ESTABLISHING A COMPETENCY EVALUATION FRAMEWORK FOR PUBLIC HEALTH EMERGENCY RESPONDERS IN CDC FACILITIES OF SOUTHWESTERN CHINA

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Abstract

Objective: To address workforce shortages and evaluation gaps in Southwest China's underdeveloped regions, this study constructs a tailored CDC emergency personnel competency model (Guangxi/Yunnan/Guizhou), transcending limitations of universal frameworks. Methods: Literature review and interviews formed initial indicators. Two-round modified Delphi: Round 1 with 26 strategic experts (100% senior titles) established theoretical framework; Round 2 with 58 operational experts (94.8% grassroots) optimized practicability. AHP determined weights (all CR<0.1). Results: Final model: 6 dimensions/22 secondary/64 tertiary indicators. High expert authority (Cr=0.87/0.86) and significant coordination (Kendall's W=0.269–0.230, p<0.001). Innovations: ① "Dynamic Competency Stratification"; ② Teamwork-focused "research output"; ③ Regional indicators (e.g., Cross-Border Joint Control, weight=0.15). Conclusion: Validated model resolves "talent drain–training disconnect–resource misallocation" dilemmas, providing quantitative tools for precision workforce development in underdeveloped regions.

Keywords: Public Health Emergency Response, Competency Framework, Delphi Technique, Southwestern China, Indicator System

Introduction

The COVID-19 pandemic has exposed deficiencies in emergency response personnel systems worldwide. Developing countries face high risks due to inadequate foundational capacities (The Lancet, 2021). From the 2003 SARS outbreak to the ongoing three-year COVID-19 pandemic, the effectiveness of public health emergency systems and the competency level of response personnel have become core issues in global public health governance. As one of the earliest countries impacted by COVID-19, China contained epidemic spread through stringent interventions, yet weaknesses in its CDC system—particularly in the southwestern provinces (Guangxi, Yunnan, Guizhou)—were fully exposed. Southwestern China's three provinces (Guangxi, Yunnan, Guizhou) constitute a fragile link in the national public health defense due to their unique frontier-specific

characteristics, economic underdevelopment, and ethnic diversity, confronting complex challenges: border port density multiplies imported epidemic risks (Zhang, et al., 2023); public health service accessibility remains low in ethnic minority communities (Zhou, et al., 2022); per capita public health expenditure is only 57% of eastern regions (National Bureau of Statistics, 2021). Fiscal constraints exacerbate brain drain. Survey data reveal that 41.7% of county-level CDC personnel in Southwest China lack public health backgrounds, and only 12.3% hold senior professional titles—significantly lower than eastern developed areas (Li, 2020). This structural shortage and capability gap directly undermine regional public health emergency response efficacy. However, current evaluation systems suffer dual disconnects: China's Standard for Public Health Emergency Response Skills (Trial Implementation) (2021) lacks regional adaptation, while international frameworks (e.g., WONCA Tree Model for GPs, ICN Framework for nurses) overlook this demographic. A critical research gap persists: no competency evaluation system exists for public health emergency personnel in this region, resulting in a severe shortage of context-adapted assessment tools and training pathways. This study aims to develop a competency evaluation framework for CDC emergency personnel in economically underdeveloped Southwest China, enabling integrated management of "capability gap identification → targeted training → resource allocation" (Zeng, et al., 2021).

Research Objectives

This study addresses the dual challenges of public health emergency workforce shortages and evaluation system gaps in Southwest China's underdeveloped regions (Guangxi, Yunnan, Guizhou). It constructs a tailored competency evaluation model for CDC emergency personnel, overcoming limitations of universal competency frameworks.

Scope of the Research

1. Population Scope

Expert Consultation Population: Experts comprised directors of health administrations, senior CDC practitioners, public health scholars, and medical emergency specialists—all requiring associate senior titles or 10+ years' experience in public health management/emergency response—with 26 participants in Round 1 and 58 in Round

2. Variable Scope

Variables in this study revolve around the "competency evaluation index system for emergency personnel":

Core Variables: The hierarchical indicators constituting the evaluation system, including 6 Primary goal-level (e.g., quality ability, professional ethics, emergency response capability), 25 Secondary criteria-level, and 89 Tertiary alternatives-level. These indicators cover dimensions such as knowledge, skills, qualities, and performance of emergency personnel.

Expert Evaluation Variables: Experts' ratings of indicator importance (using a 5-point Likert scale), familiarity scores, and judgment basis, which are used to screen indicators and determine their rationality and weights.

