

HOW TO ASSESS HEALTH SYSTEM RESILIENCE?

A scoping review

by

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Thesis submitted in partial fulfillment of the requirements for the degree of

Master of Science in Public Health

Health Systems and Disease Control

(Version corrected after the Final Oral Examination)

Antwerpen / Belgium, July 2022

Disclaimer: this dissertation was written as part of the Master of Science of Public Health's curriculum at the Institute of Tropical Medicine (ITM). It has not been subjected to peer review. The views expressed in this document are those of the author and do not necessarily reflect those of the ITM or any other party. Possible inaccuracies, factual errors and acknowledgment of due credit to the work of others, are the sole responsibility of the author.

Dedication and acknowledgements

A fulfilled desire is a tree of life

To Malia, Alohra my baby, my little miracle, my treasure!

My heartfelt gratitude goes to Kristien Verdonck and Bruno Marchal, who guided me in this work; also, to Ateba Olivia Ewokolo and Edzoa Essomba Brice who participated in the review process. My deepest appreciation to the entire course team, the support staff and the housing maintenance team, who did so much to help us achieve our training objectives and made our stay in Antwerp enjoyable. My sincere gratitude to all members of the 2021/22 MPH class for the friendly atmosphere, the active solidarity and the mutual enrichment. I feel indebted to my family, who put up with my absence for the duration of the training. Finally, I express my special thanks to the Belgian Directorate General for Development Cooperation and Humanitarian Aid (DGD) for the scholarship that enabled me to participate in this programme, to the Ministry of Public Health and the Ministry of Public Service and Administrative Reform of Cameroon, for granting me study leave.

Summary

In the wake of the 2014 Ebola outbreak in West Africa, the COVID-19 pandemic has reinforced the global interest for health systems resilience. Indeed, only a resilient health system would ensure the well-being of populations even under such critical conditions, whereas poorly resilient health systems may be disrupted and collapse. The pandemic has exposed a range of health system weaknesses, some of which were unforeseen. It also invalidated several of the indices that had been developed to grade the capacity of countries to prevent and mitigate the effects of shocks. As we expect increased challenges to health systems due to the effects of global warming, urbanisation, the non-communicable diseases 'epidemic', aging, conflicts and changing patterns of infectious diseases, there is debate about how health system resilience can best be assessed.

I conducted a scoping review to examine how health system resilience can be assessed. I followed the updated guidance for scoping reviews proposed in the JBI Manual for evidence synthesis. The search strategy was validated by an experienced librarian. The review protocol was registered and published on the Figshare platform. Peer-reviewed articles were searched from PubMed, ScienceDirect, EBSCOhost, CAIRN, SSRN, Google Scholar and DOAJ. MedRxiv was searched for preprints; OALster, reliefWeb and WHO library were searched for grey literature. Reference lists of included documents were reviewed to identify relevant documents that would have been missed during the database search.

The literature search yielded 868 records, of which 34 were included after thorough screening by 3 reviewers based on predefined inclusion and exclusion criteria. Twenty-one reports were about case studies covering 103 countries, with 12 concerning epidemiological shocks. Various definitions of the concept of health system resilience were found, as well as diverging conceptual bases for assessment. This is arguably due to the diversity in the understanding of the concept, which is gradually evolving to incorporate criticism and include contributions from various fields of research. Three main assessment approaches emerged from this review: the *system mapping* that looks at the health system core functions, the *capacity-based* that looks at the core characteristics of resilience, and the *strategy-based* that looks at resilience strategies. None of these approaches gives a full picture of resilience. They are not mutually exclusive and can be complementary; therefore, more researchers are using a mix of approaches. However, there is still need for further testing and learning from the field on their specific or integrated use. The absence of a common understanding of the concept of health system resilience represents a major hinderance to its operationalisation and assessment.

Table of contents

Dedication and acknowledgements	iii
Summary	iv
Table of contents.....	v
List of figures	vii
List of tables	vii
List of abbreviations	viii
1. Introduction	1
2. Objectives	3
2.1. General objective.....	3
2.2. Specific objectives.....	3
3. Methods.....	3
3.1. Background	3
3.1.1. Context.....	3
3.1.2. Shocks	3
3.1.3. Health systems.....	4
3.1.4. Health system resilience	6
3.2. Study design.....	7
3.3. Research question	8
3.4. Eligibility criteria	8
3.5. Literature search.....	9
3.6. Screening of identified literature.....	9
3.6.1. Screening of titles and abstracts.....	9
3.6.2. Screening of full texts	9
3.7. Data charting	10
3.8. Data collation.....	11
3.9. Ethical considerations.....	11
3.10. Protocol registration.....	11
3.11. Methodological limitations.....	11
3.12. Positionality	12
4. Results.....	13
4.1. Description of search and selection process	13
4.2. Characteristics of included reports.....	14

4.3.	Definitions and conceptual bases for assessing health system resilience.....	18
4.3.1.	Definitions of health system resilience.....	18
4.3.2.	Conceptual bases for assessing resilience	23
4.4.	Approaches for assessing health system resilience	27
4.4.1.	Approaches found in reviewed literature.....	28
4.4.2.	Approaches utilised for assessing health system resilience and details on their use	28
4.4.3.	Metrics used for assessing health system resilience	30
4.5.	Limitations and weaknesses of identified frameworks and assessment approaches	31
5.	Discussion	33
5.1.	Definitions of health system resilience.....	33
5.2.	Conceptual bases for the assessment of health system resilience	33
5.3.	Approaches for assessing health system resilience.....	34
5.3.1.	The system mapping approach.....	34
5.3.2.	The capacity-based approach	35
5.3.3.	The strategy-based approach	35
5.4.	Limitations and weaknesses of identified assessment approaches	36
5.5.	A framework situating approaches for assessing health system resilience and their use	36
5.6.	Limitations of the study	38
6.	Recommendations	39
7.	Conclusion.....	39
8.	Bibliographic references	40
9.	Annexes.....	50
	Annex 1. Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist	51
	Annex 2. Search strategy	53
	Annex 3. Studies assessing health system resilience and countries of implementation	55
	Annex 4. Key elements from the definition of resilience in relation with the health system.....	56
	Annex 5. Evolution of key references for the conceptual bases proposed or used	57
	Annex 6. Chronology of conceptual bases for the assessment of health system resilience	58
	Annex 7. Assessment approaches in reviewed reports.....	60
	Annex 8. Assessment approaches used, with related study details.....	61
	Annex 9. Assessment approaches with their levels of implementation across the health system ..	63

List of figures

Figure 1. The WHO health system building blocks framework	5
Figure 2. The health system dynamic framework	6
Figure 3. Steps for identification, screening, eligibility and inclusion of studies..	7
Figure 4. Prisma flow chart presenting the search and selection of reports included in this review ...	13
Figure 5. Distribution of included reports over the years	14
Figure 6. Map presenting countries whose health system resilience was assessed.....	14
Figure 7. Word cloud of references cited for the definition of resilience in relation with the health system	22
Figure 8. Network of reports included in the scoping review as well as the source publications of the frameworks they use	26
Figure 9. Framework situating approaches for assessing health system resilience and their use	38

List of tables

Table 1. Details of the framework used to develop the research question.....	8
Table 2. Eligibility criteria	8
Table 3. Overview of included reports	15
Table 4. Definitions of resilience provided in the included reports.....	19
Table 5. Evolution of key elements used in defining resilience	23
Table 6. Conceptual bases proposed or reported for the assessment of health system resilience	24
Table 7. Conceptual evolution of the assessment of health system resilience	27
Table 8. Proposed/used assessment approaches	28
Table 9. Characteristics and focus of studies with each of the assessment approaches.....	29
Table 10. Metrics used for system mapping	31

List of abbreviations

CAS	Complex adaptive system
CDC	Centers for Disease Control and Prevention
COVID-19	Coronavirus disease 2019
DGD	Belgian Directorate General for Development Cooperation and Humanitarian Aid
DOAJ	Directory of Open Access Journals
EHSR	Everyday Health System Resilience
EID	Emerging Infectious Diseases
EPHS	Essential Public Health Services
EPR	Emergency Preparedness and Response
EU	European Union
HS	Health System
HSSS	Health System Strengthening Strategy
ISR	Inherent System Resilience
ITM	Institute of Tropical medicine
JB I	Joanna Briggs Institute
MD	Medical Doctor
MHSCS	Multi-dimensional Health and Social Care Systems framework
MPH	Master of Public Health
OAIster	Open Archives Initiative
SDG	Sustainable Development Goals
SRN	State Registered Nurse
SSRN	Social Science Research Network
SUS	Brazilian Health System
TISM	Total Interpretive Structural Modelling
WHO	World Health Organisation

1. Introduction

The COVID-19 pandemic has reinforced the interest in health systems resilience, which was initially raised in the field of health policy and systems research by the 2014 Ebola outbreak in West Africa. The ability of national health systems to cope with disruptive events is at question, including in countries deemed to have high-performing health systems (1–3). The concept of health system resilience emerged in the public health field less than two decades ago, referring to how health systems respond to crises, shocks and stress. It has become popular in the global health discourse and is reflected in international policies, scientific literature and conferences (4).

Nevertheless, the health policy and systems research community is still to come to a common understanding of this concept, which remains polysemic (5–7). While the debate continues and keeping the critique on the health system resilience discourse (8,9), I have decided, for this thesis, to start from the definition of health system resilience by Kruk *et al.* (2015) as *“the capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and, informed by lessons learned during the crisis, reorganise if conditions require it”*. This definition seems to encompass most of the other definitions I found in the recent literature (10).

Significant shifts in disease burden, natural disasters, economic or financial crises, security and humanitarian crises among other events, can alter the health system performance, or lead to its disruption or collapse (11). This is well illustrated by the effects on health systems of the 2007 global financial crisis, the 2014 Ebola epidemic in West Africa and the ongoing COVID-19 pandemic, including in countries with supposedly high-performing health systems (12). The Ebola epidemic showed that despite decades of investments, the health systems of affected countries were not able to deal with the shock in an optimal way (1). The COVID-19 pandemic has further raised concerns about the ability of national health systems, including those considered to be stronger, to cope with shocks (3). Adding momentum to an increased interest for health system resilience, these events have led to a call by the World Health Organization (WHO) to improve the resilience of national health systems (13,14).

A health system *“consists of all organisations, people and actions whose primary intent is to promote, restore or maintain health”*. They deliver *“services that improve, maintain or restore the health of individuals and their communities”* (15). They are open complex adaptative systems, embedded within their specific contexts. As such, health systems both influence and are influenced by their environment; and changes in the context can pose real challenges to health systems (12).

While the world is still struggling to control the COVID-19 pandemic, we can anticipate that in the near future, health systems will most probably be hit by more shocks and crises, from the effects of global warming and ageing of the population (16–21). Furthermore, despite the international community's aspirations for global peace, enacted in the United Nations Charter, armed conflicts continue to wreak havoc, with civilians being the most affected (22,23). Will health systems be responsive enough and maintain their core functions if faced by one or more disruptive events? Knowing the resilience status of the health system becomes crucial as only resilient health systems are in a position to provide optimal responses in stress, shocks and crises.

Measuring and managing dynamic performance has been identified as a priority research area for health system resilience (11). Building or improving health systems resilience begins with assessing their current resilience status. However, there is still debate about how it can best be assessed (24). While some authors have conducted assessments of health system resilience, there is still no validated set of indicators and no evidence-based framework for such assessments (25,26).

A resilient health system would ensure the well-being of people even under stressful conditions. Good health is essential to human well-being and happiness, and critical to sustainable development. It is therefore a key indicator of a country's progress (27). Healthy people can achieve their optimal productivity and contribute, through the wealth they generate, to improving their living conditions and those of their communities (28). A country with healthy citizens will most likely achieve sustained growth (29). Health is also an inalienable human right (30).

As a contribution to the ongoing debate on health system resilience assessment and global efforts towards more resilient health systems, this study maps and characterises existing approaches to assessing health system resilience. To this end, I adopted the scoping review methodology. This study will be of interest for health system and policy researchers, policymakers and health system managers.

2. Objectives

2.1. General objective

The general objective of this review is to examine how health system resilience can be assessed.

2.2. Specific objectives

The specific objectives are:

1. to describe the definitions and conceptual bases supporting the assessment of health system resilience;
2. to identify approaches for assessing health system resilience; and
3. to summarise limitations and weaknesses of identified approaches.

3. Methods

3.1. Background

3.1.1. Context

Health systems are vulnerable to stress, shocks, and crises. National health systems are currently severely strained by the ongoing COVID-19 pandemic that has affected hundreds of millions of people and caused millions of deaths across the world. The pandemic has exposed a range of health system weaknesses, some of which were unforeseen. It also invalidated several of the indices that had been developed to grade the capacity of countries to prevent and mitigate (3,31). Other threats on health systems are looming on the horizon. Not only infectious diseases, but also the effects of global warming, urbanisation, the non-communicable diseases 'epidemic', ageing and conflicts will threaten health systems (22,23,32). The frequency of extreme weather events is expected to increase in the coming decades, which will impact upon disease burden and food crises. The regions highlighted as being at high risk for such events are often those whose health systems are deemed to be weaker (17,20,33). This may result in the disruption and collapse of non- or poorly resilient health systems, with substantial loss of life.

3.1.2. Shocks

Extreme changes in the context that are challenging to the health system are referred to as shocks when they are immediate and time-bound, and as crises or stressors when they unfold more gradually - although in some cases, the cut-off may not be clear (12,34). Most of the literature indiscriminately refers to these extreme changes as shocks, and in the remainder of this document, I

will do that as well. With this in mind, shocks can be characterised according to the following axes (12,35–37):

- Nature: shocks can be classified as economic (e.g., financial or unemployment crisis), environmental (e.g., extreme weather events, natural disasters), geopolitical (e.g., interstate conflict), societal (e.g., migration), epidemiological (e.g., disease outbreak) or technological (e.g., cyberattacks). Shocks that happen as the immediate consequence of human behaviour are classified as “man-made” shocks.
- Duration: acute shocks such as a tsunami or floods are immediate and usually time-bound (short- to medium-term). Chronic shocks (also named ‘crisis’ or ‘stressor’) unfold over an extended period (e.g., financial crisis and everyday strains or chronic disruptions of a health system).
- Scale: shocks can be of various scales, depending on the affected area (district, province, country, region or global). Covariate events such as earthquakes, floods and disease outbreaks directly affect large numbers of people in a limited or large geographical area. Idiosyncratic events affect specific individuals or households within a community (e.g., epidemic of non-communicable diseases).
- Frequency: some shocks can be infrequent in a particular context (e.g., volcanic eruptions), whereas some are frequent (e.g., cholera outbreaks); they can be seasonal (e.g., floods) or not.
- Effect on the system: a shock can cause pressure on the system by triggering a marked increase in the demand for services (e.g., disease outbreak), or have a wasting effect on the system through reduced inputs or loss of infrastructure and equipment as in economic crisis or war.

