



Health systems resilience: is it time to revisit resilience after COVID-19?

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ABSTRACT

The concept of health system resilience has been challenged by the COVID-19 pandemic. Even well-established health systems, considered resilient, collapsed during the pandemic. To revisit the concept of resilience two years and a half after the initial impact of COVID-19, we conducted a qualitative study with 26 international experts in health systems to explore their views on concepts, stages, analytical frameworks, and implementation from a comparative perspective of high- and low-and-middle-income countries (HICs and LMICs). The interview guide was informed by a comprehensive literature review, and all interviewees had practice and academic expertise in some of the largest health systems in the world. Results show that the pandemic did modify experts' views on various aspects of health system resilience, which we summarize and propose as refinements to the current understanding of health systems resilience.

Introduction

The idea of improving the resilience of health systems has been studied and discussed since the 2000s, although not always using resilience as a concept (Gilson, 2012; Murray and Frenk, 2000; World Health Organization, 2010; World Health Organization, 2000). As external and internal shocks increasingly affected health systems functionality worldwide, the expression “health system resilience” emerged as an adaptable approach to analyzing the impacts of different types of crises, such as economic downturns (Thomas et al., 2013), the Ebola epidemic (Kruk et al., 2015; Ling et al., 2017), influxes of refugees (Alameddine et al., 2019; Ammar et al., 2016), and infectious disease outbreaks (Nuzzo et al., 2019), among others. Only after 2014, the concept of health system resilience gained relevance in reports from the European Union (EU) (European Commission, 2014), Organization for Economic Co-operation and Development (OECD) (OECD. Organisation for Economic Co-operation & Development, 2014), Oxfam (Kamal-Yanni, 2015), and the World Health Organization Regional Office for Europe (WHO/Europe) (WHO Europe, 2017). Analytical frameworks were designed to evaluate health system capacity for responding to public health emergencies, focusing predominantly on high- and low-and-middle-income countries (HICs and LMICs) (Irene Papanicolas et al., 2022; Thomas et al., 2020; WHO Europe, 2017).

With advances in the concept, stages, and dimensions of health system resilience, initiatives to monitor and evaluate proposed analytical frameworks emerged, such as the Global Health Security Index (Bell and Nuzzo, 2021) and the European Observatory on Health Systems and Policies reports (Sagan et al., 2021; Thomas et al., 2020; WHO Europe, 2021). Despite the efforts to establish the characteristics of the most resilient countries and to propose rankings among them, the COVID-19 pandemic (World Health Organization, 2020) has challenged the concept of resilience and brought new issues into the discussion (Forman et al., 2022). For example, the Global Health Security Index (Bell and Nuzzo, 2021) ranked the United States and the United Kingdom as the 1st and 7th countries, respectively, best prepared to respond to a new health emergency. Yet, based on the number of COVID-19 deaths per million people (University of Oxford, 2022), these countries have shown worse results than the world average. Countries with well-structured and integrated health systems, such as some Western European countries, were severely hit by the pandemic (Aarestrup et al., 2021; Bureau et al., 2022). Also, qualitative and quantitative metrics in the health system resilience literature still face difficulties, in particular, related to qualitative indicators in the governance dimension and to quantitative indicators aimed at measuring changes associated with shocks (Fleming et al., 2022).

The COVID-19 pandemic is the most severe global health emergency

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since the 1918–19 influenza. It brought unprecedented challenges that tested health systems' capacity to cope and respond to shocks, ultimately revealing that the world was not prepared to respond to such emergencies. This raises the question of whether there is anything new we should look at after two and a half years on from the initial impact of the COVID-19 pandemic to update knowledge on the health system resilience concept, stages, analytical framework, and implementation mechanisms.

To address this question, we performed a two-step qualitative analysis. First, we conducted a comprehensive literature review to identify critical themes on health system resilience. Second, we conducted semi-structured interviews with 26 world-renowned experts in health systems, and the interview guide was informed by the themes identified in the first step. Semi-structured interviews aimed at collecting informed opinions on the gaps and needs for revision of the current understanding of health system resilience, considering the challenges imposed by the COVID-19 pandemic.

Methods

A deductive qualitative approach comprised a) a comprehensive literature review on health system resilience, b) semi-structured interviews with world-renowned health system experts (with an interview guide informed by the literature review), and c) content analysis of the interviews. The deductive qualitative approach was chosen to link the categories created by the scoping review with the knowledge collected from the experts in the interviews (Saulnier et al., 2022).

