Global Health & Medicine. 2025; 7(3):189-198.
POLICY FORUM
DOI: 10.35772/ghm.2025.01046

Creation and use of an index of the emergency resilience of urban public health management in China

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Abstract: This article proposes a framework for emergency resilience based on a review of the literature and theoretical analysis. On this basis, the Delphi method and the Analytic Hierarchy Process have been used to create an index of the emergency resilience of urban public health management. This index includes 6 primary indicators, 22 secondary indicators, and 93 tertiary indicators. An evaluation using the created index indicated that Shanghai's public health emergency management scored 82 out of 100, which is generally a good score. However, there are still problems such as the lack of specificity and implementability in emergency plans, the lack of diversification of reserves of emergency supplies, the low degree of sharing emergency information and cooperation, failure to capitalize on the advantages of traditional Chinese medicine, and the shortage of public health personnel in local communities. Overall, the index of the emergency resilience of urban public health management as was created from the perspective of preventing and controlling major infectious diseases is scientific and reliable, and it can effectively evaluate the current state of emergency management in urban public health.

***Keywords*:** prevention and control of major infectious diseases, emergency resilience, public health emergency management, creation of an index

Introduction

When a public health emergency occurs, the healthcare system is the first line of defense against the crisis. Kieny *et al.* published "Beyond Ebola: a new agenda for resilient health systems" in the Lancet in January 2015, marking the beginning of systematic research based on healthcare system resilience (*1*). The World Health Organization defines disaster resilience as "the ability of a system, community, or society to resist, absorb, adapt, and quickly and effectively recover from disasters when exposed to danger, while maintaining the basic structure and functions of the system" (*2*). In today's society, responding to major public health emergencies is no longer an internal matter for the healthcare system. It requires close cooperation with and a joint response by the government, social organizations, and other stakeholders from the perspective of urban governance.

Therefore, this study proposes an emergency resilience framework based on a review of the literature and theoretical analysis from the perspective of an urban response to major public health emergencies, and it created an index of the emergency resilience of urban public health management in order to provide a reference to improve public health emergency management and enhance public health resilience in Chinese cities.

Method by which an index was created

Creating an initial index

An initial index was created by conducting a review of the literature and performing a theoretical analysis. Based on emergency management theory, resilience theory, and urban governance theory, the emergency resilience framework is first proposed. There are separate dimensions on which to evaluate the emergency resilience of urban public health management, and they are the target layer. That layer is used as to further analyze the key factors influencing urban prevention and control of major public health emergencies, which are the criterion layer. Those criteria are then refined into indicators that are easy to measure, and they are used as the indicator layer.

At present, there are many frameworks with which to evaluate public health emergency response capabilities

both domestically and internationally. Zheng *et al.* used the Delphi method to create indicators of resilience to evaluate epidemic prevention and control by local disease prevention and control facilities (*3*). Based on emergency management theory and resilience theory, Wang *et al.* created indicators with which to evaluate local medical and healthcare facilities' emergency response to major infectious disease outbreaks (*4*). In 2018, the European Centre for Disease Control and Prevention (ECDC) released the Health Emergency Preparedness Self-Assessment (HEPSA) Tool (*5*). Through a review of the literature, Fallah-Aliabadi *et al.* divided disaster resilience into constructive resilience, infrastructural resilience, and administrative resilience, and they developed indicators with which to evaluate the disaster resilience of hospitals (*6*). Zhou *et al.* used the Delphi expert consultation method to create an index with which to evaluate the resilience of the healthcare system in the context of a surge in catastrophic medical demand based on entropy theory (*7*), providing a reference for improving China's disaster risk management capabilities. Cai Y *et al.* used a synthetic control method to evaluate the impact of a trial policy of equalization of healthcare services for migrant populations on the resilience of public health systems in mega cities (*8*). According to the studies above, scholars have begun to apply emergency management theory and resilience theory to jointly solve public health problems, and the research focus has also shifted from specific facilities to the healthcare system and the urban public health system.

Based on previous experience in preventing and controlling major public health emergencies (*9,10*), we believe that emergency resilience means having a system with resilience when responding to emergencies so that the system can effectively respond to shocks at various stages of the emergency response, including advance preparations, in-process handling, and post-incident recovery. This reduces vulnerability in the emergency response process, thus reducing casualties and economic losses, and it allows a quick return to normal production and life. The system's ability to respond to emergencies can grow incrementally, and sufficient preparations can be made for the system to respond to the next emergency. An emergency resilience framework should include six dimensions: organizational resilience, institutional resilience, facility resilience, social resilience, occupational resilience, and technological resilience (*11-16*) (Figure 1). The six dimensions of the emergency resilience framework served as primary indicators, ultimately constituting an initial index that included 6 primary indicators, 21 secondary indicators, and 89 tertiary indicators.

