations; PPE is personal protective equipment.

With this in mind, we also examine the impact of several individual indicators of special relevance for preparation for Covid-19: whether or not a country has universal healthcare, a country's number of hospital beds per 100,000 people, whether a country maintains a stockpile of medical countermeasures for use during public health emergencies, and whether a country conducts ongoing event-based surveillance and daily analysis for infectious diseases. To this list, we also add whether or not a country has a national plan for a pandemic, whether or not a country conducted a simulation exercise with the WHO recently, and whether or not the country experienced a public health emergency between 2017 and 2019.

We chose these measures because, in addition to inherent plausibility, measures like these have been suggested as areas for future investment. The Biden Administration's plan for improving US preparedness for future pandemics, for example, recommends that the United States 'establish [a] reliable clinical surveillance system for early detection of emerging pathogens', 'refill depleted pandemic stockpiles', and 'reduce health inequities exacerbated by public health emergencies' (Lander and Sullivan, 2021). Similarly, Rauch (2022) writes that:

> in the world of public health, there is little disagreement on the measures required for resilience and preparedness: real-time monitoring and early warning of new infectious agents; more and faster vaccine development; stockpiling equipment and expanding supply chains and health-system surge capacity; improving public-health infrastructure; and more.

In April 2020, the NTI itself pointed to the United States' 'lack of guaranteed access to healthcare for all citizens', low number of hospital beds *per capita*, and 'low level of confidence among the public' in the government as creating vulnerability to Covid-19 despite the US's number one ranking. Summary statistics for these questions of interest are detailed in Table 2.

To measure the severity of the Covid-19 pandemic in each of our countries, we use five measures: the total number of Covid-19 cases and deaths per million inhabitants according to the Center for Systems Science and Engineering at Johns Hopkins University, the total number of Covid-19 cases and deaths for each 1 million tests conducted by a country calculated using the CSSE data and Our World in Data national government reports, and the estimated number of excess deaths per 100,000 inhabitants as calculated by *The Economist*'s excess deaths model.

A concern of our analysis is omitted variable bias. Countries differ in a wide variety of variables which are correlated both with pandemic preparedness and pandemic outcomes. We control for some of the most important differences by including important demographic variables such as the fraction of the population above age 70, the obesity rate, population density, and the United Nations Development Programme's Human Development Index (HDI) as controls in most of our specifications. Micro-studies of individual components that better control for other factors will be able to estimate causal effects in greater specificity and detail. But looking at a large number of countries and a wide-range of static and dynamic indicators suggests that variables other than pandemic preparedness dominated whatever influence pandemic preparedness may have had and that finding is likely to be robust and important for guiding future investments. Summary statistics for our response and control variables are contained in Table 3.

The GHS Index primarily measures the preparedness of a country's government, but it's possible that pandemic preparation is more than just a matter of legislation. The

Table 2: GHS questions of interest

Variable	Description	Scale	Mean	Std. Dev.
Universal healthcare	Has the country enacted legislation mandating universal healthcare coverage?	0= No 1= Yes	0.55	0.49
Hospital beds	How many hospital beds does the country have per 100,000 people?	Beds per 100,000 people	20.41	17.69
Pandemic planning	Does the country have a national public health emergency response plan for disease with pandemic potential?	0= No 1= Yes	0.48	0.49
MCM stockpiles	Does the country maintain stockpiles of medical countermeasures (MCM) for use during public health emergencies?	0= No 1= Yes	0.52	0.49
IHR exercise	Has the country conducted a simulation exercise with the WHO?	0= No 1= Yes	0.16	0.36
Event surveillance	Does the country conduct ongoing event-based surveillance and daily analysis for infectious diseases?	0=No 1=Yes	0.43	0.49
Potential PHEIC	Has the country reported a potential public health emergency of international concern (PHEIC) to the WHO between 2017 and 2019?	0=No 1= Yes	0.42	0.49

Table 3: Response and control variables

Variable	Description	Source	Mean	Std. Dev.
Cases	Total Covid-19 cases per million	CSSE at Johns Hopkins University	118,299	132,036
Deaths	Total Covid-19 deaths per million	CSSE at Johns Hopkins University	1,126	1,246
Tests	Total tests performed (millions)	OWID national government reports	68	155.5
Shots	People vaccinated per 100	OWID national government reports	64.38	22.1
CFR	Age standardized case fatality rate	Hong *et al.* (2021)	2.1	1.5
Cases per test	Cases per 1 million tests	Author calculated	120,955	76,697
Deaths per test	Deaths per 1 million tests	Author calculated	1975.47	3417.4
Excess deaths	Estimated excess deaths per 100k	*The Economist*	85.6	99.9
% > 70 years	Share of the population that is 70 years and older in 2015	United Nations, Department of Economic and Social Affairs	5.4	4.24
Population density	Population density	World Bank World Development Indicators	303.1	1547.3
% Obese	Share of the population that is obese	World Health Organization	19.03	10
HDI	Human Development Index	United Nations Development Programme	0.72	0.15

