

RESILIENCE AND COMPLEX ADAPTIVE SYSTEMS: A PERSPECTIVE ON HEALTHCARE

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ABSTRACT

Purpose. The term “healthcare system resilience” is becoming topical in policy planning documents around the world, increasingly in the context of the COVID-19 pandemic. This research aimed to explore the role of the contextual framework in the research on resilience and prevailing aspects of the healthcare system’s resilience.

Design / methodology / approach. The research hypothesised on the increasing relevance of the concept of resilience in the healthcare system as demonstrated by scientific literature; on determining elements that characterise the interrelationship between the domains of the healthcare system and the concept of resilience; and on the role of the contextual framework in creating an awareness of the concept of resilience in the healthcare system. The hypotheses were verified by the literature review on the PubMed, Web of Science, and Scopus databases.

Findings. The concept of resilience was introduced to the healthcare system literature from the ecological sciences through an increased understanding of the healthcare system as a complex adaptive system (CAS). The perception of the nature of the healthcare system in the context of a CAS, viewing it as a complex, dynamic part of the socio-economic system, operating in circumstances of high uncertainty, provides additional opportunities for understanding the healthcare system’s functioning, governance and decision-making.

Originality / value. This study identified a research gap in the practical implementation of the CAS approach in the healthcare system on the highest level of governance. A CAS contains a multitude of characteristics and elements that could assist in attaining a more nuanced understanding of healthcare system resilience. Significantly, the inherent characteristics of a CAS, such as flexibility and an adaptive nature, which seem to undermine the stability of the system, actually create the core of this system’s resilience, and these aspects merit increased attention. Further research could be devoted to the investigation of healthcare system resilience in the context of healthcare system reforms.

Keywords: healthcare system, contextual framework, organization, governance, ecological approach, networks

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INTRODUCTION

The concept of system resilience is emerging in various fields and has extended in particular to healthcare due to the coronavirus disease caused by the SARS-CoV-2 virus (COVID-19) pandemic. The issue of healthcare resilience became relevant and launched a discourse among healthcare system researchers in 2014, due to the onset of the Ebola outbreak in West Africa (Kieny et al., 2014). Various policy planning documents were gradually prepared to strengthen the resilience of the healthcare system in disaster risk circumstances. The United Nations (UN) General Assembly has defined resilience as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management” (United Nations General Assembly, 2016). The topicality of healthcare system resilience manifested itself in light of the COVID-19 pandemic. One of the most recent documents is the World Health Organization (WHO) position paper “Building health systems resilience for universal health coverage and health security during the COVID-19 pandemic”, which provides recommendations for building resilience and seeking integration between promoting universal health coverage (UHC) and ensuring health security by the following means (World Health Organization, 2021):

- recovery and transformation of national health systems through investment in the essential public health functions and the foundations of the health system, with a focus on primary healthcare and the incorporation of health security
- all-hazards emergency risk management, to ensure and accelerate the sustainable implementation of the International Health Regulations (2005)
- whole-of-government approach to ensure community engagement and whole-of-society involvement

Despite plenty of policy planning documents and discussion papers, the definition and exploration of resilience within healthcare systems research remain a topic of discourse. The author hypothesised that the increasing relevance of the concept of resilience has been reflected not only in policy planning documents, but also in scientific literature. Therefore, one of the tasks of this study was to identify the signs that would indicate a growth in interest among researchers in the application of the concept of resilience to healthcare systems. Moreover, the author hypothesised that there are determining elements that characterise the interrelationship between the domains of the healthcare system and the concept of resilience. The relevant task was to reveal a feasible determinant as an interconnecting characteristic. Finally, the author hypothesised that the contextual framework has a role in creating an awareness of the concept of resilience in the healthcare system and thus approaches the main aim of this research. Accordingly, the main aim of this research is to discern the role of the contextual framework in the research on resilience and the feasible determinant of the healthcare system’s resilience. To achieve the aim of this research, the objective was formulated as the identification of the initial nature, classic domains, and feasible prevailing feature of healthcare resilience.