Delphi method

The Delphi method is a structured process that uses a series of questionnaires and "rounds" to collect information, with rounds conducted until a group consensus is reached (*17*). The Delphi method does not have specific requirements for the minimum number of experts, and in general having 15 to 50 experts is advisable (*18*). We selected 34 experts from institutions of higher education, disease prevention and control centers at the city and district level, secondary and primary-tier hospitals, health commissions, and other government agencies and grassroots organizations in Shanghai, Nanjing, Guangzhou, and Haikou to consult. The experts had worked in administration, teaching, and research related to health emergency management, health policy research, and urban governance for at least 5 years and voluntarily participated in this study. This study conducted two rounds of expert consultation *via* e-mail and created an index of the emergency resilience of urban public health management based on expert opinions.

Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP) is a decision-making technique proposed by the American operations

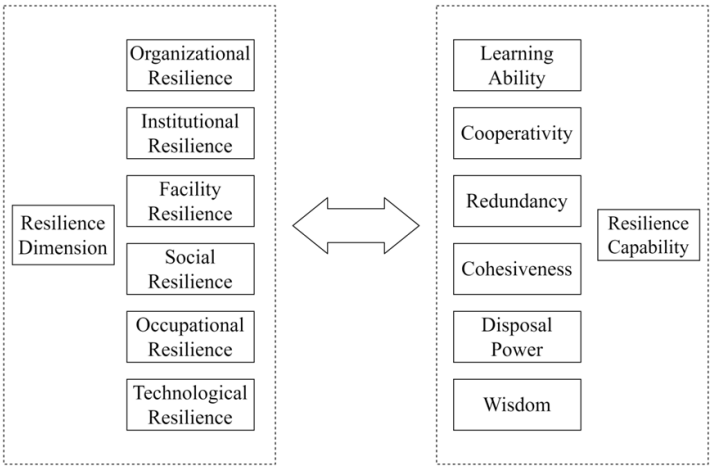

Figure 1. Dimensions and capabilities of "emergency resilience".

researcher Thomas Saaty in the 1970s. It combines qualitative and quantitative analysis and is mainly used to solve complex multi-objective decision-making problems (*19*). The AHP can be roughly divided into five steps (*20*): *i*) establishing a hierarchical structure model, *ii*) constructing a pairwise comparison matrix, *iii*) calculating eigenvalues and eigenvectors; *iv*) consistency of inspection indicators, and *v*) calculating the weights of the indicators.

Fuzzy comprehensive evaluation

Fuzzy comprehensive evaluation is a method of comprehensive evaluation based on fuzzy mathematics. By applying the principle of fuzzy relation synthesis, factors with unclear boundaries and that are difficult to quantify are quantitatively processed to comprehensively evaluate practical problems. The three levels of indicators from the index we created were used to conduct a survey, and the questionnaire was distributed to 25 experts with a wealth of work or research experience in public health emergency management, urban governance, or health policy research and who are familiar with the creation of Shanghai's public health emergency management. These experts were communicated with *via* e-mail to have them evaluate Shanghai's public health emergency management.

Creation of an index

Basic information on experts

This study contacted a total of 34 experts, 34 of whom actually participated. Of the experts, 22 were males and 12 were females; 2 were under the age of 30, 16 were between the ages of 30–39, 13 were between the ages of 40–50, and 3 were over the age of 50. Thirteen of the experts have a bachelor's degree or lower level of education, 15 have a master's degree, and 6 have a doctorate. Three of the experts worked in universities, 14 worked in disease control facilities, 5 worked in medical facilities, 6 worked in relevant municipal government agencies, and 6 worked in local communities. Seven of the experts had less than 10 years of work experience, 21 had 10–19 years of work experience, 5 had 20–29 years of work experience, and 1 had more than 30 years of work experience. See Table 1 for details.

Enthusiasm of experts

The valid response rate to the distributed expert consultation form was higher than 70%, indicating that the experts were enthusiastic about participating. A total of 34 copies of the questionnaire were distributed during the first round of consultation in this study, and 34 valid responses were received. In the second round of consultation, questionnaires were still distributed to these 34 experts, and the response rate to the questionnaire was also 100%. This indicates that experts displayed a high level of interest in participating in this study.

Coefficient for expert authority

Calculation of the coefficient for expert authority was determined by averaging two dimensions, familiarity and judgment criteria. Familiarity was divided into five levels: very familiar with a score of 1, somewhat familiar with a score of 0.8, moderately familiar with a score of 0.6, not very familiar with a score of 0.4, and very unfamiliar with a score of 0.2 (*21*). Judgment criteria were classified into four main categories: theoretical analysis, practical experience, the domestic and foreign literature, and intuitive perception (*22*). These categories were divided into the three levels of major (0.3, 0.5, 0.1, 0.1), regular (0.2, 0.4, 0.1, 0.1), and minor (0.1, 0.3, 0.05, 0.05). The average coefficient for two rounds of expert consultation was 0.832 and 0.885, respectively.

