



COMPARATIVE ANALYSIS: EXISTING DIGITAL HEALTH STANDARDS, GUIDELINES, AND TOOLKITS FOR PANDEMIC RESPONSE

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COMPARATIVE ANALYSIS: EXISTING DIGITAL HEALTH STANDARDS, GUIDELINES, AND TOOLKITS FOR PANDEMIC RESPONSE

DEFINITIONS

Standards: Formally ratified standards created and adopted by one or more influential bodies such as governments or international organizations (WHO, UN, etc.). Also includes legislation and regulation adopted by governments.

Guidelines: Published guidelines created by relevant parties.

Toolkits: Prepackaged materials, either physical or digital, that provide actionable guidance. To be considered a toolkit, the materials must be readily available and multidimensional. For example, a downloadable notice about mask wearing would not be considered a toolkit. However, a guidebook on workplace safety for employers combined with safety posters and related forms/materials provided in a single package would be considered a toolkit.

ACRONYMS

AAMI	Association for the Advancement of Medical Instrumentation
AI	Artificial Intelligence
CDC	Centers for Disease Control
ECDC	European Centre for Disease Prevention and Control
EU	European Union
eWWG	eWorldwide Group
FDA	Food and Drug Administration
HHS	Health and Human Services
ML	Machine Learning
PPE	Personal Protective Equipment
US	United States
WHO	World Health Organization

EXECUTIVE SUMMARY

The devastating consequences of the COVID-19 pandemic have revealed how unprepared many countries were. There was little consensus about how to respond, resulting in the suffering of millions worldwide and the loss of trust in authorities and leaders, undermining democracy and the rule of law.

The current pandemic is far from over—the emergence of more variants of the COVID-19 virus is likely and will continue to pose a risk to every country. Additionally, we must face the fact that global threats are likely to increase in frequency and severity due to future infectious disease outbreaks, climate-related disasters, and geopolitical events.

During the pandemic, the potential of digital technologies in COVID-19 mitigation, response, and management have been realized. Sectors and industries have become more dependent on digital systems and technologies, and digital resilience will become more crucial than ever. These digital resources, (public and private) must be better mobilized and organized to ensure that the world is better equipped to detect, prevent, and respond to an outbreak. The public needs to have confidence that digital solutions for public health emergencies protect them, respect their rights, and empower them, and do not normalize the deployment of mass surveillance as the only way to deal with a crisis.

However, studies show that the implementation of digital technologies for pandemic response and their integration into healthcare systems, particularly in low- and middle-income countries, have been hampered by the lack of globally accepted standards for digital health resilience.

This report presents a comparative analysis of the standards, guidelines, and toolkits for critical operations of COVID-19 mitigation, response, and management that have been developed by global health institutions and selected countries. Overall, findings reveal that global standards for COVID-19 mitigation, response, and management are limited. Guidelines and toolkits are more readily available, but they have not always taken a holistic approach that considers all aspects of the digital health ecosystem, particularly those related to data privacy, protection, security, and ethics.

Although the creation of standards for all categories of critical operations are important, the top priorities identified in the analysis are global standards for: 1) data collection, analysis, and destruction, including for artificial intelligence (AI), big data analytics, and machine learning (ML); 2) data analytics and reporting at local, national, regional, and international levels; 3) data privacy, protection, security, and ethics; 4) communication

and awareness; and 5) collaboration and partnerships. These categories reflect the serious concerns that have been most frequently raised during the COVID-19 pandemic in public discourse and academic research.

Based on the key findings from the comparative analysis, recommendations include creating a multistakeholder group to develop global standards to fast-track the strengthening of nations' and organizations' digital health resilience, and adopting a holistic and multidisciplinary approach to standards setting by convening the academic, technical, and scientific communities with policymakers, health sector stakeholders, technology companies, civil society representing vulnerable groups, and other stakeholders. This will help build capacities to mitigate, respond to, and manage the current COVID-19 pandemic and prepare for future pandemics.

Moving forward, it is clear that exiting the pandemic and preparing for future pandemics will require cross-country and public–private–civil society collaborations, because no individual group or country can address these complexities alone. Until transmission is curtailed throughout the world, the risk of new variants sending us back to square one cannot be ignored.

Therefore, it is more important than ever that we have in place global standards that contribute to an interoperable, resilient, inclusive, and ethical digital health ecosystem. At the same time, we must strengthen the digital health literacy and capacity of healthcare professionals, stakeholders, and public health and technology students to meet needs in the face of health risks and emergencies. This includes equipping them with the skills and competencies to promote and apply the global standards developed, as well as collaborate and co-design digital health systems and solutions that encompass principles of sustainability, inclusiveness, holistic vision, transparency, accountability, privacy, and security by design, and science-based decision-making free from politicization.

The development and application of global standards for COVID-19 mitigation, response, and management will enable countries to build forward better and help get countries back on track to meeting global goals and securing a safe and healthy future for all.

1. INTRODUCTION

The evolving COVID-19 pandemic has led to accelerated adoption of digital technologies in all aspects of COVID-19 mitigation, response, and management. As discussed in the report entitled “Overview and Insight: Performance of Digital Health Systems during COVID-19 Pandemic,” governments worldwide have leveraged digital technologies for 12 critical operations, including for the following:

1. Communication and awareness
2. Detection, testing, and mapping
3. Tracking, disease surveillance, and alerts
4. Contact tracing and rapid response
5. Containment, isolation, and quarantine
6. Treatment, telemedicine, and monitoring
7. Data collection, analysis, and destruction, including for AI, big data analytics, and ML
8. Data analytics and reporting at local, national, regional, and international levels
9. Data privacy, protection, security, and ethics
10. Logistics and supply chain management of personal protective equipment (PPE), masks, etc.
11. Cold chain management
12. Vaccination and immunization

The report highlights the urgent need for a holistic approach that considers all aspects of the digital health ecosystem, and the importance of multidisciplinary and multilevel (local to global) collaborations to strengthen and sustain healthcare resilience.