Table 4: Global Values Survey (GVS) variables

Variable	Question	Scale	Mean	Std. Dev.
WHO trust	How much confidence do you have in the World Health Organization?	1=A great deal 4=None at all	2.34	0.36
Government responsibility	How would you place your views on this scale?	1=Government should take more responsibility to ensure that everyone is provided for 10= People should take more responsibility to provide for themselves.	4.89	0.92
Selflessness	Is unselfishness an important quality in children?	0= No 1= Yes	0.29	0.12
Trust in people	Which of the following best describes your views?	0= Need to be very careful 1= Most people can be Trusted	0.20	0.15
Willingness to fight	We hope that there will not be another war, but if it were to come to that, would you be willing to fight for your country?	0= No 1= Yes	0.71	0.15
Scientific optimism	Science and technology are making our lives healthier, easier, and more comfortable.	1= Completely disagree 10= Completely agree	7.42	0.62
Scientific ignorance	It is *not* important for me to know about science in my daily life.	1= Completely disagree 10= Completely agree	4.68	0.84

public's trust in public health authorities, willingness to sacrifice individual liberties for the common good, or degree of scientific literacy could all affect the severity of Covid-19 in a country just as much as any governmental policy. What's more, differing cultural factors between countries could cause the same *de jure* policies to be highly effective in one country while having a negligible effect in another.

To assess the efficacy of cultural preparation against Covid-19, we use data from the 7th wave of the Global Values Survey (GVS), which surveyed 76,897 individuals in more than 120 countries between 2017 and 2019. The GVS questionnaire consists of more than 600 indicators measuring respondents' beliefs on a wide range of topics. After aggregating the GVS data to the country level, we use six measures of cultural attitudes that seem particularly relevant for pandemic preparation, summarized in Table 4.

III. Results

(i) Static results

Figure 1 showed that the most prepared pandemic country performed worse than the least prepared country. Table 5 shows that Figure 1 generalizes, in raw correlation the best prepared countries did no better and perhaps worse than the least prepared countries. Columns 1 and 3 in Table 1 show that total cases per million and total deaths per

Table 5: Overall preparedness vs cases, deaths, and case fatality rate

	(1)	(2)	(3)	(4)	(5)	(6)
	Total cases per million	**Total cases per million**	**Total deaths per million**	**Total deaths per million**	**CFR**	**CFR**
GHS Index	4,807.79***	764.0	34.62***	–3.777	0.006	0.0134
	(8.40)	(1.13)	(6.61)	(–0.48)	(0.61)	(0.49)
% >70 years old		11,134.2***		134.2***		–0.0294
		(3.76)		(4.01)		(–0.36)
% Obese		–207.0		20.07*		0.0616
		(–0.23)		(2.12)		(1.47)
Population density		6.299		–0.187**		–0.000690
		(0.58)		(–2.97)		(–1.76)
HDI		45,619.8***		192.5*		–0.193
		(4.69)		(2.46)		(–0.62)
Constant	–77,866.8	–59,232.6*	–297.34	–141.0	1.76**	1.007
	(–3.51)	(–2.55)	(–1.55)	(–0.61)	(3.06)	(0.99)
Observations		175		174		49

Notes: *t* statistics in parentheses. $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

million as of 15 March 2022 both increased with pandemic preparedness. Adding control variables for demographics and development changes the size of the coefficient and sometimes flips the sign, but in no cases is the effect of pandemic preparations on cases or deaths statistically or economically significant. Columns 5 and 6 show that there is also no effect of pandemic preparation on the case fatality rate (CFR).

Table 6 breaks the GHS Index down into its component categories—prevention, detection, response, and so forth—and looks at the correlation with deaths per million after controlling for demographics and development. In almost all cases, the index categories are positively related to total deaths per million. Only the risk category is negatively related. The risk category is a somewhat peculiar mix of variables, such as the risk of an armed conflict in the country, natural disaster risk, the degree of literacy, gender equality, and most importantly (in our view) a measure of government effectiveness. Later we focus on government effectiveness directly.

It's now widely recognized that many countries undercounted Covid deaths, sometimes substantially. Russia, for example, had an official Covid death count of 110,000 as of April 2021 but excess deaths in the order of 500,000, resulting in a very large undercount ratio of 4.5 (Karlinsky and Kobak, 2021). Thus, we also look at measures of excess deaths in Table 7. Coefficients change but as before there is little evidence for important effects of most preparation variables on excess deaths, with the exception of the risk category.

Even for the sub-components of the index that should reduce deaths directly, the relationship is almost always positive, i.e. the opposite to what one might expect. Excess deaths, for example, increase with the ability of the health sector to treat the sick, as shown in Figure 2. Evidently, other factors overwhelm the direct effect.

Finally, we examine the relationship between seven specific indicators of preparedness that seem especially relevant for the Covid-19 pandemic in Table 8.

With two exceptions, all of the variables most likely to be relevant to reducing deaths in a pandemic are of the 'wrong' sign or are statistically insignificant. Excess deaths, for