Coefficient for coordination among experts

The coefficient for coordination among experts can be used to measure their level of consensus on indicators. In order to quantify the consistency of expert opinions, we used Kendall's coefficient of concordance (W value) as the measurement standard. A higher W value indicates a higher level of coordination among experts, that is, a decrease in the degree of disagreement among expert opinions. As shown in Table 2, the Kendall coefficient for the first round of expert consultation on the indicators overall was 0.243, indicating that experts had differing

Table 1. Basic information on experts

Project	Frequency	Proportion (%)
Sex		
Male	22	64.7
Female	12	35.3
Age (years)		
< 30	2	5.9
30~	16	47.1
40~	13	38.2
≥ 50	3	8.8
Highest level of education		
Undergraduate or lower	13	38.2
Postgraduate	15	44.1
Ph.D. Student	6	17.7
Type of workplace		
College or university	3	8.8
Center for disease control	14	41.2
Medical facility	5	14.7
Agency of the municipal government	6	17.6
Grassroots organization	6	17.6
Work experience (years)		
< 10	7	20.6
10~	21	61.8
20~	5	14.7
≥ 30	1	2.9

opinions on the indicators. The Kendall coefficient for the second round of expert consultation on the indicators overall was 0.445, indicating less disagreement compared to the first round and a tendency towards consensus.

Indicators of the emergency resilience of urban public health management and their weights

According to expert ratings and opinions, after the first round of expert consultation, there were no changes in the primary indicators. Three indicators were modified and one indicator was divided into two secondary indicators. Three indicators were added to the tertiary indicators. Thirteen indicators were modified, the numbers of two indicators were adjusted, and one indicator was divided into separate lower level indicators. Of the secondary indicators, B2-6 was modified to the System of Post-incident Recovery and Assessment, B5-3 was modified to Command Coordination and Communication, B6-2 was modified to Translation of Research, and B3-2 was divided into B3-2 Availability of Medical Equipment or Facilities and B3-3 Availability of Emergency Response Equipment. C2-5-1 Creating a System of Joint Meetings for Public Health Work, C3-2-4 Number of Fever Clinics and C3-3-2 Emergency Medical Equipment were added as a tertiary indicator. C1-1-3 was modified to Establishing Graded and Classified Response Standards, C1-2-1 was modified to Extent of Coverage of Infectious Disease Outbreaks by Monitoring, C1-3-1 was modified to Constructing a Network for Medical Treatment of Infectious Diseases, C1-4-1 was modified to Planning to Build and Develop Emergency Capacity, C2-1-2 was modified to Team Structure and Distribution of Professional Ability, C2-2-2 was modified to Formulating a Plan for Annual Emergency Training and Drills, C3-1-1 was modified to The Number of Laboratories with Biosafety Level 3 Protection, C3-2-1 was modified to The Number of Special Vehicles such as Negative Pressure Ambulances, C5-1-1 was modified to Epidemiological Investigations of and the On-site Capacity to Handle Confirmed Cases, C5-2-5 was modified to The Ability to Transport Patients with Infectious Diseases, C5-3-1 was modified to Coordination and Communication between the Command Center and On-site Commander, C5-3-2 was modified to The Ability to Coordinate and Communicate with the Local Garrison and Armed Police, and C6-2-1 was modified to Creating a Mechanism for Cooperation between the CDC, Universities and Research Institutes. The numbers of C3-2-4 and C3-2-5 were changed to C3-3-1 and C3-3-3, respectively. C5-3-3 was divided into C5-3-3 Ability to Coordinate and Communicate across Departments and C5-3-4 Ability of the Yangtze River Delta Region to Coordinate and Communicate with other Regional Provinces and Cities.

After the second round of expert consultation, there were no changes in the primary and secondary indicators, and 5 of the tertiary indicators were modified. Specifically, the tertiary indicator C1-1-3 was revised to Establishing Graded and Classified Response Standards, C1-3-1 was revised to Constructing a Network for Medical Treatment of Infectious Diseases, C3-1-4 was revised to The Number of Healthcare Facilities, C4-2-4 was revised to Creating a Mechanism for Coordination with the Village (Community) Public Health Committee, and C6-2-3 was revised to Applied Emergency Research.

Finally, an index of the emergency resilience of urban public health management was created from the perspective of preventing and controlling major infectious diseases. The index consists of 6 primary indicators, 22 secondary indicators, 93 tertiary indicators, and their corresponding weights. See Table 3 for details.

Use of the index

A survey and fuzzy comprehensive evaluation were used to evaluate the current status of the creation of a system to manage public health emergencies in Shanghai within the context of preventing and controlling major public health emergencies. Results indicated that the system to manage public health emergencies in Shanghai scored 82 points (out of 100 points), indicating a good score overall (Table 4).