A clear lesson from the COVID-19 crisis is that global threats will continue to increase in frequency and severity due to future infectious disease outbreaks, climate-related disasters, and geopolitical events, and digital resilience will become more crucial than ever as more people go online, and sectors and industries become more dependent on digital systems and technologies. Moving forward, it is important that global standards, guidelines, and toolkits are in place for strengthening digital health resilience in a holistic manner to overcome the current crisis and withstand future crises.

A subsequent report entitled “Landscape and Ecosystem: Digital Health Ecosystem and Current Initiatives Bridging the Gap” stresses that the lack of a globally accepted standard for documenting and assessing best

practices in digital health for pandemic mitigation, response, and management is hampering countries' progress in strengthening their digital resilience. In many instances, this has been exacerbated by the lack of data standards and interoperability specifications within and across countries, and by a mismatch between the technologies adopted and the digital readiness of the countries.

The report finds that, despite some promising initiatives to develop standards, guidelines, and toolkits to help late digital health adopters and developing nations better cope with the pandemic, these have often been developed in an ad hoc and rushed manner, and gaps remain regarding ways to best address many of the critical operations listed above. Generally, policymakers continue to struggle to adopt and integrate digital technologies into their domestic health systems.

This report builds on the findings and recommendations from the previous two reports mentioned above, and presents a comparative analysis of the standards, guidelines, and toolkits for COVID-19 mitigation, response, and management that have been developed by global health institutions and selected countries.

Through this analysis, we have identified clear gaps in global standards, guidelines, and toolkits that need to be prioritized to create an interoperable, resilient, inclusive, and ethical digital health ecosystem that will enable fast response and recovery in current and future crises. Moreover, the public needs to have confidence that digital solutions to public health emergencies protect them, respect their rights, and empower them, and do not normalize the deployment of mass surveillance as the only way to deal with a crisis.

2. APPROACH AND METHODOLOGY FOR ANALYSIS

The first step in conducting the comparative analysis of standards, guidelines, and toolkits for COVID-19 mitigation, response, and management involved the selection of a representative group of countries and institutions for comparison. The rationale for selecting the countries and institutions is given in the next subsection.

For each country or institution, we searched for publicly available standards, guidelines, and toolkits across the 12 categories of critical operations identified in the previous report entitled “Overview and Insight: Performance of Digital Health Systems during COVID-19 Pandemic” and listed in Section 1.

With a topic of such complexity, it would be easy to get lost in the details of every country’s or region’s actions. To avoid this, we have focused our efforts on building a high-level picture based on a representative sample. This picture reveals overall strengths and weaknesses, and the gaps where additional standards, guidelines, and toolkits might offer value. However, the examples of specific standards, guidelines, and toolkits provided in this report should be considered as representative, rather than exhaustive.

It is important to note that, due to the overall strain on government resources during the pandemic, many countries have not published as much material as they may have created, and they certainly have not published it in English. In particular, very little information is available directly from the Chinese government in Western search engines. It is likely that the information presented for China is incomplete. If further research is undertaken, we strongly recommend working with speakers fluent in the languages of the countries being investigated.

While the pandemic has been ongoing for nearly two years, this is still less time than it would typically take to create a new formal standard. The International Organization for Standardization (ISO) estimates that: “From first proposal to final publication, developing a standard usually takes about three years.” There are many standards that are relevant to COVID-19, but not new for COVID-19. As an example, for personal protective equipment (PPE), the United States (US) Food and Drug Administration (FDA) adopted the American National Standards Institute/Association for the Advancement of Medical Instrumentation (ANSI/AAMI) PB70:2003 in 2004. It is a standard for “liquid barrier performance and classification of protective apparel and drapes intended for use in healthcare facilities.” Unless particularly relevant to this discussion, such pre-existing standards have not been included.

2.1. RATIONALE FOR SELECTION OF COUNTRIES AND INSTITUTIONS IN ANALYSIS

The COVID-19 pandemic has revealed systemic weaknesses in almost every country in the world, across a broad range of critical operations, from communication to supply chain management. Choosing which countries to select was challenging. An obvious metric is the number of infections, adjusted for population size.¹ However, this fails to address death rates, which have varied widely.² Yet, focusing solely on death rates may favor countries that experienced COVID-19 later than others, as treatment protocols were better understood. Furthermore, given the potential for “long COVID” and the currently unknown impact that will have over time, death rate may not be the most suitable primary metric. Last, but certainly not least, in a small country, it could be possible to have a relatively high death rate that represents relatively few human lives. Should that count more heavily than a large country that had a significant number of deaths?

After careful consideration, the decision was made to step back from the current COVID-19 pandemic and choose countries based largely on their rated pandemic preparedness prior to COVID-19. We are able to achieve this by using data from the 2019 Global Health Security Index (Figure 1).³ This serves two purposes: 1) it highlights the critical difference between being prepared “on paper” and actual preparedness; and 2) it eliminates any politically driven misrepresentation of data regarding which countries are “worst” or “best” as it was conducted independently and predates the outbreak of COVID-19.