RESEARCH DESIGN AND METHODOLOGY

In order to obtain an overview of the topicality of healthcare system resilience in scientific literature, a replication of the initial search by Biddle et al. in “Health system resilience: a literature review of empirical research” (Biddle et al., 2020, p. 1086) was performed. Biddle et al. conducted a review of the empirical literature, following a systematic review methodology with the following search items: (((((((secondary health care [mh]) OR primary health care [mh]) OR health services [mh]) OR delivery of health care [mh]) OR health services research [mh])) OR (((((((((((("health system") OR "health systems") OR "health care system") OR "health care systems") OR "health care") OR "health care sector") OR "health care sectors") OR "health service") OR "health services") OR "service delivery") OR "health care service") OR "health care services")))) AND Resilien*. Searches were conducted in Medline, the Social Science Citation Index and CINAHL (Cumulative Index to Nursing and Allied Health Literature) on 18 October 2019 and were limited to articles published since 2008 in English or German. The search identified 6,930 publications, as the total number of records, through database searching. The author of the current research replicated this search by using the same search items in PubMed (Medline) to identify the number of records in the period from 1 January 2020 until 18 October 2022 in English or German. The total number of records identified through database searching was 8,568. The results demonstrated that the previous study covered a 9-year longer period but showed lower publication rates than the current study.

The search flow on determining elements that characterise the interrelationship between the domains of the healthcare system and the concept of resilience is shown in Figure 1.

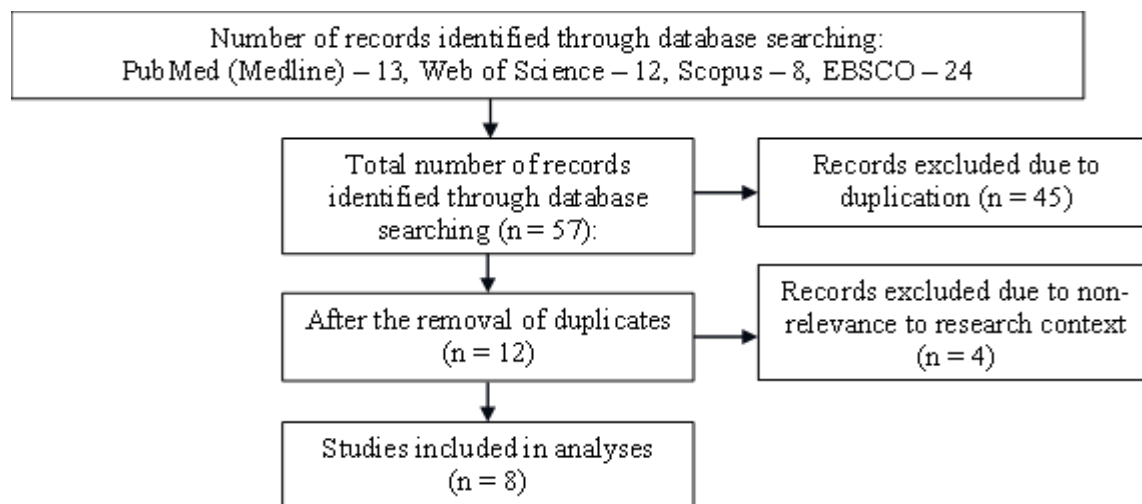


Figure 1. Flow diagram of the selection process for the literature review

In the scope of this research, a literature review was conducted using the PubMed, Web of Science, and Scopus databases (and additionally, the EBSCO database). The following keywords were used: “healthcare”, “system”, “resilience”, “concept” and “domains”. During this stage of research, it was found that “complex adaptive system (CAS)” is a unified concept used by

researchers assuming the healthcare system to be a complex system and is mentioned as a prevailing feature of healthcare resilience. Therefore, additional analysis and synthesis were devoted to the CAS's relevance to the healthcare system's nature.

RESULTS AND DISCUSSION

Overview of the healthcare system resilience concept

The author performed a replication of the previous study by Biddle et al. (2020) on the topicality of the resilience concept in healthcare system research and demonstrated that the total number of records (8,568) identified in PubMed (Medline) from 1 January 2020 until 19 October 2022 significantly exceeded the number of records (6,930) identified for the period from 1 January 2008 until 19 October 2019 in the study by Biddle et al. (2020). These results support the hypothesis that the increasing relevance of the concept of resilience to the healthcare system is not only demonstrated in policy planning documents, but also discoursed in scientific literature.

The theoretical background of this study was based on literature research on contextual issues of healthcare system resilience. Since the topicality of the term "healthcare system resilience" has arisen in relatively recent years, healthcare researchers initially used the achievements of other fields in the exploration of this phenomenon. Healthcare researchers (incl. Blanchet et al., 2017) used, as a basis for creating the conceptual framework of resilience in healthcare, the ecological model proposed by Lebel et al. (2006).