Table 6: GHS Index categories vs deaths

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Total deaths per million	**Total deaths per million**	**Total deaths per million**	**Total deaths per million**	**Total deaths per million**	**Total deaths per million**	**Total deaths per million**
Prevention	–0.849						3.491
	(–0.13)						(0.38)
Detection		0.925					3.073
		(0.25)					(0.52)
Response			–5.239				–6.109
			(–0.84)				(–0.67)
Capacity				–4.373			–3.090
				(–0.63)			(–0.28)
Norms					1.473		4.737
					(0.19)		(0.49)
Risk						–18.70*	–17.94*
						(–2.05)	(–2.01)
% >70 years old	129.4***	125.7***	134.4***	135.9***	125.6***	148.8***	140.4***
	(3.99)	(4.19)	(4.53)	(4.16)	(3.97)	(4.98)	(3.85)
% Obese	20.59*	21.03*	19.89*	20.06*	21.09*	21.74*	22.94*
	(2.20)	(2.29)	(2.12)	(2.13)	(2.27)	(2.28)	(2.39)
Population density	–0.188**	–0.188**	–0.180**	–0.190**	–0.186**	–0.152*	–0.138*
	(–3.07)	(–3.14)	(–2.72)	(–3.02)	(–3.13)	(–2.47)	(–2.24)
HDI	181.0*	172.4*	192.9*	199.8*	176.6*	335.4**	333.3*
	(2.27)	(2.20)	(2.43)	(2.58)	(2.22)	(2.68)	(2.59)
Constant	–229.7	–274.7	–90.17	–199.0	–315.4	350.4	160.0
	(–1.41)	(–1.87)	(–0.46)	(–1.74)	(–0.86)	(1.09)	(0.33)
Observations	174	174	174	174	174	174	174

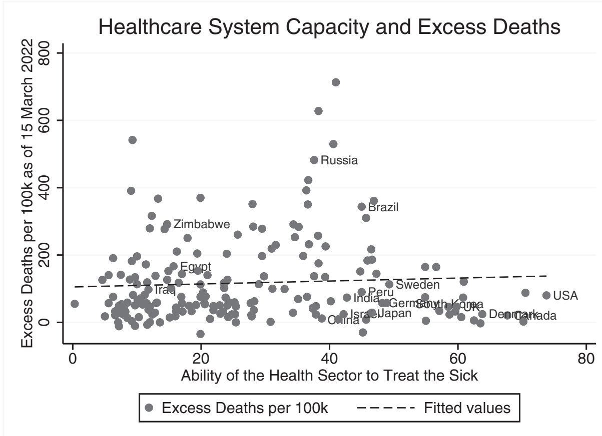
Notes: *t* statistics in parentheses. $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 7: GHS Index categories vs excess deaths

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Excess deaths per 100k	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**
Prevention	–0.164						0.800
	(–0.17)						(0.59)
Detection		0.334					1.019
		(0.66)					(1.65)
Response			–1.278				–1.618
			(–1.50)				(–1.17)
Capacity				–0.597			0.291
				(–0.87)			(0.23)
Norms					–0.766		–0.623
					(–0.83)		(–0.53)
Risk						–4.641**	–4.473**
						(–3.13)	(–2.93)
% >70 years old	3.896	2.800	5.194	4.703	4.775	8.783*	7.151
	(0.96)	(0.77)	(1.46)	(1.32)	(1.34)	(2.39)	(1.81)
% Obese	0.424	0.579	0.236	0.346	0.256	0.830	0.960
	(0.42)	(0.58)	(0.23)	(0.33)	(0.24)	(0.78)	(0.88)
Population density	–0.0214**	–0.0214**	–0.0195*	–0.0217**	–0.0226**	–0.0122	–0.0109
	(–2.66)	(–2.77)	(–2.29)	(–2.62)	(–2.66)	(–1.59)	(–1.33)
HDI	1.473	–0.940	4.654	3.844	0.531	39.48	32.61
	(0.11)	(–0.07)	(0.36)	(0.29)	(0.04)	(1.74)	(1.41)
Constant	95.66***	82.16***	130.7***	98.99***	128.0**	239.5***	261.2***
	(3.92)	(3.67)	(4.46)	(5.34)	(2.63)	(4.74)	(3.78)
Observations	175	175	175	175	175	175	175

Notes: *t* statistics in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Figure 2: Healthcare system capacity and excess deaths



example, are positively related to a country having universal health care. The exceptions are that countries that had recently conducted an exercise with the WHO or reported a potential Public Health Emergency of International Concern (PHEIC) to the WHO in any of the 3 years prior to the SARS-CoV-II pandemic had fewer excess deaths. At best, therefore, this suggests that having *experienced* a *recent* potential pandemic event is helpful in preparing for an actual pandemic. Thus, preparation may be useful but perhaps not of the type measured by capacities or resources but more of the type represented by the (unmeasured) willingness to act. Note, however, that the unmeasured willingness to act was local and experiential—evidently countries find it difficult to learn from one another—making it difficult to transmit this learning in the future.

(ii) Dynamic results

It could be the case that highly prepared countries saw the same number of infections and deaths as unprepared countries but were able to spread them more evenly over time, i.e. 'flattening the curve'. Ideally, flattening the curve would result in fewer deaths, but perhaps the pandemic lasted too long for this to be possible. Nevertheless, flattening might be useful in a shorter pandemic. If flattening happened we would expect that highly prepared countries would show a markedly different pattern of excess deaths than less prepared countries, most notably having fewer peaks, for example.

Figure 3 shows that there is little to no evidence that highly prepared countries were better able to flatten the curve or, more generally, markedly change the pattern of excess deaths. Whether looking at all countries (panel (a)) or within high HDI countries (panel (b)), countries with a high GHS Index showed similar patterns in excess deaths over time to less prepared countries. The same thing is true if we look at the more specific variable 'Ability to rapidly respond to an epidemic' (panels (c) and (d)).

Similarly, Figure 4 shows that countries with pandemic plans in place were *not* quicker to impose lockdowns, as measured by the Stringency Index, than countries that did not have pandemic plans in place.

