G20 BRASIL 2024

BUILDING A JUST WORLD AND A SUSTAINABLE PLANET

Second Joint Finance-Health Task Force (JFHTF) Meeting

Updated note on Framework for Economic Vulnerabilities and Risks (FEVR)

Report by WHO

June 19th, 2024 (Virtual)

I. CONTEXT AND OBJECTIVES

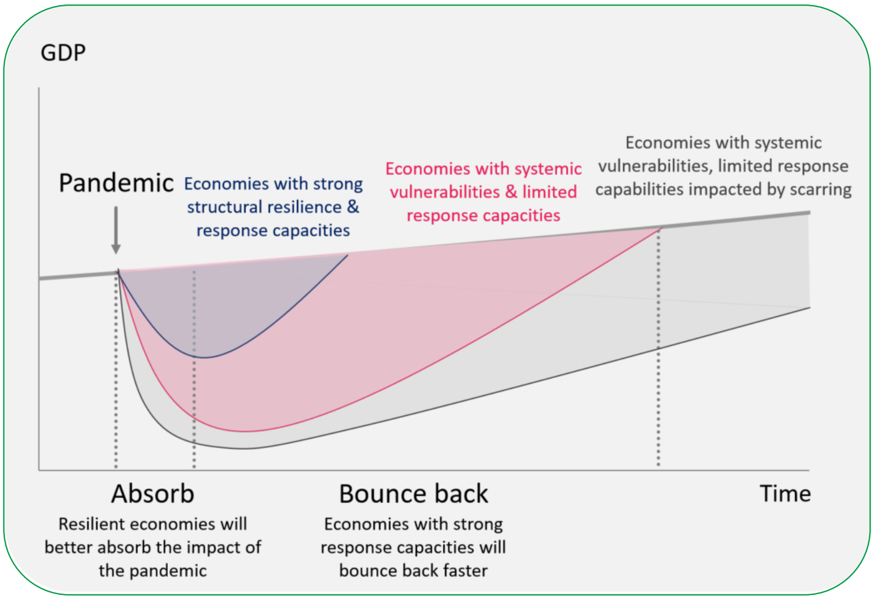
This Note summarizes the recent developments in the simulation exercise, which aims to provide further insights on Pandemics prevention, preparedness and response (PPR). In particular, it provides additional modeling and analytical work for the Framework for Economic Vulnerabilities and Risks (FEVR).

Building on the legacy of the G20 India Presidency in 2023, this Priority focuses on the refinement of the Framework for Economic Vulnerabilities and Risks (FEVR) and of the Mapping Pandemic Response Financing Options and Gaps to develop policy-relevant analysis and insights. The G20 Joint Finance and Health Taskforce (JFHTF) under the Brazil Presidency has developed further modeling and analysis building on FEVR.

In 2023 under the India Presidency, the JFHTF was asked to develop and adopt a report, outlining current economic vulnerabilities and risks to pandemics along with potential policy implications. A country's economic vulnerability to the pandemic can be in several dimensions including growth, debt, trade, and other factors. The availability of data at the time of analysis was to use GDP change as the key measure of economic vulnerability, and then conduct analysis as to the indicators that demonstrated the strongest relationship with the change in GDP. The analysis, building on existing academic research, led to the identification of 16 indicators (from a potential list of 76), across health, social and economic domains for all countries, regardless of income or other characteristics.

Health system resilience & response capacity	• Health Expenditure per capita • Logistics Index • Physicians per 1,000 population • UHC Service coverage • International Health Regulations
Social & economic protection	**Measures ability to respond & protect social & eco** • Informal economy relative to GDP • Food insecurity index • Social protection benefit coverage • SDG Index • Internet access
Macroeconomic stability	**Measures ability to withstand macroeconomic sho** • Population with bank savings • Share of export in the GDP • Credit to private sector • Global Value Chain

While there are many other indicators of pandemic preparedness and prevention that are linked to the health, social and economic impact of the pandemic, these did not exhibit a direct relationship with change in GDP, our measure of economic vulnerability. In addition, while other activities, such as seeking access to IMF financial assistance or World Bank programs could also be considered to indicate economic vulnerability at the time of the pandemic, given the comprehensive nature, with over 90 countries accessing IMF financial assistance, this may provide little insight when considering economic vulnerability to future pandemic scenarios.



Further analysis and advice from relevant experts indicated that an approach that incorporated both the concept of risk to pandemics and resilience to absorb the impact and respond effectively could be beneficial as it would further support this analysis. In addition, when considering economic vulnerability, it shows that there is a high interlinkage to the vulnerability to the development of a health emergency. At the same time, there is evidence that the incidence of economic scarring is also likely to decrease from actions to reduce the health impact.