It should be noted that although shocks can have a detrimental effect on the health system (and society at large), they also provide an opportunity for regeneration and transformation towards an alternate state of equilibrium.

3.1.3. Health systems

A healthy population is paramount to the development of a nation (29). As defined by WHO, a health system “consists of all organisations, people and actions whose primary intent is to promote, restore or maintain health”. Its overall goal is “improving health and health equity in ways that are responsive, financially fair, and make the best, or most efficient, use of available resources”, which entails achieving greater access to and coverage for effective health interventions, without compromising quality and safety of services. In order to promote a shared understanding and to

define the elements that make up the health system, WHO proposed a framework (figure 1) with six building blocks (38).

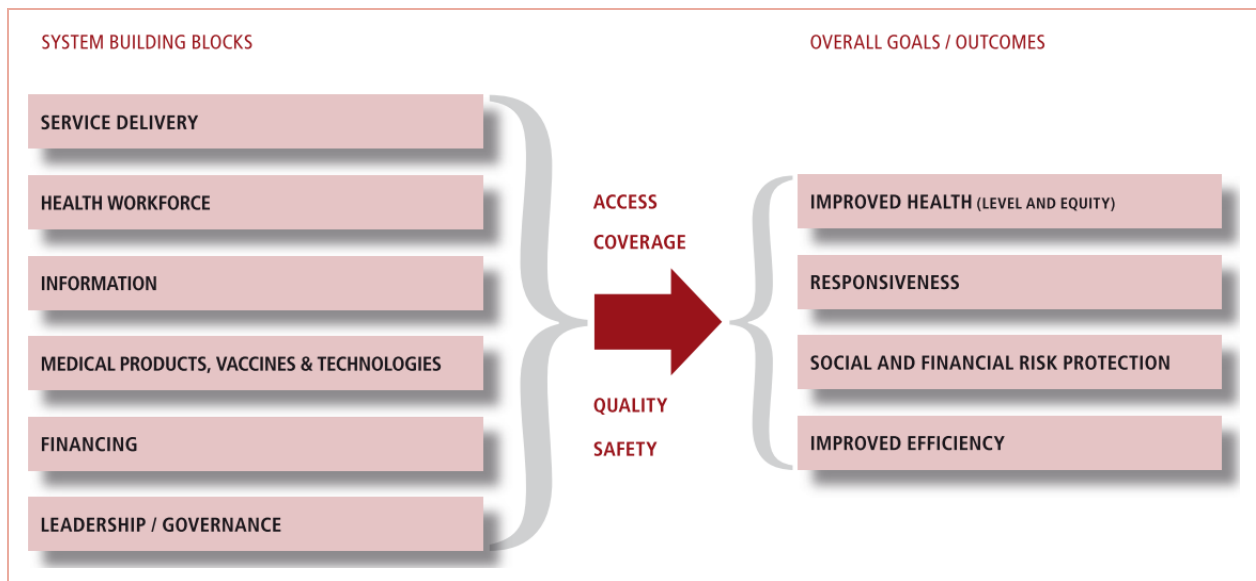


Figure 1. The WHO health system building blocks framework. Reproduced from WHO, 2007 (38).

This framework has become the most used by policymakers and researchers to describe health systems. However, there have been calls for going beyond the six building blocks and include (39,40):

- a “demand” or community component,
- an overarching, holistic health systems viewpoint (the “helicopter view”), and
- a scope for interactions between components.

In 2012, van Olmen *et al.* proposed a framework (figure 2) that incorporates elements of pre-existing frameworks including the WHO building blocks, and that goes further (41). This *health system dynamics framework* consists of ten elements and their dynamic interactions:

- It depicts the health system as geared towards outcomes and goals,
- It places service delivery at the core of the health system functioning,
- It includes the population and its interaction with other elements,
- It accounts for values and principles on which health systems are based and the context in which the health system is embedded,
- It presents some elements as more important than others (the axis between Leadership & Governance – Human Resources – Service delivery – Population).

In their regular functioning, health systems face a wide range of disturbances simultaneously (34,42,43). These may result in a surge of demand for health care, or an incapacity to deliver needed services. Such challenges to a health system’s dynamic equilibrium can lead to its disruption and collapse if the necessary adjustments are not successfully implemented on time. Only resilient health

systems are in a position to protect human life and achieve positive health outcomes for all in their everyday functioning as well as during and after a shock (10).

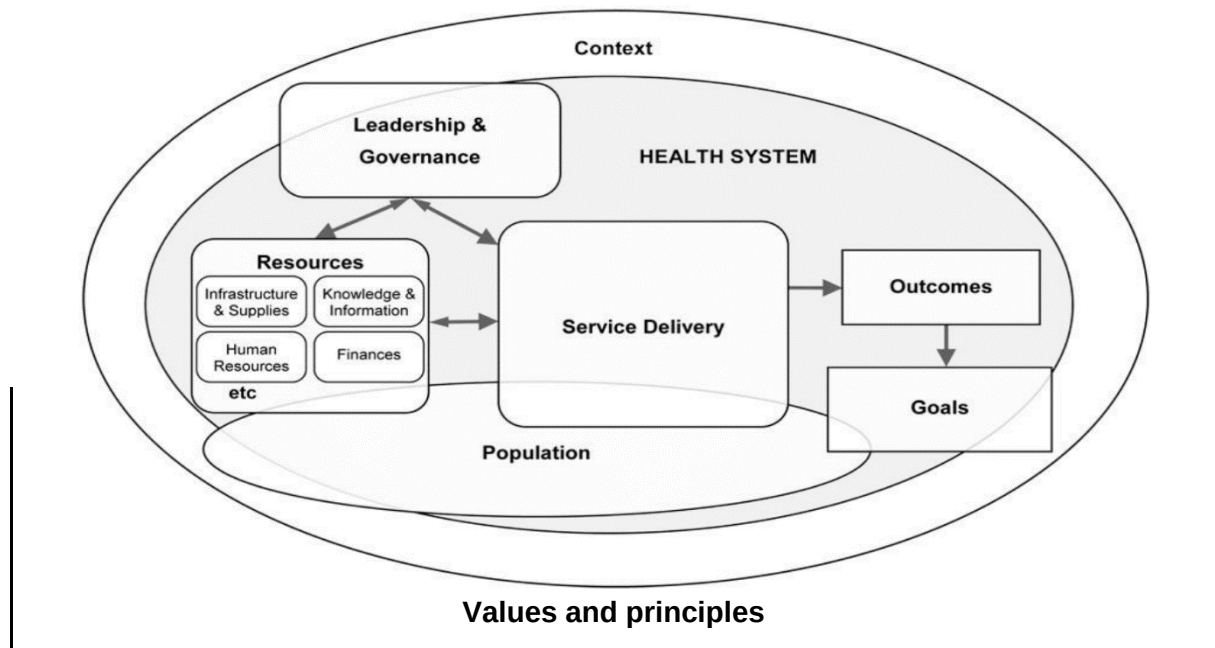


Figure 2. The health system dynamic framework. Adapted from van Olmen et al., 2012 (41).

3.1.4. Health system resilience

The word ‘resilience’ comes from the Latin *resiliens*, which means bouncing back or withdrawing. The concept originates from the fields of engineering, environmental science and ecology. It describes how natural and social systems respond to shocks in a variety of ways and return to their original equilibrium or reach a new equilibrium as a consequence of the shock (12,44). Resilience has evolved to a more dynamic interpretation that includes adaptive and transformative capabilities allowing a system to adjust or change its own characteristics or actions to soften future shocks while still retaining its basic structure, or to change its structure to eliminate risks altogether, if its current state becomes unsustainable. It emerged in the field of public health less than 2 decades ago and is becoming a core concept in global health (4).

Even though this remains a matter of debate within the health policy and systems research community, Kruk *et al.* (10) proposed the following definition of health system resilience: “*the capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and, informed by lessons learned during the crisis, reorganise if conditions require it.*” They view health system resilience as an “emergent property” of the health system, encompassing all its dimensions.

3.2. Study design

My study is exploratory and consists of a scoping review of peer-reviewed and grey literature. The scoping review approach was chosen because of:

- the complicated nature of the problem,
- the broad nature of the research question, and
- the variety of literature on health system resilience assessment.

Scoping reviews are a type of evidence synthesis that is relevant for mapping evidence on a topic and for identifying emerging themes, theories and sources as well as knowledge or evidence gaps (45,46). I followed the updated guidance for scoping reviews proposed in the Joanna Briggs Institute (JBI) Manual for evidence synthesis (47). The review was conducted in five key stages, including (i) identification of the research question, (ii) search of relevant literature, (iii) screening of identified literature, (iv) data extraction and (v) data collation. Figure 3 presents the steps I followed for the identification, screening, eligibility check and inclusion of studies in the scoping review (48). Three reviewers participated in the review process:

- Olivia ATEBA EWOKOLO, Senior Nurse, MPH, ITM Alumnus;
- Brice EDZOA, MD, MPH, Regional Delegation of Public Health, Centre Region – Cameroon; and
- Calvin TONGA, SRN, PhD, MPH student at ITM.

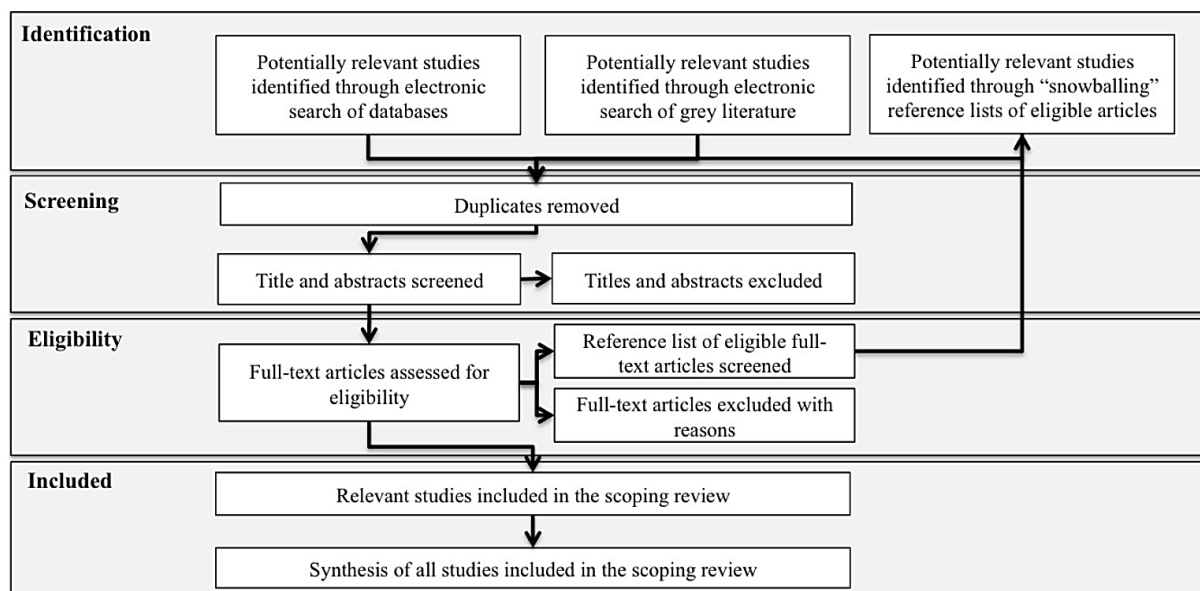


Figure 3. Steps for the identification, screening, eligibility and inclusion of studies. Reproduced from Taylor and Pagliari, 2018 (48).

3.3. Research question

The research question was developed following the Participants, Concept and Context framework (46). Details of its development are presented in table 1. The core question is framed as follows:

“According to the available literature, how can health system resilience be assessed?”

Table 1. Details of the framework used to develop the research question

Domains	Elements	Description
Participants – P	All people	No restriction in terms of population
	Resilience	Resilience
Concept – C	Assessment	Evaluation, appraisal or testing framework, tool, approach, strategy, metrics, measurement
	Health system	Components/building blocks or health system as a whole
Context – C	The world	No restriction in terms of geographical location, type of setting or cultural context

3.4. Eligibility criteria

Details on inclusion and exclusion criteria are presented in table 2. The criteria were set in a way to keep focus but remain inclusive and avoid potential omission of important information on the topic (49). The eligibility criteria included: the type of documents, language, publication dates and concepts of focus. Search was limited to documents published over the 10 past years.

Table 2. Eligibility criteria

Inclusion criteria
Full document written in English or French
Peer-reviewed articles, reports, books, opinion papers, guidelines
Published between 01/03/2012 and 28/02/2022
Reflects on the topic, provides guidance or reports on the assessment of health system resilience
Uses, proposes or discusses approaches, tools, methods, strategies or frameworks for assessing or measuring resilience
Focuses on components or on the health system as a whole
Exclusion criteria
Focuses on individual psychological or ecological dimensions of resilience
Focuses on other thematic area (e.g., hospital organization, illness management, ecosystems)
Conference proceedings, commentaries, letter to the editor, news articles, videos and webpages
Full text version not available
Published before 01/03/2012

3.5. Literature search

To identify relevant documents in a systematic way, a search strategy was developed. The strategy was reviewed by the ITM librarian who assisted in refining and validating the last version. Peer-reviewed articles were searched from 7 databases, including PubMed, ScienceDirect, EBSCOhost, CAIRN, SSRN, Google Scholar and DOAJ. MedRxiv was searched for preprints whereas OAster, reliefWeb and WHO library were searched for grey literature¹. The final search strategy is presented in annex 2. The search was conducted from the 2nd to the 5th March 2022. Boolean operators, keywords from the research question and related words, were used where relevant, depending on the searched database. In addition, applying a snowballing approach, reference lists of included documents were reviewed to identify relevant documents that were missed during the database search.

3.6. Screening of identified literature

Peer-reviewed articles, preprints and grey literature obtained from literature search were listed in an MS Excel file and duplicates were identified using the MS Excel conditional formatting function to highlight duplicate values in authors and titles. Highlighted values were checked, and duplicates were removed. Missed duplicates were manually removed. Each document was independently screened for inclusion by the three reviewers, based on the inclusion and exclusion criteria (table 2). Records² or reports³ selected by at least two of the reviewers were retained for further screening following the procedure described below.

3.6.1. Screening of titles and abstracts

Document titles and abstracts (when available) were screened for eligibility. A document was selected if its primary focus was on resilience of the health system or of components of the health system. Synonyms of resilience such as shock responsiveness were considered.