Table 8: GHS Index questions of interest vs excess deaths

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Excess deaths per 100k	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**
Universal healthcare	14.24							7.759
	(0.83)							(0.43)
Hospital beds		1.047						0.490
		(0.90)						(0.44)
Pandemic planning			10.38					12.22
			(0.50)					(0.57)
MCM stockpiles				27.50				36.67
				(1.57)				(1.80)
IHR exercise					–41.42*			–41.63*
					(–2.18)			(–2.05)
Event surveillance						–35.91		–12.11
						(–0.99)		(–0.36)
PHEIC report							–66.26***	–67.46***
							(–3.71)	(–3.72)
% >70 years old	3.117	1.539	3.465	2.606	3.787	4.078	4.315	1.948
	(0.99)	(0.43)	(1.07)	(0.82)	(1.21)	(1.25)	(1.45)	(0.52)
% Obese	0.491	0.740	0.590	0.614	0.174	0.507	–0.187	0.0534
	(0.50)	(0.67)	(0.59)	(0.64)	(0.17)	(0.50)	(–0.19)	(0.05)
Population density	–0.0211**	–0.0199*	–0.0218**	–0.0227**	–0.0227**	–0.0221**	–0.0267**	–0.0297**
	(–2.87)	(–2.40)	(–2.70)	(–2.68)	(–2.81)	(–2.67)	(–3.00)	(–2.92)
HDI	–0.989	–4.951	–0.919	–2.083	–0.623	0.196	–1.801	–11.91
	(–0.08)	(–0.36)	(–0.07)	(–0.17)	(–0.05)	(0.02)	(–0.15)	(–0.95)
Constant	89.17***	87.18***	88.41***	85.41***	105.8***	92.24***	134.6***	131.1***
	(4.94)	(4.70)	(4.73)	(4.84)	(5.73)	(5.44)	(6.69)	(4.72)
Observations	175	175	175	175	175	175	175	175

Notes: *t* statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

(iii) Cultural preparedness

Preparing for a pandemic may require more than government investment. It may also require a public who trust public health authorities and who are willing to sacrifice for the common good. Slavitt (2021), for example, argues that in comparison to countries that did well in the pandemic: 'the American public was impatient, untrusting, and unaccustomed to sacrificing individual rights for the public good' (p. 65).

A similar assessment was offered by Miranda (2020) who argued

> We live in a culture of rugged individualism run amok. Call it toxic individualism. Because in the case of this pandemic, it is literally toxic.... The focus on individual rights over the greater good is one for which we are paying with our health and our lives.

To test this we draw from questions on the Global Values Survey dealing with trust in government, selflessness as a virtue, trust in science, trust in other people, and willingness to sacrifice for the collective. Table 9 shows the results.

Of the five measures of cultural preparedness we examine, only three are significantly associated with the severity of the pandemic conditional on development, and one is associated in the 'wrong' direction. Namely, countries that were more trusting of the WHO had more deaths per capita than similarly developed countries that were less trusting of the WHO.

Figure 3: Preparedness and dynamics of excess deaths

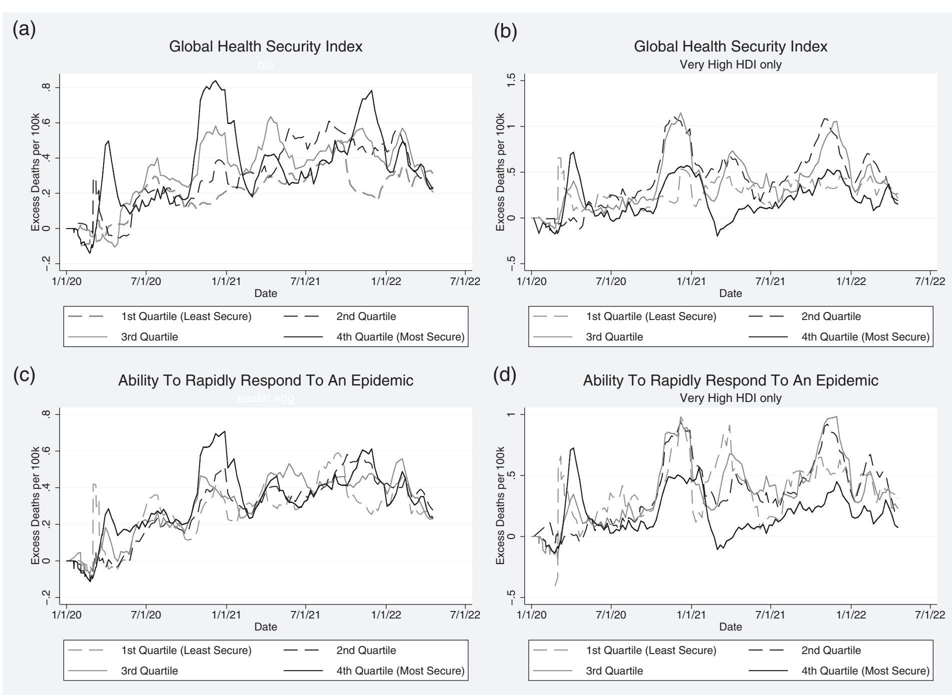
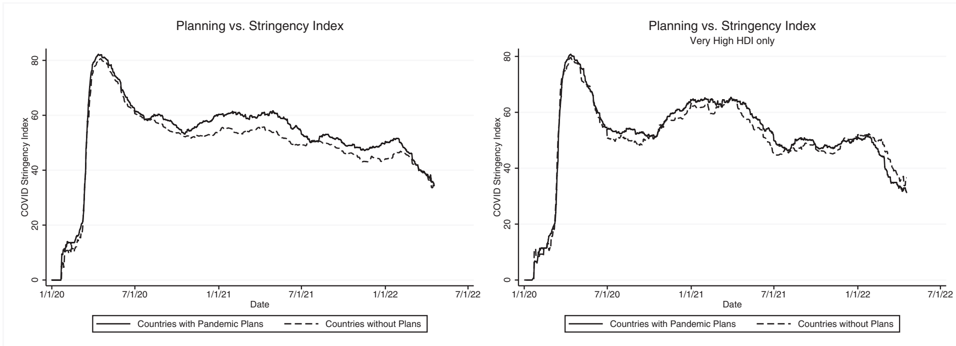