Literature review

We used a scoping review approach to collect and categorize scientific papers and reports about health system resilience in the world. In this sense, our literature review is qualitative in nature by extracting information on health system resilience concepts, stages, dimensions, or implementation, and not by measuring quantitatively the studies through bibliometric analysis or meta-analysis.

The first search was conducted in September 2020, and updated every 3 months until September 2022 (Fig. 1).

Description: the scoping review flow chart demonstrates the applied steps to collect and select the scientific papers and technical reports used

in the paper.

For scientific papers, we searched the strings “health system” and “resilience” in the Web of Science, PubMed, and Scopus databases with no time filter. An initial screen was done based on the title, keywords, and abstract. For reports, we searched the strings “health system” and “resilience” and “report” in the google academic platform. Results were filtered by the publishing organization (e.g., World Health Organization and its regional offices, European Commission, OECD), and initially screened based on the title and abstract.

We used the Mendeley reference manager software to organize and detect duplicated studies. We used the PRISMA flow diagram to guide the steps and eligibility of the collected scientific papers and reports following Page et al. (2021). The authors screened the titles, abstracts, and summary executive and excluded those with clearly no relevant information to the health system resilience discussion. In sequence, the authors reviewed the full scientific papers and reports and elected those to be included in the final sample, based on their contribution to the health system resilience concept, stages, dimensions, or implementation.

We extracted from the included studies the general characteristics (title, authors, abstract, year, journal/organization) and the full texts. The full texts were analyzed through content analysis, and we created categories according to the health system resilience concept, stages, dimensions, or implementation to organize the existing topics.

Semi-structured interviews

We sought experts with solid knowledge of health systems, both in the practice and academic fields. The selection criteria were two-fold: i) current or previous work as a health system practitioner – e.g., worked for a government, served as a health system advisor for a government, or worked in a WHO/UNICEF unit of a country, and/or ii) an academic with expertise and active research in health systems – e.g., professors, senior lecturers, or WHO/UNICEF advisors with published reports and/or relevant scientific papers.

Deductive content analysis of the semi-structured interview transcripts was done using QSR NVivo v.12. Categories and subcategories were discussed in light of the literature review and classified as novel contributions if not present in the available literature. In this sense, we deduced the content of the experts' interviews through the categories

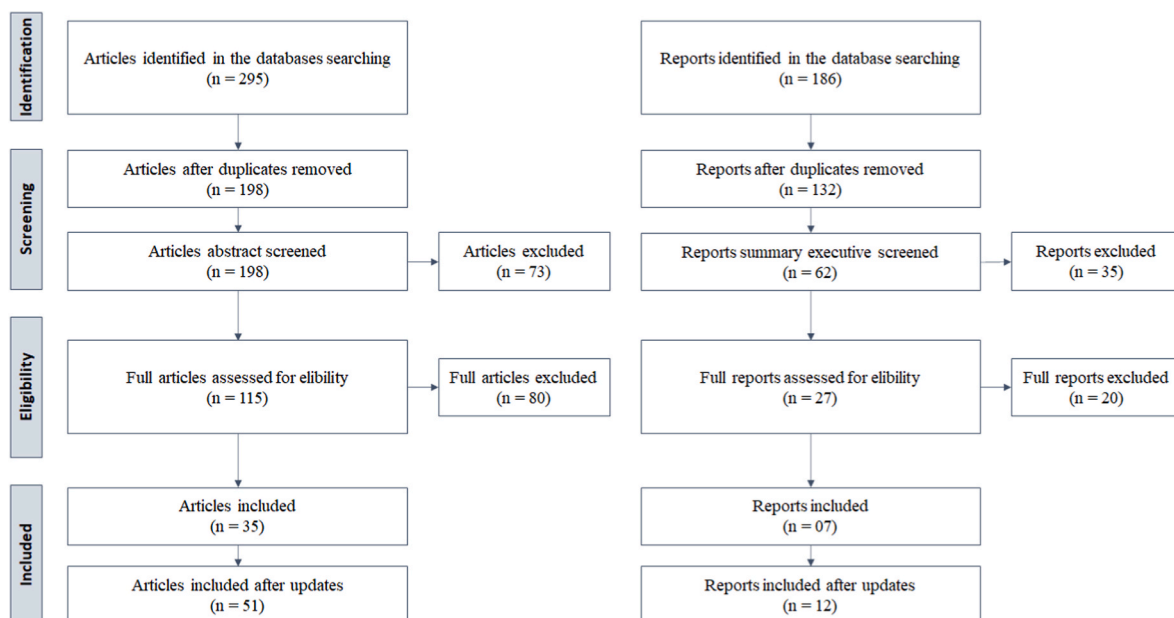


Fig. 1. Scoping review flow chart.

and subcategories generated by the scoping review (Naylor et al., 2018).