II. ECONOMIC ANALYSIS

Further economic analysis of the relationship between COVID-19 containment measures, economic characteristics, and GDP losses across countries indicates that **stricter health policies, higher income levels, and dependencies on tourism, trade, and natural resources significantly influenced economic outcomes during the pandemic.**

The key findings from the analysis of the impact of various country characteristics on GDP and broader economic and social impacts during the COVID-19 pandemic are as follows:

- There is a significant and positive association between the stringency of government containment measures (like school closures and lockdowns) and GDP losses, suggesting that stricter policies, while aiming to protect public health, have led to greater economic losses.

- **Vaccination Speed:** The rate at which a country vaccinated 20% of its population was associated with lower GDP losses, but this association did not exist after controlling for GDP per capita. This suggests that the economic impact of vaccination speed may be mediated by a country's overall income level, with wealthier countries generally being better equipped to obtain and distribute vaccines.

- **GDP Per Capita:** Higher-income countries experienced lower GDP losses from COVID-19, highlighting the protective effect of economic wealth against pandemic-induced economic downturns.

- **Dependency on Tourism, Trade, and Natural Resources:** Countries more dependent on tourism, trade, and natural resources suffered more significant economic impacts from the pandemic.

Overall, these results indicate that the economic impacts of the COVID-19 pandemic have been uneven, heavily influenced by a country's policy responses, economic structure, and level of dependency on certain sectors. Further details can be found in the methodology background.

There are many factors that contribute to vulnerabilities to pandemics and there is a significant amount of work by many others, including the Global Pandemic Monitoring Board and the Pandemic Fund that aim to better understand and identify risks and vulnerabilities to pandemics. FEVR has informed some of that work and will aim to avoid duplication and build on existing work where possible.

In order to better understand how health, social and economic vulnerabilities interact, and develop a framework for policy development, an approach was taken to build on existing academic modelling to bring together the epidemiological modelling and the fiscal and economic impact of implementing public health and social measures (PHSM). This modeling and a simulation exercise were presented in April 2024 as part of a broader effort to develop and utilize FEVR related to pandemics.[1] Indeed, the aim of FEVR is to increase awareness and understanding of vulnerabilities, inform prevention, preparedness and response investments and policies, and monitor progress over time. The pandemic simulation exercise was facilitated by WHO, the World Bank and partners, and attended by representatives from ministries of finance and health. The approach and results of the simulation exercise were intended to stimulate discussion, further ongoing coordination efforts between finance and health decision-makers, inform policy development, and highlight the need and value of more sustainable PPR financing.

The **objectives** of the exercise were to use an analytical and model-based approach to build a better understanding of the interlinkages between health, social and economic impacts during a health emergency with the aim of:

1. G20 Report on Development of a Framework for Health, Social, and Economic Vulnerabilities (FEVR) and Risks from Pandemics, August 2023; G20 Report on Economic Vulnerabilities and Risks to Pandemics and Potential Policy Measures, August 2023.

1. identifying key vulnerabilities that can be addressed through enhanced preparedness and increased investments before a pandemic;

2. using the indicative outcomes of the different pandemic scenarios to assess the tradeoffs of different policies and interventions during a pandemic;

3. demonstrating a proof of concept for an integrated model which can be further developed to estimate the health, social, and economic costs and inform policy development and decision making; and

4. incentivizing and enhancing coordination between the health and finance sectors with regard to pandemic preparedness and response policies and financing.

Analysis and Simulation Exercise

The analysis is the result of collaborative work with academics to develop an epidemiological model that had been extended to include the fiscal and economic impact of non-pharmaceutical interventions (referred to as Public Health and Social Measures, PHSM). The model identified key parameters that are critical in the speed of spread and impact on individuals of a health emergency such as detection, capacity to diagnose, manage and treat those infected as well as the impact of access to medical countermeasures. The model builds on the impact of measures to reduce transmission and importantly identifies the costs associated with such measures in terms of both the direct budgetary financial impact as well as the economic impact.

The model was back-tested for the COVID-19 pandemic and the simulation exercise assumed similar characteristics to COVID-19. This enabled using the model parameter to establish the linkages between prevention, preparedness, and response, and assess the impact of increased investment in prevention, preparedness and increasing speed of access to MCMs as well as introduce the impact of budgetary constraint on policy choices.

The model can be applied to future scenarios with different characteristics by adjusting pathogen parameters such as incubation rate, transmission rate and severity of disease. In addition, different responses can be assessed as well including spending on surveillance, speed of access to effective measures such as vaccinations.

