PAN AMERICAN JOURNAL OF PUBLIC HEALTH 100 YEARS

Original research

A framework to assess potential health system resilience using fuzzy logic

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Suggested citation Jatobá A; de Castro Nunes P; de Carvalho PVR. A framework to assess potential health system resilience using fuzzy logic. Rev Panam Salud Publica. 2023;47:e73. https://doi.org/10.26633/RPSP.2023.73

ABSTRACT

Objectives. To develop and test a framework to assess the potential of public health systems to maintain a resilient performance.

Methods. Quantitative data from public databases and qualitative data from technical reports of Brazilian health authorities were used to develop the framework which was assessed and modified by experts. Fuzzy logic was used for the mathematical model to determine scores for four resilient abilities – monitoring, anticipation, learning, and response – and an aggregated coefficient of resilient potential in health care. The coefficient measures used data from before the coronavirus disease 2019 (COVID-19) pandemic. These were compared with measures of the actual performance of health systems in 10 cities in Brazil during the pandemic.

Results. The coefficient of resilient potential in health care showed that the cities most affected by COVID-19 had lower potential for resilient performance before the pandemic. Some local health systems had adequate response capabilities, but other abilities were not well developed, which adversely affected the management of the spread of COVID-19.

Conclusions. The coefficient of resilient potential in health care is useful to indicate important areas for resilient performance and the different types of resilience capacities that can be considered in different contexts and levels of public health systems. Regular assessment of the potential of health systems for resilient performance would help highlight opportunities for continuous improvement in health system functions during chronic stress situations, which could strengthen their ability to keep functioning in the face of sudden disturbances.

Keywords Management indicators; indicators of health services; risk management; disaster preparedness.

Although unexpected events create disturbances, health systems can increase their resilience to maintain adequate functioning during extraordinary events. The most recent challenge to the resilience of health systems has been the coronavirus disease 2019 (COVID-19) pandemic which pushed health systems worldwide to their limits and showed that they were unprepared and unable to tackle the rapid spread of a disease.

In Latin America, one of the most visible effects of the struggle of health systems to remain resilient in the face of the pandemic was the suspension of several regular services, such as elective surgeries, outpatient appointments, and routine vaccination; these suspensions may have consequences for years to come (1–3). Although some services can be delayed during an emergency, interruption of other urgent services may have long-term negative effects.

While resilience is a core concept in disaster risk reduction, its application to health systems is relatively new, although recent studies on related aspects, such as preparedness, strength, and responsiveness, have been done (4–7). Building a resilient health system means more than ensuring safety, strength, or preparedness: resilience relies on the system's ability to adjust before, during, or after an unexpected event while continuing to deliver regular, good-quality health services (8, 9).

The recent COVID-19 pandemic is the latest example of how health systems in the Americas have been challenged

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over the past several years. Health systems in the region have long been affected by growing disparities in political, social, and economic determinants of health, leaving large numbers of people outside the scope of public health services. The many casualties of COVID-19 in the Americas highlight the persistence of vulnerabilities within the region, especially to hazards associated with socioeconomic and environmental changes (10). Thus, it is imperative that health systems in Latin America become better prepared to respond to the challenges posed by emerging health problems and their determinants.

The resilience of health systems, however, is complex and cannot be represented solely by objective measures. Instead, it is important to know whether the system has the potential (or the ability) to be resilient when a disturbance occurs, in terms of both its structure – usually measured in quantitative and objective terms – and how its structure operates – a more subjective measure.

Thus, the objective of this study was to develop a new framework to assess the potential resilience of health systems, combining both objective and subjective functional aspects to calculate a coefficient of resilient potential in health care (CoReS) based on typical resilient abilities, namely anticipation, monitoring, response, and learning.

In addition, to show this framework in use, a case study in 10 cities in Brazil was conducted using the framework. The calculated CoReS were then compared with the actual performance of the cities in managing the pandemic.