Blanchet et al. emphasized that, based on frameworks used in ecology, three domains of resilience can be applied to healthcare systems: absorptive capacity, adaptive capacity and transformative capacity (Blanchet et al., 2017). Additionally, the researchers extended existing frameworks from ecological science to the study of healthcare systems and proposed a modified conceptual framework. The four suggested dimensions consisted of understanding: (i) the mechanisms through which healthcare system actors collect, systematise, and interpret complex information, as well as the way this information feeds into complex decision-making processes; (ii) the strategies healthcare system actors may use to manage uncertainty and surprises; (iii) the interdependence of healthcare systems with other complex systems; and (iv) the approaches through which healthcare systems develop socially and contextually acceptable institutions and norms (Blanchet et al., 2017).

At the same time, Barasa et al. reflected on criticisms of the concept of resilient healthcare systems, such as assuming that systems are apolitical, ignoring actor agency, promoting inaction, and requiring the acceptance and embracing of vulnerability, rather than striving for stronger and more responsive systems (Barasa et al., 2017). The researchers argued that the observed weaknesses of resilience thinking can be addressed by reframing and applying a resilience lens that is better suited to the attributes of healthcare systems as complex adaptive systems (CASs). Specifically, the researchers proposed that: (1) in addition to sudden shocks, healthcare systems face the ongoing strain of multiple factors. Healthcare systems need the capacity to continue to deliver services of good quality and respond effectively to wider health challenges – to ensure "everyday resilience"; (2) healthcare system resilience entails more than bouncing back from shock. In CASs, resilience emerges from a combination of absorptive, adaptive, and transformative strategies; (3) nurturing the resilience of healthcare systems requires understanding healthcare systems as comprising not only hardware elements (such as finances and infrastructure), but also software elements (such as leadership capacity, power relations, values, and appropriate organizational culture) (Barasa et al., 2017).

These two conceptualizations of resilience successfully complemented each other – “top-down” (Blanchet *et al.*, 2017) and “bottom-up” (Barasa *et al.*, 2017) approaches, which both acknowledge the importance of the context of the resilience process and the agency of actors involved.

Great support in the achievement of the aim of the current research related to the contextual issues of healthcare system resilience was also provided by the correspondence published in *The Lancet* in 2017. In this correspondence, Haldane *et al.* revealed that resilience is a concept loaded by its multidisciplinary context, and applying a narrow definition can be problematic. Resilience in healthcare systems research should accommodate myriad healthcare systems’ experiences, ranging from shocks such as infectious disease outbreaks and natural disasters to slow-burning challenges such as chronic diseases and rising healthcare costs. Furthermore, factors beyond the healthcare system should be understood – resilience within communities and other systems, including financial and socio-political systems, which influence and underpin how healthcare systems function (Haldane *et al.*, 2017).

Subsequently, Haldane *et al.* noted that 21st-century healthcare systems will face simultaneous challenges, and the concept of resilience must be dynamic enough to reflect the complexity and change inherent in diverse healthcare systems. A view of healthcare system resilience should be grounded in the understanding that each healthcare system is unique and influenced by context and circumstances. The meaning of resilience should then emerge from and be shaped by the context in which it is applied. The conceptualisation of resilience should therefore not be prescriptive, but have breadth and flexibility, recognise complexity, consider shocks and cumulative stresses, attempt to deal with disruptions, and anticipate future failures (Haldane *et al.*, 2017).

Researchers Biddle *et al.* emphasized that while substantial effort has gone into the conceptualization of healthcare system resilience, there has been no review of how the concept has been operationalized in empirical studies. The findings were synthesized using descriptive quantitative analysis and by mapping aims, findings, underlying concepts, and measurement approaches according to the resilience definition by Blanchet *et al.* (Biddle *et al.*, 2020, p. 1084). The researchers identified 71 empirical studies on healthcare system resilience from 2008 to 2019 (62% of studies published since 2017). Most studies addressed a specific crisis or challenge (82%), most notably infectious disease outbreaks (20%), natural disasters (15%), and climate change (11%). A large proportion of studies focused on service delivery (48%), while other health system building blocks were side-lined. Despite extensive theoretical work on the domains which constitute healthcare system resilience, the researchers found that most of the empirical literature only addressed particular aspects related to absorptive and adaptive capacities, with the legitimacy of institutions and transformative resilience seldom addressed. The review showed that the way in which resilience was applied in the empirical literature did not match its theoretical foundations. The researchers suggested that knowledge from both quantitative and qualitative research traditions should be integrated into a comprehensive assessment framework, and only then will the theoretical ‘resilience idea’ be able to prove its usefulness for the research community (Biddle *et al.*, 2020).