3.6.2. Screening of full texts

After title and abstract screening, all selected reports full texts were managed with Mendeley[®] reference management software (version 2.66.0, Mendeley Ltd., 2022). Each full text was screened

¹ The Grey Literature Network Service defines grey literature as multiple document types produced on all levels of government, academia, business, and organizations in electronic and print formats not controlled by commercial publishing, i.e., where publishing is not the primary activity of the producing body. <http://www.greynet.org/home/aboutgreynet.html>

² The title or abstract (or both) of a report indexed in a database or website (such as a title or abstract for an article indexed in Medline). <https://doi.org/10.1136/bmj.n71>

³ A document (paper or electronic) supplying information about a particular study. It could be a journal article, preprint, conference abstract, study register entry, clinical study report, dissertation, unpublished manuscript, government report, or any other document providing relevant information. <https://doi.org/10.1136/bmj.n71>

by the three reviewers based on inclusion and exclusion criteria. A document was selected if its primary focus was about assessing resilience and if it proposed or reported the use of approaches for assessment (tools, frameworks, methods, strategies, etc.). Reports validated by at least two reviewers were selected. Selected literature was not formally assessed for quality, as this is not relevant for scoping reviews (46).

The process from literature search to final document selection is summarised in the PRISMA-ScR flow chart (50).

3.7. Data charting

A MS Excel form was developed for charting data from selected documents. The three reviewers revised this form. To build a common understanding of its use and set a systematic and reproducible data charting process, we conducted a pilot test during which the three reviewers did the charting of three reports together. We then included the adjustments found necessary and used the final version of the form for independent charting of reports. The charting items included:

- Authors: Referring to the name of the first author, followed by *et al.* in case more than one person authored the document
- Year: referring to the year of publication
- Title: referring to the title of the document
- Objective: referring to the main objective of the study/report
- Literature type: to be selected from a list including administrative reports, book, norms/standards/guidelines, original peer reviewed, unpublished Scientific report and others.
- Geographical area: referring to the geographical area (e.g.: country, region) where the study was conducted or to which the document refers
- Shock: referring to the nature, type and intensity of the shock against which resilience is assessed or anticipated
- Application period: referring to the period in relation with the shock; before, after or during the shock
- Definition of resilience: referring to the definition used by the author(s) in the report about the concept of resilience or health system resilience
- Reference framework: the framework the author(s) referred to for their work and identifying its components
- Assessment approach: referring to the approach used or proposed by the author(s) for assessing resilience of the health system

- Research design: to be selected from a list including case studies, opinions, analysis, reviews, and other designs
- Study methods: to be selected from a list including qualitative, quantitative, mixed methods and evidence synthesis
- Key metrics: Referring to the metrics used for assessing health system resilience
- Weaknesses and limitations of the study
- Pertinent records from the reference list.

Each of the three reviewers independently carried out the data charting using the dedicated form. Outputs from the three reviewers were merged, reviewed and validated during a virtual meeting.

3.8. Data collation

The charted data were summarised in graphic (including charts, word cloud, geographic and network maps), narrative and tabular ways. This was done in two main steps:

- A summary of the literature search, screening and inclusion, as well as a general description of reports that were included in the review in terms of publication year, type of report, proposition or use of a conceptual basis, nature of the shock and country of interest.
- A synthesis of the of the information organised in line with the specific objectives of the study:
 - definitions and conceptual bases supporting the assessment of health system resilience
 - approaches used or proposed for assessing health system resilience
 - limitations and weaknesses of identified approaches

3.9. Ethical considerations

My study is a review of publicly available literature and did not include human participants or personal information. An ethical clearance is therefore not required.

3.10. Protocol registration

The updated guidance for scoping reviews recommends the registration and publication of the review protocol (47). The review protocol was published on the Figshare platform and is publicly available (51).

3.11. Methodological limitations

Arksey and O'Malley and Levac *et al.* suggest setting up an expert panel as an additional step that can add methodological rigour to a scoping review (52,53). Drawing from their experience and expertise,

these stakeholders' can enrich the analysis, and provide a higher level of meaning to the findings. Due to time and resource constraints, however, an expert panel could not be organised. The results were discussed with the thesis supervisors who are health system evaluation and evidence synthesis experts. Their feedback has been included in the final version of the thesis.

3.12. Positionality

I am a nurse and parasitologist from Cameroon. I work with the Expanded Programme on Immunisation, Ministry of Public Health, as Planning, Monitoring and Evaluation officer. I felt concerned about the effect COVID-19 on the Programme and the health system as a whole. Has the health system been resilient to the pandemic? I thought of writing my thesis on this topic until I was confronted with methodological issues. How do we assess health system resilience?

My previous studies, office and research work were mainly focused on quantitative analysis. I am aware that I may have a preference for quantitative approaches and designs. However, I have made efforts to open up to new approaches as I endeavoured to better understand health systems and health policy during this MPH programme.

4. Results

4.1. Description of search and selection process

The literature search yielded 868 records. The search of scientific databases yielded 830 records, of which 346 duplicate were removed; 52 records were selected based on their title and abstract, and 27 met all inclusion criteria. Thirty-eight records were found through citations and websites; seven met all inclusion criteria. An overall set of 34 reports were finally included in the review as presented in the Prisma flow chart below (figure 4).

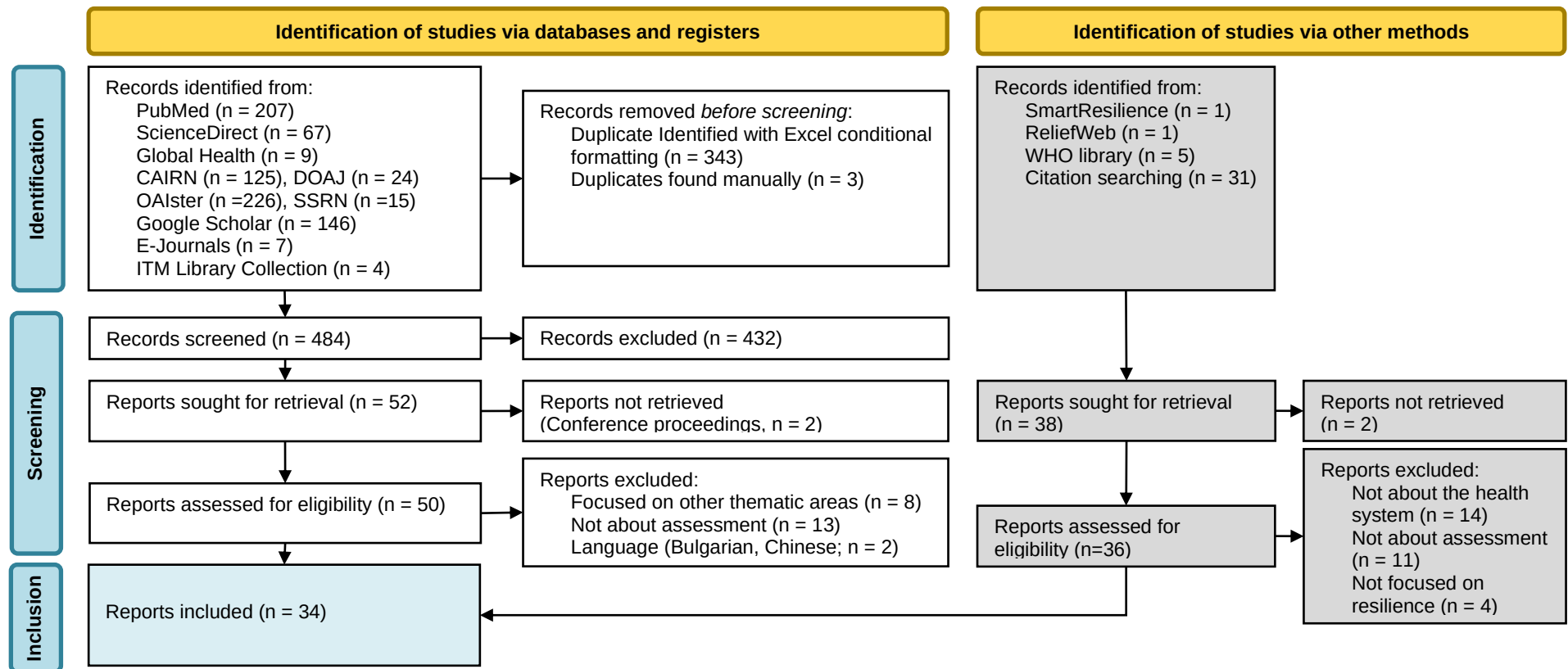


Figure 4. Prisma flow chart presenting the search and selection of reports included in this review

4.2. Characteristics of included reports

Among the 34 reports included in the review, 21 discuss case studies; 22 look at country level specifically, and 12 are about epidemiological shocks (table 3). There are periods of increased frequency of reports; first, in the 2016-2017 period, then in the 2020-2022 period (figure 5).

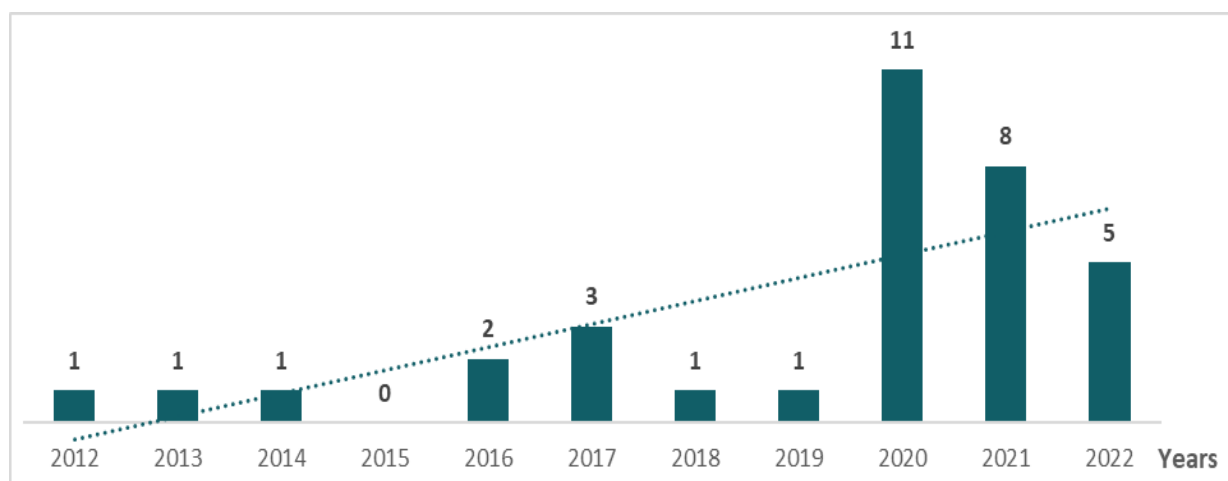


Figure 5. Distribution of included reports over the years

Looking at their core content, 13 reports propose an approach to health system resilience assessment; 16 reports on an actual assessment of health system resilience, and five propose an approach and also report on its use for assessing health system resilience. Reports on the assessment of health system resilience cover 103 countries (figure 6; annex 3).

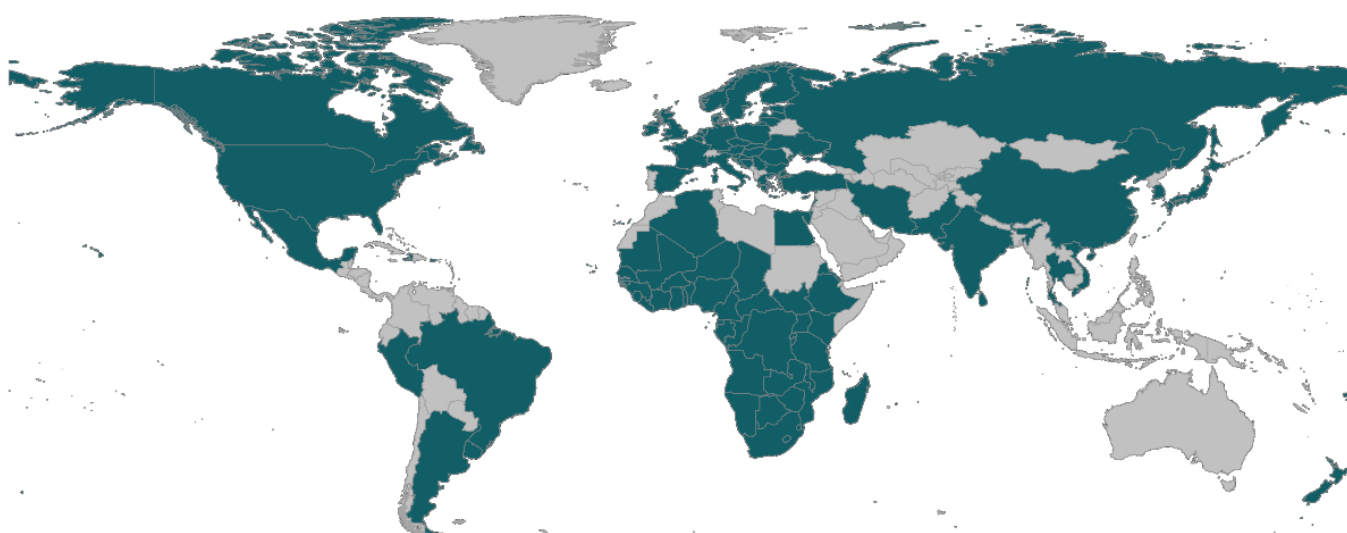


Figure 6. Map presenting countries whose health system resilience was assessed (in ITM dark green)

Table 3. Overview of included reports

N°	Report	Main objective	Level of the health system	Nature of the shock	Type of study
1	Alami <i>et al.</i> , 2021 (54)	To describe and discuss the experience of the HSSS in the Canadian province of Quebec in the management of COVID-19 crisis	Subnational	Epidemiological	Case study
2	Ammar <i>et al.</i> , 2016 (55)	To assess the resilience of the Lebanese health system in the face of an acute and severe crisis and in the context of political instability	Country	Societal	Case study
3	Bayntun <i>et al.</i> , 2012 (56)	To describe the analysis of the worldwide experience of disasters through a health systems approach	Country	Public health threats*	Systematic review
4	Bhandari and Alonge, 2020 (57)	To propose a measurement model for community resilience in health systems, including relevant constructs and indicators for measuring these constructs.	Country	Not specific	Scoping review
5	Bigoni <i>et al.</i> , 2022 (58)	To discuss the SUS (Brazil Health System's) functionality and resilience, describing the impact of the pandemic on non-COVID health services delivery while considering the regional inequalities of the allocation of financing health system, health infrastructure and health workforce	All levels	Epidemiological	Case study
6	Bureau <i>et al.</i> , 2022 (59)	To analyse the adaptive, absorptive and transformative capacities of the health workforce during the first wave of the COVID-19 pandemic in Europe	Country	Epidemiological	Multiple case studies
7	Crowe <i>et al.</i> , 2014 (60)	To explore the feasibility of assessing resilience across local health services and developing a computer software tool to assist with decisions concerning service reconfiguration in the NHS in England	Local	Not specific	Operational research
8	Etemadi and Tadayon, 2021 (61)	To propose some facets to be considered in the quantitative scale based on the comprehensive Kruk framework such as political economy of the health system, network governance, policy coherence, and discuss their necessities	Country	Epidemiological	Analysis
9	Expert Group HSPA, 2020 (62)	To support European health policymakers in their quest to identify more advanced tools and methods to measure and	Country	Not specific	Multiple case studies and