METHODS

Study design

The study used a mixed methods cross-sectional design to develop a framework to assess the potential resilience of public health systems. Quantitative public data were obtained from the databases of the Brazilian Ministry of Health and the local health departments of selected cities. Qualitative data were obtained from official technical reports.

Literature review for the initial framework

The research team reviewed recent scientific and gray literature and developed an initial list of health system performance indicators organized according to the four cornerstones of resilient performance and the CoReS calculation rationale. The cornerstones are anticipation, monitoring, response, and learning. They have been used extensively to operationalize resilience, that is, to highlight the elements that enhance resilient behavior, making it possible to mobilize resources to strengthen these elements, and improve the rationality of the analysis of the system's behavior (11).

Each of the four cornerstones for resilient performance is described using several indicators, some objective (quantitative) and others subjective (qualitative). In complex systems such as health care systems, especially in universal and public systems such as the Brazilian Unified Health System, the important literature indicates the need to aggregate existing global indicators with the qualitative evaluation of care actions, because in much of the recent research, the indicators have been based on the opinion of major stakeholders (12–14).

Validating the proposed framework

This stage aimed to correct any remaining biases made by the authors in the initial selection of indicators and their correlation with the cornerstones of resilience. In addition, the essential characteristics of each indicator were described, including nature (qualitative or quantitative), evaluation parameters (value ranges and weights), and data collection procedures.

The proposed framework was presented to a panel of five experts in a focus group. The experts were recruited according to the following criteria: (i) academics in the field of health management with at least one published article that mentions management indicators in the title, abstract, or keywords; and (ii) health professionals who had co-authored at least one published article that mentions management indicators in the title, abstract, or keywords (Table 1).

The validation followed the typical procedures of focus groups, lasted about 2 hours, and was moderated by the study authors. None of the moderators had any relationship – personal or professional – with the experts.

In the first 30 minutes of the focus group discussion, the moderators explained the definitions of the four cornerstones of resilience and presented the indicators selected for each cornerstone, including evaluation of the indicators (range and weight). The experts had 20 minutes to work on modifications to the proposal, and each expert had 10 minutes to present their suggestions. In the next 30 minutes, the experts debated the suggestions and worked to reach a consensus on the framework indicators for each cornerstone and evaluation parameter. The final 30 minutes were used for discussions, explanation of the next stage, and recording of decisions.

Populating the framework and calculating CoReS

The experts were given technical reports on the management actions of the selected cities and a questionnaire with qualitative indicators. They had 48 hours to read the material and return the completed questionnaire to the moderators. At the same time, the research team collected quantitative data according to the procedures, data sources, and variables defined in the framework.

Fuzzy logic was chosen as the theoretical background for the mathematical model that calculates the coefficient of resilience by aggregating indicators. Fuzzy logic was selected because it is a useful way to rationalize situations in which different phenomena and imprecise or subjective criteria must be combined with objective assessments. It allows a definition of sets of values that represent dynamic behavior and, through arithmetic functions, a measurement of the level of membership of a given value within existing sets, that is, the degree of similarity between a specific data value and the standard values of its set. A value can have different memberships in multiple sets. Thus, resilience potential can be indicated fluidly and trends toward great or low resilience potential can be identified according to the levels of membership of the given values in different predefined sets.

An important step in the use of resilience indicators is the selection of the level of measurements (categorical or numerical/ordinal) that are used in an evaluation, namely, how the indicators are populated since ordinal scales offer limited representation. Thus, resilience assessment judges which attributes