Results

Scoping review

The scoping review identified 51 scientific papers and 12 reports. Their content was summarized into categories and subcategories (Table 1) that were used to guide and analyze the semi-structured interviews.

Description: the selected scientific papers and technical reports generated categories and subcategories to guide the and analyze the interviews.

Semi-structured interviews

We interviewed 26 world-renowned health system experts, with experience in 27 countries across all continents, except Antarctica (Fig. 2), between November 23, 2021, and March 1st, 2022. The final sample included health systems' perspectives from 7 of the 10 most populous countries in the world (China, India, the United States, Brazil, Nigeria, Russia, and Mexico) (World Bank, 2021), and some of the leading universities and organizations in health system research (Table 2). The interviews had an average duration of 28 min, ranging from 14 to 59 min (Appendix 1). Although the length of the interviews varied across interviewees, we did not observe any differences in the depth of information collected by interview length."

Description: the map represents the countries based on the health system experts experience, selected if the expert was engaged in the country for at least 2 years.

Description: the world-renowned health system experts were characterized according to their countries knowledge, organizational practical and academic background, and positions.

Health system resilience - concept

The scoping review indicated an evolution in the concept of health system resilience. Initially, there was a focus on the capacity of the system to absorb shocks and maintain its functions and identity (Thomas et al., 2013). This initial concept was revised to consider (i) preparedness and learning, including the analysis of the role of actors, such as institutions and the population (Chua et al., 2020; Kruk et al., 2015; Ling et al., 2017; Nuzzo et al., 2019); (ii) recognizing that shocks could be internal or external to the system (Ammar et al., 2016; Ozawa et al., 2016; Van de Pas et al., 2017); (iii) management as a sequence of actions that imply absorbing, adapting, and transforming; and (iv) different shock types, such as epidemics, pandemics, or natural disasters (Blanchet et al., 2017; Khan et al., 2018; Nzinga et al., 2021; Saulnier et al., 2021). Lastly, based on previous studies, a synthetic version was created considering the ability of preparedness, management (including absorb, adapt, and transform), and learning when facing a shock (Biddle et al., 2020; Fridell et al., 2020; Thomas et al., 2020).

Analysis of the semi-structured interviews showed that experts interviewed demonstrated knowledge of the health system resilience concept and its evolution, mainly with the emphasis on the ability or capacity to keep the health system operating and learning about shocks (Haldane et al., 2021; Kruk et al., 2015; Thomas et al., 2013, 2020). According to the interviews, however, that ability or capacity could influence or be influenced by community participation and context understanding. This is a novel concept improvement, not found in the scoping review. As one interviewee said:

"... healthcare systems don't happen to people, they happen with people. So at the same time understand their expectations and how they react when a crisis happens ... and then we switch back to the

Table 1

Categories and subcategories summarizing the systematic review.