N°	Report	Main objective	Level of the health system	Nature of the shock	Type of study
		assess health system resilience			guideline document
10	Fitter <i>et al.</i> , 2017 (63)	To examine public health recovery efforts in Haiti through the lens of CDC's EPHS framework	Country	Natural disaster and epidemiological	Case study
11	Foroughi <i>et al.</i> , 2022 (64)	To achieve a comprehensive model to analyse and guide achieving health system resiliency	All levels	Not specific	Systematic review
12	Giarelli, 2020 (65)	To describe governance of resilience in various health systems during the COVID-19 pandemic	Country	Epidemiological	Analysis
13	Gilson <i>et al.</i> , 2020 (66)	To test an existing framework of everyday health system resilience (EHSR) in examining how a local health system responded to the chronic stress of large-scale organizational change	Local	Structural	Case study
14	Haldane <i>et al.</i> , 2021 (67)	To review COVID-19 responses in 28 countries using a new health systems resilience framework	Country	Epidemiological	Multiple case studies
15	Jovanović <i>et al.</i> , 2020 (68)	To identify the main elements of the larger, possibly global, framework, supported by international standards, needed to deal with new (emerging) risks resulting from threats like Corona and assess the resilience of systems affected.	All levels	Epidemiological	Analysis
16	Kagwanja <i>et al.</i> , 2020 (34)	To examine the challenges experienced by the health system at a sub-national level in Kenya, using an 'everyday resilience' lens, in examining the responses and organizational capacities underpinning those responses, with a view to contributing to the understanding of health system resilience	Local	Structural	Case study
17	Karamagi <i>et al.</i> , 2022 (69)	To generate empirical measures for resilience, aimed at supporting decision makers as they plan and monitor the levels of resilience they need in order to mitigate against the effects of shock events	Country	Not specific	Multiple case studies
18	Kruk <i>et al.</i> , 2017 (24)	To propose measures of health system resilience	All levels	Epidemiological	Analysis
19	Ling <i>et al.</i> , 2017 (70)	To review the evolution of Liberia's health system response to the 2014–15 Ebola epidemic from the perspective of global,	Country	Epidemiological	Case study

N°	Report	Main objective	Level of the health system	Nature of the shock	Type of study
		national and local actors involved			
20	Lo Sardo <i>et al.</i> , 2019 (71)	To quantify the resilience of regional primary care networks on a fully data-driven basis	Country and Subnational	Not specific	Operational research
21	Massuda <i>et al.</i> , 2021 (72)	To analyse the resilience of SUS before the pandemic	Country	Epidemiological	Case study
22	McKenzie <i>et al.</i> , 2016 (73)	To help understand the foundation for resilience from examining the complex adaptive nature of health systems in the processes of health policy development, health systems reform and health systems strengthening	Subnational	Security	Analysis
23	Meyer <i>et al.</i> , 2020 (74)	To propose a checklist for measuring the specific capacities, capabilities and processes that health systems need in order to ensure resilience in the face of both infectious disease outbreaks and natural hazards	Not specific	Epidemiological Natural disasters	Case study
24	Odhiambo <i>et al.</i> , 2020 (75)	To understand the utility of the health system resilience when evaluating progress of the health system of South Sudan	Country	Security	Case study
25	Ozen and Tuncay, 2021 (76)	To understand whether there is a complementarity between the earlier efforts in the Turkish health system and the current capabilities that is necessary to meet the Syrian Populations Health Needs	Country	Societal	Case study
26	Pilevari and Shiva, 2021 (77)	To design a resilience model for the Iranian health system	Country	Not specific	Analysis
27	Popic <i>et al.</i> , 2021 (78)	To analyse links between three institutional dimensions of health systems – financial input, infrastructure input and workforce input – and the number of excess deaths in 30 Eastern and Western European countries during the first and the second waves of the pandemic	Country	Epidemiological	Comparative case study
28	Rios <i>et al.</i> , 2020 (79)	To assess the ability of the University of Porto Rico health system to provide patient care in response to Hurricane Maria	Local	Natural disasters	Case study
29	Rogers <i>et al.</i> , 2021 (80)	To contribute to the previous literature by refining the definition of resilience, which maps into a multidimensional framework for health and social care, and developing a pragmatic set of tools	Country	Not specific	Comparative case study

N°	Report	Main objective	Level of the health system	Nature of the shock	Type of study
		and guidelines for resilience test structure and implementation			
30	Thomas <i>et al.</i> , 2013 (25)	To develop a framework for assessing the resilience of health systems in terms of how they have adjusted to economic crisis	Country	Economic/financial	Case study
32	Thomas <i>et al.</i> , 2020 (26)	To support a more consistent understanding and use of the concept of resilience	Country	Not specific	Policy brief
32	Wang <i>et al.</i> , 2020 (81)	To examine the health system resilience of selected countries and analyse their strategies and measures in response to the COVID-19 pandemic	Country	Epidemiological	Comparative case study
33	WHO Regional Office for Africa, 2018 (82)	To provide guidance on where countries need to focus as they plan their work towards attaining the SDGs	Country	Not specific	Comparative case study
34	WHO, 2022 (83)	To propose a framework for measuring the climate resilience of health systems	Country	Climate-related shocks and stresses	Guideline document

* Public health threat: 'new or newly emerging diseases, the accidental release or deliberate use of biological, chemical or radio-nuclear agents, natural disasters, human-made disasters, complex emergencies, conflicts and other events with a potentially catastrophic impact on human health.

4.3. Definitions and conceptual bases for assessing health system resilience

4.3.1. Definitions of health system resilience

Definitions of resilience in relation with the health system were found in 29 reports (85.3%) of which five did not cite a reference (table 4). Kruk *et al.* (10) was the most frequent reference (cited 11/24; 45.8%), followed by Thomas *et al.* (26), who was cited three times (12.5%) (figure 7). Although Bhandari and Alonge (2020) presented resilience as a *process*, whereas Gilson *et al.* (2020) view it as a *characteristic* of complex adaptive systems, all the other authors (27; 93.1%) consider resilience either as an *ability*, a *capacity* or a *capability*. 17.1%, 12.6%, 10.8%, 8.1%, 8.1%, 7.2%, 6.3%

Twenty-five key elements emerged from the analysis of definitions. The seven more frequent are: maintain (19; 17.1%), respond (14; 12.9%), prepare (12; 10.8%), absorb (9; 8.1%), adapt (9; 8.1%), transform (8; 7.2%), re-organise (7; 6.3%) and learn (6; 5.4%). The 18 other elements had frequencies lower than 5% (annex 4).

Table 4. Definitions of resilience provided in the included reports

N°	Source	Definition	View and key elements	Reference
1	Ammar <i>et al.</i> , 2016	Capacity of a health system to absorb internal or external shocks (for example prevent or contain disease outbreaks) and maintain functional health institutions while sustaining achievements	<i>Capacity</i> Absorb, Maintain, Sustain	NA*
2	Bayntun <i>et al.</i> , 2012	Capability of the public health and health-care systems, communities, and individuals to prevent, protect against, quickly respond to, and recover from health emergencies, particularly those whose scale, timing, or unpredictability threatens to overwhelm routine capabilities	<i>Capability</i> Prevent, Protect, Respond, Recover	Nelson <i>et al.</i> , 2007
3	Bhandari and Alonge, 2020	Process linking a set of networked adaptive capacities (resources with their dynamic attributes) at individual or community level to a positive trajectory of functioning and adaptation of the health system at the community level after a health shock.	<i>Process</i> Adapt, Maintain	Norris <i>et al.</i> , 2008
4	Bigoni <i>et al.</i> , 2022	Capacity to absorb the impacts of external shocks caused by epidemics, natural disasters, economic crises, or other causes without altering its operations and avoiding an increase of unmet health needs for different reasons.	<i>Capacity</i> Absorb, Maintain, Sustain	Thomas <i>et al.</i> , 2020
5	Crowe <i>et al.</i> , 2014	Capability of a health system to mitigate the impact of major external disruptions on its ability to meet the needs of the population during the disruption	<i>Capacity</i> Mitigate, Sustain	NA
6	Etemadi and Tadayon, 2021	Capacity to prepare and respond effectively to crises, while maintaining the key functions of the health system before, during and after the crisis.	<i>Capacity</i> Prepare, Respond, Maintain	Nuzzo <i>et al.</i> , 2019
7	Expert Group HSPA, 2020	Capacity of a health system to (a) proactively foresee; (b) absorb; and (c) adapt to shocks and structural changes in a way that allows it to (i) sustain required operations; (ii) resume optimal performance as quickly as possible; (iii) transform its structure and functions to strengthen the system; and (possibly) (iv) reduce its vulnerability to similar shocks and structural changes in the future".	<i>Capacity</i> Foresee, Absorb, Adapt, Maintain, Resume, Transform, Reduce vulnerability	NA
8	Foroughi <i>et al.</i> , 2022	Ability of the system to prepare for and respond to sudden shocks and everyday challenges and its capacity to absorb deteriorations, adapt, and transform the health system to cope with them	<i>Ability</i> : Prepare, Respond <i>Capacity</i> : Absorb, Adapt, Transform	Thomas <i>et al.</i> , 2020; Barasa <i>et al.</i> , 2018
9	Giarelli, 2020	Capacity to absorb, adapt and transform when exposed to a shock such as a pandemic, natural disaster, armed conflict or a financial crisis and still retain the	<i>Capacity</i> Absorb, Adapt, Transform,	Blanchet <i>et al.</i> , 2017)

N°	Source	Definition	View and key elements	Reference
		same control over its structure and functions.	Maintain	
10	Gilson <i>et al.</i> , 2020	Characteristic of complex, adaptive health systems that allows them to respond to chronic stress in ways that transform how they function	<i>Characteristic</i> Respond, Transform	Barasa <i>et al.</i> , 2017
11	Haldane <i>et al.</i> , 2021	Institutions' and health actors' capacities to prepare for, recover from and absorb shocks, while maintaining core functions and serving the ongoing and acute care needs of their communities. During a crisis, a resilient health system is able to effectively adapt in response to dynamic situations and reduce vulnerability across and beyond the system.	<i>Capacity</i> Prepare, Respond, Maintain, Re-organise	Kruk <i>et al.</i> , 2015
12	Jovanović <i>et al.</i> , 2020	Ability to understand and anticipate the risks - including new/emerging risks - threatening the critical functionality of the infrastructure, prepare for anticipated or unexpected disruptive events, optimally absorb/withstand their impacts, respond and recover from them, and adapt/transform the infrastructure or its operation based on lessons learned	<i>Ability</i> Understand, Anticipate/Prepare, Absorb/Withstand, Respond/Recover, Adapt/transform	Russoa and Ciancarinia, 2016
13	Kagwanja <i>et al.</i> , 2020	Maintenance of positive adjustment under challenging conditions such that the organisation emerges from those conditions strengthened and more resourceful	<i>Capacity</i> Maintain, Emerge	Gilson <i>et al.</i> , 2017
14	Karamagi <i>et al.</i> , 2022	Capacity to “prepare and effectively respond to crises; maintain core functions; and, informed by lessons learnt, reorganize if conditions require it”.	<i>Capacity</i> Prepare, Respond, Maintain, Learn, Re-organise	Kruk <i>et al.</i> , 2015
15	Kruk <i>et al.</i> , 2017	Capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and, informed by lessons learnt during the crisis, reorganise if conditions require it.	<i>Capacity</i> Prepare, Respond, Maintain, Learn, Re-organise	Kruk <i>et al.</i> , 2015
16	Ling <i>et al.</i> , 2017	Capacity to prepare for and effectively respond to crises while maintaining core health system functions pre-, during, and post-crisis	<i>Capacity</i> Prepare, Respond, Maintain	Kruk <i>et al.</i> , 2015
17	Lo Sardo <i>et al.</i> , 2019	Resilience quantifies the rate of recovery and the extent to which a system is able to recover from disruptive events	<i>Ability</i> Recover	Woods, 2015
18	Massuda <i>et al.</i> , 2021	Capacity of health agents, institutions, and populations to prepare themselves to respond to such shocks, keeping the systems' essential functions without changing health outcomes, as well as the ability to reorganize from lessons learned	<i>Capacity</i> Prepare, Respond, Maintain, Re-organise, Learn	Kruk <i>et al.</i> , 2017
19	McKenzie <i>et al.</i> , 2016	Capacity of a health system to deal with change, to adapt and transform, and to maintain relevance, when confronted by such major disruptions	<i>Capacity</i> Deal with, Adapt, Transform,	Kruk <i>et al.</i> , 2015