TABLE 1. Profiles of the members of the expert panel

Specialist	Sex	Profile
S1	Female	BSc in public health, MSc in public health, PhD in health policy planning and management. She has worked as a lecturer in public health for undergraduate medical courses. She currently collaborates on the development of public health research for the Brazilian Unified Health System. Her areas of research are: dimensions of health practices; health care; care coordination; health care work; health law; health education; health management; and evaluation of health policies and programs.
S2	Male	Ergonomist, MSc in public health, PhD in systems design engineering. In the past 8 years, he has been working as a manager and researcher on projects on health care, resilient health care, and primary health care. He currently collaborates on the development of public health research for the Brazilian Unified Health System.
S3	Male	BSc, MSc, and PhD in systems design engineering. He has experience in research and development of projects in the field of health care (primary care, outpatient regulation, drug therapy management, and emergency networks).
S4	Male	Physician, MSc and PhD in public health. He was the head of a public health monitoring and evaluation department. Currently he works as a manager for a municipal health department and collaborates on research on resilience of public health systems.
S5	Female	Physician (obstetrician), MSc and PhD in public health. She has worked as both an obstetrician and family physician in primary care clinics. Currently she works for a municipal health department as a health data analyst and collaborates on research on public health.

Source: prepared by the authors.

empower or hinder the capacity to adapt to the unexpected. It is therefore necessary to validate a reference base (prioritization of indicators) for the results so as to determine an improvement or worsening of potential resilience.

The prioritization of resilience indicators usually follows perceptions, knowledge, and subjective evaluations of experts. Since perceptions and opinions are expressed in subjective terms, fuzzy logic has been increasingly accepted as a tool to represent human knowledge, map qualitative models of decision-making, and express flexible reasoning. The fuzzy logic theory provides a discrete mathematical structure in which a conceptually vague phenomenon can be accurately represented (15).

The following steps were used in this study: (i) fill each indicator (quantitative with numerical values and qualitative with the Likert-like scale); (ii) calculate the level of membership of values ($A(x)$); (iii) aggregate indicators for each function (anticipation, monitoring, response, and learning); and (iv) aggregate functions to obtain the potential of health systems to have a resilient performance (CoReS).

The calculation of membership levels ($A(x)$) was done by means of the general membership function for trapezoidal fuzzy sets (16) shown in Figure 1, where x *is* a given value and a, b, c, and d are coordinates of a fuzzy set. As an example, in Figure 1, the membership level of the α value in a trapezoidal set is shown in red. The membership determines whether an indicator is low, between low and regular, regular, between regular and high, high, between high and very high, or very high according to the set in which the given value has a high membership. Qualitative variables receive non-numeric values according to the Likert-like scale.

The third step determines the individual potential of each resilient skill by aggregating the respective indicators. There are several methods for aggregating fuzzy values such as mean, median, maximization, minimization, or mixed operators. In this study, the fuzzy mean aggregation method was used as it is the most popular and simplest method.

In the fourth step, the calculated potentials of each of the four resilient skills were also aggregated through the fuzzy mean method. Then, the fuzzy value obtained was converted into a single (or crisp) value in a process called "defuzzification" using the centroid method. This process gave the CoReS. Calculations for this study were made using the *jFuzzyLogic* software (17).

Testing CoReS results

The research team compared the calculated CoReS values with the actual performance of the selected cities in tackling the COVID-19 pandemic.

The measure of performance in coping with the pandemic was determined using the pandemic efficacy index (18). Thus, data to support the calculations of the CoReS refer to the first quarter of 2020, while the pandemic efficacy index refers to April 2022.

The pandemic efficacy index is based on the difference between the number of deaths caused by COVID-19 and the number of expected deaths calculated according to characteristics such as size, population profile, and health structure of each city. For this study, Brazilian cities with high and low pandemic efficacy indexes were selected as shown in Table 2. Table 2 also shows the corresponding socioeconomic data.

Ethics

The study was approved by the institutional review board of the Oswaldo Cruz Institute and followed all ethics guidelines regarding research with human subjects. All the experts in the qualitative data collection (Table 1) signed informed consent forms. According to Brazilian regulations on research ethics, all data collected from human participants must be kept anonymous and stored at a safe location and destroyed after 5 years of the date of its collection.

This article was written according to the STROBE (19) recommendations for reporting observational studies.