Figure 4: Preparedness and dynamics of Covid restrictions



Public beliefs that the state ought to ensure that everyone is taken care of, that selflessness is an admirable quality in children, and that military service to one's country is virtuous were all unassociated with excess deaths.

Countries with greater trust in people and less scientific ignorance do appear to have had fewer excess deaths, though neither relationship is statistically significant when the model includes all our measures of cultural preparedness as shown in column 7 of Table 9.

Figure 5 below tests the idea that the US failure to contain SARS-CoV-II was a result of the public's unwillingness to 'sacrifice individual liberty for the common good'. Peru and South Korea, two countries with very similar beliefs about the degree to which the government should ensure that everyone is cared for, had among the highest and lowest levels of excess deaths, respectively. Additionally, the United States is not an outlier, with Americans giving similar answers on average to Canadians.

Figure 6 shows the relationship between trust in others and cumulative excess deaths. While higher levels of social trust are clearly associated with fewer deaths, the data also do not support the claim that the United States specifically failed due to low levels of trust. The United States is the sixth-most trusting country in our sample, ahead of countries like South Korea and Japan who were extremely effective at containing the virus. Indeed, the United States did much *worse* than its levels of social trust would predict.

It could be the case that cultural preparedness *augments* the impact of state preparedness measured using the GHS Index. For example, non-pharmaceutical interventions, such as mask mandates and stay-at-home orders, could only be effective in countries where people are more trusting of science or are more willing to sacrifice individual liberty for the common good. To test this possibility, we interact each country's levels of cultural preparedness with its GHS measure of health security. As displayed in Table 10, none of the five measures of cultural preparedness curtailed excess deaths when interacted with the GHS Index.

Although countries' cultural values did not appear to influence the severity of the pandemic, it is possible that cultural values influenced countries' responses to the pandemic. We examine the influence that cultural values had on countries' pandemic responses by comparing the path of Oxford's Covid-19 stringency index in countries in the highest and lowest quartile of our measures of cultural preparedness. Figure 7 compares the policy responses of countries where most respondents believe the government should do more to provide for everyone and countries where more respondents believe that people should instead take more responsibility for themselves. There does

Table 9: Cultural preparedness vs excess deaths

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Excess deaths per 100k	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**
Confidence in WHO	133.2						29.86
	(1.62)						(0.32)
Government responsibility		–15.58					–10.23
		(–0.86)					(–0.53)
Selflessness			–123.9				–43.93
			(–0.74)				(–0.26)
Trust in people				–397.7***			–337.4
				(–3.64)			(–1.54)
Willingness to fight					15.79		–40.80
					(0.10)		(–0.27)
Scientific ignorance						49.16*	34.50
						(2.25)	(1.37)
% >70 years old	–12.96*	–11.21	–11.34	–3.726	–10.42	–7.814	–4.903
	(–2.19)	(–1.88)	(–1.96)	(–0.60)	(–1.45)	(–1.28)	(–0.55)
% Obese	–4.535	–0.257	0.342	–0.823	–0.112	–0.528	–1.508
	(–1.38)	(–0.14)	(0.18)	(–0.52)	(–0.06)	(–0.27)	(–0.45)
Population density	–0.0308**	–0.0218**	–0.0207**	–0.0181*	–0.0215**	–0.0169*	–0.0162
	(–3.00)	(–2.97)	(–2.94)	(–2.59)	(–2.83)	(–2.24)	(–1.37)
HDI	39.00	28.00	26.12	35.44	26.49	19.10	31.56
	(1.11)	(0.88)	(0.81)	(1.12)	(0.84)	(0.60)	(0.86)
Constant	–61.26	244.7*	196.1**	197.9***	152.3	–60.17	76.49
	(–0.38)	(2.38)	(3.51)	(5.11)	(1.03)	(–0.55)	(0.28)
Observations	42	44	44	44	44	44	42

Notes: *t* statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Figure 5: Public support for the common good and excess deaths