N°	Source	Definition	View and key elements	Reference
			Maintain	
20	Meyer <i>et al.</i> , 2020	Capacities that could potentially strengthen health system to either infectious disease threats or natural hazards	<i>Capacity</i>	Kruk <i>et al.</i> , 2015
21	Ozen and Tuncay, 2021	Capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and, informed by lessons learnt during the crisis, and re-organise if conditions require it.”	<i>Capacity</i> Prepare, Respond, Maintain, Learn, Re-organise	Kruk <i>et al.</i> , 2015
22	Pilevari and Shiva, 2021	Providing the community with the best available and equitable care, withstand shocks, endure crisis and support people against hardships and uncertainty of all kinds when national health integrity is at risk	Maintain, Withstand, Endure crisis, Support people	NA
23	Rios <i>et al.</i> , 2020	Capability of a health system to prepare, respond and reorganize under conditions of stress, is posited to protect the population from excess morbidity and mortality	<i>Capability</i> Prepare, Respond, Re-organise	Kruk <i>et al.</i> , 2015
24	Rogers <i>et al.</i> , 2021	Capacity of a health system to (a) proactively foresee; (b) absorb; and (c) adapt to shocks and structural changes in a way that allows it to (i) sustain required operations; (ii) resume optimal performance as quickly as possible; (iii) transform its structure and functions to strengthen the system; and (possibly) (iv) reduce its vulnerability to similar shocks and structural changes in the future	<i>Capacity</i> Foresee, Absorb, Adapt, Maintain; Resume, Transform, Reduce vulnerability	Expert Group HSPA, 2020
25	Thomas <i>et al.</i> , 2013	Capacity of a system to absorb disturbance and reorganise while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks	<i>Capacity</i> Absorb, Reorganise, Maintain	Walker <i>et al.</i> , 2004
26	Thomas <i>et al.</i> , 2020	Ability to prepare for, manage (absorb, adapt and transform) and learn from shocks	<i>Ability</i> Prepare, Absorb, Adapt, Transform, Learn	NA
27	Wang <i>et al.</i> , 2020	Capacity to effectively prepare for and respond to pandemics while maintaining core functions, informed by lessons learned on an ongoing basis, and reorganize promptly if conditions require it	<i>Capacity</i> Prepare, Respond, Maintain, Learn, Re-organise	Kruk <i>et al.</i> , 2015
28	WHO Regional Office for Africa, 2018	Inbuilt capacity of the system to sustain provision of essential health and health-related services even when challenged by outbreaks, disasters, or other shocks	<i>Capacity</i> Maintain	NA
29	WHO, 2022	Capability of anticipating, responding to, coping with, recovering from, and adapting to climate-related shocks and stresses, so as to bring about sustained	<i>Capability</i> Anticipate, Respond, Cope,	Kruk <i>et al.</i> , 2015 ; Thomas <i>et al.</i> ,

N°	Source	Definition	View and key elements	Reference
		improvements in population health, despite an unstable climate	Recover, Adapt	2020

*No reference cited for the definition



Figure 7. Word cloud of references cited for the definition of resilience in relation with the health system

Generated with WordCloud Generator by MonkeyLearn; <https://monkeylearn.com/word-cloud/>

Based on these key elements, it appears that the definition of resilience has evolved over time, incorporating new elements and leaving or modifying others. *Adapt, prepare, transform* and *learn* were introduced between 2016 and 2019, mainly influenced by the definition from Kruk *et al.* (2015) (24,73). From 2020 to 2022, *anticipate* (68,83), *foresee* (62,80), and *support people* were introduced (77). On the other hand, *prevent* and *protect* did no longer appear since 2015; this may illustrate some distancing from the emergency preparedness and response field by health system resilience scholars (table 5). The second period is thus marked by the emergence of the transformative dimension of resilience which is maintained in the third period during which emphasis is set on vulnerability reduction.

Table 5. Evolution of key elements used in defining resilience

Periods	2012-2015		2016-2019		2020-2022	
Number of reports	3		6		20	
Key elements from definitions with their percentage of occurrence	Elements*	%	Elements	%	Elements	%
	<i>Absorb</i>	11.1%	<i>Absorb</i>	5.9%	<i>Absorb</i>	8.6%
	<i>Maintain</i>	11.1%	<i>Maintain</i>	29.4%	<i>Maintain</i>	16.0%
	<i>Mitigate</i>	11.1%	<i>Deal with</i>	5.9%	<i>Cope/withstand/endure</i>	4.9%
	<i>Prevent</i>	11.1%				
	<i>Protect</i>	11.1%				
	<i>Recover</i>	11.1%	<i>Recover</i>	5.9%	<i>Recover/resume/emerge</i>	6.2%
	<i>Re-organise</i>	11.1%	<i>Re-organise</i>	5.9%	<i>Re-organise</i>	7.4%
	<i>Respond</i>	11.1%	<i>Respond</i>	11.8%	<i>Respond</i>	13.6%
	<i>Sustain</i>	11.1%	<i>Sustain</i>	5.9%	<i>Sustain</i>	1.2%
			<i>Adapt</i>	5.9%	<i>Adapt</i>	9.9%
			<i>Learn</i>	5.9%	<i>Learn/understand</i>	2.5%
			<i>Prepare</i>	5.9%	<i>Prepare/Reduce vulnerability</i>	14.8%
			<i>Transform</i>	5.9%	<i>Transform</i>	8.6%
					<i>Anticipate/foresee</i>	4.9%
					<i>Support people</i>	1.2%

*Key elements that are maintained across the periods are in *italics*; new elements are in **bold**.

4.3.2. Conceptual bases for assessing resilience

The conceptual bases found in the reports are presented in table 6. These bases were reported 35 times overall, as McKenzie *et al.* (2016) used two frameworks (73). Twenty-four different bases were identified, of which four were reported more than once (figure 8):

- The resilient health system framework from Kruk *et al.* (10);
- The health system building blocks framework from WHO (38);
- The everyday health system resilience framework from Kagwanja *et al.* (34);
- The 13 Resilience-enhancing strategies from the EU Expert Group (62).

Table 6. Conceptual bases proposed or reported for the assessment of health system resilience

N°	Report	Conceptual basis	Reference
1	Alami <i>et al.</i> , 2021	Conceptual framework for emerging infectious diseases preparedness	Palayi <i>et al.</i> , 2019 From a modification of Hanefeld <i>et al.</i> 2018
2	Ammar <i>et al.</i> , 2016	Health system building blocks framework	WHO, 2007
3	Bayntun <i>et al.</i> , 2012	Health system building blocks framework	WHO, 2007
4	Bhandari and Alonge, 2020	Community resilience in health systems	(i) Norris <i>et al.</i> , 2008 (ii) Kruse <i>et al.</i> , 2017 (iii) Patel <i>et al.</i> , 2017
5	Bigoni <i>et al.</i> , 2022	Health system building blocks framework	WHO, 2007
6	Burau <i>et al.</i> , 2022	Health system resilience analytical framework	(i) Van Schalkwyk <i>et al.</i> , 2020 (ii) Chamberland-Rowe <i>et al.</i> , 2019 (iii) Blanchet <i>et al.</i> , 2017 (iv) Biddle <i>et al.</i> , 2020
7	Crowe <i>et al.</i> , 2014	Stylised health system, akin to an industrial process	NA*
8	Etemadi and Tadayon, 2021	Resilient health system framework	Kruk <i>et al.</i> , 2015
9	Expert Group HSPA, 2020	13 Resilience-enhancing strategies based on health system core functions and shock cycle stages	(i) WHO, 2007 (ii) Thomas <i>et al.</i> , 2020
10	Fitter <i>et al.</i> , 2017	CDC's 10 Essential Public Health Services (EPHSs) framework (CDC's EPHS)	CDC, 2014
11	Foroughi <i>et al.</i> , 2022	Health System Resiliency Analysis meta Framework	(i) Kruk <i>et al.</i> , 2017 (ii) Hollnagel <i>et al.</i> , 2006 (iii) Blanchet <i>et al.</i> , 2017 (iv) Bruneau <i>et al.</i> , 2003 (iv) Rogers, 2011
12	Giarelli, 2020	Conceptual framework of the dimensions of resilience governance	Blanchet <i>et al.</i> , 2017
13	Gilson <i>et al.</i> , 2020	The everyday health system resilience (EHSR) framework	Kagwanja <i>et al.</i> , 2020
14	Haldane <i>et al.</i> , 2021	Determinants of Resilient health system framework	WHO, 2010
15	Jovanović <i>et al.</i> , 2020	SmartResilience project concept of resilience	(i) Fischer, 2010 (ii) Øien <i>et al.</i> , 2012 (iii) Jovanović <i>et al.</i> , 2018
16	Kagwanja <i>et al.</i> , 2020	The everyday health system resilience (EHSR) framework	Gilson <i>et al.</i> , 2017

N°	Report	Conceptual basis	Reference
17	Karamagi <i>et al.</i> , 2022	Emergency preparedness and response (EPR) and inherent system resilience (ISR) based Health System Resilience Index	(i) IHR, 2005 (ii) Kruk <i>et al.</i> , 2015
18	Kruk <i>et al.</i> , 2017	Resilient health system framework	Kruk <i>et al.</i> , 2015
19	Ling <i>et al.</i> , 2017	Resilient health system framework	Kruk <i>et al.</i> , 2015
20	Lo Sardo <i>et al.</i> , 2019	Data-driven computational framework	NA
21	Massuda <i>et al.</i> , 2021	Health system building blocks framework	WHO, 2010
22	McKenzie <i>et al.</i> , 2016	(i) Complex adaptive systems (CAS) theory (ii) Health system building blocks framework	(i) Paina <i>et al.</i> , 2012 (ii) WHO, 2007
23	Meyer <i>et al.</i> , 2020	Health System Resilience Assessment Checklist	(i) Nuzzo <i>et al.</i> , 2019 (ii) WHO, 2016
24	Odhiambo <i>et al.</i> , 2020	Briguglio's vulnerability and resilience framework	Briguglio, 1995
25	Ozen and Tuncay, 2021	Input-Output-Outcome	(i) Kruk <i>et al.</i> , 2015 (ii) Kruk <i>et al.</i> , 2017 (iii) Hanefeld <i>et al.</i> , 2018
26	Pilevari and Shiva, 2021	Total interpretive structural modelling (TISM)	Shahabi <i>et al.</i> , 2019
27	Popic <i>et al.</i> , 2021	Production process	Wendt <i>et al.</i> , 2010
28	Rios <i>et al.</i> , 2020	Resilient health system framework	Kruk <i>et al.</i> , 2015
29	Rogers <i>et al.</i> , 2021	Multi-dimensional Health and Social Care Systems (MHSCS) framework	(i) WHO, 2006 (ii) WHO, 2010 (iii) WHO, 2018
30	Thomas <i>et al.</i> , 2013	Framework for assessing the resilience of health systems in terms of how they have adjusted to economic crisis	NA
31	Thomas <i>et al.</i> , 2020	13 Resilience-enhancing strategies based on health system core functions and shock cycle stages	WHO, 2007
32	Wang <i>et al.</i> , 2020	Resilient health system framework	Kruk <i>et al.</i> , 2015
33	WHO Regional Office for Africa, 2018	Resilient health system framework	Kruk <i>et al.</i> , 2015
34	WHO, 2022	WHO framework for measuring the climate resilience of health systems	(i) WHO, 2010 (ii) WHO, 2015 (iii) WHO, 2017

*The report did not mention an external reference for the conceptual base proposed or used

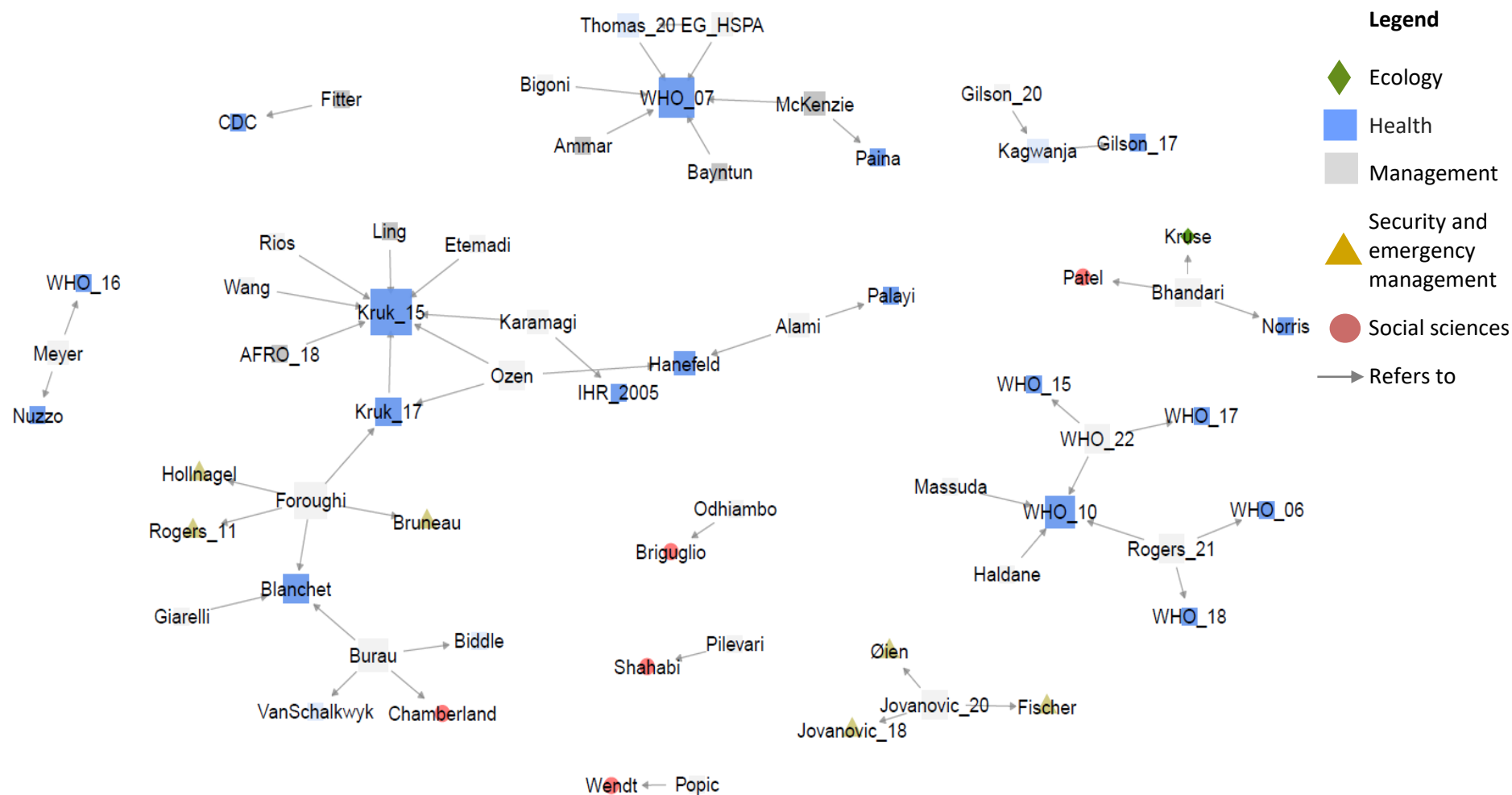


Figure 8. Network of reports included in the scoping review as well as the source publications of the frameworks they use

The arrows are directed from the reports included in the review towards the source publications of the frameworks they use. The size of the nodes indicates their centrality, measured as the “degree”, i.e., the number of times one report cites or is cited by another report in the network. The transparency of the nodes corresponds with the period of publication: before 2016 (not transparent - dark), from 2016 to 2019 (semi-transparent), 2020 or later (very transparent - light)

From three conceptual bases reported between 2012 and 2015, these have increased to five in 2016-2019, and 19 in 2020-2022. However, the four bases mentioned above are the ones most referred to. Over these periods, the health system building blocks framework (38) has continuously been used (table 7).