Key indicative results

This modeling is indicative and aims to be able to compare different high-level policy options that will then require further development at country, regional and global levels. The actual pathway of a health emergency and future pandemic is uncertain, and there is limited evidence on the exact combination of policy measures to support an improved health, social and economic outcome. The package of measures indicated in these scenarios require significant costs to strengthen many aspects of preparedness and response and the impact and effectiveness of single policy measures will need to be explored, although the

FEVR analysis of the 16 indicators provides an important starting point. Nevertheless, the indicative cost-benefit ratios are very high and the scale of change from different policy options can provide a framework to support the prioritization of further analysis.

Nearly half of deaths directly caused by a pandemic could be avoided if countries make efforts to prepare for pandemics and strengthen health systems and essential public health functions beforehand (Table 6). Enhancing preparedness and readiness could include: strengthening surveillance; engaging with building more resilient clinical services, facilities and workforce; ensuring that R&D, manufacturing, and supply chain systems can be rapidly scaled which will result in rapid and more equitable access to medical countermeasures. **A package of strengthening effective and timely response measures can contribute to a significant (>70%) reduction in the estimated number of deaths.** These response measures are heavily dependent on early access to contingency financing and strong international cooperation. During a pandemic, a rapid and well-coordinated response, including the capability to initiate vaccination up to 150 days sooner can support this significant reduction in mortality.

Enhancing preparedness *and* response is expected to drastically reduce the expected number of deaths and cases (Table 6) and would likely result in significantly lower indirect health impacts due to fewer disruptions to essential health services. While the investments in preparedness and response would result in some direct financial costs**, the increased response capacity and therefore reduced need for social and economic protection costs would ultimately lead to much lower short-term fiscal costs as well as broader economic and social costs (Table 5)**.

III. POLICY IMPLICATIONS

The indicative results analysis and simulation exercise are based on a single country and a pandemic based on a pathogen with COVID-19 characteristics. Policy implications at this stage indicate that the benefits from a package of measures that include investments in prevention and preparedness are substantial and can significantly reduce the high costs of response. This includes both the health spending which on average was up to 5% of GDP and the wider economic and social measures that incurred costs of up to 40% of GDP. Further analysis and exploration of the costs and impact of specific investments will be important when considering prioritizing investment to improve prevention and preparedness.

The availability of finance is also a critical component of an effective response; in terms of accessing medical countermeasures and also financing social protection and other measures that require curtailing economic activity to reduce transmission and control the disease. Further assessment of the triggers, speed, and scale of finance to meet the requirements for a response, as well as the interaction between domestic and international finance will be important in further understanding how more rapid access to finance can reduce the spread of a pandemic and its severe health, social and economic consequences.

Further understanding of how specific characteristics of an economy and dependencies on tourism, trade, and natural resources significantly influenced economic outcomes during the pandemic can support the assessment of specific vulnerabilities and interaction with access to finance; the economic vulnerabilities may indicate the scale and balance of spending between a health and economic response may differ according to those characteristics.

The speed of access to medical countermeasures requires both the successful development and production of medical countermeasures (MCMs) at the scale required and the access to finance to be able to contract and secure supply. The role of different stakeholders in these complex chains will be critical in understanding how to support a more rapid deployment and fully assess the benefits of earlier access to effective MCMs.

IV. NEXT STEPS

This preliminary analysis is currently based on a single country with a pandemic scenario similar to COVID-19 and a package of intervention measures. Extensions and further development of this analysis will support assessing and prioritizing future policy options.

This is a preliminary list based on feedback from members and further views will be sought:

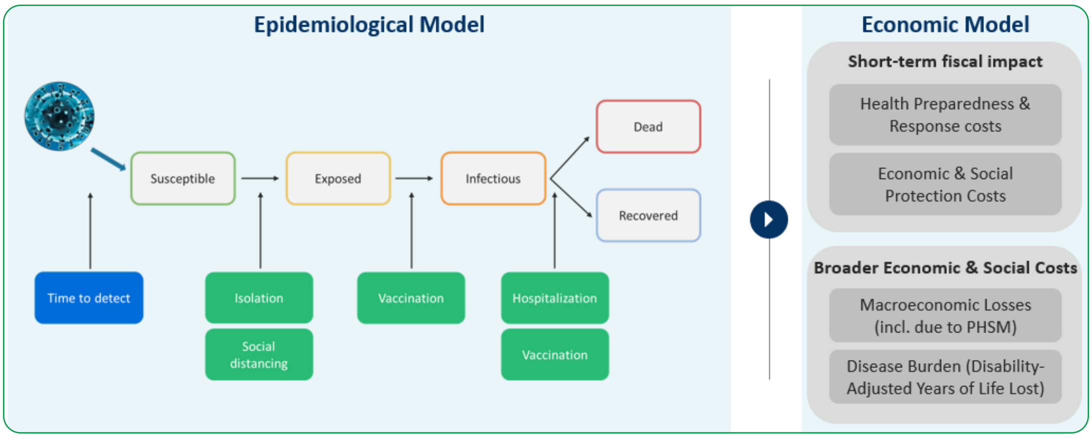
Introduce future pathogen risks, based on the WHO priority list of pathogens of concern and different country scenario settings;