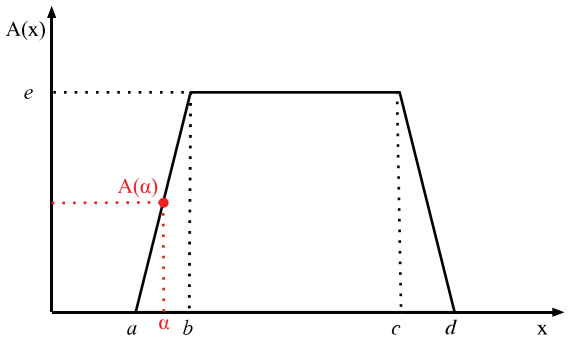
RESULTS

Final framework

The indicators and data collection and analysis procedures are summarized in Table A1 (supplementary material). For the quantitative indicators, the table also gives the data sources and variables obtained from the public databases of the Department of Informatics of the Brazilian Unified Health System and from the information systems of local health departments of the selected cities.

FIGURE 1. Analytical representation of the membership level of fuzzy set elements and graphical presentation of a fuzzy trapezoidal set

$$A(x) = \begin{cases} \dfrac{(a - x)\, e}{a - b}, & \text{when } a \le x \le b \\ e, & \text{when } b \le x \le c \\ \dfrac{(d - x)\, e}{d - c}, & \text{when } c \le x \le d \\ 0, & \text{otherwise} \end{cases}$$



Note: *x is* a given value, a, b, c, and d are coordinates of a fuzzy set, and e is the maximum membership degree of the set. The red line shows the membership level of α.
Source: prepared by the authors.

TABLE 2. Characterization of the selected Brazilian cities

City	Pandemic efficacy index	Population	Human Development Index	Infant mortality rate[a]	Gross domestic product per capita in US$[b]
Florianopolis	0.831	516 524	0.847	5.38	8 768.51
Sao Paulo	0.786	12 396 372	0.805	11.21	12 468.24
Palmas	0.749	313 349	0.788	11.53	6 986.73
Belo Horizonte	0.748	2 530 701	0.810	10.49	7 739.06
Curitiba	0.715	1 963 726	0.823	6.50	9 941.33
Cuiabá	0.568	623 614	0.785	10.76	8 039.82
Manaus	0.574	2 255 903	0.737	13.81	7 776.15
Porto Velho	0.575	548 952	0.736	13.04	6 765.09
João Pessoa	0.580	825 796	0.763	12.65	5 153.62
Rio de Janeiro	0.595	6 775 561	0.799	12.15	10 566.65

[a] Deaths in children younger than 1 year per 1000 live births, caused by communicable diseases.
[b] Based on exchange rate of April 2, 2022.
Source: Brazilian Institute of Geography and Statistics; 2022.

The experts discussed at length the weights of each criterion but decided not to assign different weights in the first version of the framework. Thus, this first version gave the same weight to all indicators, although the possibility of using different weights in future applications was allowed for. To simplify the framework, collinearity between the selected indicators was evaluated. This assessment resulted in primary care indicators being summarized in a synthetic index (see the seven indicators in Table A1, supplementary material).

CoReS calculations

The calculations of CoReS for the 10 selected cities are shown in Table A2 (supplementary material). Each indicator had its membership calculated to determine whether the value corresponded to insufficient, sufficient, high, too high, or some intermediate value in between. For example, in the city of Belo Horizonte, the indicator "percentage of diabetics with glycated hemoglobin …", in the anticipating ability, had a value of 22%. In calculating *A(x)*, this value resulted in high membership between the fuzzy sets "insufficient" and "sufficient."

The indicators for each ability, both qualitative and quantitative, were aggregated. For example, Florianopolis had for their abilities of anticipation, learning, monitoring and response, the fuzzy aggregated values (0.1, 0.1, 0.3, 0.4), (0.5, 0.6, 0.7, 0.7), (0.3, 0.3, 0.5, 0.5), and (0.2, 0.3, 0.4, 0.5), respectively (Table A2, supplementary material). These numbers were also aggregated and converted to crisp numbers to determine the CoReS. Table 3 shows the results of the fourth and final stage of the analysis with the CoReS. The closer the CoReS is to 1.0, the greater the potential of the health system to be resilient.