We identified countries from four strata of the Global Health Security Index and conducted some initial research to ensure that we could find relevant material for each country, eliminating the ones where data was less readily available. To ensure diversity, we selected countries from different regions, across different income groups, and with different population sizes. We then reviewed infection and mortality rates, and used unexpectedly high or low rates as additional criteria for filtering. The resulting list of countries is as follows: Austria, Bangladesh, Brazil, China, Israel, Japan, Malaysia, Nepal, New Zealand, Nigeria, Pakistan, Venezuela, and Vietnam (Table 1).

In addition, the comparative analysis includes examining the standards, guidelines, and toolkits published by health institutions with global influence and recognition, such as the World Health Organization (WHO), the European Union (EU) and the European Centre for Disease Prevention and Control (ECDC), and the US Centers for Disease Control (CDC) and Prevention and FDA.

¹ Dean T. Jamison et al., “Country performance against COVID-19: Rankings for 35 countries,” *BMJ Global Health* 5, no. 12 (2020). <https://gh.bmj.com/content/bmjgh/5/12/e003047.full.pdf>.

² Johns Hopkins University & Medicine Coronavirus Resource Center, “Mortality in the most affected countries.” <https://coronavirus.jhu.edu/data/mortality>.

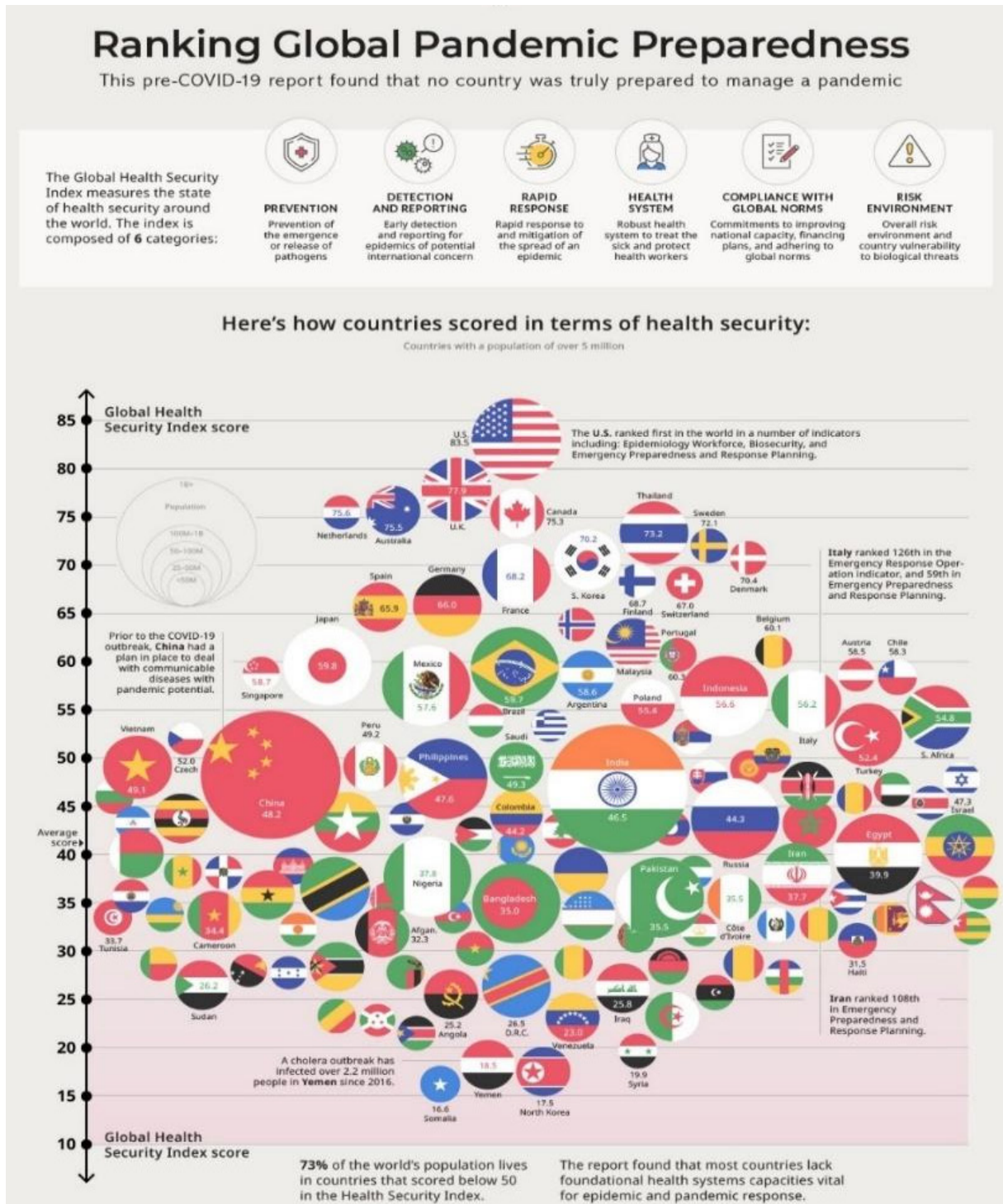
³ 2019 Global Health Security Index. <https://www.ghsindex.org/>.