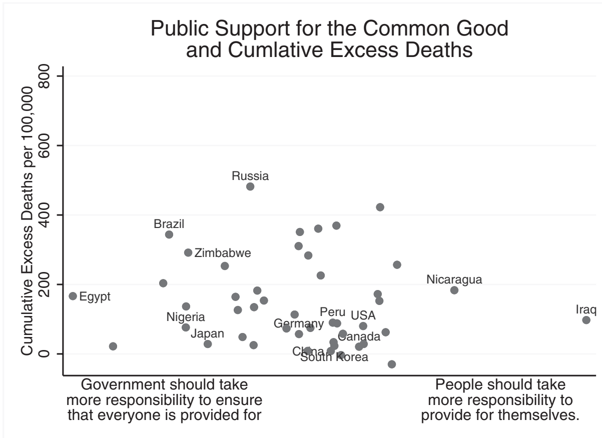
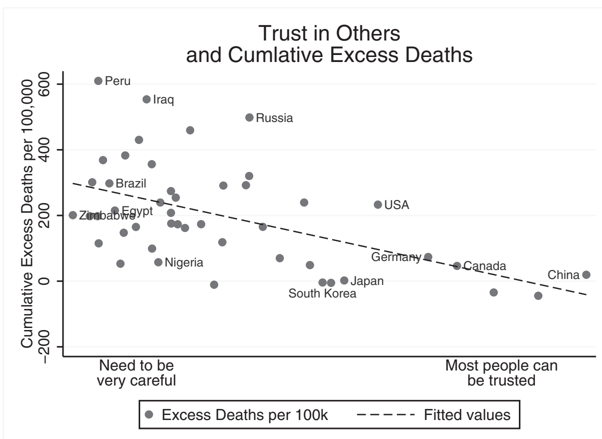


Figure 6: Social trust and excess deaths



not appear to be a systematic difference between the two groups: the most individually minded countries and the most socially minded implemented equally harsh restrictions early in the pandemic with equal speed. In the spring and summer of 2020, communitarian countries relaxed their restrictions faster than individualist countries, before ramping them back up in the fall and winter.

Overall, there is little to no evidence that cultural values played a major role in explaining excess deaths or the dynamic response to the pandemic.

(iv) State capacity

State capacity is a multi-dimensional concept widely used and debated in political science and economics (e.g. Besley and Persson, 2009; Cingolani, 2013; Johnson and Koyama, 2017). We define it here as the ability of a state to implement its goals or

Table 10: Cultural preparedness interactions vs excess deaths

	(1)	(2)	(3)	(4)	(5)	(6)
	Excess deaths per 100k	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**	**Excess deaths per 100k**
Confidence in WHO	–160.6					
	(–0.44)					
Government responsibility		176.4*				
		(2.27)				
Selflessness			–554.7			
			(–0.99)			
Trust in people				–316.3		
				(–0.38)		
Willingness to fight					–196.0	
					(–0.27)	
Scientific ignorance						155.8
						(1.07)
Global Health Security Index	–18.84	12.47	–6.828	–2.159	–5.021	4.245
	(–1.08)	(1.09)	(–1.54)	(–0.43)	(–0.52)	(0.32)
Interaction	7.425	–3.134	9.384	–0.0663	1.638	–1.521
	(0.96)	(–1.47)	(0.97)	(–0.00)	(0.12)	(–0.53)
HDI	1.624	41.45	42.38	46.44	29.50	28.48
	(0.05)	(1.15)	(1.08)	(1.26)	(0.87)	(0.89)
Constant	618.6	–638.9	441.5*	240.6	436.5	–483.3
	(0.78)	(–1.54)	(2.18)	(1.02)	(0.82)	(–0.74)
Observations	44	46	46	46	46	46

Notes: t statistics in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Figure 7: Public support for the common good and dynamics of Covid restrictions

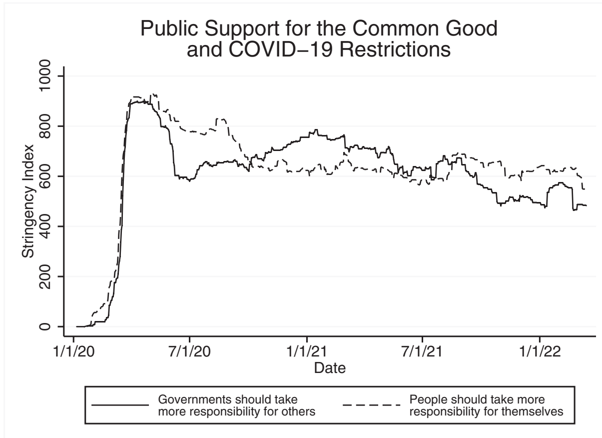


Table 11: State capacity vs excess deaths

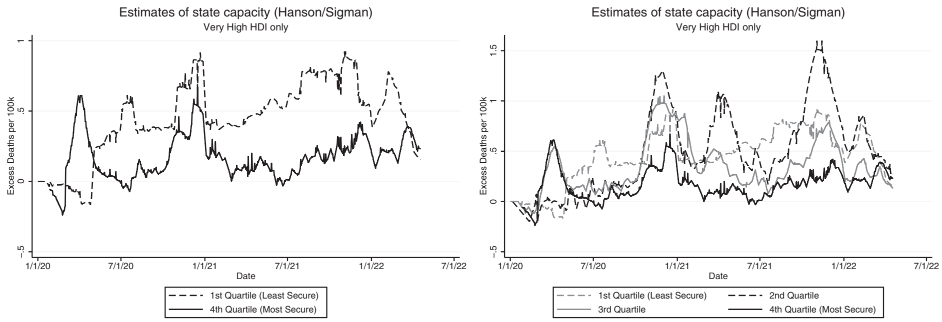
	(1)	(2)
	Excess deaths per 100k	**Excess deaths per 100k**
State capacity	–1.294	–45.13*
	(–0.13)	(–2.16)
% >70 years old		7.979
		(1.78)
% Obese		1.462
		(1.11)
Population density		–0.0153*
		(–2.17)
HDI		12.92
		(0.74)
Constant	128.1***	61.23**
	(11.69)	(2.83)
Observations	159	157

Notes: *t* statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

policies. The Indian government, for example, requires, and by all accounts wants, drivers to pass a driving test before obtaining a driver's licence, but up to 30–40 per cent of drivers in India have fake licences and may be unqualified to drive (Bertrand *et al.*, 2007). The Indian government, therefore, has difficulty implementing its driving goals and this failure can be considered an illustration of low state capacity.