- Conduct further simulation exercises that will enable a more detailed assessment of policy response options and associated tradeoffs to support the development of the strategy/ operational playbook;
- Extension of the model to include international impacts through economic activity, trade, and cooperation. Further develop the model to analyze other threats, specific settings, additional policy levers, indirect health impacts, and social costs;
- Assessment of the interaction of the package of policy measures and linking back to FEVR indicators
- Incorporate a one-health approach by considering the underlying vulnerabilities of countries by considering the impact of the environment and other issues on the parameters of the modeling.
- Introduce equity issues and specific community settings based on the discussion of Social Determinants of Health (SDH) and the impact on vulnerabilities to pandemics as well as the cost and effectiveness of response. Further discussion with experts following the JFHTF side event on 3 June will inform the including of SDH indicators to be discussed at the 3rd JFHTF meeting in September.

V. DETAILED METHODOLOGY

An **integrated economic-epidemiological model** was developed to simulate four scenarios based on different pandemic preparedness and response levels, in a COVID-19-like outbreak situation (Figure 1).

Figure 1. Integrated economic-epidemiological model



This **policy model** was developed to account for pandemic preparedness capacities and response capabilities for the scenarios. The preparedness capacities and response capabilities determined the adjustable input parameters for the **economic-epidemiological model** based on a causal pathway framework that was developed through a literature review and expert consultation. The levels of preparedness and response corresponded to quantified input parameters (levels 1 -5) based on existing literature and information (Table 1 below). The existing baseline and different levels of preparedness, characterized by input parameters under categories of collaborative surveillance, community protection, safe & scalable care, access to countermeasures and emergency coordination. Response interventions were categorized by parameters relating to diagnostic capability and effectiveness and vaccination rate.

The associated costs were captured in the *health preparedness and response costs* as part of the short-term fiscal impact (as described below in point #2).

This type of integrated model was chosen because it enables the integration of health, social, and economic outcomes and the assessment of potential tradeoffs of different policies. Please note that data sources are detailed in Annex 1.

1. The **epidemiological model** was based on a standard SEIR (Susceptible, Exposed, Infected and Recovery) model. The input parameters which were modeled and adjusted according to the levels of preparedness and response interventions in the different scenarios include timeliness of event detection, time, and effectiveness of case isolation, contact rates among the population, time and rate of vaccination, and hospitalization rate and capacity.

2. The **economic model** was responsive to the relevant input parameters (detailed in the methodology) and the outputs of the epidemiological model.

- For the **short-term fiscal impact**, the *health preparedness & response costs* included: (i) the estimated costs (per capita) associated with increasing preparedness capacity from the baseline level to the new level[2] (e.g., increasing surveillance from level 2 to 3 for a middle-income country was estimated to be $0.71 per capita); and (ii) the estimated costs (per capita) associated with scaling response capabilities[3] (e.g., increasing testing capacity to level 3 for a middle-income country was estimated to be $7.52 per capita). The **short-term fiscal impact** also encompasses the *economic & social protection costs* associated with the public health and social measures (PHSM)[4] that were applied in each scenario, including to facilitate social distancing, one of the adjustable input parameters for the epidemiological model (in green).

- The **broader economic and social costs** included the *macroeconomic loss associated with the PHSMs*[5] that were applied in each scenario. The stringency and duration of the PHSMs determined these estimated costs. The **broader economic and social costs** also included the *disease burden calculated from years of life lost due to mortality and disability,* i.e., Disability-adjusted life years (DALYs),[6] which was based on the epidemiological model outputs (the number of people who were infected and either recovered or died).

2. Estimated cost per capita to increase preparedness capacity by country income group.

3. Health response costing including the estimated procurement and delivery costs per unit for diagnostics (PCR tests) and vaccines by country income group.

4. The estimated economic & social protection costs calculation was: (stringency & duration of PHSMs) X (the average social protection & fiscal response costs incurred by country by income group (as % of GDP) during the COVID-19 pandemic).

5. The estimated GDP loss associated with the PHSMs calculation was: (Containment index) X (Tourism as % of GDP) X (Trade as % of GDP) X (Natural resources as % of GDP).

6. The estimated GDP loss associated with years of life lost due to mortality and disability (DALYs) calculation was: (Years of life lost due mortality (YLLs)) X (Years of life lost due to disability (YLDs)) X (Life Expectancy) X (Ratio of Value of Statistical Life (VSL) to GDP Per Capita).