Categories/Subcategories (codes)	References
1. Health System Resilience Definition (concept)	
1.1 capacity of a health system to absorb change but continue to retain essentially the same identity and function	(Odhiambo et al., 2020; Thomas et al., 2013; Turenne et al., 2019)
1.2 capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and be informed by lessons learned pre, during, and after the crisis	(Chua et al., 2020; Haldane et al., 2017, 2021; Kruk et al., 2015; Ling et al., 2017; Nuzzo et al., 2019)
1.3 capacity of a health system to absorb internal or external shocks, and maintain functional health institutions	(Ammar et al., 2016; Ozawa et al., 2016; Van de Pas et al., 2017)
1.4 capacity of the health system to absorb, adapt and transform when exposed to a shock such as a pandemic, natural disaster, or armed conflict and still retain the same control of its structure and functions	(Abimbola et al., 2019; Alameddine et al., 2019; Blanchet et al., 2017; Khan et al., 2018; Nzinga et al., 2021; Saulnier et al., 2021; Turenne et al., 2019; Wiig and O'Hara, 2021)
1.5 ability to prepare for, manage (absorb, adapt, and transform) and learn from shocks	(Biddle et al., 2020; Fridell et al., 2020; Thomas et al., 2020)
1.6 COVID-19 changes the health system resilience definition	
1.6.1 an improvement, with the insert and giving more attention to preparing, and later to learning, inserting the previous "steps" into the management place.	(Biddle et al., 2020; Fridell et al., 2020; Haldane and Morgan, 2021; Thomas et al., 2020)
1.6.2 more attention to the steps, to evaluate the process	(Burke et al., 2021; Thomas et al., 2020)
2. Health System Resilience Stages	
2.1 preparedness, shock onset and alert, shock impact and management, and recovery and Learning	(Burke et al., 2021; Khan et al., 2018; Thomas et al., 2020)
3. Health System Resilience Dimensions	
3.1 financing, health services provision, resource generation, stewardship, vertical integration, and external factors to the health system – as a network	Murray and Frenk (2000)
3.2 financing, services delivery, health workforce, health information systems, medicines, and leadership and governance - as building blocks	(Ammar et al., 2016; Bigoni et al., 2022; Fridell et al., 2020; McDarby et al., 2019; World Health Organization, 2010)
3.2.1 medicines, vaccines, and technology.	Olu (2017)
3.2.2 "community engagement" dimension	(Barasa et al., 2018; Khan et al., 2018; Nzinga et al., 2021)
3.3 financial resilience; adaptive resilience and transformative resilience	Thomas et al. (2013)
3.3.1 focus on governance: "anticipatory capacity, absorptive capacity, adaptive capacity, and transformative capacity"	(Alameddine et al., 2019; Blanchet et al., 2017; Bureau et al., 2022; WHO Europe, 2017)
3.3.2 cognitive, contextual, and behavioural capacities – strategies	(Gilson et al., 2020; Kagwanja et al., 2020)
3.4 attributes: aware, diverse, self-regulating, integrated, and adaptive	(Foroughi et al., 2022; Humphrey Cyprian Karamagi et al., 2022; Ling et al., 2017; Nuzzo et al., 2019)
3.5 synthetic version of the World Health Organization building blocks: governance, financing, resources, and services delivery	(Irene Papanicolas et al., 2022; Sagan et al., 2021; Thomas et al., 2020)
3.5.1 expanding with new dimensions: political environment and community, legal foundation, risk communication, and containment measures	(Chua et al., 2020; Humphrey Cyprian Karamagi et al., 2022; Meyer et al., 2020)
3.5.2 final framework excludes leadership and includes public health functions	(Haldane et al., 2021; Mustafa et al., 2021)
3.6 inputs, outputs, and outcomes, crossing with equity, efficiency, and financing	(European Commission, 2020; Rogers et al., 2021)
4. Incorporate Health System Resilience	
4.1 investing and protecting health funding	

(continued on next page)

Table 1 (continued)