At the same time, Fridell *et al.* aimed to identify the descriptions and characteristics of healthcare system resilience, finding variation in how resilience was described and to what extent it was explained in the existing literature. The descriptions of healthcare system resilience primarily focused on major shocks. Leadership and governance were recognized as the most important building block for creating healthcare system resilience. Adjustments to long-term changes and the element of learning should be considered for a better understating of healthcare system resilience (Fridell *et al.*, 2020).

Fridell *et al.* compiled the characteristics of health system resilience within each of the WHO's six healthcare system building blocks (World Health Organization, 2007): leadership and governance, information, health workforce, financing, health technologies and service delivery. For instance, in the category "Leadership and Governance", which was recognized as the most important building block for creating healthcare system resilience, the following characteristics were identified: ethics, system capacity, engagement, operationalisation, and institutional design (Fridell *et al.*, 2020). However, the proposed indicators for each of the characteristics entail considerations of their measurability, for instance, "system capacity" means "predict disturbances, respond to diverse challenges and adjust the system if needed".

In a study from 2021, Saulnier *et al.* concluded that the concept of "healthcare system resilience" is relatively new in health policy and systems research and the existing research remains mostly theoretical. Previous research viewed resilience as an outcome that can be measured through performance outcomes, as an ability of CASs that is derived from dynamic behaviour and interactions, or as both. However, there is little congruence on the theory, and the existing frameworks have not been widely used, which has diluted the research applications for healthcare system resilience (Saulnier *et al.*, 2021).

In this context, initiatives like the Resilience in Healthcare programme provide a constructive basis for researching healthcare resilience indicators. In the framework of this programme, Lyng *et al.* have conducted a study with the overall aim of providing empirical and analytical indicators and different learning tools for resilience in healthcare across contextual settings and levels. The exploratory phase has focused on screening, synthesising, and validating results from existing empirical projects covering a variety of healthcare settings. The researchers emphasised that indicator development is not a straightforward matter, due to the difficulty in operationalizing different resilience concepts, the desire to avoid context specificity, and a lack of empirical investigations to test theoretical frameworks; however, identifying leading indicators for resilience is nonetheless important (Lyng *et al.*, 2022).

The complex adaptive system (CAS) approach's relevance to the healthcare system

The CAS approach is a variation of traditional systems theory that has emerged in the natural science fields of ecology and biology aimed at explaining non-linear adaptation on micro and macro scales in the natural environment (Coetzee *et al.*, 2016). Sociologist Walter Frederick Buckley was among the first to apply the term "complex adaptive system" based on complexity theory in which a collective behaviour and self-organizing patterns emerge as a result of a large number of interactions among components within a system and among system components and their environment (Bentley and Anandhi, 2020). There is some disagreement on all aspects and definitions in the CAS field, including the concepts of complexity, agents, adaptation, feedback, emergence, and self-organization (Carmichael and Hadžikadić, 2019). The CAS's features have been defined by various authors, and one of the more prominent authors, John Holland, in his book *Hidden Order: How Adaptation Builds Complexity* (1995), identified the following features: aggregation, nonlinearity, flows, diversity, tagging, internal models, building blocks (Preiser *et al.*, 2018). In healthcare-related literature, the following core elements of a CAS have been mentioned: multiple agents with schemata (features: informal, collaborative networks of individuals that partner and contribute to solution-making), self-organising networks (features: holistic patterns formed through interactions), coevolution (features: innovative pathways of governance emerge – a variety of what is known as "emergent behaviour" in a CAS), and system adaptation (features: networks represent additions to hierarchies) (Ellis and Herbert, 2011).

One of the leading researchers of CASs, William B. Rouse, declared that the best way to approach the management of a CAS is with organizational behaviours that differ from the usual behaviours, such as adopting a human-centred perspective that addresses the abilities, limitations, and inclinations of all stakeholders (Rouse, 2008). A comparison of the traditional system and the CAS, according to Rouse (2008) and the updated version ten years later (Sturmberg and Bircher, 2019), highlighted the potential changes in priorities (Table 1).