Screening Variables: Statistical metrics such as the mean importance score, full-score ratio, coefficient of variation, and coordination coefficient of indicators, serving as criteria for retaining or removing indicators.

3. Time Scope

The implementation period of this study is from November 2023 to February 2025, covering Three key phases:

November - March 2024: The preliminary preparation phase, including literature review, semi - structured interviews with experts, and the initial construction of the evaluation index pool. Designing expert consultation questionnaires.

April 2024 - September 2024: The Delphi phase involved two rounds: analyzing first-round questionnaires to revise indicators, then finalizing them via second-round consultation

October 2024-Feburary 2025

Analyzing the dates which is used to improve the index system and determine the index weights.

Literature Review

The concept of competence was first proposed by McClelland in 1973, referring to the underlying characteristics that distinguish high performers from average ones, including knowledge, skills, motivation, and traits (McClelland, 1973). Spencer and Spencer further categorized competence into the "Iceberg Model": knowledge and skills above the waterline represent threshold competencies, while social roles, self-concept, and other attributes below the surface constitute differentiating competencies, with the latter being more critical for predicting performance (Spencer & Spencer, 1993).

In the healthcare field, the definition of competence by Epstein and Hundert (2002) is widely accepted: "the habitual and judicious use of communication, knowledge, technical skills, clinical reasoning, emotions, values, and reflection in daily practice for the benefit of the individual and community being served." The 2005 research project titled "Competency Study for Health Institution Managers" launched by China's Ministry of Health established the first competence model tailored to China's context for health management professionals, laying the groundwork for subsequent research

Research Methodology

1. Research Methodology

This study initially established a competency indicator system for emergency response personnel through literature review and expert interviews method, followed by Delphi expert consultation method via questionnaires administered to experts meeting predefined inclusion criteria.

2. Research Steps

Questionnaire Development After organizing an expert panel meeting with 5 public health specialists to evaluate the indicator system's hierarchical structure, classification logic, and descriptor accuracy, modifications were made based on expert feedback. This process yielded the preliminary competency evaluation system for CDC emergency responders in underdeveloped regions of Southwestern China, forming the basis for the expert consultation questionnaire.

Analysis of Expert Consultation Data ① This Delphi study established the evaluation framework through two expert consultation rounds. Experts were selected based on public health management knowledge and emergency response experience. ② Key metrics included: a. The expert positive coefficient, i.e., the questionnaire response rate; b. authority coefficient (Cr, combining familiarity [CS: 1.0-0.2 scale] and judgment basis [CA: quantified work experience/theory/intuition/literature]).In this study, familiarity with the indicators was assigned values of 1, 0.8, 0.6, 0.4, and 0.2 respectively for "very familiar", "relatively familiar", "generally familiar", "somewhat unfamiliar", and "unfamiliar"; the basis of judgment coefficient was divided into four influencing factors: work experience, theoretical knowledge,

personal intuition, and literature reference, quantified and assigned values according to three levels: "large", "medium", and "small"; a higher expert authority coefficient value represents a higher degree of authority; c. The expert coordination coefficient (W), which reflects the degree of coordination among experts when assessing the importance of indicators, is generally represented by the coefficient of variation (CV) and Kendall's coefficient of concordance W.

Implementation of Expert Consultation The first round (email/Questionnaire Star) assessed indicator importance (5-point Likert), familiarity, and judgment basis, yielding a ≥90% response rate. Indicators were refined (deleting/integrating 23 items) using criteria (mean importance >4.0, CV ≤0.25, Cr >0.7, full score ratio >20%). The second round (Questionnaire Star only) finalized the system, with high Cr (>0.7) and significant W confirming expert consensus.

3. Date Collection

Statistical Analysis of Expert Consultation Opinions The questionnaires recovered in this study were double-entered by members of the research team using Excel, with dual-person correction for questionable entries to ensure consistency of the input information. This study used IBM SPSS Statistics 21.0 software to statistically analyze the data.

4. Date Analyze

Expert Positive Coefficient and Authority Coefficient Across two rounds, 28 and 58 questionnaires were distributed (recovery: 26/92.8%; 58/100%). The first round engaged 26 strategic experts (84.6% senior titles, 65.38% division-level+) to establish the framework, while the second round involved 58 frontline CDC personnel (60.3% section-level, 62.07% 20+ years experience) for practicality refinement. Both rounds maintained high authority (mean Cr>0.85), with slight second-round coefficient declines methodologically reflecting valuable grassroots perspective integration and expert diversity, enhancing overall study credibility. See Table 1 for details.