Categories/Subcategories (codes)	References
1. Health System Resilience Definition (concept)	
4.2 health system with a people-centered focus	(Bureau et al., 2022; Etienne et al., 2020; Lal et al., 2021; Sagan et al., 2021; Thomas et al., 2020)
4.3 equity and universal coverage	(Thomas et al., 2013; WHO Europe, 2017)
4.4 strengthening the health system capacities - adaptive, absorptive, and transformative	(Foroughi et al., 2022; Lal et al., 2021; Massuda et al., 2018)
4.5 protect the provision of the services, as well as the health workforce in this process	(Bureau et al., 2022; Jung et al., 2021; Saulnier et al., 2021; WHO Europe, 2017)
4.6 a constant and interactive network with other spheres (actors) and countries, including the knowledge of the scientific community	(el Bcheraoui et al., 2020; Kagwanja et al., 2020; Sagan et al., 2021; Thomas et al., 2020, 2013)
4.7 an integration of communication technologies to support a constant and interactive network	(Blanchet et al., 2017; Gilson et al., 2020; Jit et al., 2021; Kruk et al., 2015; Legido-Quigley et al., 2020)
4.8 one health approach	(European Commission, 2020; Foroughi et al., 2022; Rogers et al., 2021; Saulnier et al., 2022)
4.9 community engagement, solidarity, and trust (legitimacy) in the communication, associated with leadership, local or not, and governance.	(Aarestrup et al., 2021; Forman et al., 2022)
4.10 developing plans and protocols during all the process (before until after), with flexibility and coordination, and monitoring capacity	(Alameddine et al., 2019; Blanchet et al., 2017; Chua et al., 2020; Forman et al., 2022; Haldane et al., 2021; Legido-Quigley et al., 2020; Nzinga et al., 2021; Ozawa et al., 2016)
4.11 protect the medicines and physical resources supply chain	(Meyer et al., 2020; Mustafa et al., 2021; Nuzzo et al., 2019; Rogers et al., 2021; Sagan et al., 2021; Thomas et al., 2020)
5. Health System Resilience Framework – Implementation	
5.1 to be in the political agenda and process, with stability	(Kagwanja et al., 2020; Pehudoff et al., 2021)
5.2 create new political spaces to discuss and deliberate about the health system resilience	(Alameddine et al., 2019; Forman et al., 2022; Kruk et al., 2015; Rogers et al., 2021; Saulnier et al., 2022)
5.3 coordinate the different political leaders and communities during the event	(Khan et al., 2018; Saulnier et al., 2022; Van de Pas et al., 2017)
5.4 have a strong legal and regulatory foundation to support it, with legal proceedings and being flexible to adapt to new scenarios	(Abimbola et al., 2019; Chua et al., 2020; Foroughi et al., 2022; Lal et al., 2021)
5.5 protect the social structure to justify the resilience issue	(Barasa et al., 2018; Chua et al., 2020; Forman et al., 2022; Kruk et al., 2015; Nuzzo et al., 2019; Thomas et al., 2020)
5.6 have funding to discuss and implement the framework	(Etienne et al., 2020; Ozawa et al., 2016; Thomas et al., 2013)
5.7 combine the technical resources – communication, workforce, and structure, with new strategies and knowledge	(European Commission, 2020; Rogers et al., 2021)
5.8 information, technology, and data, as important issues to give relevance to the implementation	(Abimbola et al., 2019; Alameddine et al., 2019; Bigoni et al., 2022; Ling et al., 2017; Thomas et al., 2013, 2020)
	(el Bcheraoui et al., 2020; European Commission, 2020; Rogers et al., 2021)

Description: the selected scientific papers and technical reports generated categories and subcategories to guide and analyze the interviews.

technical part because it is a lot easier. And then we follow to political and then legal”

When inquired about possible changes in the health system resilience concept considering COVID-19, experts suggested that the concept of health system resilience has been tested, challenged, and therefore changed.

“It showed a certain amount of flexibility, and the things that people might have taken years to implement in a hospital were implemented overnight. A pivot to telehealth, for example, things, you know, people have been talking about that, but well, it just had to happen.”

The changes proposed are a) resilience needs to have a strong element of context in your concept; b) health system resilience should go beyond the health care boundaries, emphasizing the need for financial, political, and social support; c) health care supply chain gained importance in the health system resilience discussion, with influence on public policies; d) health system resilience should include new technologies and instruments to strength resilient health system, as artificial intelligence and telemedicine; and e) surveillance, governance instruments, and social measures should gain more relevance in the health system resilience debate.

Health system resilience - stages

Based on the scoping review, health system resilience includes four stages (Burke et al., 2021; Khan et al., 2018; Thomas et al., 2020). The first, preparedness, represents the health system’s readiness to respond before the shock event (Aarestrup et al., 2021; el Bcheraoui et al., 2020). The second, onset and alert, aims to understand the shock and establish timelines of action (Thomas et al., 2020). The third, shock impact and management, refers to the health system in action during the shock, with some adaptations and transformations to keep the health system operating (Burke et al., 2021; Khan et al., 2018). Finally, recovery and learning is the process of rethinking the health system and how it could be made more resilient (Sagan et al., 2021; Sheikh and Abimbola S. editor, 2021).

Experts interviewed proposed some changes to this framework. The first relevant change is to consider the four stages as a complex adaptive system with a continuing process of multiple interconnected and interdependent interactions among stages, thus building upon the framework developed by Thomas et al. (2020).