As we noted earlier, the GHS Risk Index includes a measure of government effectiveness that covers concepts such as the control of corruption and the perceived quality of bureaucracy, but it also covers gender equality, risks from non-state actors such as organized crime, and the quality of the roads, airports, and infrastructure. To focus attention on state capacity we turn to a recent comprehensive effort to quantify state capacity, the Hanson and Sigman (2021) state capacity index. Using this index, we ask whether state capacity influenced the course of the pandemic.

Figure 8: State capacity and dynamics of excess deaths



As seen in Table 11, higher levels of state capacity, conditional on demographics and economic development, tend to be associated with fewer cumulative excess deaths.

Figure 8 below compares the trajectory of excess deaths in rich countries in the highest and lowest quartile of state capacity scores. Here again the highest state capacity countries appear to have had lower excess mortality for most of the pandemic. Breaking state capacity into quartiles the effect is a little less clear since the quartiles are not uniformly ordered, but the highest (4th quartile) state capacity countries had lower excess mortality through most of the pandemic.

(v) Preparedness and vaccination

Vaccination was by far the best weapon against the virus. Quite a few of our measures correlate with the percent of people vaccinated (as of 1 September 2021) including the GHS Index and subcomponents like the 'ability to rapidly respond to an epidemic'. Percent vaccinated also correlates positively with state capacity, as shown in Table 12. Most of these correlations, however, are simply measures of development and GDP *per capita*. A more precise question is whether preparedness or any of these other variables predicted *faster* vaccination.

As Table 13 shows, preparedness as measured by the GHS Index or the rated ability to respond rapidly did not predict faster vaccination. In addition, level of concern for others and level of distrust in science all fail to predict speedier vaccination. Only Hanson and Sigman's (2021) estimate of state capacity predicts speedier vaccination: each additional point of state capacity decreases the time needed to vaccinate 10 per cent of the population by nearly 4 weeks. The online Appendix demonstrates that this result is consistent across multiple vaccination thresholds.

IV. Discussion and conclusion

More 'preparedness' is surely better. Yet, more prepared nations as measured by the GHS Index did not perform systematically better over the course of the pandemic. Why? We suggest two reasons. First, the window of opportunity for preparedness

Table 12: Preparedness measures and vaccine uptake

	(1)	(2)	(3)	(4)	(5)
	% Vaccinated	**% Vaccinated**	**% Vaccinated**	**% Vaccinated**	**% Vaccinated**
GHS Index	0.490**				
	(3.09)				
Response		0.305*			
		(2.30)			
Government responsibility			0.897		
			(0.24)		
Scientific ignorance				4.036	
				(1.10)	
State capacity					8.803**
					(2.80)
% >70 years old	–0.890	–0.673	0.0679	0.462	–1.293*
	(–1.56)	(–1.19)	(0.08)	(0.56)	(–2.10)
% Obese	–0.833***	–0.862***	–0.572*	–0.524*	–0.890***
	(–3.74)	(–3.76)	(–2.28)	(–2.14)	(–4.10)
Population density	0.00113	0.000704	0.000614	0.00129	0.0000851
	(0.66)	(0.41)	(0.59)	(1.28)	(0.09)
HDI	19.48***	21.66***	16.54*	14.83*	19.28***
	(4.86)	(5.69)	(2.30)	(2.25)	(3.99)
Constant	16.53*	20.95*	37.87	23.74	37.05***
	(2.04)	(2.51)	(1.72)	(1.04)	(4.73)
Observations	67	67	27	27	63

Notes: *t* statistics in parentheses. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 13: Preparedness measures and time to vaccinate 10 per cent of population

	(1)	(2)	(3)	(4)	(5)
	Days to vaccinate 10% of population	**Days to vaccinate 10% of population**	**Days to vaccinate 10% of population**	**Days to vaccinate 10% of population**	**Days to vaccinate 10% of population**
GHS Index	0.144				
	(0.26)				
Response		–0.0971			
		(–0.27)			
Government responsibility			–12.45		
			(–1.48)		
Scientific ignorance				–8.348	
				(–1.27)	
State capacity					–27.44*
					(–2.28)
% >70 years old	–1.975	–1.600	1.215	0.986	0.677
	(–1.32)	(–1.04)	(0.80)	(0.56)	(0.43)
% Obese	–1.969*	–2.002*	–0.991*	–0.841	–1.758*
	(–2.34)	(–2.46)	(–2.17)	(–1.63)	(–2.20)
Population density	–0.0130	–0.0128	–0.00294	–0.00347*	–0.00728
	(–1.78)	(–1.75)	(–2.01)	(–2.26)	(–1.75)
HDI	–31.88**	–31.06**	–58.05***	–57.69***	–21.91*
	(–2.75)	(–2.91)	(–4.66)	(–4.18)	(–2.08)
Constant	238.2***	245.1***	331.8***	307.7***	228.1***
	(10.21)	(12.95)	(5.91)	(7.32)	(14.79)
Observations	158	158	44	44	141

Notes: *t* statistics in parentheses. $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

is short. Second, in part due to the short window, what mattered were less technical capabilities *per se* than the will to exercise those capabilities in an effective and timely manner, and the latter was not measured by the GHS Index.