Shanghai's public health emergency management received a good score overall, but there are also several shortcomings in its resilience. Based on field research, the main issues identified in this evaluation were as follows: first, the emergency plans lack specificity and implementability. Most of the emergency plans in some agencies are based on the requirements of higher-level documents and have not fully incorporated actual local circumstances. At the same time, the revision of the city's emergency plan is progressing slowly and it cannot adapt to the new reality of public health emergency

Table 2. Coefficient for coordination from two rounds of expert consultation

Index	First round			Second round		
	Kendall's coefficient of concordance (W)	c^2	p	Kendall's coefficient of concordance (W)	c^2	p
Primary index	0.378	64.219	< 0.001	0.572	97.181	< 0.001
Secondary index	0.237	161.471	< 0.001	0.487	347.456	< 0.001
Tertiary index	0.225	671.793	< 0.001	0.476	1489.218	< 0.001
Overall index	0.243	950.927	< 0.001	0.445	1817.463	< 0.001

Table 3. Indices and weights of the emergency resilience of urban public health management

Primary indicator (weight)	Secondary indicator (weight)	Combined (weight)	Tertiary indicator (weight)	Combined (weight)
A1 Organizational Resilience (0.256)	B1-1 Emergency Command System (0.294)	0.075	C1-1-1 Establishing an Emergency Command Group (0.226)	0.066
			C1-1-2 Establishing Public Health Emergency Command Centers with Two Levels in Urban Areas (0.049)	0.014
			C1-1-3 Establishing Graded and Classified Response Standards (0.290)	0.085
			C1-1-4 Establishing an Emergency Command System for Multi-departmental Collaboration (0.049)	0.014
			C1-1-5 Creating a System for Public Health Emergency Command Information (0.385)	0.113
	B1-2 Monitoring and Early Warning System (0.417)	0.107	C1-2-1 Extent of Coverage of Infectious Disease Outbreaks by Monitoring (0.077)	0.032
			C1-2-2 Mechanism for Reporting Infectious Disease Outbreaks (0.437)	0.182
			C1-2-3 Handling of Warning Information (0.053)	0.022
			C1-2-4 Conducting a Risk Assessment (0.333)	0.139
	B1-3 Medical Treatment System (0.213)	0.055	C1-3-1 Constructing a Network for Medical Treatment of Infectious Diseases (0.498)	0.106
			C1-3-2 Establishing a Hierarchical System for Diagnosis and Treatment during Major Epidemics (0.354)	0.075
			C1-3-3 Creating a "Reserve" System for Urgent Treatment (0.087)	0.019
			C1-3-4 Building Capacity for Urgent Treatment in Traditional Chinese Medicine (0.061)	0.013
	B1-4 Organizational Support System (0.076)	0.019	C1-4-1 Planning to Build and Develop Emergency Capacity (0.053)	0.004
			C1-4-2 Preparing a List of Public Health Responsibilities for Disease Control, Medical Care, and Relevant Municipal Government Committees and Bureaus (0.098)	0.007
			C1-4-3 Devising Incentive and Penalty Policies for Illegal Activities such as Obstructing Epidemic Prevention and Control, Inflating Prices, and Spreading Rumors (0.389)	0.030
			C1-4-4 Creating a System to Reduce and Exempt Residents' out of Pocket Expenses During Emergencies (0.389)	0.030
			C1-4-5 Devising Policies to Assist Key Industries and Small and Medium-sized Companies in Emergencies (0.071)	0.005
A2 Institutional Resilience (0.335)	B2-1 System for Forming and Managing Emergency Teams (0.131)	0.044	C2-1-1 Forming Expert Emergency Response Teams for Disease Prevention and Control, Medical Treatment, *etc.* (0.227)	0.030
			C2-1-2 Team Structure and Distribution of Professional Ability (0.059)	0.008
			C2-1-3 Building a Database of Experts on the Treatment of Major Infectious Diseases (0.335)	0.044
			C2-1-4 Creating a System to Manage Emergency Teams (0.044)	0.006
			C2-1-5 Special Funds for Emergency Teams (0.335)	0.044
	B2-2 Emergency Training and Drill System (0.204)	0.068	C2-2-1 Completeness of Emergency Plan (0.133)	0.027
			C2-2-2 Formulating a Plan for Annual Emergency Training and Drills (0.424)	0.086
			C2-2-3 Frequency of Emergency Training and Drills (0.073)	0.015
			C2-2-4 Developing Training Materials and Formulating Drill Plans (0.321)	0.065
			C2-2-5 Creating a System to Evaluate the Effectiveness of Training and Drills (0.050)	0.010
	B2-3 Emergency Supplies and Fund Management System (0.294)		C2-3-1 Amassing a Reserve of Emergency Supplies (0.226)	0.066
			C2-3-2 Inventorying and Dynamic Management of Reserves of Medical Supplies (0.049)	0.014
			C2-3-3 The Degree of Concordance between the Quantity of Reserves of Emergency Supplies and Demand During Emergencies (0.385)	0.113
			C2-3-4 Status of Annual Emergency Reserve Funds (0.049)	0.014
			C2-3-5 Emergency Procurement of Supplies (0.290)	0.085
	B2-4 Mechanism to Integrate Activities During Normal Times and Emergencies (0.131)	0.098	C2-4-1 Creating a Mechanism for Allocation and Regional Mobilization of Emergency Personnel (0.100)	0.013
			C2-4-2 Creating an Emergency Mechanism to Open up Beds to Treat Patients with Infectious Diseases (0.437)	0.057
			C2-4-3 Constructing a Network of Laboratories among the CDC, Medical Facilities, Universities, Research Institutes, Customs and Third-party Testing Agencies (0.077)	0.010
			C2-4-4 Increasing and Changing over Production by Companies during Emergencies (0.053)	0.007