Table 1

Comparison of the traditional system and complex adaptive system, in light of organizational behaviours and governance (Rouse, 2008; Sturmberg and Bircher, 2019)

	(Rouse, 2008)		(Sturmberg and Bircher, 2019)	
	Comparison of organizational behaviours		Comparison of governance in traditional and complex organizations (adapted from Rouse, 2008)	
	Traditional system	Complex adaptive system	Traditional organizational system	Complex adaptive organizational system
Roles	Management	Leadership	Management	Leadership
Methods	Command and control	Incentives and inhibitions		
Motivation			Command and control	Sense, purpose and norms
Measurement	Activities	Outcomes	Activities	Outcomes
Focus	Efficiency	Agility	Efficiency	Problem-orientation
Relationships	Contractual	Personal commitments	Contractual	Personal commitments
Network	Hierarchy	Heterarchy		
Organization			Hierarchy	Heterarchy
Design	Organizational design	Self-organization	Top-down organization	Bottom-up self-organization

The most remarkable shifts are observed in network, organization and design. Rouse mentioned hierarchy and heterarchy as the types of networks. At the same time, he emphasized that the success of traditional systems depends on being able to decompose and recompose the elements of the system and, most importantly, on someone or some entity having the authority and resources to design the system. However, not all system design and management problems can be addressed through hierarchical decomposition. For example, decomposition may result in the loss of important information about interactions among the phenomena of interest. Another fundamental problem for very complex systems like healthcare is that no one is “in charge”, and no one has the authority or resources to design the system. Rouse noted that hierarchical decomposition does not work for a CAS, and it tends to have design and management limitations (Rouse, 2008). Rouse’s

statements seem logical and reasonable but are rarely found in practical healthcare organizations, as the tendency to strictly regulate, control, design and hierarchically manage the healthcare system prevails.

In high-income countries, healthcare systems generally are organized top-down. This hierarchical structure goes from the health ministry all the way down to the youngest physicians, nurses and orderlies in hospitals or physician practices (Uvhagen *et al.*, 2018). Since all co-workers must contribute according to rules from above, it is assumed that such systems lose an important part of their intrinsic motivation and productivity. Another method of organizing healthcare would be bottom-up. Sturmberg and Bircher did not reject hierarchy by nature, assuming that a CAS results in a hierarchical layering where higher layer suprasystems “constrain” the potential “bottom-up” emergent behaviour of lower layer subsystems, in accordance with Ellis’s comments on top-down causation and emergence (Sturmberg and Bircher, 2019; Ellis, 2012). Ellis identified five essentially different classes of top-down: algorithmic top-down causation, top-down causation via non-adaptive information control, top-down causation via adaptive selection, top-down causation via adaptive information control and intelligent top-down causation (the effect of the human mind on the physical world). Ellis noted that understanding top-down causation can have important effects on society – in particular, medical/healthcare issues and education; in both cases, an ongoing battle between bottom-up and top-down approaches has important consequences for society (Ellis, 2012).

Sturmberg and Bircher proposed a conceptual model of the implications of bottom-up leadership on the function of healthcare systems. The effects of the top-down policy-driven approach on healthcare delivery demonstrate the ever-decreasing size of the inner circles from one organizational level to the next where each level further constrains what the next lower level can achieve – the top-down leadership’s constraints minimize bottom-up feedback. The bottom-up approach emphasizes the open and adaptive nature of entities at each level – all focused on the system’s overall goal. Every higher-level circle emerges as a result of various interactions (arrows) at a lower level, resulting in the variance of characteristics and behaviours that depend on unique local circumstances. While each level shows variability in its components, each level component is the best adapted version of this level in its unique environment, and each does uniquely contribute to the achievement of the overall policy goals and settings – leadership minimizes constraints and encourages constant feedback across all levels of the system (Sturmberg and Bircher, 2019). In practice, these two approaches reflect the tension in leadership between trust (minimize constraints, maximize contextual adaptation) and distrust (maximize constraints, minimize variability).

Additionally, Sturmberg and Bircher defined healthcare systems as “organizational systems”; thus, they are socially constructed. An organizational CAS emerges based on purpose, goal and value propositions that give rise to its operating principles or driver. Besides health professionals and support workers, a health system’s agents also include – amongst others – politicians, administrators, pharmaceutical organizations, device makers and insurance companies (Sturmberg and Bircher, 2019). Researchers have proposed models to demonstrate healthcare’s interaction with other systems; for instance, Ruiz *et al.* expanded the chronic care model, which highlights self-management support arising from the healthcare system, combined with the social-ecological model, which recognizes the multiple levels of influence (individual, healthcare system, community, policy, media) (Ruiz *et al.*, 2014). These findings demonstrate the complexity of the healthcare system and its internal and external interaction in a dynamic continuous process.