Table 7. Conceptual evolution of the assessment of health system resilience (full table in annex 5)

Period	2012-2015		2016-2019		2020-2022	
Reports	3		7		24	
Total occurrence	3		8		24	
Conceptual bases with their percentage of reporting	Conceptual base*	%	Conceptual base	%	Conceptual base	%
	<i>Health system building blocks framework</i>	33,3%	<i>Health system building blocks framework</i>	25,0%	<i>Health system building blocks framework</i>	8,3%
	Framework for assessing the resilience of health systems in terms of how they have adjusted to economic crisis	33,3%	Resilient health system framework	37,5%	<i>Resilient health system framework</i>	12,5%
	Stylised health system, akin to an industrial process	33,3%	CDC's 10 Essential Public Health Services (EPHSs) framework (CDC's EPHS)	12,5%	The everyday health system resilience framework	8,3%
			Complex adaptive systems (CAS) theory	12,5%	13 Resilience-enhancing strategies based on health system core functions and shock cycle stages	8,3%
			Data-driven computational framework	12,5%	Briguglio's vulnerability and resilience framework	4,2%

*Conceptual bases that are maintained across the periods are in *italics*; new concepts are in **bold**

4.4. Approaches for assessing health system resilience

Approaches used to assess health system resilience were identified as 'system mapping', 'capacity-based' or 'strategy-based' (6,64,84). 'System mapping approach' refers to approaches aiming to capture resilience through the assessment of the organisation and/or performance of core functions of the health system. They may focus on one or more functions and go beyond the traditional six building blocks (38) to include other components as values or community participation, depending on the health system framework they refer to (12,41).

The two other approaches capture resilience through the assessments of resilience capacities (or characteristics), or through the assessments of resilience strategies.

4.4.1. Approaches found in reviewed literature

Approaches proposed or used in the 34 included reports are presented in table 8. The capacity-based approach appeared in the 2016-2019 period. Since 2021, mixed approaches have appeared in the literature, associating two or the three previously identified approaches for assessing the resilience of health systems (64,69,77). However, in the period 2020-22, the system mapping approach increased most, becoming by far the most dominant approach.

Table 8. Proposed/used assessment approaches (full details in annex 6)

	Period			Total
	2012-2015	2016-2019	2020-2022	
System mapping approach	2	3	14	19
Strategy-based approach	1	1	4	6
Capacity-based approach	0	3	3	6
Mix of approaches	0	0	3	3
Total	3	7	24	34

4.4.2. Approaches utilised for assessing health system resilience and details on their use

As mentioned above, 21 out of the included papers reported on 23 studies assessing health system resilience in 103 countries with one of the approaches listed above. The system mapping approach was by far the most frequently used (13/23; 56.5%). Core functions, outputs and outcomes of the health system were assessed. However, equity and health outcome emerged only twice and once respectively, which is still marginal (table 9).

A capacity-based or strategy-based approach were used in five (21.7%) studies each (table 9 and annex 7). Except for Giarelli, who made a narrative analysis on the governance of COVID-19 response in five countries (65), all other studies were single or multiple case studies, including comparative case studies.

Studies grounded in the Kruk *et al.* conceptual framework (five dimensions of resilience) used the capacity-based approach. The strategy-based approach was used to assess absorptive, adaptive and transformative capacities of the health system.

Table 9. Characteristics and focus of studies with each of the assessment approaches

Assessment approach	#	Associated conceptual basis	Study methods*				Assessed		Type of results
			Evidence synthesis	Quantitative	Qualitative	Mixed	Components/capacities/dimensions	Frequency	
System mapping	13	(i) Briguglio's vulnerability and resilience framework					Financing	6 (46,2%)	Metrics and narrative
		(ii) CDC's EPHS framework					Infrastructures	5 (38,5%)	
		(iii) Complex adaptive systems theory					Health workforce	9 (69,2%)	
		(iv) Conceptual framework for EID preparedness					Information systems	9 (69,2%)	
		(v) Determinants of Resilient health systems framework	3 (25%)	8 (66,7%)	2 (16,7%)	2 (16,7%)	Leadership and governance	8 (61,5%)	
		(vi) Health system resilience index					Engagement with communities and other sectors	8 (61,5%)	
		(vii) Health system building blocks					Service delivery	6 (46,2%)	
		(viii) Input-output-outcome					Access to health care	3 (23,1%)	
		(ix) Production process					Equity	2 (15,4%)	
		(x) Stylised health system, akin to an industrial process					Health outcome	1 (7,7%)	
							Medical/non-medical products and technologies	5 (38,5%)	
Strategy-based approach	5	(i) Conceptual framework of the dimensions of resilience governance					Absorption	5 (100%)	Narrative
		(ii) Everyday HS Resilience framework					Adaptation	5 (100%)	
		(iii) Framework for assessing how health systems adjusted to economic crisis	0 (0%)	0 (0%)	1 (25%)	3 (75%)	Transformation	5 (100%)	
		(iv) HS resilience analytical framework					Health system pre-requisites (Funding, Provision, Governance [§])	4 (80%)	
Capacity-based approach	5	(i) Health system resilience index					Awareness	5 (100%)	Narrative
		(ii) Resilient health systems framework					Diversity	5 (100%)	
			0 (0%)	0 (0%)	3 (60%)	2 (40%)	Integration/mobilisation	5 (100%)	
							Adaptability and learning/Transformation	5 (100%)	
							Self-regulation	5 (100%)	

*Method could not be determined for one report

[§]Governance included knowledge, legitimacy, uncertainties, interdependence capacities (85), or cognitive, behavioural and contextual capacities (34)

Since 2020, authors have started adding some health systems pre-requisites to the strategy-based approach, including funding, provision (service delivery and availability of resource such as workforce, medical products, vaccines and technologies), and governance. Governance is then broken down into its managerial characteristics. In studies with a conceptual basis inspired by the Blanchet *et al.* framework (85), these include knowledge, legitimacy, uncertainties, and interdependence capacities; for studies grounded on the everyday health system resilience framework (34), they include cognitive, behavioural and contextual capacities (annex 8).

Authors using capacity-based or strategy-based approaches always covered all core capacities or dimensions in their assessment. However, with the system mapping approach, the use of the various components of health system frameworks was inconsistent.

Although qualitative and mixed methods were used with the three assessment approaches, evidence review, and exclusive use of quantitative method were only found with the system mapping approach (table 9). The capacity-based approach was mostly used in the absence of a shock (4/5), whereas 5/5 studies using the strategy-based approach were during the shock. System mapping approach was used both in the absence of a shock and during a shock (4/13 and 9/13 respectively). The three approaches are used at country level as well as at lower levels (annex 9).

Assessment approaches are not mutually exclusive. Karamagi *et al.* give an example of mix of approaches for assessing health system resilience. They generated a combined health system resilience index by associating the Inherent System Resilience (ISR) index with Emergency Preparedness and Response (EPR) index (69). The ISR index is grounded on the Kruk *et al.* (61) framework, thus assessing resilience using the capacity-based approach, whereas the EPR index is grounded in the 2005 International Health Regulation (IHR 2005) and uses the system mapping approach.

4.4.3. Metrics used for assessing health system resilience

Metrics were found only in reports using the system mapping approach. These metrics are presented in table 10; they consist of health system input, output and outcome indicators. However, no metrics were found for assessing governance and other 'soft' components like values or trust.

Table 10. Metrics used for system mapping

Health system indicators' categories		Metrics
Inputs	Health workforce (54,55,58,78)	Figures and trends of (i) physicians, nurses, nurse-aids and other professional categories, (ii) training, safety & protection activities, (iii) Incentives
	Infrastructure (54,55,60)	Figures and trends of (i) functional health facilities, (ii) hospital beds, (iii) quantity of available vs required
	Information/Surveillance & Monitoring systems (54)	Data completeness Data quality and access
	Medical/non-medical products and technologies (54,60)	Figures and trends of equipment and drugs available vs required
	Financing (55,76)	Figures and trends of (i) state budget allocated to the health sector, (ii) funding from donors, (iii) funds transferred to lower levels, (iv) financial protection including subsidisation of healthcare and insurance, (v) payment delays, (vi) efficiency of health expenditures
Outputs	Service provision and Equity (55,58,60)	Figures and trends of (i) functional health programmes, (ii) level of implementation of planned activities, (ii) activities targeting vulnerable/hard-to-reach groups, (iii) outbreak response campaigns, (iv) quantity of health care provided (childbirth, screening, physician appointment, surgeries, other procedures), and (v) patient satisfaction
Outcome	Utilisation of health care (55,58,73,75)	Figures and trends of (i) unmet demand, and (ii) coverage of interventions, including mass activities (campaigns), (iii) treatment success rate, and (iv) disease outbreaks/case new diseases
Impact	(55,73,75,76)	Figures and trends of (i) morbidity of selected diseases, (ii) infant and under 5 mortality, (iii) maternal mortality, (iv) excess death due to specific disease, and (v) out-of-pocket expenditures

4.5. Limitations and weaknesses of identified frameworks and assessment approaches

Thirteen reports proposed frameworks and/or checklists for assessing health system resilience using a strategy-based approach, capacity-based approach, system mapping approach, or a mix. It is important to note that these frameworks and checklist have not been applied in different settings and have not been validated (64). Furthermore, in some cases, metrics for their use have not been defined or there is need for their contextualisation to local realities (24,74). Finally, some implementation issues are anticipated (80).

Five reports proposed and tested their conceptual bases for assessing health system resilience; we however found no evidence of independent testing of these conceptual bases.

For used frameworks, some common limitations and weaknesses are:

- For system mapping approach
 - Limited availability of data needed for the assessment (54,55)
 - High probability of errors, delays, and biases in administrative data collection processes; this may result in the alteration of data reliability (58)
 - Blindness to the processes of achieving resilience (75)
 - Some frameworks do not account for complexity in the system (60)
- For strategy-based approach
 - In everyday health system resilience, same people may be involved both in the process of resilience and in the analysis of the experience, which raises some credibility issues (34,66).
- For all assessment approaches
 - Although assessment of resilience during a shock may give a useful indication, it remains a snapshot at a point in time, given the dynamic nature of the system, the shock and the shock/system equilibrium
 - Failure to consider other non-shock parameters that may affect the resilience of the health system (75).

5. Discussion

This study aimed at mapping and characterising existing approaches for assessing health system resilience. It included 34 reports from 868 records found from literature search. On the basis of the scoping review, I described the definitions and conceptual bases supporting the assessment of health system resilience, identified approaches for assessing health system resilience, and summarised their weaknesses and limitations.

5.1. Definitions of health system resilience

Three views on resilience were identified from the reviewed literature: resilience as a *process*, as a *characteristic*, and as *an ability, a capacity or a capability*. In their review on the meaning of community resilience, Patel *et al.* identified three main views on resilience, including resilience as a *process*, the *absence of adverse effect* and a *range of attributes* (86). However, the two later translate into abilities. There is thus no contradiction with findings from the present review. Moreover, the meaning of *characteristic* is broad and includes *abilities, capacities and capabilities* (87).

The definition of resilience has evolved over time, integrating some new terms and views, while leaving or rephrasing others. Although more elements emerged over the years, they did not consolidate yet in a uniform and commonly accepted definition. Efforts are however done to get to a more comprehensive definition as illustrated by Rogers *et al.* who define health system resilience as “*the capacity of a health system to (a) proactively foresee; (b) absorb; and (c) adapt to shocks and structural changes in a way that allows it to (i) sustain required operations; (ii) resume optimal performance as quickly as possible; (iii) transform its structure and functions to strengthen the system; and (possibly) (iv) reduce its vulnerability to similar shocks and structural changes in the future*” (62). A great variety is observed even in the recent literature. Authors will cite a definition, modify it according to gaps they may identify, to their own purpose, and to their interpretation of the concept. This attests to the lack of maturity of the concept of health systems resilience, as found by Turenne *et al.* (6). It is a major challenge to health systems and policy research (HSPR) scholars, as conceptual maturity is a key requirement for effective operationalisation of concepts.

5.2. Conceptual bases for the assessment of health system resilience

I found 24 conceptual bases for assessing health system resilience, from various backgrounds, including public health, ecology, social sciences, security and emergency fields. Exploration of

background fields has however been limited by the fact that we did not investigate beyond the cited reference. Most of the frameworks related to the field of public health could thus originate from other fields as the concept only recently emerged in the public health field (88).

Four conceptual frameworks were most referred to: (i) the resilient health system framework (10), (ii) the WHO health system building blocks (38), (iii) the everyday health system resilience framework (34), and the 13 Resilience-enhancing strategies framework (62). The variety of conceptual bases owes to the inconsistency in the definition of health system resilience. Each author thus develops, adopts or/and adjusts a framework according to his own understanding of the concept, which further illustrates the lack of clarity on the meaning of health system resilience (5,6,8). Only few authors referred to frameworks from other disciplines, although efforts towards the development and operationalisation of the concept of resilience began earlier in these fields. While discussions continue, much work has been done in the fields of disaster management, food security and economics, among others. International development organisations have developed resilience assessment models, including the United Nations Development Programme (UNDP), the Food and Agriculture Organisation (FAO) and the United States Agency for International Development (USAID) (89). Their work could enrich ongoing efforts for assessing health systems resilience.

5.3. Approaches for assessing health system resilience

Inspired by previous work, we identified three approaches to assessing health system resilience: (i) the *system mapping approach*, (ii) the *strategy-based approach*, and (iii) the *capacity-based approach* (6,64,84).

5.3.1. The system mapping approach

This approach builds primarily on the six components of the WHO health system building blocks framework and is the most used (figure 1). It is more about assessing the performance of the health system than about assessing resilience, as can be confirmed from the metrics it uses. Considering the purpose of resilience (resilience for what and for whom?), it is an appealing approach as it enables conception of an input-output-outcome alignment, most used by field actors and in the assessment of most public health interventions, projects and programmes with results frameworks. It can be used at any phase of the shock cycle. As further advantage, conventional surveys and administrative reports as well as routinely collected data can easily feed into this approach (25,69,81). This allows for rapid assessment at a relatively low cost, despite some concerns with data quality. It also facilitates standardisation and comparison, which would allow the identification and prioritisation of settings requiring urgent action.

5.3.2. The capacity-based approach

This approach builds primarily on the resilient health system framework by Kruk *et al.* (10). It is mostly used in the absence of shock (before or after the shock). The researchers using the capacity-based approach assess resilience through the five elements of the framework. They identify and describe elements attesting to the *awareness, diversity, self-regulation, integration* and *adaptability* of the system, as well as system gaps. Kruk *et al.* refer to the Rockefeller's City Resilience Framework as a source of inspiration and 'tested' their frame in three case studies, but here too, the theoretical underpinnings of the choice of the five elements is not well developed (10,24).