“They’re all connected in true life. They overlap quite a lot. We are dealing with a complex adaptive system. I mean, unfortunately, when we try and classify stages, which is convenient, because when we are trying to under each heading consider, what are the actions that are required, what are the consequences of an action? And what are the consequences of inaction? It is convenient to divide into stages, but quite often, we find that in a complex adaptive system, there is an iteration of very many factors and alteration of very many factors as they come into play. And therefore, I don’t think we can always say that these are sequential”.

At the core of that adaptive system should be the decision-making process and management capacity, influencing all the stages of action. Interviewees discussed the importance of the decision-making process through management. Therefore, the decision-makers – e.g., health system managers, front-line health professionals, among others – are the core of the adaptive system, and the management capacity connects them with all the other stages. Also, the resilience adaptive system is part of the health system, which influences and is influenced by the context.

Health system resilience - dimensions

Based on the scoping review, dimensions to be considered in the assessment of health system resilience have their roots in analytical frameworks to evaluate health system performance, initially proposed by the WHO in 2000 (Murray and Frenk, 2000). Over time, many changes were proposed to those frameworks, with dimensions (or building blocks) to analyze health systems including financing, service delivery, health workforce, health information systems, medicines/vaccines/technology (Olu, 2017), leadership and governance (World Health Organization, 2010), and community engagement (Barasa et al., 2018; Khan et al., 2018). These health systems dimensions contributed to creating a version to evaluate health systems resilience, proposed in 2020 and continued to be refined until 2022 (Irene Papanicolas et al., 2022; Thomas et al., 2020). Dimensions considered include governance, financing, resources, services delivery, political

Table 2
Characteristics of experts interviewed.

Continents	Asia, Africa, Europe, North America, South America, and Oceania.
Countries*	Asia: China, India, and the Philippines. Africa: Angola, Mozambique, Nigeria, and South Africa. Europe: Cyprus, Finland, Germany, Ireland, Liberia, Netherlands, Portugal, Serbia, Slovenia, Spain, Russia, and the United Kingdom. North America: Barbados, Canada, Mexico, and the United States. South America: Brazil. Oceania: Australia and New Zealand.
Organizations* practical background	Non-governmental: World Health Organization (Africa, Americas, Europe, South-East Asia, Western Pacific, China, and Russia), World Bank; World Economic Forum, International Monetary Fund, Organization for Economic Co-operation and Development, United Nations International Children's Emergency Fund, United Nations Development Programme, UK Medical Research Council, Commonwealth Fund International Program, and Public Health Foundation of India. Governmental: Ministry or Department of Health (Australia, Brazil, India, Mexico, Nigeria, Portugal, and Spain), Centers for Disease Control and Prevention, Centers for Medicare and Medicaid Services, and European Commission.
Organizations* academic background	Harvard T.H. Chan School of Public Health, University of Miami, London School of Economics, Trinity College Dublin, NOVA School of Business and Economics, London School of Hygiene and Tropical Medicine, University of São Paulo, UTS Business School, Getúlio Vargas Foundation, Grattan Institute, Oswaldo Cruz Foundation, University of Massachusetts Amherst, and the University of Campinas.
Positions*	Advisors (health, social or economic), Coordinators (health systems), University leadership, Directors and Representative of international organizations, Leader Economists, Leader Physicians, Ministers and Secretariats of Health, Directors of public health associations, Professors, and Researchers.
* Countries, organizations, and positions were listed if the interviewee was engaged in the work for at least 2 years.	

Description: the world-renowned health system experts were characterized according to their countries' knowledge, organizational practical and academic background, and positions.

support the health system adaptation.

"(...) you're going to have to engage, not just the Ministry of Health, but all the particular economy, finance, the other sectors that have been very clearly impacted by the pandemic and make the strong, make the strong justification, (...). The arguments at the moment will be you, you should be able to make them even recognizing the current situation there at the moment, from the economic perspective on the political economy perspective. Also, (...) strengthening of the health system there from the technical a strategic perspective."

From an economic perspective, it is essential to establish a fund to support implementation, understand the resource constraints of the healthcare system, and improve resources management capacity in strategic areas. Lastly, regarding technical elements, five actions were highlighted by the experts: (i) create or adapt a national representative survey to increase social participation and bottom-up communication by analyzing people's perception of what a resilient health system is; (ii) establish national, state, regional, and local data analysis capacity; (iii) improve health care data system interoperability between government spheres (e.g., federal, state, regional and local) and country borders, health care subsystems (private x public), and different services delivery subsystems (e.g., PHC and specialized care); (iv) have a high and stable

competent team to manage, implement, monitor, and assess the health system resilience framework implementation; and (v) create a benchmarking atmosphere between the health departments in state, regional and local levels.