Getting back to networks, the contemporary assumption is to use complexity and network concepts to inform healthcare knowledge translation (KT). Kitson *et al.* argued that many representations of the movement of healthcare knowledge through society exist, and multiple models for

the translation of evidence into policy and practice have been articulated. The researchers proposed that knowledge translation (KT) is a complex network composed of five interdependent sub-networks that interact dynamically in different ways at different times across one or more sectors (for example, community, health, government, education, research). They called this the KT Complexity Network, defined as a network that optimises the effective, appropriate and timely creation and movement of knowledge to those who need it in order to improve what they do. Activation within and throughout any one of these processes and systems depends on the agents promoting the change, successfully working across and between multiple systems and clusters (Kitson *et al.*, 2018). KT substantially impacts the communication between layers of a system, as mentioned by Bentley and Anandhi, and in complex systems, policy and decision-making strategies are understood only partially, but they can be improved as knowledge and understanding improves (Bentley and Anandhi, 2020).

Simultaneously, some authors, as mentioned by Kuziemsky, have noted that studies on CASs in healthcare have ranged from empirical to rhetorical, and there is a lack of methodological guidance for using the CAS approach to inform decision-making. Applying the CAS approach to healthcare requires a balance between understanding complexity and designing formal approaches to represent it. Kuziemsky proposed developing a system model to guide formal decision modelling approaches in complex healthcare settings. The researcher noted that healthcare processes have varying degrees of complexity, and system understanding should be done as a precursor to all decision-making to understand the inter- and intra-complexities of the processes, no matter how large or small, to mitigate unintended consequences (Kuziemsky, 2016).

According to Martin, despite the flurry of interest in complex systems and non-linear dynamics in recent decades, the application of knowledge and innovation regarding complexity and adaptation in systems for healthcare has been slow. Critics typically state that there is no evidence that applying the CAS approach and complexity science is needed for work in the real world of healthcare systems. However, a growth in applications of CAS thinking in health research has been observed since 2000, and since 2018, the indicator of more than 300 publications per year has been achieved on PubMed (Martin, 2018). The CAS approach is being investigated in various domains of healthcare, such as healthcare teams as CASs (Pype *et al.*, 2018), primary healthcare (Phillips *et al.*, 2017), hospital healthcare (Glover *et al.*, 2020), palliative care (Hodiamont *et al.*, 2019), and more specific areas of healthcare.

Researchers also propose discussing health and healthcare opportunities from a complexity science perspective, which supports the elucidation of the essence of health processes. It provides a unique perspective on health with a focus on the relationships within networks of dynamically interacting factors and the emergence of health out of the organization of those relationships. Complexity science offers various theories and methods to capture the path toward unhealthy and healthy states, facilitating the development of a dynamic integrated biopsychosocial perspective on health. Such models are essential for aligning and reconnecting the many institutions and disciplines involved in the healthcare sector and evolving toward an integrated healthcare ecosystem (van Wietmarschen *et al.*, 2018).

CONCLUSIONS AND RECOMMENDATIONS

1. The concept of resilience was introduced to the healthcare systems literature from the ecological sciences through an increased understanding of healthcare systems as complex adaptive systems. In this context, the idea of resilience can act as a useful tool to understand healthcare system dynamics. The ecological idea that strategies to enhance resilience can

be based on absorptive, adaptive or transformative domains depending on the impact and intensity of the crisis has been particularly impactful in the healthcare system resilience discourse.

2. More active research on the healthcare system's resilience has been observed since 2017. In the pre-COVID-19 period, empirical studies on infectious disease outbreaks, as a causal factor inducing the necessity of resilience, accounted for a small part of empirical studies. The present data may demonstrate a significant increase in this domain and reinforce the importance of a contextual framework. The results of this research identified the lack of scientific information on practical measuring of resilience domains and indicators, and this obstacle indicates the need for further research.
3. Simultaneously, the perception of the nature of the healthcare system in the context of systems theory, viewing it as a complex, dynamic part of the socio-economic system, operated in circumstances of high uncertainty, could strengthen future research. Measuring the resilience of a changing system is a significant methodological challenge, and presumably the shift of approach from fragmentation to a holistic ecosystem scope could be considered.
4. Assuming the healthcare system to be a CAS provides additional opportunities for understanding a healthcare system's functioning, governance and decision-making. A CAS contains a multitude of characteristics and elements that could assist in attaining a more nuanced understanding of healthcare system resilience. Significantly, the inherent characteristics of a CAS, such as flexibility and an adaptive nature, which seem to undermine the stability of the system, actually create the core of this system's resilience, and these aspects merit increased attention.
5. The research hypotheses were confirmed by revealing that: the increasing relevance of the concept of resilience has been reflected in policy planning documents and observed in the scientific literature; there are determining elements that characterise the interrelationship between the domains of the healthcare system and the concept of resilience; the contextual framework plays a role in creating an awareness of the concept of resilience in healthcare. Within its scope, this research was able to provide insight into healthcare system resilience issues, and further research could be devoted to the investigation of healthcare system resilience in the context of healthcare system reforms.