TABLE 1 Summary of Countries Selected for Comparative Analysis

Country	Region	Global Health Security Index Ranking	Infection Rate Per 100,000 People (as of 09/21/2022)	Total Deaths (as of 09/22/2022)	Comments
Stratum 1					
Japan	Asia	21	1,330	17,294	
Brazil	Latin America	22	9,996	591,440	Exceptionally high infection and mortality rates
Stratum 2					
Austria	Europe	26	8,068	10,918	Landlocked and small population size
New Zealand	Pacific	35	85	27	Exceptionally low infection and mortality rates
Stratum 3					
Vietnam	Asia	50	727	17,545	
China	Asia	51	8	4,849	Large population size and exceptionally low infection and mortality rates
Israel	Middle East	54	14,352	7,567	Exceptionally high infection rates
Stratum 4					
Pakistan	Asia	105	557	27,374	
Venezuela	Latin America	176	1,257	4,329	

Sources: Nicholas Le Pan, "Ranked: Global pandemic preparedness by country," *Visual Capitalist*, 20 March 2020, <https://www.visualcapitalist.com/global-pandemic-preparedness-ranked/>; and Johns Hopkins University & Medicine Coronavirus Resource Center, "COVID-19 Dashboard," 30 August 2022, <https://coronavirus.jhu.edu/map.html>.

FIGURE 1 Global Health Security Index Scores



Source: Nicholas Le Pan, "Ranked: Global pandemic preparedness by country," *Visual Capitalist*, 20 March 2020, <https://www.visualcapitalist.com/global-pandemic-preparedness-ranked>.

2.2. RATIONALE FOR SELECTION OF CRITICAL OPERATIONS

The selection of 12 critical operations is based on findings from the report entitled “Overview and Insight: Performance of Digital Health Systems during COVID-19 Pandemic.” These 12 critical operations comprehensively cover all aspects of public health emergency and digital health resilience, particularly for COVID-19 mitigation, response, and management, and include the following:

1. Communication and awareness
2. Detection, testing, and mapping
3. Tracking, disease surveillance, and alerts
4. Contact tracing and rapid response
5. Containment, isolation, and quarantine
6. Treatment, telemedicine, and monitoring
7. Data collection, analysis, and destruction, including for AI, big data analytics, and ML
8. Data analytics and reporting at local, national, regional and international levels
9. Data privacy, protection, security and ethics
10. Logistics and supply chain management of PPE, masks, etc.
11. Cold chain management
12. Vaccination and immunization

These critical operations have been selected for analysis because they pose common challenges and gaps faced by countries coping with the COVID-19 crisis. These common challenges and gaps that require standards, guidelines, and toolkits are summarized next.

2.1.1 COMMUNICATION AND AWARENESS

At the onset of the pandemic, one of the first things many governments did was to provide COVID-19 information. Countries have generally used a mix of channels to disseminate public health information and issue alerts, including television, radio, public billboards, SMS, instant messenger apps, social media platforms, and websites, but the messages and delivery across these channels were not always consistent. Despite the aim to achieve wide coverage using multiple communication channels, governments faced challenges in ensuring

inclusive communication, especially among ethnic minorities, migrants, persons with disabilities, and children. Addressing rising incidences of misinformation and disinformation was also a challenge. Moreover, open and transparent communication was generally lacking, undermining public trust.

2.1.2 DETECTION, TESTING, AND MAPPING

Technologies such as thermal cameras, wearables and sensors, and smartphone apps combined with AI, ML, and computer vision have been used to detect those who need testing, with the results displayed on maps or dashboards. Countries have generally made use of existing health information systems to keep track of COVID-19 testing and test results, and have developed guidelines for how to report COVID-19 test results (e.g., the CDC's guidance on how to report COVID-19 laboratory data). However, the strategy for COVID-19 testing varies between countries and there is a lack of global collaboration to ensure that the data collected is standardized for fair comparison. Moreover, efforts to promote commitment to responsible and ethical visualization and mapping are needed, as the data can easily be manipulated to mislead, contribute to misinformation and disinformation, and result in real-world consequences affecting human health and societal stability.

2.1.3 TRACKING, DISEASE SURVEILLANCE, AND ALERTS

The use of apps, wearables, and sensors for tracking, disease surveillance, and alerts have raised privacy and security concerns globally due to the large amount of personal data being collected, often in real time and on a continuous basis. Similarly, AI-based facial recognition surveillance systems, established to help trace contacts and enforce quarantine, often lack transparency regarding who has access to the data and how it is being used, as well as lacking consent from citizens. Methods to prevent unethical use of these technologies have not been addressed.

2.1.4 CONTACT TRACING AND RAPID RESPONSE

Many countries have developed apps and systems for contact tracing and rapid response. As there are no global standards for developing contact tracing apps and systems, there are wide variations in their system architecture, data management approach, and approach to privacy and security. Many of these apps and systems have raised privacy and security concerns for various reasons, including insecure apps that risk exposing users' personal data, and data collected for contact tracing being used for purposes other than public health. Moreover, the apps are sometimes opt-in, but in other places many or all citizens are compelled to download and use them. The violation of privacy and security rights has contributed to low uptake of contact tracing apps, reducing their effectiveness, and more broadly, it has contributed to public mistrust in authorities and leaders.

Another issue is the lack of collaboration to ensure the interoperability of contact tracing apps and systems, which will become more important as borders reopen.

2.1.5 CONTAINMENT, ISOLATION, AND QUARANTINE

Digital technologies have been deployed to monitor containment, isolation, and quarantine compliance. However, mandating the use of an app risks introducing security vulnerabilities and harming people's privacy and autonomy, which can break people's trust and undermine public health. Some countries have introduced wearables for wrists or ankles for monitoring and quarantine enforcement. Users may have even less control over how these wearables work (compared to smartphones that can be switched off), especially when they are made mandatory and users are not able to stop the wearables from collecting and broadcasting data.