5.3.3. The strategy-based approach

The strategy-based approach builds primarily on the *absorptive, adaptive, and transformative* strategies developed by resilient health systems. Researchers using this approach describe how the shock affects the system and what mechanisms are developed under each of the three strategies. These are considered as processes for dealing with issues created by the shock. The framework used for this approach has recently been adapted by Blanchet *et al.* in their framework on the dimensions of resilience governance, and by Kagwanja *et al.* in their everyday health system resilience framework. Grounded in complex systems sciences, Blanchet *et al.* included a governance component to the framework, with four interlinked management capacities including (i) knowledge management; (ii) management of uncertainties; (iii) capacity to manage interdependence; and (iv) capacity to build or develop legitimacy. Kagwanja *et al.* included three health system resilience capacities, namely cognitive, behavioural and contextual capacities, which are *in se* management capacities. These adjustments are illustrative of the perceived need to identify precursors or determinants of resilience; in this approach, the focus is set on capacities needed to better manage resilience, which should exist prior to the shock.

Assessment of health system resilience using this approach provides details about mechanisms for resilience, with a broad view on interactions and complexity issues in the process of responding to the shock. Strategy-based approach is used during the shock and requires the assessment team to be embedded in the system, mapping and describing the shock and resilience processes. This may last for years when assessing resilience to structural challenges. In this case, adjustments are made to the response to the shock, as difficulties appear. Criticism has been made that it is simply change management. However, to a large extent, ensuring resilience is half a management responsibility and half a society's responsibility to do something about structural factors that weaken health systems and indeed the society. The above-mentioned adjustments to the primary framework show that its conceptualisation is still to reach full maturity.

5.4. Limitations and weaknesses of identified assessment approaches

Although most used, the system mapping approach provides only an *indirect assessment* of health system resilience. It considers only observable/measurable “effects” of resilience on core functions of the health system. Importantly, this approach has inherited the shortcomings of the model; it is linear and static, and blind about mechanisms of both shock and resilience. It ignores the complexity and dynamics inherent to the health system as it does not capture the complex interactions between the various components, nor the role and opinion of the people for whom a resilient health system is supposedly built. About this last point, translating the evolutions in the health system debate, some authors added new components to their assessment framework, including community engagement.

Both the capacity-based and strategy-based approaches investigate how resilience is developed and unfolds when the health system is faced with a shock. They may be considered as providing *direct assessment* of health system resilience. However, I argue that resilience does not appear from a vacuum; it is an emerging feature of the health system which it characterises. Describing processes and labelling them as “resilience” make little sense without showing how they relate to the goal of health system resilience: to protect human life and achieve positive health outcomes for all, in everyday functioning as well as during and after a shock (10). These processes are conducted by people, using the resources of the system. For example, drugs must be available before rationing can be implemented as an absorptive strategy; governance, implementation of change strategies and other activities, are driven by health workers while knowledge and awareness are built from the output of the information system. Many authors using these approaches are aware of this; they often mention pre-requisites to resilience that usually correspond to resources of the health system. Moreso, to complement their description and give “tangible” evidence of resilience, they report on health system inputs, outputs and/or outcomes, linking to the system mapping approach (34,59,66,81).

However, none of the three approaches pays attention to the structural political, social, economic and other determinants of the performance (or not thereof) of health systems. They do not tackle the structural disturbances weakening health systems, which has been raised as a main issue (8).

5.5. A framework situating approaches for assessing health system resilience and their use

From the above, it clearly appears that none of the approaches gives full picture of resilience; none is adapted to all contexts, shock types and steps of the shock cycle. They are also not mutually exclusive, but complementary. Therefore, some researchers are using a mix of approaches for assessing health system resilience; others are proposing assessment frameworks using mix of approaches (64,69). As an example, Foroughi *et al.* noted that each of the major health system

resilience frameworks focuses on one or two out of the aspects necessary for the operationalisation of this concept and suggested the combination of their elements into a comprehensive framework (64). This tendency towards integration can also be seen in the evolution of the definition of health system resilience, notably with Thomas *et al.* (table 4, lines 25 and 26), between 2013 and 2020.

However, there are inconsistencies in the use of terms across frameworks, which adds to the already existing confusion. While Blanchet *et al.* consider absorption, adaptation and transformation as capacities, Kagwanja *et al.* see strategies. Management capacities for the latter are considered as dimensions by the first (34,85). Moreso, Kruk *et al.* referred to elements of their framework as to elements that “characterises resilient health system” (10), or “characteristics of resilience” (24), not as dimensions as extensively presented in the literature.

From the present review, I suggest that the word ‘dimension’ used for Kruk *et al.* is changed to ‘attributes’, and ‘dimensions’ in the Blanchet *et al.* framework to ‘strategies’. With this in mind, I propose a framework which situates the three approaches for assessing health system resilience and their use (figure 9). It shows that when a resilient system is faced with a shock, people ensuring its governance use system resources and resilience capacities to select and implement adequate resilience strategies that allow the system to continue performing, protect human life and achieve positive health outcomes. Governance itself encompasses core management capacities and extends beyond the health system boundaries, to cross-sectoral engagement. Resilience can thus be assessed based on the performance of the core functions of the health system, based on core resilience capacities and/or based on the appropriateness and success in the implementation of resilience strategies. However, a mix would always be better, and the full picture would include these three approaches.

This frame could be improved as I am aware that health system resilience has not yet reached its conceptual maturity. In the absence of a consensus on definitions and frameworks, I expect possible changes. Especially, research that could deepen the theoretical underpinnings and test these would lead to further development of resilience assessment tools.

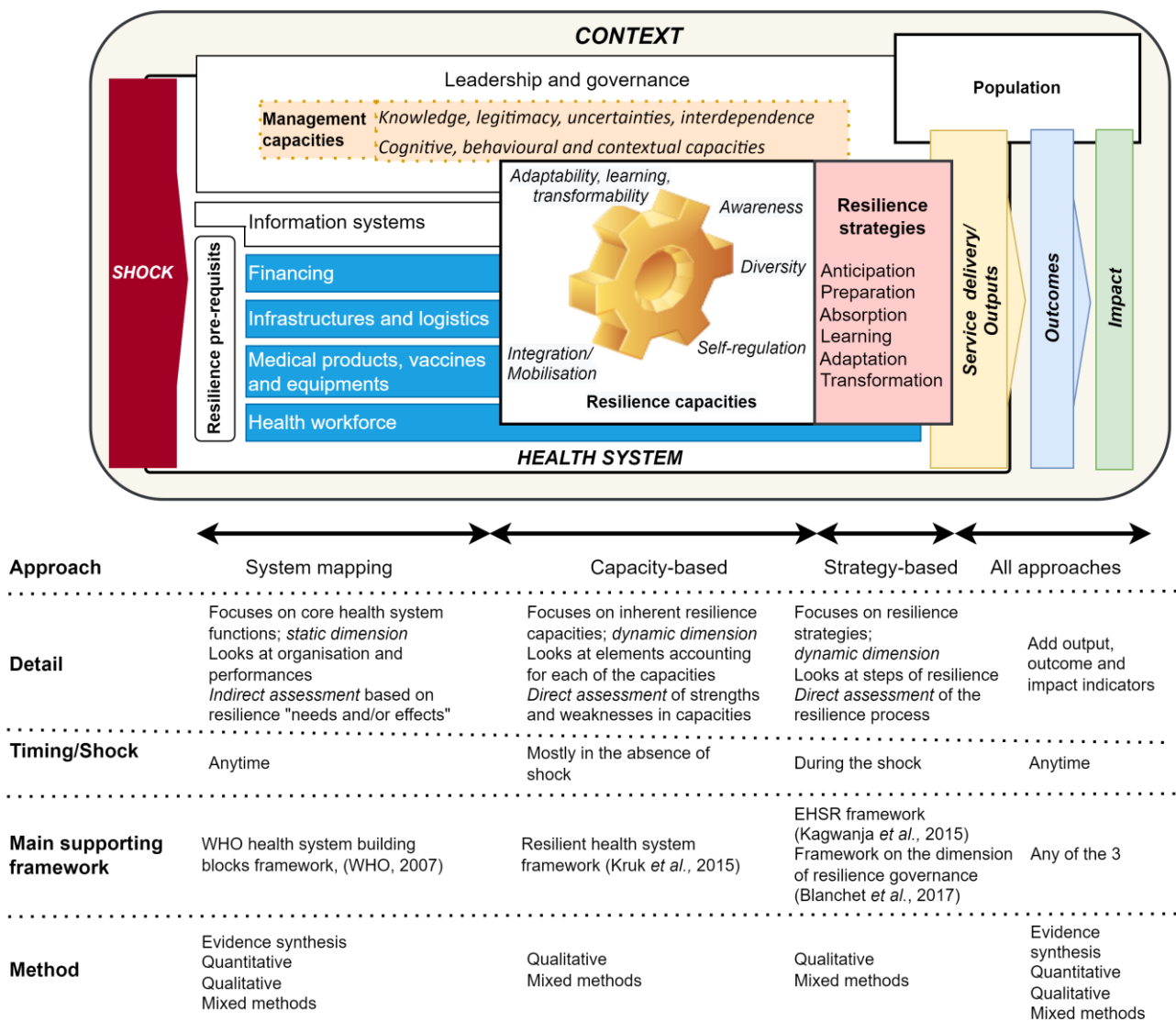


Figure 9. Framework situating approaches for assessing health system resilience and their use

5.6. Limitations of the study

This study has some limitations:

1. full text version of two records were not retrieved, although I contacted the authors for this purpose
2. included records were limited to those in English and French; we could have missed some in other languages
3. exploration of background fields did not investigate the origins of the frames and concepts used by the authors, beyond the cited reference. This was due to lack of time and capacity within the duration of the MPH.

6. Recommendations

As way forward for the health systems and policy research community I suggest the following priority areas:

- Further research into the factors that shape resilience of a health system
- Continue to test the identified assessment approaches, separately or in combination
- Work on developing and validating an integrative meta-framework for health system resilience
- Define and validate a toolkit with specific packages for frequent scenarios based on three main parameters: the context, the type of shock and the phases of the shock
- Define the optimal frequency and/or circumstances for the assessment at various levels of the health system.

7. Conclusion

Discussions continue about the assessment of health system resilience and, to date, there is no agreed and validated assessment approach, although there has been growing interest in the concept over the past decade. This is undoubtedly due to changes and diversity in the understanding of health system resilience, which is gradually evolving to incorporate criticism and include contributions from various fields of research. Three main assessment approaches emerged from this review: the system mapping that looks at the health system core functions, the capacity-based that looks at the core characteristics of resilience, and the strategy-based that looks at resilience strategies. None of these approaches gives a full picture of resilience. They are not mutually exclusive and can be complementary; therefore, more researchers are using a mix of approaches. However, there is still need for further testing and learning from the field on their specific or integrated use. The absence of a common understanding of the concept of health system resilience represents a major hinderance to its operationalisation and assessment.

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9. Annexes

Annex 1. Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	i
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	iv
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	2
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	3
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	11
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	8
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	9
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	9, 53, 54
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	9
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	10
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	10, 11
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	Not appropriate for scoping reviews
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	11

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	13
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	14-18
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	Not appropriate
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	18-32
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	18-32
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	33-37
Limitations	20	Discuss the limitations of the scoping review process.	38
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	39
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	Not relevant for the thesis

JB1 = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

- * Where sources of evidence (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.
- † A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).
- ‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.
- § The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, *et al.* PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: [10.7326/M18-0850](https://doi.org/10.7326/M18-0850).



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Annex 2. Search strategy

Source	Type of literature	Search terms
PubMed	Peer-reviewed	("health system"[Title/Abstract] OR "health systems"[Title/Abstract] OR "healthcare system"[Title/Abstract] OR "healthcare systems"[Title/Abstract] OR "healthcare system"[Title/Abstract] OR "health care systems"[Title/Abstract]) AND ("resilience"[Title/Abstract] OR "resiliences"[Title/Abstract] OR "resiliencies"[Title/Abstract] OR "resiliency"[Title/Abstract] OR "resilient"[Title/Abstract] OR "resilients"[Title/Abstract]) AND ("assess"[Title/Abstract] OR "assessed"[Title/Abstract] OR "assessment"[Title/Abstract] OR "assesses"[Title/Abstract] OR "assessing"[Title/Abstract] OR "assessment"[Title/Abstract] OR "assessment s"[Title/Abstract] OR "assessments"[Title/Abstract] OR "appraised"[Title/Abstract] OR "appraisal"[Title/Abstract] OR "appraising"[Title/Abstract] OR "evaluated"[Title/Abstract] OR "evaluation"[Title/Abstract] OR "evaluating"[Title/Abstract]) AND ("framework"[Title/Abstract] OR "framework s"[Title/Abstract] OR "frameworks"[Title/Abstract] OR ("tool"[Title/Abstract] OR "tools"[Title/Abstract] OR "tool s"[Title/Abstract]) OR ("approach"[Title/Abstract] OR "approaches"[Title/Abstract]) OR ("strategy"[Title/Abstract] OR "strategies"[Title/Abstract]) OR ("metrics"[Title/Abstract] OR "metric"[Title/Abstract]) OR ("measure"[Title/Abstract] OR "measuring"[Title/Abstract] OR "measurement"[Title/Abstract])) AND (y_10[Filter])
		health system AND resilience AND (assessment OR appraisal OR evaluation OR test) AND (tool OR approach); Title, abstract or author-specified keywords; 2012-2022
ScienceDirect	Peer-reviewed	health system AND resilience AND (assessment OR appraisal OR evaluation OR test) AND (framework OR method); Title, abstract or author-specified keywords; 2012-2022 health system AND resilience AND (assessing OR appraising OR evaluating OR testing) AND (framework OR method); Title, abstract or author-specified keywords; 2012-2022

Source	Type of literature	Search terms
EBSCOhost	Peer-reviewed	"Heath system" resilience assessment framework; <i>find all my search terms, apply related words, year of publication: 20120301-20220228, ITM All collection, all languages, all results, all databases</i>
CAIRN	Peer-reviewed	"health system" AND (resilience OR sustainability) AND (assessment OR appraisal OR evaluation OR test) AND (tool OR approach); <i>intégral, 10 dernières années, revues, santé publique</i> "système de santé" ET résilien* ET évalu* ET (cadre OU outil* OU méthode OU approche) ; texte intégral, 10 dernières années, revues, santé publique. <i>Exclues les analyses de livres et Bibliographies</i>
SSRN	Peer-reviewed	"Health system" resilience
Google Scholar	Peer-reviewed	allintitle: "Health system" resilience; 2012-2022
DOAJ	Peer-reviewed	Health system resilience
MedRxiv	Preprint	Health system resilience
OAlster	Grey literature	ti : "health system" resilience; <i>Articles et documents d'archives, 2012-2022</i>
ReliefWeb	Grey literature	resilience, "health system"
WHO library	Grey literature	"Health system", assessment