Table 3. Indices and weights of the emergency resilience of urban public health management (continued)

Primary indicator (weight)	Secondary indicator (weight)	Combined (weight)	Tertiary indicator (weight)	Combined (weight)
			C2-4-5 Creating a Mechanism for Repurposing of Large Venues During Emergencies (0.333)	0.044
	B2-5 Joint Prevention and Control Mechanism (0.204)	0.044	C2-5-1 Creating a System of Joint Meetings for Public Health Work (0.297)	0.061
			C2-5-2 Creating a Mechanism of Joint Prevention and Control among Medical and Healthcare Facilities (0.056)	0.011
			C2-5-3 Creating a Mechanism of Joint Prevention and Control between Medical and Non-medical facilities (Education, Agriculture, Forestry, Animal CDC, Airports, *etc.*) (0.421)	0.086
			C2-5-4 Creating a Mechanism for the Yangtze River Delta Region to Coordinate and Work with other Provinces and Cities (0.169)	0.034
			C2-5-5 Actively Participating in Global Public Health Governance (0.056)	0.011
	B2-6 System of Post-incident Recovery and Assessment (0.038)	0.068	C2-6-1 Resuming Work and Production as soon as possible (0.221)	0.008
			C2-6-2 Participating in a Mechanism of Amenities and Compensation for Personnel (0.363)	0.014
			C2-6-3 Creating a Mechanism for a Post-Incident Summary and Assessment (0.053)	0.002
			C2-6-4 The Improvement of Subsequent Systems, Mechanisms, Emergency Plans, and Levels of Prevention (0.363)	0.014
A3 Facility Resilience (0.050)	B3-1 Construction of Infrastructure (0.312)	0.013	C3-1-1 The Number of Laboratories with Biosafety Level 3 Protection (0.053)	0.017
			C3-1-2 The Number of Large Indoor Venues such as Stadiums (0.447)	0.139
			C3-1-3 The Number of Facilities that can be used as Centralized Isolation Sites (0.099)	0.031
			C3-1-4 The Number of Healthcare Facilities (0.328)	0.102
			C3-1-5 The Number of Dedicated Public Health Facilities (0.073)	0.023
	B3-2 Availability of Medical Equipment or Facilities (0.198)	0.016	C3-2-1 The Number of Special Vehicles such as Negative Pressure Ambulances (0.339)	0.067
			C3-2-2 The Number of Infectious Disease Wards and Beds (0.099)	0.020
			C3-2-3 The Number of Infectious Disease Wards and Beds (0.066)	0.013
			C3-2-4 The Number of Fever Clinics (0.497)	0.098
	B3-3 Availability of Emergency Response Equipment (0.491)	0.010	C3-3-1 Provision of Equipment for On-site Epidemiological Investigations, On-site Sampling, and Other Emergency Response Equipment (0.164)	0.081
			C3-3-2 Emergency Medical Equipment (0.297)	0.146
			C3-3-3 Communication Equipment (0.539)	0.265
A4 Social Resilience (0.084)	B4-1 Publicity and Health Education (0.491)	0.025	C4-1-1 Formulating a Health Promotion Plan (0.359)	0.176
			C4-1-2 Conducting Regular Health Education and Publicity Activities (0.564)	0.277
			C4-1-3 Diversification of the Ways to Promote Health Education (0.077)	0.038
	B4-2 Management of Grassroots Efforts (0.198)	0.025	C4-2-1 Creating a Mechanism of Social Mobilization (0.497)	0.098
			C4-2-2 Creating a System to Manage Volunteer Teams (0.066)	0.013
			C4-2-3 Training of Grassroots Staff and Volunteers (0.339)	0.067
			C4-2-4 Creating a Mechanism for Coordination with the Village (Community) Public Health Committee (0.099)	0.020
	B4-3 The Public's Response (0.312)	0.041	C4-3-1 Monitoring Public Opinion (0.55)	0.173
			C4-3-2 Release of Information by the Government (0.090)	0.028
			C4-3-3 Media Communication and Shaping of Public Opinion (0.354)	0.110
A5 Career Resilience (0.207)	B5-1 Disease Prevention and Control (0.346)	0.017	C5-1-1 Epidemiological Investigations of and the On-site Capacity to Handle Confirmed Cases (0.115)	0.040
			C5-1-2 The Ability to Manage Suspected Cases and Close Contacts (0.050)	0.017
			C5-1-3 Disinfection Capacity On-site (0.440)	0.152
			C5-1-4 Laboratory Testing and Diagnostic Capabilities (0.318)	0.110
			C5-1-5 Building Capacity for Emergency Vaccination (0.077)	0.027
	B5-2 Medical Assistance (0.110)	0.026	C5-2-1 Hospitals that Meet the Admission Criteria (0.246)	0.027