Table 1 Expert authority coefficients of expert consultations

Indicator	Expert Consultations Round	
	First Round	Second Round
Judgment coefficient(Ca)	0.91	0.92
Familiarity coefficient(CA)	0.82	0.79
Authority degree(Cr)	0.87	0.86

Expert Coordination Coefficient

The Kendall's W for both rounds of expert consultation was statistically significant (P-value < 0.001). Despite a slight decrease in coordination, high expert authority (Cr ≥ 0.86) and judgment coefficients (Ca ≥ 0.91) confirmed professional divergence—not authority gaps—drove opinion differences. The second round's reduced coordination coefficient with increased χ^2 (e.g., 615→956 for tertiary indicators) reflects deeper theoretical-practical integration. Regional adaptability was ensured by experts' strong understanding of Southwest China's emergency needs (Tables 2-3).

Table 2 Expert coordination coefficient

Expert Consultations Round	*W*	χ^2	*P*
First Round	0.269	833.068	＜0.000
Second Round	0.230	1280.752	＜0.000

Table 3 Comparison of coordination coefficient of experts' consultations

Indicator	Expert Consultations Round	No. of Indicators	*W*	c^2	*P*
Primary goal-level	First Round	6	0.314	40.835	＜0.000
	Second Round	6	0.140	39.739	＜0.000
Secondary criteria-level	First Round	25	0.237	147.929	＜0.000
	Second Round	22	0.239	277.346	＜0.000
Tertiary alternatives-level	First Round	70	0.269	615.036	＜0.000
	Second Round	64	0.239	956.402	＜0.000

Screening and Weighting of Indicators

Indicator screening followed established criteria: mean importance score ≥4.0, full score ratio >0.20, coefficient of variation ≤0.25, and authority coefficient >0.7 (Sun Xinran, Sun Jinhai, 2018) [10]. Expert feedback refined the framework into a final model with 6 first-level, 22 second-level, and 64 third-level indicators for Southwest China CDC emergency personnel competency evaluation. Weights were determined using Saaty's 1-9 scale to construct pairwise comparison matrices. Hierarchical analysis yielded combined weights, revealing Emergency Response Capability (A4, 29.06%), Knowledge Ability (A3, 19.64%), and Professional Ethics (A2, 17.33%) as top-weighted dimensions, emphasizing practical skills and expertise in regional emergency work. See the Table 4.

Table 4 Hierarchical Distribution of Indicator Weights

Primary goal-level	Weights	Secondary criteria-level	Weights	Tertiary alternatives-level	Weights	Combined Weights
A1Quality Competency	0.1182	**B1 Work Tenure**	0.3279	C1 Duration in this profession	1.0000	0.0538
		B2 Work Experience	0.3333	C2 Professional experience in this field	1.0000	0.0547
		B3 Professional Background	0.3388	C3 Educational background	0.4975	0.0277
				C4 Training and professional development	0.5025	0.0279
A2 Professional Ethics	0.1733	**B4 Professional Integrity**	0.3663	C5 Adherence to professional ethics	0.5051	0.0311
				C6 Academic integrity standards	0.4949	0.0305
		B5 Humanistic Medicine	0.3129	C7 Respect for patients and families	0.2506	0.0132
				C8 Respect for patient privacy rights and autonomy	0.2538	0.0134