Assumptions

Table 1. The input parameters and values from the policy model used for the different pandemic scenarios which were simulated

Area	Sub-area	Input parameter	Value of input parameter for levels 1-5 of preparedness and response capacity				
			1	2	3	4	5
Health emergency preparedness capacity[7]	C1 Collaborative surveillance	Time to detect first case or new variants (days)	150	120	90	60	30
		Time to isolation (hours)	96	72	48	24	0
	C2 Community protection	Adherence to isolation (%)	29	47	65	83	100
	C3 Safe & scalable care	Hospital bed capacity (per 100k population)	0	121	236	320	502
	C4 Access to countermeasures	Delay in start of vaccination given Vx availability (days)	118	88	64	36	12
	C5 Emergency coordination	Delay in implementing response measures (days)	52	39	26	13	0
Response interventions	Diagnostics (DX)	Effectiveness of isolation (%)	0	27	41	41	49
	Vaccination (VX)	Vaccination rate (per 100k population per day)	50	137	223	320	438
Public health & social measures (PHSM)	Social distancing	Reduction in contact rates by setting (%): home, school and work	6 10 8	13 21 17	31 52 42	56 94 75	63 100 83

Four pandemic scenarios were simulated using the economic-epidemiological model and inputs from the policy model (Table 2). The pandemic scenarios also utilized specific parameters for the **country profile** and **pathogen characteristics** (Table 3). A pathogen similar to SARS-CoV-2 was used for the simulated pandemic scenarios due to the high availability of data and literature from the COVID-19 pandemic that could be used for the pathogen characteristics, other input parameters, and estimated costs.

- Scenario 1: Baseline: level 2 in Table 1 above: this is a characteristic level of the current real-world state, based on country-level evidence

- Scenario 2: Enhanced preparedness (increasing preparedness from level 2 to level 4 as detailed in Table 1: this is characterized by health emergency preparedness capacity for example increasing detection from 120 days to 60 days, and the other improvements in collaborative surveillance, community protection, safe and scalable care, access to countermeasures and emergency coordination)

- Scenario 3: More rapid response (increasing response from level 2 to level 4 as detailed in Table 1: this is characterized by more rapid access to diagnostic and vaccines which increase the effectiveness of isolation from 27% to 41% and an improvement in the days to vaccinate by 150 days and the vaccination rate from 137 to 320/100k population. Spending on up front R&D is outside the scope, but will be important global costs)

- Scenario 4: Enhanced preparedness & more rapid response (increasing both preparedness and response from level 2 to level 4, i.e. the combination of measures in scenario 2 and scenario 3)

Table 2. Input parameters used to simulate four pandemic scenarios

Input parameters	Scenario 1: Baseline	Scenario 2: Enhanced preparedness	Scenario 3: Enhanced response	Scenario 4: Enhanced preparedness and response
Preparedness level (level 1 to 5)	Level 2	Level 4	Level 2	Level 4
Time to vaccination (days)	300 days	300 days	150 days	150 days
Contingency financing (days)	> 30 days	> 30 days	< 30 days	< 30 days
Application of public health & social measures (level 1 to 5)	Level 2 for 190 days	Level 1 for 190 days	None	None
Time to detect first case (days)	120 days	60 days	120 days	60 days
Isolation effectiveness	0.27%	0.27%	0.41%	0.41%
Hospital bed capacity (per 10K population)	121	320	121	320

Table 3. Input parameters for the country profile and pathogen characteristics used to simulate four pandemic scenarios

Country profile parameters	Value
Population	50 million
GDP per capita ($US per capita)	6,000
Key pathogen characteristics	**Value**
Reproduction rate (R0)	3
Mean generation time between primary and secondary cases (days)	10
Mean incubation period (days)	6
Relative infectiousness of pre-symptomatic cases to symptomatic cases	0.25
Proportion of infected cases that eventually develop symptoms	0.8

VI. RESULTS

The health outcomes and economic outcomes, including both short-term fiscal costs and broader social and economic costs, for the four pandemic scenarios were derived from the integrated economic-epidemiological model.

Health outcomes (Table 4):

- **Scenario 2: Enhanced preparedness capacities** (as identified in the parameters in Table 1 from level 2 to level 4) contribute to a 50% reduction in the estimated number of deaths.

- **Scenario 3: Rapid response capabilities** (as identified in Table 1 from level 2 to level 4) contribute to a 74% reduction in the estimated number of deaths.

- **Scenario 4: Enhanced preparedness capacities and rapid response capabilities** (the full range of improvement from level 2 to level 4 in all the categories identified in Table 1) contribute to a 97% reduction in the estimated number of deaths.