Discussion

Health system resilience has gained relevance in academic and practical discussions, affecting the decision-making process of many countries worldwide since the beginning of the 21st century. In the last two and a half years, the COVID-19 pandemic challenged the concept of health system resilience. Here, we reviewed the current literature and conducted interviews with experts to discuss the advances in health system resilience.

First, the resilience concept was improved with the addition of one important element: context dependence (Gilson et al., 2020; Sagan et al., 2021). It is important to consider the management and learning capacity with shocks, but also the context in which the shock happens. The capacity or ability to respond must engage the community, with an empathetic approach, and be adapted to local contexts. This understanding provides a refinement to the health system resilience definition as seen in the last studies (Biddle et al., 2020; Fridell et al., 2020; Haldane et al., 2021; Thomas et al., 2020). Specifically, it could be read as the "ability to prepare for, manage (absorb, adapt, and transform) and learn from shocks, *based on community participation and context adaptation*". This refinement was influenced by the COVID-19 pandemic, placing more emphasis on non-medical elements, such as health surveillance (Haldane and Morgan, 2021; Legido-Quigley et al., 2020; Sundararaman et al., 2021), health care supply chain (Bhaskar et al., 2020b; Kandel et al., 2020), governance mechanisms to coordinate integrated responses (Haldane et al., 2021; Haldane and Morgan, 2021), and speed in the development and incorporation of new health technologies to support response worldwide (from vaccines to digital health) (Bhaskar et al., 2020a).

Second, we summarized the suggestions regarding the health system resilience stages in Fig. 3. Decision-making gains a central role in the response to shocks and crises, supported by its management capacity, connected with all the health system resilience stages, and in constant interaction with the health system and the context. Most importantly, the previous four health system resilience stages discussed in the literature (Thomas et al., 2020) should be seen as an adaptive system (Atun et al., 2013; Haldane et al., 2021).

Description: the scheme illustrates the health system resilience stages, with a complex-based adaptive system and in constant interaction. Decision-making has a central role and is operationalized by the management capacity to connect with the 4 stages, acting in the health system environment and context.

Third, the scoping review and interviews brought advances in the health system resilience dimensions, with a new and adaptable framework. We summarize the findings in Fig. 4 and propose a system-based approach with technology and information systems playing an important role to connect the decision-makers with all the health system resilience dimensions (Yoon et al., 2022). In this refined framework, regulation gains more emphasis on governance and leadership (Bhaskar et al., 2020a; Kandel et al., 2020; Kringos et al., 2020; Sagan et al., 2021), and communication and social participation appear in the fourth level, connecting all other dimensions with the context. Therefore, the proposed framework (Fig. 4) advances in the health system resilience analysis with a system model, based on the importance of the decision-makers and management capacity, powered by technology and information, to improve the third-level dimensions performance. Also, the framework shows the importance of communication and participation to connect the health system's performance with the context.

Description: the figure illustrates an adaptable health system resilience framework. The decision-makers are in the center and connected with the 6 dimensions through technology and information. All the