Testing CoReS against the COVID-19 response

São Paulo and Rio de Janeiro, which are two of the most populous, high-income cities in Brazil, had low CoReS. Palmas and Belo Horizonte had the highest CoReS (and pandemic efficacy index). These latter two cities strongly supported and sustained social distancing in addition to encouraging social and economic protection measures during the pandemic.

Manaus had the lowest CoReS (0.37) and the second lowest pandemic efficacy index (0.574), very close to that of Cuiabá (0.568). The local health system in Manaus collapsed in early 2021 because of a lack of basic resources such as oxygen for intensive care and inpatient beds, and harmful working conditions for health workers (20, 21).

São Paulo responded quickly to the pandemic, instigating quarantine, closing schools, and encouraging social distancing

TABLE 3. Coefficients of resilient potential in health care (CoReS) of the selected Brazilian cities

City	Anticipation	Learning	Monitoring	Response	CoReS
Belo Horizonte	0.4	0.65	0.6	0.73	0.82
Palmas	0.44	0.53	0.71	0.59	0.82
Curitiba	0.54	0.82	0.17	0.74	0.74
Florianopolis	0.26	0.9	0.55	0.49	0.74
Porto Velho	0.42	0.53	0.44	0.33	0.65
Cuiabá	0.47	0.65	0.17	0.51	0.62
João Pessoa	0.17	0.53	0.6	0.42	0.62
Sao Paulo	0.42	0.74	0.17	0.4	0.57
Rio de Janeiro	0.4	0.53	0.17	0.45	0.53
Manaus	0.64	0.17	0.17	0.26	0.37

Source: prepared by the authors from the results.

to prevent the spread of SARS-CoV-2. In addition, São Paulo manufactured the first vaccine in Brazil. Moreover, São Paulo and Rio de Janeiro had the highest number of physical resources. However, São Paulo struggled to tackle the spread of COVID-19, especially early in the outbreak.

In Rio de Janeiro, social distancing measures were barely implemented in the first year of the pandemic as there was a lack of consensus among authorities. At the same time, there was intense commercial pressure for a return of normal activities. Furthermore, the city lacked social protection policies for vulnerable populations. Rio de Janeiro experienced the peak of the epidemic between April and May 2021; and there was a quick and substantial increase in infection rates in June 2021, when the (already) weak social distancing measures started to relax (22).

DISCUSSION

The countries in Latin America, despite their great diversity, share many epidemiological, social, and economic burdens, which make them similarly prone to growing threats to the health of their populations. These threats include the emergence of infectious diseases, increase in noncommunicable diseases, aging, increase in mental illness, climate change disasters, and violence. Examples of infectious diseases threats are the H1N1 outbreak in 2009, the Chikungunya virus and Zika virus epidemics between 2013 and 2015, and the recurrent dengue and yellow fever surges in the region.

Moreover, limited access to health care services, combined with irregular migration due to humanitarian disasters, economic crises, drug trafficking, organized crime, armed conflicts, and violence, puts vulnerable populations at great risk of violence, abuse, and injuries besides exposure to diseases (10).

One of the most important issues for health system resilience is the continuity of collective care, especially at the primary care level. Thus, it is imperative that any assessment of resilient behavior includes indicators that reflect the performance of primary care and related activities, such as health surveillance, house calls, and promotion of health, developed at the community level.

This finding is corroborated by Giovanella et al., (23) who determined local and regional experiences in four aspects of primary care in the Brazilian Unified Health System in coping with COVID-19, namely: health surveillance in vulnerable locations; individual handling of confirmed and suspected cases of COVID-19; community support for vulnerable groups; and continuity of routine care. The authors highlighted performance limitations due to recent changes in the Brazilian Primary Care Policy, which affected the health surveillance model and funding, and introduced untrained multidisciplinary teams within the family health strategy.