Annex 3. Studies assessing health system resilience and countries of implementation

N°	Authors	Countries
1	Alami <i>et al.</i> , 2021	Canada
2	Ammar <i>et al.</i> , 2016	Lebanon
3	Bigoni <i>et al.</i> , 2022	Brazil
4	Burau <i>et al.</i> , 2022	Austria, Denmark, Germany, Italy, Netherlands, United Kingdom
5	Crowe <i>et al.</i> , 2014	United Kingdom
6	Fitter <i>et al.</i> , 2017	Haïti
7	Giarelli, 2020	China, Italy, South Korea, United Kingdom, United States of America
8	Gilson <i>et al.</i> , 2020	South Africa
9	Haldane <i>et al.</i> , 2021	Argentina, Brazil, China, Egypt, Fiji, Germany, India, Japan, Liberia, Mexico, Mozambique, New Zealand, Niger, Nigeria, Pakistan, Peru, Russia, Singapore
		South Korea, Spain, Sri Lanka, Sweden, Thailand, Uganda, United Kingdom, United States of America, Uruguay, Vietnam
10	Kagwanja <i>et al.</i> , 2020	Kenya
11	Karamagi <i>et al.</i> , 2022	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Congo (Dem. Rep.), Ivory Coast, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia (The), Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, South Sudan, Tanzania (United Republic of), Togo, Uganda, Zambia, Zimbabwe
12	Ling <i>et al.</i> , 2017	Liberia
13	Massuda <i>et al.</i> , 2021	Brazil
14	McKenzie <i>et al.</i> , 2016	Nigeria
15	Odhiambo <i>et al.</i> , 2020	South Sudan
16	Ozen and Tuncay, 2021	Turkey
17	Popic <i>et al.</i> , 2021	Austria, Belgium, Bosnia and Hergozevina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Israël, Italy, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Ukraine, United Kingdom
18	Rios <i>et al.</i> , 2020	Puerto Rico
19	Thomas <i>et al.</i> , 2013	Ireland
20	Wang <i>et al.</i> , 2020	Iran, Japan, South Korea, United Kingdom, United States of America
21	WHO Regional Office for Africa, 2018	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Congo (Dem. Rep.), Ivory Coast, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia (The), Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, South Sudan, Tanzania (United Republic of), Togo, Uganda, Zambia, Zimbabwe

Annex 4. Key elements from the definition of resilience in relation with the health system

Key elements	Frequency	Percentage
Maintain	19	17.1%
Respond	14	12.6%
Prepare	12	10.8%
Absorb	9	8.1%
adapt	9	8.1%
transform	8	7.2%
Re-organise	7	6.3%
Learn	6	5.4%
Recover	4	3.6%
Sustain	3	2.7%
Anticipate	2	1.8%
Foresee	2	1.8%
Reduce vulnerability	2	1.8%
Resume	2	1.8%
Withstand	2	1.8%
Cope	1	0.9%
Deal with	1	0.9%
Emerge	1	0.9%
Endure	1	0.9%
Mitigate	1	0.9%
Prevent	1	0.9%
Protect	1	0.9%
Re-organise	1	0.9%
Support	1	0.9%
Understand	1	0.9%
Total occurrence	106	100%

Annex 5. Evolution of key references for the conceptual bases proposed or used

Period	2012-2015		2016-2019		2020-2022	
Number of reports	1		6		24	
Number citations	1		7		44	
References for conceptual bases with their percentage of citations	Reference	%	Reference	%	Reference	%
	WHO, 2007	100%	Kruk <i>et al.</i> , 2015	42,9%	Kruk <i>et al.</i> , 2017	11,4%
			WHO, 2007	28,6%	WHO, 2010	9,1%
			Paina <i>et al.</i> , 2012	14,3%	Blanchet <i>et al.</i> , 2017	6,8%
			CDC, 2014	14,3%	WHO, 2007	6,8%
					Kruk <i>et al.</i> , 2015	4,5%
					Biddle <i>et al.</i> , 2020	2,3%
					Briguglio, 1995	2,3%
					Bruneau <i>et al.</i> , 2003	2,3%
					Chamberland-Rowe <i>et al.</i> , 2019	2,3%
					Fischer, 2010	2,3%
					Gilson <i>et al.</i> , 2017	2,3%
					Hanefeld <i>et al.</i> , 2018	2,3%
					Hollnagel <i>et al.</i> , 2006	2,3%
					IHR, 2005	2,3%
					Jovanović <i>et al.</i> , 2018	2,3%
					Kagwanja <i>et al.</i> , 2020	2,3%
					Kruse <i>et al.</i> , 2017	2,3%
					Norris <i>et al.</i> , 2008	2,3%
					Nuzzo <i>et al.</i> , 2019	2,3%
					Øien <i>et al.</i> , 2012	2,3%
					Palayi <i>et al.</i> , 2019	2,3%
					Patel <i>et al.</i> , 2017	2,3%
					Rogers, 2011	2,3%
					Shahabi <i>et al.</i> , 2019	2,3%
					Thomas <i>et al.</i> , 2020	2,3%
					Van Schalkwyk <i>et al.</i> , 2020	2,3%
					Wendt <i>et al.</i> , 2010	2,3%
					WHO, 2006	2,3%
					WHO, 2015	2,3%
					WHO, 2016	2,3%
					WHO, 2017	2,3%
					WHO, 2018	2,3%

Annex 6. Chronology of conceptual bases for the assessment of health system resilience

Period	2012-2015		2016-2019		2020-2022	
Reports	3		7		24	
Total occurrence	3		8		24	
Conceptual bases and percentage of occurrence	Conceptual base	%	Conceptual base	%	Conceptual base	%
	Health system building blocks framework	33,3%	Health system building blocks framework	25,0%	Health system building blocks framework	8,3%
	Framework for assessing the resilience of health systems in terms of how they have adjusted to economic crisis	33,3%	Health system resilience framework	37,5%	Health system resilience framework	12,5%
	Stylised health system, akin to an industrial process	33,3%	CDC's 10 Essential Public Health Services (EPHSs) framework (CDC's EPHS)	12,5%	The everyday health system resilience (EHSR) framework	8,3%
			Complex adaptive systems (CAS) theory	12,5%	13 Resilience-enhancing strategies based on health system core functions and shock cycle stages	8,3%
			Data-driven computational framework	12,5%	Briguglio's vulnerability and resilience framework	4,2%
					Community resilience in health systems	4,2%
					Conceptual framework for EID preparedness	4,2%
					Conceptual framework of the dimensions of resilience governance	4,2%
					Determinants of health system resilience framework	4,2%

Period	2012-2015	2016-2019	2020-2022	
			Emergency preparedness and response (EPR) and inherent system resilience (ISR) based Health System Resilience Index	4,2%
			Health System Resilience Analysis meta Framework	4,2%
			Health system resilience analytical framework	4,2%
			Health System Resilience Assessment Checklist	4,2%
			Input-output-outcome	4,2%
			Multi-dimensional Health and Social Care Systems (MHSCS) framework	4,2%
			Production process	4,2%
			SmartResilience project concept of resilience	4,2%
			TISM (Total interpretive structural modelling)	4,2%
			WHO framework for measuring the climate resilience of health systems	4,2%

Annex 7. Assessment approaches in reviewed reports

AUTHOR	Year	category	Approach
Bayntun <i>et al.</i> , 2012	2012	Proposed	System mapping approach
Thomas <i>et al.</i> , 2013	2013	Used	Strategy-based approach
Crowe <i>et al.</i> , 2014	2014	Used	System mapping approach
Ammar <i>et al.</i> , 2016	2016	Used	System mapping approach
McKenzie <i>et al.</i> , 2016	2016	Used	System mapping approach
Fitter <i>et al.</i> , 2017	2017	Used	System mapping approach
Kruk <i>et al.</i> , 2017	2017	Proposed	Capacity-based approach
Ling <i>et al.</i> , 2017	2017	Used	Capacity-based approach
WHO Regional Office for Africa, 2018	2018	Used	Capacity-based approach
Lo Sardo <i>et al.</i> , 2019	2019	Proposed	System mapping approach
Giarelli, 2020	2020	Used	Strategy-based approach
Gilson <i>et al.</i> , 2020	2020	Used	Strategy-based approach
Kagwanja <i>et al.</i> , 2020	2020	Used	Strategy-based approach
Rios <i>et al.</i> , 2020	2020	Used	Capacity-based approach
Wang <i>et al.</i> , 2020	2020	Used	Capacity-based approach
Bhandari and Alonge, 2020	2020	Proposed	System mapping approach
Expert Group HSPA, 2020	2020	Proposed	System mapping approach
Odhiambo <i>et al.</i> , 2020	2020	Used	System mapping approach
Thomas <i>et al.</i> , 2020	2020	Proposed	System mapping approach
Jovanović <i>et al.</i> , 2020	2020	Proposed	System mapping approach
Meyer <i>et al.</i> , 2020	2020	Proposed	System mapping approach
Etemadi and Tadayon, 2021	2021	Proposed	Capacity-based approach
Pilevari and Shiva, 2021	2021	Proposed	Mix of the 3 approaches (i) Health system performance, (ii) Capacity-based approach, (iii) Strategy-based approach
Alami <i>et al.</i> , 2021	2021	Used	System mapping approach
Haldane <i>et al.</i> , 2021	2021	Used	System mapping approach
Massuda <i>et al.</i> , 2021	2021	Used	System mapping approach
Ozen and Tuncay, 2021	2021	Used	System mapping approach
Rogers <i>et al.</i> , 2021	2021	Proposed	System mapping approach
Popic <i>et al.</i> , 2021	2021	Used	System mapping approach
Burau <i>et al.</i> , 2022	2022	Used	Strategy-based approach
Karamagi <i>et al.</i> , 2022	2022	Used	Mix of the 2 approaches (i) System mapping approach , (ii) Capacity-based approach
Foroughi <i>et al.</i> , 2022	2022	Proposed	Mix of the 3 approaches (i) System mapping approach , (ii) Capacity-based approach, (iii) Strategy-based approach
Bigoni <i>et al.</i> , 2022	2022	Used	System mapping approach
WHO, 2022	2022	Proposed	System mapping approach

Annex 8. Assessment approaches used, with related study details

N°	Report	Framework	Assessment approach	Study design	Method	Data source
1	Alami <i>et al.</i> , 2021	Conceptual framework for EID preparedness	System mapping	Case study	Evidence synthesis Mixed methods	Literature review; Expert panel Secondary administrative data
2	Ammar <i>et al.</i> , 2016	Health system building blocks framework	System mapping	Case study	Evidence synthesis Quantitative	Literature review; MOPH, the UN, WB and NGOs secondary data
3	Bigoni <i>et al.</i> , 2022	Health system building blocks framework	System mapping	Case study	Quantitative	Information System on Public Health Budgets (SIOPS); National Registry of Health Facilities; CNES database
4	Burau <i>et al.</i> , 2022	Health system resilience analytical framework	Strategy-based approach	Comparative case study	Mixed methods	Written secondary and primary sources; Expert information
5	Crowe <i>et al.</i> , 2014	Stylised health system, akin to an industrial process	System mapping	Case study	Quantitative (Modelling)	Routine MoH data
6	Fitter <i>et al.</i> , 2017	CDC's EPHS framework	System mapping	Case study	Not described	Not described
7	Giarelli, 2020	Conceptual framework of the dimensions of resilience governance	Strategy-based approach	Narrative around the dimensions	Not described	Not described
8	Gilson <i>et al.</i> , 2020	The everyday health system resilience (EHSR) framework	Strategy-based approach	Case study	Mixed methods	Notes from observation; Records from IDIs; Meeting minutes; Secondary data
9	Haldane <i>et al.</i> , 2021	Determinants of Resilient health systems framework	System mapping	Case study	Mixed methods	Literature review; Semi-structured interviews; National government submissions; Experts
10	Kagwanja <i>et al.</i> , 2020	The everyday health system resilience (EHSR) framework	Strategy-based approach	Case study	Qualitative	Field experience; Informal observations notes; meetings' notes; Records from IDIs
11	Karamagi <i>et al.</i> , 2022	EPR and ISR based Health System Resilience Index	System mapping and Capacity-based approach	Comparative case study	Mixed methods	Routine surveillance data; IHR SPAR data; Experts

N°	Report	Framework	Assessment approach	Study design	Method	Data source
12	Ling <i>et al.</i> , 2017	Resilient health systems framework	Capacity-based approach	Case study	Qualitative	Records from semi-structured IDIs/FGDs
13	Massuda <i>et al.</i> , 2021	Health system building blocks framework	System mapping	Case study	Evidence synthesis Qualitative	Scientific literature and official documents; experts
14	McKenzie <i>et al.</i> , 2016	CAS theory; Health system building blocks framework	System mapping	Case study	Mixed methods	Project implementation records and reports
15	Odhiambo <i>et al.</i> , 2020	Briguglio's vulnerability and resilience framework	System mapping	Case study	Quantitative	National surveys on health indicators, UNOCHA dataset
16	Ozen and Tuncay, 2021	Input-output-outcome	System mapping	Case study	Quantitative (Modelling)	Demographic data MoH database
17	Popic <i>et al.</i> , 2021	Production process	System mapping	Comparative case study	Quantitative (modelling)	The Economist; European Health for All database; Johns Hopkins CSSE; COVID-19 government response tracker
18	Rios <i>et al.</i> , 2020	Resilient health systems framework	Capacity-based approach	Case study	Qualitative	Records from KII
19	Thomas <i>et al.</i> , 2013	Framework for assessing the resilience of health systems adjustment to economic crisis	Strategy-based approach	Case study	Mixed methods	Budget and policy documents; Reports on key indicators; Key performance metrics
20	Wang <i>et al.</i> , 2020	Resilient health systems framework	Capacity-based approach	Comparative case study	Mixed methods	WHO COVID-19 dashboard; SPAR results; GHS index Article and press material
21	WHO Regional Office for Africa, 2018	Resilient health systems framework	Capacity-based approach	Comparative case study	Mixed methods	Records from KII

Annex 9. Assessment approaches with their levels of implementation across the health system

		Level of implementation		
		Country	Local	Subnational
Assessment approach	Strategy-based approach	3	2	0
	Capacity-based approach	4	1	0
	System mapping approach	9	2	3