Table 4. Health outcomes associated with the four pandemic scenarios

Health Outcomes	Scenario 1: Baseline	Scenario 2: Enhanced preparedness	Scenario 3: Enhanced response	Scenario 4: Enhanced preparedness and response
Cases	37 million	25 million	24 million	5 million
Deaths (hospital cases + community cases with no care, with the latter a higher rate)	83K	40K	21K	3K
% Change in number of deaths compared to baseline (scenario 1)		-51%	-74%	-97%

Economic outcomes (Table 5)

- **Scenario 2: Enhanced preparedness capacities** requires investments before the pandemic which results in higher preparedness costs but lower economic and social protection costs because the PHSMs that are applied are less stringent (as indicated in Table 1 so from level 1 instead of level 2 for 190 days i.e. impact from social distancing policies in reducing contact rates by the following percentages: at home (from 6% to 13%), school (10% up to 21% and work (from 8% to 17%)). This results in *a 41% reduction in the estimated short-term fiscal impact*. Increasing preparedness results in a reduction in the broader economic and social costs from the application of PHSMs (due to less stringent measures being applied) and the economic cost associated with DALYs (due to fewer cases and deaths). This results in a *52% reduction in the estimated broader social and economic costs.*

- **Scenario 3: More rapid response capabilities** require rapid access to finance to scale the country's response to the pandemic: this includes rapid access to diagnostics and access to vaccines (not including R&D). This assumption is based on faster access to diagnostics and therapeutics, but with equivalent cost and effectiveness of vaccines to the baseline scenario to scale the response to the pandemic; however, the economic and social protection costs are eliminated because PHSMs are not necessary as hospital capacity is not being reached/ exceeded. This is a result of the response significantly improving detection and an earlier and more rapid vaccination rate. This results in an *86% reduction in the estimated short-term fiscal costs*. Enhanced response results in the elimination of short-term fiscal costs from the application of PHSMs (due to them not being applied) and a reduction in the economic and social impact associated with DALYs (due to fewer cases and deaths). This results in a *92% reduction in the estimated broader social and economic costs.*

- **Scenario 4: Enhanced preparedness capacities and more rapid response capabilities** require investments in preparedness and response; however, the economic and social protection costs are once again eliminated because PHSMs are not required as hospital capacity is not breached. This results in an *84% reduction in the estimated short-term fiscal costs*. Enhanced preparedness and more rapid response results in the elimination of broader economic and social costs from the application of PHSMs (due to them not being applied) and a significant reduction in the economic costs associated with DALYs (due to fewer cases and deaths). This results in a *99% reduction in the estimated broader social and economic costs.*

Table 5. Short-term fiscal impact and broader economic & social costs associated with the four pandemic scenarios (USD)

Direct economic costs	Scenario 1: Baseline	Scenario 2: Enhanced preparedness	Scenario 3: Enhanced response	Scenario 4: Enhanced preparedness and response
Preparedness		330 million		330 million
Health response[8]	2.5 billion	2.5 billion	2.5 billion	2.5 billion
Economic & Social Protection	15 billion	7.5 billion	0	0
Total	17.5 billion	10.33 billion	2.5 billion	2.83 billion
% Change in total direct economic costs compared to baseline (scenario 1)		-41%	-86%	-84%
Broader social and economic costs				
Economic impact (PHSMs)	75 billion	36 billion	0	0
Economic impact (DALYs)	12.9 billion	6.6 billion	4.58 billion	620 million
Total	87.9 billion	42.64 billion	4.58 billion	620 million
% Change in total broader social and economic costs compared to baseline (scenario 1)		-52%	-95%	-99%
Indicative benefit-to-cost ratio (reduction in broader social and economic costs /cost of preparedness)		131x	Costs not in this model include global R&D costs to support rapid vaccine development and rapid access to finance	

The indicative findings are that close to half of deaths directly caused by a pandemic could be avoided if countries make significant efforts to prepare for pandemics and strengthen health systems and essential public health functions beforehand (Table 6). Enhancing preparedness and readiness could include: strengthening surveillance which will enable earlier detection; engaging with communities and building trust which will increase adherence to isolation and vaccination rates (minimize vaccine hesitancy); building more resilient clinical services, facilities and workforce which will lead to lower mortality rates in hospitals, lower healthcare-associated infection and few disruptions to other health services; ensuring that R&D, manufacturing, and supply chain systems can be rapidly scaled which will result in rapid and more equitable access to medical countermeasures which can improve case isolation as well as infection and survival rates; and enhancing coordination which will enable countries and communities to rapidly initiate an effective response. The current approach does not yet account for the *indirect health impacts* (e.g., increased morbidity or morality associated with health conditions such as NCDs for which health services will be disrupted or delayed). WHO's Pulse surveys[7] revealed that 84% (105 of 125) countries reported some disruptions in essential health services, with up to 56% of essential health services disrupted in 2020. Therefore, **efforts to ensure health systems and services and prepared and ready for pandemics and other emergencies will not only reduce the direct health impacts, but also reduce the indirect health impacts**. **Enhancing preparedness is also expected to reduce broader social and economic costs** due to less stringent and shorter-lasting PHSMs and fewer DALYs (Table 5). While the cost of such efforts is estimated at USD330m and not insignificant, there is an indicative BCR of over 100x.