On the short window of opportunity, consider the four primary methods used to fight the pandemic (i) testing and contact tracing, (ii) lockdowns, (iii) social distancing and masks, (iv) vaccines. Of these only contact tracing and testing clearly benefit from preparedness. A nation that can act quickly with tests and contact tracing can suppress the virus and prevent widespread spread, especially when combined with travel restrictions. Korea, Taiwan, Singapore, Australia, and New Zealand all applied this strategy. In contrast, lockdowns, social distancing, and masks are old technologies that don't rely on much in the way of preparedness, except it may be useful to have a reserve of masks. Finally, vaccines are never the first tool used against a pandemic and again, barring basic capacity in vaccine production and research, there isn't much to be done in the way of preparedness, especially for those countries rich enough to buy vaccines.

The second reason why preparedness, as measured by the GHS Index, mattered less than one would expect is that the Index measured capabilities that were not always practised. The GHS Index rated the United States as the most pandemic prepared country, in part because of the capabilities of the Centers for Disease Control and Prevention (CDC). The CDC did have the capability to rapidly produce a SAR-CoV-II test and the United States could have widely deployed such a test using commercial labs. In practice, however, the CDC failed to follow standard laboratory operating procedures, thereby contaminating their own test and then they failed to work with commercial labs to make a test widely available. As a result, US testing was delayed by critical weeks (Gottlieb, 2021). In contrast, Thailand, a much less well-prepared country, developed a test, ironically with the help of local CDC experts, and used it to identify the first case outside of China (Gottlieb, 2021). The CDC failed not due to a (relative) lack of preparedness but due to a failure to implement and execute appropriate policies in a timely manner. The state capacity variable may capture this kind of execution ability better than some of the pandemic preparedness variables, which is why it's one of the few variables to show up with the expected negative sign.

Our results also emphasize the role of practice and 'learning by doing' in preparedness for public health emergencies. Countries which reported a potential Public Health Emergency of International Concern to the WHO between 2017 and 2019 had significantly fewer excess deaths over the course of the pandemic. Experience gained from dealing with a public health crisis before Covid-19 appears to be a much stronger ward against deaths than any of the other measures of preparedness from Table 8, such as a national pandemic response plan or a stockpile of medical countermeasures. Just as the body's immune system creates antibodies following exposure to pathogens, smaller, less severe public health events appear to strengthen a country's response to future crises. In this framework, countries should seek out something analogous to a vaccine, an opportunity to gain the critical experience necessary without any of the risks of a real crisis. It's notable that the recent completion of a WHO biological threat simulation exercise did appear to have some effect in reducing excess deaths, albeit not as much as having actually experienced a PHEIC.

Two lessons follow from this analysis. First, passive alarms are likely to work better than 'break the glass' alarms. By passive alarm we mean a routinely updated, ongoing collection of data, while a 'break the glass' alarm requires some sort of deployment or executive action, which we have seen can be slow even when coming from experts. Meta-genomic sequencing, for example, could routinely be used in public health settings to monitor for unusual viral genes (Roux *et al.*, 2021). Similar systems could be used to monitor sewage (Bibby *et al.*, 2019; Hendriksen *et al.*, 2019). Making the data publicly available, as is done with similarly continuously monitored pollution data, could also increase the possibility of signals being spotted early.

The second lesson is that we should plan on early monitoring and suppression to fail. In which case, advancing vaccines by even a few months can be tremendously valuable (Castillo *et al.*, 2021). In a last resort, vaccines can be advanced by Operation Warp Speed-like investments in building vaccine factories in advance of approval and running clinical trials concurrently (Ahuja *et al*., 2021). More generally, however, vaccines can be advanced by long-term investments in basic science. It's well known that the Moderna coronavirus vaccine was designed by researchers at the National Institutes of Health within 48 hours of the virus's genetic code being uploaded to the web. But it took decades of work to make it possible to design a vaccine within 48 hours (Borrell, 2021).

More specifically, research on pan-coronavirus vaccines has high expected value (Rubin, 2021). The coronavirus family includes SARS and MERS which have higher fatality rates than SARS-CoV-II. A virus that combined the transmissibility of SARS-CoV-II with the lethality of MERS could be devastating, on a par with a nuclear war. Yet, it's possible to develop potential vaccines in advance by creating a library of vaccine candidates that we could draw upon in the event of a pandemic. Indeed, it's possible to begin to test and advance to phase I and phase II trials vaccines for every virus that is likely to jump from animal to human populations (Krammer, 2020). These types of investments are global public goods and so don't show up in pandemic preparedness indexes, but are key to making vaccines available much more quickly in the event of another pandemic.

A final lesson may be that a pandemic is simply one example of a low-probability but very bad event. Other examples which may have even greater expected cost are super-volcanoes, asteroid strikes, nuclear wars, and solar storms (Ord, 2020; Leigh, 2021). Preparing for X, Y, or Z may be less valuable than building resilience for a wide variety of potential events. The Boy Scout motto is simply 'Be prepared'.

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