Table 3. Indices and weights of the emergency resilience of urban public health management (continued)

Primary indicator (weight)	Secondary indicator (weight)	Combined (weight)	Tertiary indicator (weight)	Combined (weight)
			C5-2-2 Hospital Capacity (0.049)	0.005
			C5-2-3 Capacity of Relevant Hospital Departments (0.390)	0.043
			C5-2-4 Capacity for Infection Prevention and Control in Hospitals (0.068)	0.007
			C5-2-5 The Ability to Transport Patients with Infectious Diseases (0.246)	0.027
	B5-3 Command Coordination and Communication (0.544)	0.072	C5-3-1 Coordination and Communication between the Command Center and On-site Commander (0.484)	0.053
			C5-3-2 The Ability to Coordinate and Communicate with the Local Garrison and Armed Police (0.071)	0.008
			C5-3-3 The Ability to Coordinate and Communicate across Departments (0.344)	0.038
			C5-3-4 The Ability of the Yangtze River Delta Region to Coordinate and Communicate with other Regional Provinces and Cities (0.101)	0.011
A6 Technical Resilience (0.068)	B6-1 Emergency Information Technology (0.703)	0.023	C6-1-1 Constructing a Platform for the Reporting of Information on Infectious Diseases (0.095)	0.067
			C6-1-2 The Use of New Technologies in the Early Warning System (0.642)	0.451
			C6-1-3 Monitoring the Capacity to Collect Information (0.095)	0.067
			C6-1-4 Standardizing Public Health Emergency Information (0.168)	0.118
	B6-2 Translation of Research (0.182)	0.113	C6-2-1 Creating a Mechanism for Cooperation between the CDC, Universities and Research Institutes (0.564)	0.103
			C6-2-2 Constructing and Implementing a Platform to Connect Industry and Universities (0.359)	0.065
			C6-2-3 Applied Emergency Research (0.077)	0.014
	B6-3 Medicines and Vaccines (0.115)	0.048	C6-3-1 Emergency Research and Development of Targeted Drugs and Vaccines (0.101)	0.012
			C6-3-2 Emergency Use of Drugs and Vaccines (0.739)	0.085
			C6-3-3 Supervision of Drug and Vaccine Safety (0.160)	0.018

Table 4. Score table for comprehensive evaluation of Shanghai public health "emergency resilience" governance system

Target Layer	Score	Criterion Layer	Score	Sub Criteria Layer	Score
Shanghai public health "emergency resilience" governance system	82	A1 Organizational Resilience	79	B1-1 Emergency Command System	80
				B1-2 Monitoring and Early Warning System	77
				B1-3 Medical Treatment System	84
				B1-4 Organizational Support System	77
		A2 Institutional Resilience	81	B2-1 System for Forming and Managing Emergency Teams	88
				B2-2 Emergency Training and Drill System	82
				B2-3 Emergency Supplies and Fund Management System	78
				B2-4 Mechanism to Integrate Activities During Normal Times and Emergencies	80
				B2-5 Joint Prevention and Control Mechanism	81
				B2-6 System of Post-incident Recovery and Assessment	76
		A3 Facility Resilience	87	B3-1 Construction of Infrastructure	85
				B3-2 Availability of Medical Equipment or Facilities	87
				B3-3 Availability of Emergency Response Equipment	87
		A4 Social esilience	86	B4-1 Publicity and Health Education	89
				B4-2 Management of Grassroots Efforts	80
				B4-3 The Public's Response	86
		A5 Career Resilience	85	B5-1 Disease Prevention and Control	86
				B5-2 Medical Assistance	85
				B5-3 Command Coordination and Communication	85
		A6 Technical Resilience	82	B6-1 Emergency Information Technology	82
				B6-2 Translation of Research	79
				B6-3 Medicines and Vaccines	82

management. In addition, large-scale exercises can easily disrupt social order and require stress testing to expose potential vulnerabilities, balancing the contradiction between "practicality" and "controllability".

The second issue is the lack of diversification of reserves of emergency supplies. At present, reserves of emergency supplies in Shanghai mainly in the form of the government's physical reserves, and participation by companies is insufficient. The lack of both long-term and short-term planning for emergency supply reserves hampers relevant departments in responding quickly and effectively to crises after major emergencies occur, and may even result in missing the optimal window for an early response.