Effective and timely response measures can contribute to a significant (>70%) reduction in the estimated number of deaths (Table 6). These response measures are heavily dependent on early access to contingency financing and strong international cooperation, including sharing critical information in a timely manner and the allocation of critical medical supplies based on needs and not means. During a pandemic, a rapid and well-coordinated response includes the capability to initiate vaccination up to 150 days sooner compared to the baseline scenario and to improve case isolation due to better access to testing. These response measures will reduce transmission, increase survival rates and mitigate the strain on health systems thereby enabling governments to reduce or remove PHSMs as the health system will not be overwhelmed. This will lead to lower indirect health impacts and broader social and economic costs. While scenario 3 (more rapid response) resulted in a greater reduction in health impacts compared to scenario 2 (enhanced preparedness) – 71% vs. 51% reduction in deaths – **the direct costs of a response are significantly higher than enhancing preparedness** (2.5 billion vs. 330 million) (Table 5). Not only is it costly to respond during a pandemic, but it may also be slow or even impossible to achieve such as scaling bed capacity which will require substantial investments in infrastructure, supplies, training, and healthcare workers, all of which are likely to be in short supply and impossible to scale rapidly. Some measures are far easier and less costly to scale during "peacetime". However**, social and economic protection costs**, e.g., furlough schemes or efforts to ensure food security, **may be lower when countries are able to scale response measures** (scenario 3) compared to when they only focus on enhancing preparedness (scenario 2) (Table 5). The early reduction or removal of PHSMs will also lead to lower social impacts such as disruptions to schooling and education and associated future economic impacts (outside the scope of this analysis). **A more rapid response is expected to significantly reduce broader social and economic costs** due to the lack of need to implement PHSMs which will minimize business closures and losses in productivity as well as fewer DALYs (Table 6).

Enhancing preparedness *and* more rapid response is expected to drastically reduce the expected number of deaths and cases (Table 6) and would likely result in significantly lower indirect health impacts due to fewer disruptions to essential health services. While the investments in preparedness and response would result in some short-term fiscal costs**, the increased response capacity and therefore reduced need for social and economic protection costs would ultimately lead to much lower financial and economic costs to respond (Table 5)**. The drastic reduction in cases and deaths associated with **enhancing**

7. https://www.who.int/publications/i/item/WHO-2019-nCoV-EHS_continuity-survey-2023.1

preparedness and response is expected to significantly reduce economic costs in avoided PHSMs and in DALYs (Table 5). It is clear that the ideal scenario would be for countries to **invest in and enhance preparedness *and* a more rapid response to mitigate the health, social *and* economic costs of pandemics (Table 6).**

Table 6. Summary of the health and economic outcomes for the four pandemic scenarios which were modeled

	Scenario 1: Baseline	Scenario 2: Enhanced preparedness	Scenario 3: More rapid response	Scenario 4: Enhanced preparedness and more rapid response
% Change in number of deaths compared to baseline (scenario 1)		-51%	-74%	-97%
% Change in short-term fiscal impacts compared to baseline (scenario 1)		-41%	-86%	-84%
% Change in broader economic and social costs compared to baseline (scenario 1)		-52%	-95%	-99%

Economic analysis

Further economic analysis of the relationship between COVID-19 containment measures, economic characteristics, and GDP losses across countries indicates that **stricter health policies, higher income levels, and dependencies on tourism, trade, and natural resources significantly influenced economic outcomes during the pandemic.**

The key findings from the analysis of the impact of various country characteristics on GDP and broader economic and social impacts during the COVID-19 pandemic are as follows:

- There is a significant and positive association between the stringency of government containment measures (like school closures and lockdowns) and GDP losses. A one standard deviation increase in a Containment and Health Index (detailed in the annex) is associated with a roughly 7 percentage point rise in GDP losses, suggesting that stricter policies, while aiming to protect public health, have led to greater economic losses.

- **Vaccination Speed:** The rate at which a country vaccinated 20% of its population was associated with lower GDP losses, but this association did not exist after controlling for GDP per capita. This suggests that the economic impact of vaccination speed may be mediated by a country's overall income level, with wealthier countries generally being better equipped to obtain and distribute vaccines.

- **GDP Per Capita:** Higher-income countries experienced lower GDP losses from COVID-19. Specifically, a country with a GDP per capita one standard deviation above the mean saw about 7 percentage points less in cumulative GDP losses from 2020 to 2024, highlighting the protective effect of economic wealth against pandemic-induced economic downturns.