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REFERENCES

1. Barasa, E. W., Cloete, K. and Gilson, L. (2017), “From bouncing back, to nurturing emergence: reframing the concept of resilience in health systems strengthening”, *Health Policy and Planning*, Vol. 32, pp. 91-94, doi: 10.1093/heapol/czx118.
2. Bentley, C., Anandhi, A. (2020), “Representing driver-response complexity in ecosystems using an improved conceptual model”, *Ecological Modelling*, Vol. 437, doi: 10.1016/j.ecolmodel.2020.109320.
3. Biddle, L., Wahedi, K. and Bozorgmehr, K. (2020), “Health system resilience: a literature review of empirical research”, *Health Policy and Planning*, Vol. 35, No. 8, pp. 1084-1109, doi: 10.1093/heapol/czaa032.
4. Blanchet, K., Nam, S., Ramalingam, B. and Pozo-Martin, F. (2017), “Governance and Capacity to Manage Resilience of Health Systems: Towards a New Conceptual Framework”, *International Journal of Health Policy and Management*, Vol. 6, No. 8, pp. 431-435, doi: 10.15171/ijhpm.2017.36.
5. Carmichael, T., Hadžikadić, M. (2019), “The Fundamentals of Complex Adaptive Systems”, in Carmichael, T., Collins, A. and Hadžikadić, M. (Eds.), *Complex Adaptive Systems. Understanding Complex Systems*, Springer, Cham, doi: 10.1007/978-3-030-20309-2_1.
6. Coetzee, C., Van Niekerk, D. and Raju, E. (2016), “Disaster resilience and complex adaptive systems theory: Finding common grounds for risk reduction”, *Disaster Prevention and Management*, Vol. 25, No. 2, pp. 196-211, doi: 10.1108/DPM-07-2015-0153.
7. Ellis, B., Herbert, S. I. (2011), “Complex adaptive systems (CAS): an overview of key elements, characteristics and application to management theory”, *Informatics in Primary Care*, Vol. 19, No. 1, pp. 33-37. doi: 10.14236/jhi.v19i1.791.
8. Ellis, G. F. (2012), “Top-down causation and emergence: some comments on mechanisms”, *Interface Focus*, Vol. 2, No. 1, pp. 126-140, doi: 10.1098/rsfs.2011.0062.
9. Fridell, M., Edwin, S., von Schreeb, J. and Saulnier, D. (2020), “Health System Resilience: What Are We Talking About? A Scoping Review Mapping Characteristics and Keywords”, *International Journal of Health Policy and Management*, Vol. 9, No. 1, pp. 6-16, doi: 10.15171/ijhpm.2019.71.
10. Glover, W. J., Nissinboim, N. and Naveh, E. (2020), “Examining innovation in hospital units: A complex adaptive systems approach”, *BMC Health Services Research*, Vol. 20, pp. 1-12, doi: 10.1186/s12913-020-05403-2.
11. Haldane, V., Ong, S. E., Chuah, F. L. and Legido-Quigley, H. (2017), “Health systems resilience: meaningful construct or catchphrase?”, *The Lancet*, Vol. 389, No. 10078, doi: 10.1016/S0140-6736(17)30946-7.
12. Hodiamont, F., Jünger, S., Leidl, R., Bernd, O. M., Schildmann, E. and Bausewein, C. (2019), “Understanding complexity – the palliative care situation as a complex adaptive system”, *BMC Health Services Research*, Vol. 19, doi: 10.1186/s12913-019-3961-0.