The third issue is a low degree of sharing emergency information and collaboration. When building their own emergency information systems, various entities in Shanghai lack unified construction standards and reasonable system planning, resulting in chaotic emergency information management and difficulty in sharing emergency information, thus causing the phenomenon of "information islands".

The fourth issue is that the advantages of traditional Chinese medicine have not been effectively capitalized upon. When a healthcare system is responding to a major public health emergency, traditional Chinese medicine has displayed certain limitations in terms of being at disparate locations, being in different stages, and differences in regional availability, and there is still a lack of systematic and institutional support for its use. During the initial stage of the COVID-19 pandemic, Shanghai did not fully understand the assistance traditional Chinese medicine could provide and failed to capitalize on the advantages of traditional Chinese medicine, and especially in terms of assisting patients.

The fifth issue is the lack of personnel in community public health. Most local community workers have not received relevant professional education and when faced with sudden public health emergencies, they can only rely on instructions from superiors to take action. Most training is only conducted in the immediate aftermath of a public health emergency, hampering the effective enhancement of the emergency management capabilities of personnel. At the same time, community volunteer teams are relatively older people, with most of them being elderly who are retired or about to retire. And due to the lack of sound laws and regulations, the legitimacy of volunteers in emergency management is often questioned, which also restricts the forming of volunteer teams.

Perspectives on the index of management of emergency resilience

China has proposed the establishment of a "big security and big emergency" framework and revised and released a new version of the Emergency Response Law of the People's Republic of China and the National Emergency Plan in 2024. Over the past few years, the national and local governments have also issued a series of policy documents to guide localities to accelerate the development of disease control systems, enhance the monitoring of infectious diseases, enhance early warning and response capabilities, and enhance the construction of resilient cities. Creation of this index is based on a review of the relevant literature on management of public health emergencies, infectious disease prevention and control policies, and evaluation of emergency capacity. It has a solid theoretical foundation and

follows the principles of implementability, systematicity, comparability, and a scientific basis to select indicators to ensure the index's reliability. Therefore, this index can serve as a reference for the creation of a urban system to manage public health emergencies in China and to improve the emergency resilience of the urban public health system.

Use of this index revealed that Shanghai's public health emergency management has insufficient specificity and implementability of emergency plans, insufficient diversification of the reserves of emergency supplies, a low level of sharing emergency information and cooperation, insufficient capitalization on the advantages of traditional Chinese medicine, and a shortage of local community public health personnel, which are hidden dangers when creating a safe and resilient city. Important factors such as local economic conditions, geographic conditions, cultural characteristics, susceptibility to disasters, the state of medical and health care, and functional organizational structures should be carefully considered when revising emergency plans. Reserves of supplies should be classified and varied for multiple levels such as the city level, district level, and neighborhood level, and the different departments and agencies at different levels should clarify who will store those reserves, what they will store, and how much they will store. A system linking public health disease prevention and control that combines traditional Chinese medicine and Western medicine should be created, ensuring close integration and collaboration between traditional Chinese medical care and other forms of medical care. Unified standards on coding information should be established to facilitate the exchange of data between different departments. Emergency response capabilities at the grassroots level should be enhanced, community health emergency teams and volunteer teams should be forming, emergency training should be conducted regularly, and the expertise of the grassroots emergency teams should be increased.

This article has focused on cities, and the indicators may not be generalizable to rural and remote areas. This study only evaluated the current status of public health emergency management in Shanghai and did not involve surveys of or comparisons to other cities. Therefore, the next step will be to compare Shanghai to other cities in China and to adjust the index to improve its utility and practicality, thus providing a reference to enhance the emergency resilience of urban public health.

Acknowledgements

The authors wish to thank the experts who were consulted during this study for their active participation and support in the creation and evaluation of this index. The authors would also like to thank the Shanghai Center for Disease Control and Prevention and other agencies for the opportunity to analyze their practical experience.

Funding: This study was supported by a grant for a key project of the Shanghai Action Plan to Enhance the Creation of a System of Urgent Medical Assistance for Emergencies (2024-2027) (A Study on a Planned System of Urgent Medical Assistance for Emergencies), a Health Policy Research Project of the Shanghai Municipal Health Commission (Analysis of the Current State of Management of Intelligent Drug Use and an Examination of Approaches in Shanghai in the Context of Artificial Intelligence and Clinical Integration (2025HP24)), a Special Project in Decision-making and Consulting Research on Health of the Shanghai Municipal People's Government (A Study on the System for and Path to Implementation of the Strategy of Prioritizing Health" (2025-LH-WJ01), Shanghai University of Medicine and Health Science Key Research Project "Research on the Integrated Emergency Response Strategy of" Search and Rescue Medical Management "for Comprehensive Response to Multiple Disasters and Safety Resilience in Urban Areas" (SSF-23-02-001), and The "Domestic Visiting Study" Project of the Hundred Talents Pool of Shanghai University of Medicine and Health Science, titled "Comprehensive Strategy Research on Health and Safety Management in Shanghai's Super Large City" (A1-020-25-311007-1).