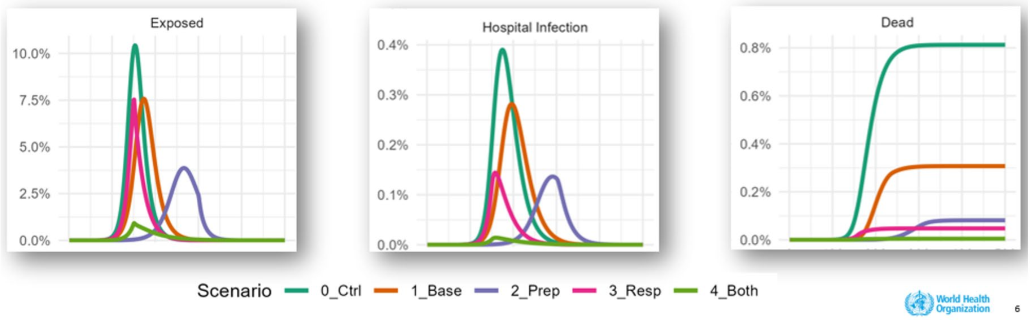
- **Dependency on Tourism, Trade, and Natural Resources:** Countries more dependent on tourism, trade, and natural resources suffered more significant economic impacts from the pandemic. The data show that a one percentage point increase in the share of trade and natural resource rents per GDP led to 0.23 and 0.45 percentage point increases in GDP losses, respectively, underscoring the vulnerability of these sectors to pandemic-related disruptions.

Annex 1. Data sources used to determine the values for the input parameters used in the economic-epidemiological model for the different pandemic scenarios

Area	Sub-area	Tracer indicator/input parameter	Data source
Health emergency preparedness capacity	C1 Collaborative surveillance	Time to detect first case or new variants (days) Time to isolation (days)	WHO DNR indicator & 7-1-7 framework UK COVID-19 data & LSHTM
	C2 Community protection	Adherence to isolation (days)	Petherick *et al.* (2021)
	C3 Safe & scalable care	Hospital bed capacity (per 100k)	WHO
	C4 Access to countermeasures	Delay in start of vaccination given Vx availability (days)	UK COVID-19 data & OWID
	C5 Emergency coordination	Delay in implementing response measures (days)	Tselios (2023) & ACAPS
Response interventions	Diagnostics (DX)	Effectiveness of isolation (%)	UK COVID-19 data & LSHTM
	Vaccination (VX)	Vaccination rate (per 100k per day)	Doohan *et al*. (2022) – preprint
	Therapeutics (TX)	*To be added in future iterations*	*To be added in future iterations*
Public health & social measures (PHSM)	Social distancing	Reduction in contact rates by setting (%)	Imperial College
Costing of health emergency preparedness capacity	C1 Collaborative surveillance, C2 Community protection, C3 Safe & scalable care, C4 Access to countermeasures, & C5 Emergency coordination	Cost per capita to increase preparedness capacity by income group (US$)	G20's global estimates, WHO IHR & HEPR costing methodology, Georgetown IHR costing tool
Costing of response interventions	Diagnostics (DX)	Procurement costs per capita/unit (US$) Delivery costs per capita/unit (US$)	LIC: OWID MIC: Rahmanzadeh *et al.* (2023) HIC: Health system tracker
	Vaccination (VX)	Procurement costs per capita/unit (US$) Delivery costs per capita/unit (US$)	*Procurement* LIC: Serum Institute of India, AU MIC: Serum Institute of India HIC: Moderna, EC *Delivery*: UNICEF
	Therapeutics (TX)	*To be added in future iterations*	*To be added in future iterations*
Short-term fiscal impact	fiscal impact of measures resulting in social protection and other budgetary impacts	(Stringency & duration of PHSM) x (avg. social protection and other fiscal costs during COVID-19 as % of GDP)	IMF country fiscal measure database
Broader economic and social costs	Economic cost – disease burn - Disability-adjusted life years lost (DALYs)	(Years of life lost due to mortality (YLLs)) X (Years of life lost due to disability (YLDs)) X (Life Expectancy) X (Ratio of Value of Statistical Life (VSL) to GDP Per Capita)	Factors Driving Economic Costs of COVID-19 (pre-print)
	Macroeconomic losses - Public health and social measures (PHSMs)	(Containment index) X (Tourism as % of GDP) X (Trade as % of GDP) X (Natural resources as % of GDP)	Factors Driving Economic Costs of COVID-19 (pre-print)

Annex 2. Simulation Results

Health Outcomes	Baseline	Preparedness +	Response +	Both +
Cases	37 million	25 million	24 million	5 million
Deaths	83K	40K	21K	3K
% Change Deaths from Baseline		-51%	-74%	-97%



G20 BRASIL 2024

BUILDING A JUST WORLD
AND A SUSTAINABLE PLANET