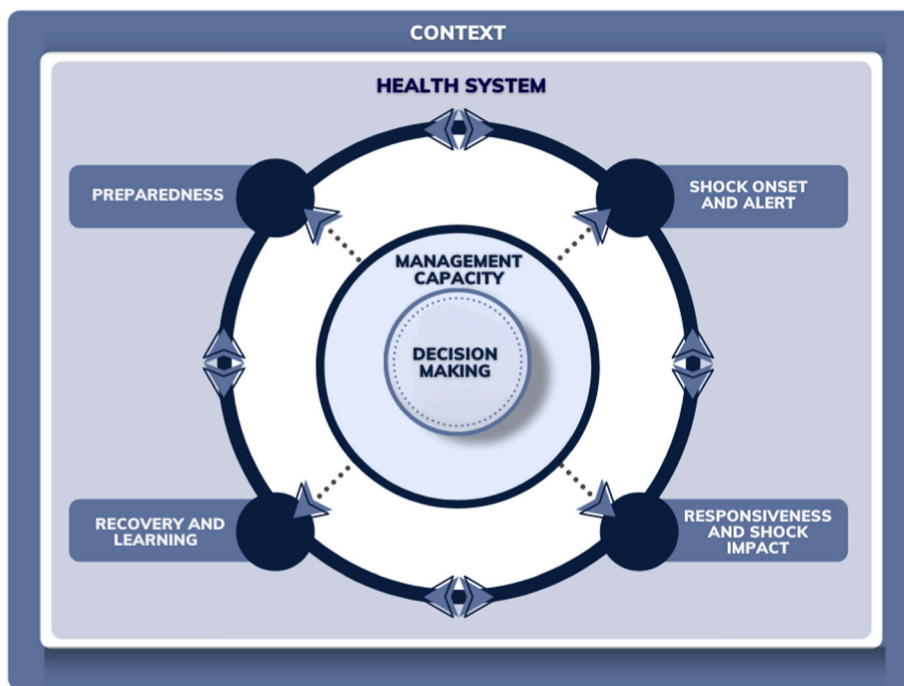


Fig. 3. Health system resilience adaptive stages.



Fig. 4. Health system resilience framework.

health system resilience dimensions interact with the context using communication and social participation.

In a comparative vision between HICs and LMICs, the main differences to incorporate resilience in health systems are resources (Haldane et al., 2021; Haldane and Morgan, 2021), social protection capacity, logistics and supply chain structure, and information and communication technologies (Bhaskar et al., 2020b; Haldane et al., 2021; Sundararaman et al., 2021). Governance mechanisms depend on the democracy maturity stage and are more frequently found in HICs (Foroughi et al., 2022; Lal et al., 2021; Robert et al., 2022), while communication and social participation, context, and target dimensions play a similar role in

all countries. To properly respond to crises, it is necessary to have all parts of the health system resilience framework work together.

Regarding the implementation of the health system resilience framework, it is necessary to understand people’s expectations about what a resilient healthcare system to them would be (Haldane et al., 2021; Nimako and Kruk, 2021), adapt the discussion to different government levels (H. C. Karamagi et al., 2022), and have policy support and a strong narrative (Herron et al., 2022). Therefore, organizations and actors must be connected (Kringos et al., 2020; Sundararaman et al., 2021; Williamson et al., 2022), through an improved information system (Chua et al., 2020; Jit et al., 2021; Sagan et al., 2021) and flexible regulation, to better respond to a crisis (Bhaskar et al., 2020a; Kandel et al., 2020). Having a stable team to manage the initiative and create a benchmarking environment between all the actors should be considered (Carroll et al., 2022; Yoon et al., 2022).

Finally, most studies on health systems resilience have focused on the context of HICs with well-established health systems or LICs with very fragile systems. It is essential to expand studies on health system’s resilience in the context of MICs with highly fragmented systems in the public and private sectors.

Conclusion

Based on a scoping review and in-depth interviews we propose improvements in the health system resilience discussion. We revisited key aspects of the concept, stages, dimensions/framework, differences across countries, and framework implementation.

This paper contributed new conceptual insights to the health system resilience academic debate as well as to the policy and practical discussion around the topic by i) advancing towards a refinement in the health system resilience 4 adaptive stages model and the health system resilience framework; ii) pointing out differences in the way health systems resilience should be incorporated in HICs and LMICs, iii) identifying the timing and conditions upon which the health system resilience framework should be implemented; and iv) identifying gaps in the understanding of health system resilience in countries with fragile institutions and financial vulnerability.

Credit author statement

Marco Antonio Catussi Paschoalotto - Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Resources; Software; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing. **Marcia C. Castro** and **Adriano Massuda** - Conceptualization; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing. **Rudi Rocha** and **Eduardo Alves Lazzari** - Conceptualization; Methodology; Project administration; Supervision; Validation; Visualization; Writing – original draft; Writing – review & editing.

Ethics approval

The research received ethical approval by the Committee for Ethical Compliance in Research Involving Human Beings of Fundação Getúlio Vargas (CEPH/FGV) on September 27th, 2021–228/2021 statement number.

Consent to participate

Before voluntary participation, all participants were informed that their responses would be used only for scientific purposes.

Consent for publication

All authors provided consent for this publication.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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