Conflict of Interest: The authors have no conflicts of interest to disclose.

References

1. Kieny MP, Dovlo D. Beyond Ebola: A new agenda for resilient health systems. Lancet. 2015; 385:91-92.
2. World Health Organization. World Health Organization Health Systems Strengthening Glossary. *https://www.who.int/docs/default-source/documents/health-systems-strengthening-glossary.pdf* (accessed June 8, 2025).
3. Zheng F, Wang X, Qian D. Research on the creation of a resilience evaluation system for disease control and prevention at the grassroots level. Soft Sci Health. 2024; 38:16-20. (in Chinese)
4. Wang J, Wu H, Zhao Y. Creation of a system to evaluate the emergency response capacity of primary medical facilities in Beijing to major infectious disease. Chin Gen Practice. 2024; 11:1-12. (in Chinese)
5. Li FQ, Zhang Y. Introduction of the health emergency preparedness self-assessment tool of European Centre for Disease Prevention and Control. Chin J Public Health. 2019; 35:1724-1727. (in Chinese)
6. Fallah-Aliabadi S, Ostadtaghizadeh A, Ardalan A, Fatemi F, Khazai B, Mirjalili MR. Towards developing a model for the evaluation of hospital disaster resilience: A systematic review. BMC Health Serv Res. 2020; 20:64.
7. Zhou W, Wang L, Guo Y, Ning N, Wu Q. Establishment of an evaluation index system for health system resilience in the context of catastrophic medical surge. Chin J Public Health. 2022; 38:134-138. (in Chinese)
8. Cai Y, Han H. Evaluation of the resilience of the public health system in megacities under a trial policy of equalization. Chin Health Service Mgmt. 2023; 40:730-735. (in Chinese)

9. Wei L, Jing L. Thoughts on creating a Chinese public health system with the normalization of epidemic prevention. J Hubei Univ Econ (Humanities and Social Sciences). 2021; 18:51-54. (in Chinese)
10. Lee JM, Jansen R, Sanderson KE, Guerra F, Keller-Olaman S, Murti M, O'Sullivan TL, Law MP, Schwartz B, Bourns LE, Khan Y. Public health emergency preparedness for infectious disease emergencies: A scoping review of recent evidence. BMC Public Health. 2023; 23:420.
11. Chen RJ, Xie YP, Liu YQ. Defining, conceptualizing, and measuring organizational resilience: A multiple case study. Sustainability. 2021; 13:2517.
12. Sjöstedt, M. Resilience revisited: taking institutional theory seriously. Ecology and Society. 2015; 20:23-30.
13. Namgung J, Byun E, Kim S. Covid-19 response of neighborhood public facilities in the perspective of urban resilience: A case study of siheung city, Gyeonggi-do. Journal of The Korean Urban Management Association. 2024; 37:57-82. (in Korean)
14. Moya J, Goenechea M. An approach to the unified conceptualization, definition, and characterization of social resilience. Int J Environ Res Public Health. 2022; 19:5746.
15. Hyun-Sil Y. A theoretical review on the concepts of career resilience and the implications for adult career counseling. Korea Journal of Counseling. 2013; 14:423-439. (in Korean)
16. Zhang LH, Xiao K. Risk governance in megacities using artificial intelligence: Convergence, technological change, and direction. Theory Monthly. 2020; 9:60-72. (in Chinese)
17. Boulkedid R, Abdoul H, Loustau M, Sibony O, Alberti C. Using and reporting the Delphi method for selecting healthcare quality indicators: A systematic review. PLoS One. 2011; 6:e20476.
18. Zeng G. Modern Epidemiological Methods and Applications. Union Press of Peking Union Medical College, Beijing, 1994; pp.55-56. (in Chinese)
19. Wang H, Sun Z. Research on multi decision making security performance of IoT identity resolution server based on AHP. Math Biosci Eng. 2021; 18:3977-3992.
20. Zhou ZW, Huang XG. Construction of comprehensive benefit evaluation index system for tertiary hospitals. J Nanjing Med Univ Soc Sci. 2020; 6: 547-552. (in Chinese)
21. Wu HC, Li CG, Liu Z, Guo YZ , Li Y, Hou XD, Li YY, Zhao SS, Li FM. Construction and empirical research of the evaluation index system of environmental protection enterprises' competitiveness based on the Delphi and AHP methods. Water Reuse. 2023; 13:205-219.
22. Wang XJ, Si JP, Guo Q. Research on the creation of an index to evaluate the performance of integrated at-home and community-based medical and nursing care with characteristics of traditional Chinese medicine. Chin J Health Policy. 2023; 16:60-67. (in Chinese)

Received April 28, 2025; Revised June 9, 2025; Accepted June 18, 2025.

Released online in J-STAGE as advance publication June 21, 2025.

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