2.1.6 TREATMENT, TELEMEDICINE, AND MONITORING

A combination of technologies such as wearables and sensors, smartphone apps, robotics, AI, and dashboards are being used for treatment, telemedicine, and monitoring. During the pandemic, with a surge in demand for telemedicine services, many governments issued temporary regulations to enable telemedicine services, which contributed to their rapid uptake. This rapid adoption and expansion of telemedicine, however, is leaving marginalized and vulnerable groups behind, such as patients with limited English proficiency, immigrants, and refugees, even in high-income countries. Moreover, there is a lack of a global standard for ensuring the quality, safety, security, and privacy of treatment, telemedicine, and monitoring through digital means.

2.1.7 DATA COLLECTION, ANALYSIS, AND DESTRUCTION FOR AI, BIG DATA ANALYTICS, AND ML

Algorithms for data analytics and AI have been developed to analyze the massive amount of data gathered from one or more data sources to gain insights and support decision-making. Concerns have been raised about these algorithms for several reasons. For instance, the datasets required to train the algorithms in healthcare often require a great deal of personal data, raising privacy and security concerns, including the re-identification of de-identified data, and the repurposing of data for other forms of surveillance. Moreover, the biases in datasets and algorithms are leading to discrimination against certain social groups and exacerbating inequalities. In light of these grave concerns, standards for data collection, analysis, and destruction are urgently needed.

2.1.8 DATA ANALYTICS AND REPORTING AT LOCAL, NATIONAL, REGIONAL, AND INTERNATIONAL LEVELS

A key challenge is the lack of global standards for COVID-19 reporting using consistent indicators that can be compared across localities, nations, and regions over time for evidence-based decision-making. Another key issue is the lack of open access to machine-readable data. Globally, datasets are biased, with low-income countries underrepresented. At the national level, data from electronic health records, genome databases, and biobanks on underserved and vulnerable groups are generally limited due to the lack of access to healthcare in these groups. The increased use of digital technologies, like smartphones and wearables, for health monitoring creates potential for biased datasets, by excluding those without access to such devices. Datasets that lack representation may lead to higher error rates for underrepresented groups, or to results that favor certain groups.

2.1.9 DATA PRIVACY, PROTECTION, SECURITY, AND ETHICS

Personal health data is very sensitive, and privacy, protection, safety, and security are understandably the most often cited issues, especially considering how the health sector has been facing more frequent cyberattacks during the pandemic. There is substantial concern among the public regarding the growing commodification of patient data and the risks involved in data sharing and integration. Risks include the re-identification of de-identified data; the potential to discriminate against specific groups, which could lead to denied access to services, harassment, and violence; and violation of personal autonomy. Authorities have cited COVID-19 to justify expanded surveillance powers and the deployment of intrusive technologies that often lack transparency, independent oversight, and avenues for redress.

2.1.10 LOGISTICS AND SUPPLY CHAIN MANAGEMENT OF PPE, MASKS, ETC.

The pandemic has strained the supply chain for medical equipment and supplies such as ventilators, disinfectants, face masks, gloves, and other PPE. Demand for medical equipment and supplies has exponentially increased, and meeting the demand has been challenging, especially with the disruptions to international transport. Further compounding the challenge has been the export prohibitions and restrictions introduced by countries to mitigate critical shortages. In general, the pandemic has seen a rise in protectionism and economic nationalism, replacing decades of expansive trade and foreign investment regimes. At the same time, there has been the rapid digitalization of supply chains, the use of drones to deliver medical equipment and supplies, and

the development of digital supply chain management systems to track and monitor critical medical equipment and supplies in real time. Safety and security will be more important than ever to ensure both supplies and data are protected from theft, damage, and fraud.

2.1.11 COLD CHAIN MANAGEMENT

Most vaccines need to be transported and stored at an optimal temperature throughout the cold chain for safety and effectiveness. A major challenge is the need for long-term cold storage ranging from 2–8 °C (Oxford-AstraZeneca) to –70 °C (Pfizer-BioNTech), which may not be available in rural and remote regions, especially given the lack of electricity supply in many of these regions. Most vaccines have short shelf lives once they are removed from storage. Strong coordination will be needed between workers at central depots and local vaccinators to ensure the timely and efficient distribution of vaccine batches to areas without freezers. Errors in handling, scheduling, documentation, transportation, temperature control, and storage across the supply chain can have significant consequences.

2.1.12 VACCINATION AND IMMUNIZATION

With the virus mutating and the unequal global rollout of the vaccines, there is always the risk that more variants, more virulent and resistant to treatments, will emerge. This means it is important to distribute vaccines worldwide as fast as possible. Besides the need to boost the supply of COVID-19 vaccines for low- and middle-income countries, other challenges include ensuring an adequate network of trained, technically competent personnel across the vaccine supply chain, including managing the two-dose regimen, monitoring and reporting on vaccine uptake and effectiveness, and addressing concerns over vaccine hesitancy. A major risk is criminal activities, both online and offline, targeted at disrupting the vaccine supply chain, either by stealing or manipulating vaccination-related data, or by spreading disinformation around COVID-19 vaccination. Moreover, the emergence of fake COVID-19 vaccines and fake COVID-19 vaccination certifications are urgent issues that need to be tackled.

3. COMPARATIVE AND GAP ANALYSIS FRAMEWORK FOR RELEVANT STANDARDS, GUIDELINES, AND TOOLKITS

A comparative analysis was conducted for thirteen selected countries and three health institutions with global influence and recognition to identify whether standards, guidelines, and toolkits for COVID-19 mitigation, response, and management have been published across the 12 critical operations of COVID-19 mitigation, response, and management. The results are summarized in the table below, categorized by the presence (yes), absence (no), or limited (ltd) evidence of standards, guidelines, and toolkits. In the case of Austria, the country has adopted EU guidelines for some of the critical operations.