13. Kieny, M. P., Evans, D. B., Schmets, G. and Kadandale, S. (2014), "Health-system resilience: reflections on the Ebola crisis in western Africa", *Bulletin of the World Health Organization*, Vol. 92, No. 12, p. 850, doi: 10.2471/BLT.14.149278.
14. Kitson, A., Brook, A., Harvey, G., Jordan, Z., Marshall, R., O'Shea, R. and Wilson, D. (2018), "Using Complexity and Network Concepts to Inform Healthcare Knowledge Translation", *International Journal of Health Policy and Management*, Vol. 7, No. 3, pp. 231-243, doi: 10.15171/ijhpm.2017.79.
15. Kuziemy, C. (2016), "Decision-making in healthcare as a complex adaptive system", *Healthcare Management Forum*, Vol. 29, No. 1, pp. 4-7, doi: 10.1177/0840470415614842.
16. Lebel, L., Anderies, J. M., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T. P. and Wilson, J. (2006), "Governance and the capacity to manage resilience in regional social-ecological systems", *Ecology and Society*, Vol. 11, No. 1, Art. 19, available at: <http://www.ecologyandsociety.org/vol11/iss1/art19>.
17. Lyng, H. B., Macrae, C., Guise, V., Haraldseid-Driftland, C., Fagerdal, B., Schibeveag, L. and Wiig, S. (2022), "Capacities for resilience in healthcare; a qualitative study across different healthcare contexts", *BMC Health Services Research*, Vol. 22, Art. 474, doi: 10.1186/s12913-022-07887-6.
18. Martin, C. M. (2018), "Complex adaptive systems approaches in health care – A slow but real emergence?", *Journal of Evaluation in Clinical Practice*, Vol. 24, No. 1, pp. 266-268, doi: 10.1111/jep.12878.
19. Phillips, C., Hall, S., Elmitt, N., Bookallil, M. and Douglas, K. (2017), "People-centred integration in a refugee primary care service: Managing community care", *Journal of Integrated Care*, Vol. 25, No. 1, pp. 26-38, doi: 10.1108/JICA-10-2016-0040.
20. Preiser, R., Biggs, R., De Vos, A. and Folke, C. (2018), "Social-ecological systems as complex adaptive systems: organizing principles for advancing research methods and approaches", *Ecology and Society*, Vol. 23, No. 4, Art. 46, doi: 10.5751/ES-10558-230446.
21. Pype, P., Mertens, F., Helewaut, F. and Krystallidou, D. (2018), "Healthcare teams as complex adaptive systems: Understanding team behaviour through team members' perception of interpersonal interaction", *BMC Health Services Research*, Vol. 18, doi: 10.1186/s12913-018-3392-3.
22. Rouse, W. B. (2008), "Health Care as a Complex Adaptive System: Implications for Design and Management", *The Bridge Linking Engineering and Society*, Vol. 38 (Healthcare), pp. 17-25.
23. Ruiz, S., Brady, T. J., Glasgow, R. E., Birkel, R. and Spafford, M. (2014), "Chronic Condition Self-Management Surveillance: What Is and What Should Be Measured?", *Preventing Chronic Disease*, Vol. 11, doi: 10.5888/pcd11.130328.
24. Saulnier, D. D., Blanchet, K., Canila, C., Cobos Muñoz, D., Dal Zennaro, L., de Savigny, D., Durski, K. N., Garcia, F., Grimm, P. Y., Kwamie, A., Maceira, D., Marten, R., Peytremann-Bridevaux, I., Poroës, C., Ridde, V., Seematter, L., Stern, B., Suarez, P., Teddy, G., Wernli, D., Wyss, K. and Tediosi, F. (2021), "A health systems resilience research

- agenda: moving from concept to practice”, *BMJ Global Health*, Vol. 6, No. 8, doi: 10.1136/bmjgh-2021-006779.
25. Sturmberg, J. P., Bircher, J. (2019), “Better and fulfilling healthcare at lower costs: The need to manage health systems as complex adaptive systems” [version 1; peer review: 2 approved], *F1000Research*, Vol. 8, Art. 789, doi: 10.12688/f1000research.19414.1.
 26. United Nations General Assembly (2016), Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction (document A/71/644). Note by the Secretary-General, United Nations, New York, available at: https://www.preventionweb.net/files/50683_oiewgreportenglish.pdf (accessed 16 July 2022).
 27. Uvhagen, H., Hasson, H., Hansson, J. and von Knorring, M. (2018), “Leading top-down implementation processes: a qualitative study on the role of managers”, *BMC Health Services Research*, Vol. 18, No. 1, Art. 562, doi: 10.1186/s12913-018-3360-y.
 28. Van Wietmarschen, H. A., Wortelboer, H. M. and van der Greef, J. (2018), “Grip on health: A complex systems approach to transform health care”, *Journal of Evaluation in Clinical Practice*, Vol. 24, No. 1, pp. 269-277, doi: 10.1111/jep.12679.
 29. World Health Organisation (2007), *Everybody’s Business: Strengthening Health Systems to Improve Health Outcomes: WHO’s Framework for Action*, World Health Organisation, Geneva, available at: <https://www.who.int/publications/i/item/everybody-s-business---strengthening-health-systems-to-improve-health-outcomes> (accessed 16 July 2022).
 30. World Health Organization (2021), *Building health systems resilience for universal health coverage and health security during the COVID-19 pandemic and beyond: WHO position paper*, World Health Organization, Geneva, available at: <https://www.who.int/publications/i/item/WHO-UHL-PHC-SP-2021.01> (accessed 16 July 2022).