It is worth noting that Brazil has significant disparities in primary care coverage. For example, while some cities supposedly cover 100% of the population, others cover less than 10% despite the expansion of the family health strategy in previous decades. Moreover, Brazilian primary care databases refer to primary care clinics that have nurses, pediatricians, general practitioners, and/or gynecologists–obstetricians, and a broad population coverage, although this set up is not widely prevalent.

A significant increase in coverage of the family health strategy in Rio de Janeiro was reported between 2008 and 2013, from 3.5% to 41.0% (24, 25). In December 2016, this coverage reached 66%. However, due to a financial crisis and the then upcoming municipal elections, family health teams in Rio de Janeiro were reduced and primary care clinics were closed, while hospital expansion became a priority of the newly elected government. Therefore, the coverage of the family health strategy fell to 44.09% in January 2020 (26). As a result, the potential for resilient performance in Rio de Janeiro would be expected to be low because of this reduction in primary care coverage.

Given the situations explored, the results of the present study support the use of CoReS as a pre-pandemic assessment of resilience potential as it corresponds closely to the actual outcomes in the cities in tackling the pandemic. Moreover, the study enables a conceptual expansion of resilience in terms of potential and allows complex retrospective and prospective analyses of the everyday challenges of health systems.

The proposed framework enables coherent assessments of how the operating conditions of health systems promote resilience. Furthermore, it provides useful insights for the development of public health actions to attain a resilient performance in the face of growing challenges posed to health systems, especially in vulnerable and underprivileged areas such as Brazil and other countries in Latin America.

This study proposes that CoReS be a permanent measure of health systems resilience which can indicate opportunities for improvement in specific resilient abilities and give managers an aggregated measure of the strengths and weaknesses of the performance of the system. This concept of resilience that manifests through certain abilities focuses on what should be developed before, during, or after any disturbances so that a system can maintain its essential operations under normal or unforeseen conditions.

In this sense, research on health care resilience provides a theoretical perspective for an understanding of health systems as complex adaptive systems and highlights how health practices need to cope with, respond to, and adapt to stress, challenges, or demands according to their capabilities. In addition, the use of the concept of resilience has allowed the incorporation of new ideas into the health sector because resilience, from a theoretical perspective, is derived from different fields, such as safety, industrial systems, and natural disaster management.

This study has some limitations. First, limited public data on the structure and capabilities of health systems were available. Second, this research explored the potential of public health systems to show a resilient performance and did not include the provision of private health services in Brazil. Third, the qualitative stage of the study relied on the perceptions and opinions of the five experts recruited, whose profiles are described in Table 1.

Conclusions

The proposed framework addresses the different types of resilience capacities that can be considered for different contexts and levels of public health systems that have been experiencing adversity, such as in Latin America. Because most research on health care resilience has focused on shocks and crises, such as epidemics and natural disasters, this study highlights the importance of resilience for daily operations.

The CoReS was useful in indicating the areas that need to be developed to achieve a more resilient performance. It also showed the different types of resilience capacities that can be considered for different contexts and levels of public health systems in low- and middle-income countries in Latin American. Furthermore, ongoing assessment of resilience will provide continuous quality-of-care data since a system's ability to operate effectively in chronic stress situations can also strengthen its capacity to maintain a functioning system in the face of sudden disturbances.

Author contributions. AJ conceived the study, collected and analyzed the data, and was responsible for writing the manuscript. PCN and PVRC provided a theoretical background and assessed the results. All authors read and approved the final version of the manuscript.

Funding. AJ (grants #307029/2021-2, #402670/2021-3, and #E-26/201.252/2022) and PVRC (grants #304770/2020 and #260003/001186/2020) are partially funded by the National Council for Scientific and Technological Development and the Carlos Chagas Filho Foundation for Supporting Research in the State of Rio de Janeiro. PCN is partially funded by the Inova Fiocruz Program (grant #310815559697153).

Conflicts of interest. None declared.

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Manuscript received on 11 January 2023. Revised version accepted for publication on 17 January 2023.