In the next section, key observations and findings based on the comparative analysis are presented. These in turn form the basis for the recommendations in Section 5.

OPERATIONS		INTERNATIONAL				COUNTRIES											
		WHO ⁽ⁱ⁾	ECDC ⁽ⁱⁱ⁾	CDC ⁽ⁱⁱⁱ⁾	Austria	Bangla- desh	Brazil	China	Israel	Japan	Malaysia	Nepal	New Zealand	Nigeria	Pakistan	Venezuela	Vietnam
1. Communication and Awareness	Standards	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO
	Guidelines	YES	YES	YES	YES	YES	YES*	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	Toolkits	YES	YES	YES	YES	YES	NO	NO	NO	YES	YES	NO	YES	YES	NO	NO	NO
2. Detection, Testing and Mapping	Standards	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO
	Guidelines	YES	YES	YES	EU	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES
	Toolkits	NO	YES	YES	YES	YES	NO	NO	NO	LTD	YES	NO	YES	NO	NO	NO	NO
3. Tracking, Disease Surveillance and Alerts	Standards	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO
	Guidelines	YES	YES	YES	YES	YES	YES*	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES
	Toolkits	YES	NO	YES	YES	YES	NO	NO	NO	NO	YES	NO	YES	YES	NO	NO	NO
4. Contact Tracing and Rapid Response	Standards	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO
	Guidelines	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES
	Toolkits	YES	NO	YES	YES	YES	NO	YES	NO	NO	YES	NO	YES	NO	NO	NO	YES
5. Containment, Isolation and Quarantine	Standards	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO
	Guidelines	YES	YES	YES	EU	YES	LTD	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
	Toolkits	NO	YES	NO	NO	YES	NO	NO	NO	NO	YES	NO	NO	YES	NO	NO	LTD
6. Treatment, Telemedicine and Monitoring	Standards	NO	NO	NO	NO	YES	YES	NO	NO	NO	NO	NO	NO	YES	NO	NO	YES
	Guidelines	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	LTD	NO	YES
	Toolkits	NO	NO	YES	NO	YES	NO	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO
7. Data Collection, Analysis and Destruction (including for AI, Big Data Analytics and ML)	Standards	NO	NO	LTD	NO	YES	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO
	Guidelines	YES	YES	YES	EU	LTD	LTD	YES	YES	YES	YES	LTD	YES	NO	LTD	NO	YES
	Toolkits	YES	NO	YES	NO	YES	NO	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO

OPERATIONS		INTERNATIONAL				COUNTRIES											
		WHO ⁽ⁱ⁾	ECDC ⁽ⁱⁱ⁾	CDC ⁽ⁱⁱⁱ⁾	Austria	Bangla- desh	Brazil	China	Israel	Japan	Malaysia	Nepal	New Zealand	Nigeria	Pakistan	Venezuela	Vietnam
8. Data Analytics and Reporting (Local, National, Regional and International)	Standards	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO
	Guidelines	YES	NO	YES	EU	YES	NO	YES	NO	YES	YES	LTD	YES	NO	YES	NO	YES
	Toolkits	YES	NO	YES	NO	YES	NO	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO
9. Data Privacy, Protection, Security	Standards	NO	NO	NO	EU	YES	LTD*	NO	NO	NO	YES ⁴	NO	YES	YES	NO	NO	LTD
	Guidelines	YES	YES	YES	EU	LTD	LTD*	YES	YES	YES	YES	LTD	YES	NO	NO	NO	YES
	Toolkits	NO	NO	NO	NO	YES	NO	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO
10. Logistics and Supply Chain Management (PPE, Masks, etc.)	Standards	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO
	Guidelines	YES	YES	YES	EU	YES	NO	NO	NO	YES	YES	LTD	YES	NO	YES	NO	YES
	Toolkits	YES	NO	YES	NO	YES	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO
11. Cold Chain Management	Standards	NO	NO	YES	NO	YES	NO	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO
	Guidelines	YES	YES	YES	EU	YES	NO	NO	NO	YES	YES	NO	YES	NO	YES	NO	YES
	Toolkits	YES	NO	YES	NO	YES	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO
12. Vaccination and Immunization	Standards	YES	NO	YES	NO	YES	NO	NO	NO	NO	YES	NO	YES	YES	NO	NO	NO
	Guidelines	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	LTD	YES
	Toolkits	YES	YES	YES	YES	YES	NO	NO	NO	NO	YES	NO	YES	YES	LTD	NO	NO
13. Other Information of Note	General	N/A	N/A	N/A	<u>YES</u>	N/A	<u>YES</u>	<u>YES</u>	<u>YES</u>	<u>YES</u>	N/A	N/A	N/A	N/A	N/A	<u>YES</u>	YES
YES = Evidence Found		NO = No Evidence Found					LTD = Limited in Scope					EU = Follows EU Guidelines					
Private and Confidential © eWWG																	
Controlled Distribution																	

NOTES:

- (i) WHO publishes guidelines far more often than standards.
- (ii) ECDC appears to follow WHO in primarily publishing guidelines, not standards. It defines itself as a body dedicated to risk assessment, not risk management.⁵ There is no mention of standards on their website. See [About ECDC \(europa.eu\)](#)
- (iii) Multiple US agencies are involved in some aspects of COVID-19 mitigation, response and management, e.g., CDC, FDA and Health and Human Services (HHS). The boundaries between them are often unclear. CDC and FDA both publish regulations, which effectively act as standards in the United States of America. They also publish guidelines and toolkits. Refer to the detailed notes in the appendix.

