

Article title: How Is Health System Resilience Being Assessed? A Scoping Review

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Supplementary file 2. Data Charting

Table S2: Detailed 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])
Science Direct	Peer reviewed	health system AND resilience AND (assessment OR appraisal OR evaluation OR test) AND (tool OR approach); Title, abstract or author-specified keywords; 2012-2022 health system AND resilience AND (assessment OR appraisal OR evaluation OR test) AND (framework OR method); Title, abstract or author-specified keywords; 2012-2022

Source	Type of literature	Search terms
		health system AND resilience AND (assessing OR appraising OR evaluating OR testing) AND (framework OR method); Title, abstract or author-specified keywords; 2012-2022
EBSCOhost	Peer reviewed	"Health 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) ; <i>texte intégral, 10 dernières années, revues, santé publique. 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
OAIster	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

Table S3: 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

Table S4: 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%

Table S5: 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	Reference	%	Reference	%	Reference	%
	WHO, 2007	100%	Kruk <i>et al.</i> , 2015	42,9%	Kruk <i>et al.</i> , 2017	11,4%
Period	2012-2015		2016-2019		2020-2022	
with their percentage of citations			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%

Table S6: 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%	<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%	<i>Health system resilience framework</i>	37,5%	<i>Health system resilience 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 (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%

* New conceptual bases are in **bold**; those that are maintained across the periods are *italicised*.

Table S7: Assessment approaches in reviewed reports

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

Table S8: 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	Odhambo <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

Table S9: Assessment approaches with their levels of implementation across the health system

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