Marco para evaluar la resiliencia potencial de un sistema de salud mediante la lógica difusa

RESUMEN

Objetivos. Elaborar y examinar un marco para evaluar el potencial de los sistemas de salud pública de mantener un desempeño resiliente.

Métodos. Para elaborar el marco, se emplearon datos cuantitativos de bases de datos públicas y datos cualitativos de informes técnicos de las autoridades de salud brasileñas. A continuación, este marco fue evaluado y modificado por expertos. Se utilizó la lógica difusa en el modelo matemático empleado para determinar la puntuación de cuatro capacidades resilientes (seguimiento, anticipación, aprendizaje y respuesta) y un coeficiente agregado de potencial resiliente en la atención médica. Para las medidas del coeficiente se emplearon datos previos a la pandemia de la enfermedad por el coronavirus del 2019 (COVID-19), que se compararon con las medidas del desempeño real de los sistemas de salud en diez ciudades de Brasil durante la pandemia.

Resultados. El coeficiente de potencial resiliente en la atención de salud indicó que las ciudades más afectadas por la COVID-19 presentaban un menor potencial de desempeño resiliente antes de la pandemia. En algunos sistemas de salud locales la capacidad de respuesta era adecuada pero otras capacidades no estaban suficientemente desarrolladas, lo que afectó de manera negativa el manejo de la propagación de la COVID-19.

Conclusiones. El coeficiente de potencial resiliente en la atención de salud es útil para indicar aspectos importantes del desempeño resiliente y los diferentes tipos de capacidades de resiliencia que pueden considerarse en diferentes contextos y niveles de los sistemas de salud pública. La evaluación periódica del potencial de los sistemas de salud para tener un desempeño resiliente ayudaría a poner de relieve las oportunidades de mejora continua de las funciones del sistema de salud en situaciones de estrés crónico, lo que podría fortalecer su capacidad para seguir funcionando frente a perturbaciones repentinas.

Palabras clave Indicadores de gestión; indicadores de servicios; gestión de riesgos; preparación ante desastres.

Estrutura de avaliação do potencial de resiliência dos sistemas de saúde utilizando a lógica fuzzy

RESUMO

Objetivos. Desenvolver e testar uma estrutura de avaliação do potencial dos sistemas de saúde pública de manter um desempenho resiliente.

Métodos. Dados quantitativos de bancos de dados públicos e dados qualitativos de relatórios técnicos das autoridades sanitárias brasileiras foram utilizados para desenvolver a estrutura, que foi avaliada e modificada por especialistas. A lógica fuzzy foi utilizada na criação de um modelo matemático para determinar a pontuação em quatro capacidades de resiliência (monitoramento, antecipação, aprendizagem e resposta) e um coeficiente agregado do potencial de resiliência na atenção à saúde. O coeficiente foi calculado utilizando dados anteriores à pandemia da doença provocada pelo coronavírus de 2019 (COVID-19). Esses dados foram comparados com medidas do desempenho real dos sistemas de saúde em 10 cidades brasileiras durante a pandemia.

Resultados. O coeficiente de potencial de resiliência na atenção à saúde revelou que as cidades mais afetadas pela COVID-19 tinham menor potencial de desempenho resiliente antes da pandemia. Alguns sistemas de saúde locais tinham capacidades de resposta adequadas, porém as outras capacidades não estavam bem desenvolvidas, o que prejudicou o gerenciamento da propagação da COVID-19.

Conclusões. O coeficiente de potencial de resiliência na atenção à saúde é útil para indicar áreas importantes para um desempenho resiliente e os vários tipos de capacidade de resiliência que podem ser considerados em diferentes contextos e níveis dos sistemas de saúde pública. Uma avaliação periódica do potencial de desempenho resiliente dos sistemas de saúde ajudaria a assinalar oportunidades para melhorias contínuas das funções desses sistemas durante situações de estresse crônico, o que poderia aumentar sua capacidade de continuar funcionando diante de perturbações repentinas.

Palavras-chave Indicadores de gestão; indicadores de serviços; gestão de riscos; preparação em desastres.