⁴ Laws of Malaysia Act 709 Personal Data Protection Act 2010, <https://www.kkmm.gov.my/pdf/Personal%20Data%20Protection%20Act%202010.pdf>

⁵ ECDC, "Strategic and performance analysis of ECDC response to the COVID-19 pandemic," November 2020.

4. KEY OBSERVATIONS AND FINDINGS

1. Metrics for pandemic preparedness are outdated. All countries, regardless of level of development, have been impacted by the COVID-19 pandemic. Countries that have been successful at responding to the pandemic are not necessarily those from high-income groups, and those from high-income groups are not necessarily those most prepared for the pandemic. We need to re-evaluate and update the metrics for pandemic preparedness in a holistic manner, including the consideration for digital health readiness.⁶
2. Digital technologies for pandemic mitigation, response, and management are here to stay. During the pandemic, all countries, regardless of level of development, adopted digital technologies across the 12 critical operations of COVID-19 mitigation, response, and management. Countries have leveraged digital technologies to improve the speed, reach, and cost efficiency of many public health response measures, and to help ease the burden on and protect healthcare workers.
3. Global standards for COVID-19 mitigation, response, and management are limited. In most cases, there has not been sufficient time to create new formal standards specific to COVID-19 mitigation, response, and management. As a result, countries have struggled to effectively adopt and integrate digital technologies into their domestic health systems, and strengthen digital health resilience. Instead, governments have mostly adopted a “get whatever we have out as fast as we can” approach. Information is often scattered and disjointed, and a significant number of governments have published broken links, or their webpages themselves are broken.⁷
4. Guidelines are available but they are not holistic. Most countries have published guidelines in many of the critical operations, which could be built upon when developing global standards. However, these guidelines for specific critical operations have not necessarily taken a holistic approach that considers all aspects of the digital health ecosystem and the importance of multidisciplinary and multilevel (local to global) collaborations to strengthen and sustain digital health resilience.⁸

⁶ For example, the Global Health Security Index featured in Figure 1 does not include metrics for digital health readiness.

⁷ For example, at the time of writing, Germany’s published link for data privacy is broken (see https://www.bfdi.bund.de/DE/Datenschutz/Themen/Gesundheit_Soziales/GesundheitSozialesArtikel/Datenschutz-in-Corona-Pandemie.html).

⁸ For example, studies show that digital contact tracing technologies alone are insufficient to curb the spread of the virus. The ability for digital solutions to help, rather than hinder, depends on a country’s digital readiness, such as the coverage and quality of its digital infrastructure, the digital competencies of healthcare stakeholders and the population, and the data protection and cybersecurity measures that are in place. In addition, the provision of safe places and financial support for quarantine, and the availability of widespread rapid testing and treatment, are important conditions for successfully containing outbreaks.

5. Collaborations have failed or been ad hoc. There appears to have been a systemic failure in collaboration between governments. Instead of collaboration, there has been significant duplication of efforts, monopolization of scarce resources, and increased protectionism and nationalism. While there have been successful examples of public–private–civil society partnerships in developing and deploying digital technologies to support COVID-19 response, many of these partnerships have been established in an ad hoc manner. Moving forward, it is clear that exiting the pandemic and preparing for future pandemics will require cross-country and public–private–civil society collaborations, because no individual group or country can address the complexities alone. Until transmission is curtailed throughout the world, the risk of new variants sending us back to square one cannot be ignored.
6. Lack of open and transparent communication results in the undermining of trust. Quick and timely responses and restrictions have demonstrated greater success than slower, weaker ones. But evidence suggests that compliance, trust, and social support are also key to response effectiveness. Three of the more successful countries—Japan, New Zealand, and Vietnam—made open and transparent communication a cornerstone of their approach. This appears to have been a key differentiator in determining successful outcomes.
7. Standards are absent from most critical operations except in well-entrenched areas such as vaccine development and distribution. The creation of standards for all categories of critical operations are important, but the top three priorities are standards for: 1) data collection, analysis, and destruction, including for AI, big data analytics, and ML; 2) data analytics and reporting at local, national, regional, and international levels; and 3) data privacy, protection, security, and ethics. These categories reflect the serious concerns that have been most frequently raised during the COVID-19 pandemic in public discourse and academic research.
8. Lack of standards for data collection, analysis, and destruction, including for AI, big data analytics, and ML. Vast amounts of data on COVID-19 are being collected from a variety of “nontraditional” sources, such as from mobile apps and cell towers, sensors and wearables, social media sites and search engines, and drones and satellites. They have been combined with “traditional” data sources from health records, surveys, and statistics, and with the help of AI, big data analytics, and ML, trends and insights have been generated. However, the lack of standards has resulted in concerns regarding the quality, comparability, and interoperability of the data. There are also concerns regarding privacy, security, and biases in datasets and algorithms leading to discrimination and inequalities, as well as the repurposing of COVID-19 data for other forms of surveillance without any sunset conditions for destruction of data.

9. Lack of standards for data analytics and reporting at local, national, regional, and international levels. The lack of global standards for collecting and reporting vital data such as COVID-19 test results, hospitalizations, confirmed cases, deaths, and vaccinations has contributed to the continuous spread of the virus. Common variations in data include age, disability and vulnerable group categories, language and date formats, location names and political boundaries, and spatial and temporal resolutions. With growing data sources available, from statistical offices and different government agencies, the private sector (e.g., mobile network operators and social media platforms), and development organizations and academia, standards to rapidly normalize, format, and integrate data for spatiotemporal analysis and visualization is needed.
10. Lack of standards for data privacy, protection, security, and ethics. In the rush to roll out digital technologies that collect a massive amount of personal data, ethical, privacy, and security concerns are being raised, infringing upon individuals' civil liberties, and exposing people to constant and mass surveillance. Many countries have failed to enact any data privacy guidelines, and several countries with guidelines or laws in place have chosen to relax them.⁹ A number of countries, including Brazil, Israel, and Venezuela, have enacted policies that appear to endanger human rights, and most countries have failed to explicitly state the importance of human rights and the rule of law. Exceptions include the EU and New Zealand.
11. Useful toolkits are scarce and most do not address privacy and security concerns. The US CDC appears to have produced the most detailed toolkits and related material for contact tracing, but they have not addressed data privacy. The EU has addressed data privacy for contract tracing apps and produced a few toolkits.¹⁰ The EU has provided a toolkit specifically to address human rights, democracy, and the rule of law during the COVID-19 crisis. Most countries, however, have not done so.

⁹ For example, the US reduced privacy requirements in their Health Insurance Portability and Accountability Act. Centers for Medicare and Medicaid Services, "Medicare telemedicine health care provider fact sheet," 17 March 2020, <https://www.cms.gov/newsroom/fact-sheets/medicare-telemedicine-health-care-provider-fact-sheet>

¹⁰ Hunton Andrews Kurth, "EU publishes common toolbox and data protection guidance on tracing apps to fight COVID-19," 21 April 2020, <https://www.huntonprivacyblog.com/2020/04/21/eu-publishes-common-toolbox-and-data-protection-guidance-on-tracing-apps-to-fight-covid-19/>

5. RECOMMENDATIONS

Based on the key observations and findings discussed in Section 4, the following recommendations are made (with the corresponding observations and findings provided in parentheses):

1. Create a multi-stakeholder group to develop global standards to fast-track the strengthening of nations' and organizations' digital health resilience. This will help build capacities to mitigate, respond to, and manage the current COVID-19 pandemic and prepare for future pandemics.
2. Adopt a holistic and multidisciplinary approach to standards setting by convening the academic, technical, and scientific communities with policymakers, health sector stakeholders, technology companies, civil society representing vulnerable groups, and other stakeholders.
3. Develop a global standard for collaboration to enable fast and effective establishment of partnerships for pandemics and other public health emergencies.¹¹ This could include requirements and mechanisms across the 12 critical operations for the following:
 - Identification, development, and management of collaborative relationships within or between organizations;
 - Integrating digital technologies into collaborative initiatives in an inclusive and sustainable manner with security and privacy safeguards; and
 - Mobilizing and sharing data, knowledge, expertise, technologies, and financial resources towards deploying and scaling innovative solutions for successful outcomes.
4. Develop a global standard for COVID-19 communication to restore and promote greater transparency and public trust, building on existing guidelines and best practices. Such a standard could contain:
 - A clearly designated single information portal (and associated website, phone, email, etc.) for all official communication, rather than separate locations within different government agencies

¹¹ For example, being able to use private sector facilities to rapidly increase diagnostic testing capacity or access to ventilators is advantageous, but only possible if systems for coordination and data sharing are in place. Moreover, consider the development of long-term partnerships for interdisciplinary exchanges, capacity building, and professional development, and investments in addressing the complex challenges related to lack of digital connectivity and digital literacy, misinformation and disinformation, health inequalities, and bias, and safeguarding the privacy and security rights of vulnerable populations.

- A predefined set of stakeholders, each with their own section of the portal, e.g., medical professionals, individuals, regional government, educators, etc.
 - A predefined set of informational areas, each with their own section of the portal, e.g., countrywide case overview, clear guidelines, vaccine status
 - A grading system for the information presented, e.g., “highly certain,” “evolving,” “uncertain at this time”
 - A commitment to apolitical messaging and multipartisan authors, endorsement, and support, i.e., content should not be political in nature (or politicized) and should be authored, endorsed, and supported by individuals that represent a range of political affiliations, not just the group in power; and
 - A strategy for inclusive communication, especially among ethnic minorities, migrants, persons with disabilities, and children.
5. Develop global standards for COVID-19 data collection, analysis, and destruction (including for AI, big data analytics, and ML), especially for multisource data collection and integration. Build on existing standards and initiatives such as the Health Level Seven International’s Fast Healthcare Interoperability Resources for the exchange of digital health data and the Institute of Electrical and Electronics Engineers (IEEE) Global Initiative on Ethics in Autonomous and Intelligent Systems. Also build on various guidelines by the EU, WHO, and other organizations for testing and auditing AI models to identify and address bias, and ensure transparency, explainability, privacy, and security, as well as the presence of adequate human control.
6. Develop global standards for COVID-19 data analytics and reporting at local, national, regional, and international levels, building on existing guidelines by the WHO and other organizations.¹² This should:
- Include data format standards for vital data such as COVID-19 test results, hospitalizations, confirmed cases, deaths, and vaccinations to allow fair comparison across localities, countries, and regions over time;
 - Address common variations in data related to age, disability and vulnerable group categories, language and date formats, location names and political boundaries, and spatial and temporal resolutions; and
 - Consider responsible and inclusive display of data on dashboards and maps.¹³

¹² For example, Vital Strategies, a public health organization, has been working with governments across the US to improve the reporting of COVID-19 data using consistent indicators that can be compared across states over time. A model COVID-19 dashboard has been developed that can be adapted with state or county data to generate a color-coordinated dashboard for embedding in a website.

¹³ For example, ensure that the color and classification schemes of maps are universally accessible and inclusive of persons with disabilities (e.g., visual impairment and color blindness).