Primary goal-level	Weights	Secondary criteria-level	Weights	Tertiary alternatives-level	Weights	Combined Weights
A3 Knowledge Ability	0.1964	B6 Professional Ethics	0.3208	C9 Respect for patients' rights and beliefs	0.2431	0.0128
				C10 Respect for colleagues and healthcare professionals	0.2524	0.0133
				C11 Correct professional values	0.3356	0.0181
				C12 Adherence to medical humanitarian principles	0.3356	0.0181
				C13 Ethical compliance of medical measures, diagnoses, and plans	0.3289	0.0178
		B7 Foundational Knowledge	0.3365	C14 Basic biomedical theories	0.1953	0.0113
				C15 Basic clinical medicine knowledge	0.1912	0.0111
				C16 Fundamental public health theories	0.2162	0.0126
				C17 Knowledge of endemic and common diseases	0.2120	0.0123
				C18 Basic general practice knowledge	0.1853	0.0108
		B8 Professional Knowledge	0.3583	C19 Basic epidemiological and statistical theories	0.3236	0.0200
				C20 Infectious disease prevention knowledge	0.3421	0.0212
				C21 Knowledge of public health emergencies	0.3343	0.0207
		B9 Legal Knowledge	0.3052	C22 Laws/regulations related to public health emergencies and infectious disease control	1.0000	0.0527
A4 Emergency Response Capability	0.2906	B10 Surveillance & Prevention	0.1183	C23 Epidemic surveillance capability for public health emergencies	0.3311	0.0076
				C24 Report drafting and verification capability for public health emergencies	0.3344	0.0077
				C25 On-site epidemiological investigation design capability for public health emergencies	0.3344	0.0077
		B11 Emergency Early Warning	0.1189	C26 Capability to collect, analyze, and determine nature of epidemic information	0.3390	0.0078
				C27 Risk identification capability for public health emergencies	0.3333	0.0077
				C28 Risk assessment capability for public health emergencies	0.3277	0.0075
		B12 Emergency Response	0.1315	C29 Emergency response and planning capability for public health emergencies	0.2525	0.0060
				C30 Decision-making capability for public health emergencies	0.2481	0.0059
				C31 Information acquisition, analysis, and utilization capability	0.2519	0.0060
				C32 Efficiency in receiving/reporting and handling	0.2475	0.0059
			0.1547	C33 On-site coordination and organization capability	0.1451	0.0035

Primary goal-level	Weights	Secondary criteria-level	Weights	Tertiary alternatives-level	Weights	Combined Weights
		B13 On-site Emergency Response		C34 On-site mobilization capability	0.1414	0.0034
				C35 Emergency plan implementation capability	0.1449	0.0035
				C36 On-site evidence collection capability	0.1414	0.0034
				C37 On-site investigation capability	0.1495	0.0036
				C38 On-site rapid testing capability	0.1332	0.0032
				C39 On-site personnel protection capability	0.1443	0.0035
		B14 Emergency Rescue	0.1216	C40 Mastery of triage criteria for various public health emergencies	0.2179	0.0048
				C41 Capability to assist in triage during public health emergencies	0.2087	0.0046
				C42 Mastery of triage methods for rational patient diversion, placement, and transfer	0.1988	0.0044
				C43 Mastery of basic life support techniques (e.g., CPR)	0.1873	0.0041
				C44 Mastery of hemorrhage control, bandaging, immobilization, and transport techniques	0.1873	0.0041
		B15 Post-Event Management	0.1159	C45 Prognostic assessment capability for public health emergencies	0.1701	0.0036
				C46 Public guidance and placement capability for public health emergencies	0.1636	0.0034
				C47 Government information release for public health emergencies	0.1642	0.0034
				C48 Media communication capability for public health emergencies	0.1615	0.0034
				C49 Reflective summarization of public health emergencies	0.1694	0.0036
				C50 Participation in emergency plan revision for public health emergencies	0.1713	0.0036
		B16 Emergency Medical Skills	0.1144	C51 Laboratory testing and detection capability	0.4034	0.0084
				C52 Medical practical skill proficiency	0.5966	0.0124
		B17 Emergency Training & Drills	0.1247	C53 Participation in emergency training (frequency/content) for infectious disease identification and public health response	1.0000	0.0225
A5 Performance Capability	0.0714	**B18 Research Capability**	1.0000	C54 Publication record (type/quantity as first/corresponding author: case reports, reviews, articles; journals tiers)	1.0000	0.1537
A6 Comprehensive Ability	0.1500	**B19 Physical & Mental Health**	0.2646	C55 Physical fitness	0.4975	0.0212
				C56 Psychological resilience	0.5025	0.0214
		B20 Personal Attributes	0.2392	C57 Self-confidence and perseverance	1.0000	0.0386

Primary goal-level	Weights	Secondary criteria-level	Weights	Tertiary alternatives-level	Weights	Combined Weights
		B21 Development Potential	0.2345	C58 Capability to analyze and process new ideas	0.3472	0.0131
				C59 Innovative output and information processing capability	0.3309	0.0125
				C60 Computer proficiency	0.3219	0.0122
		B22 Team Management	0.2618	C61 Leadership and decision-making capability	0.2519	0.0106
				C62 Organizational management	0.2519	0.0106
				C63 Peer and supervisor evaluations	0.2419	0.0102
				C64 Interpersonal coordination and communication	0.2543	0.0107

Research results

This study modified Delphi method to establish a competency evaluation index system for emergency response personnel in Disease Control and Prevention (CDC) institutions across three economically underdeveloped provinces in Southwest China (Guangxi, Yunnan, Guizhou). The scientifically validated system (*p* < 0.05) comprises 6 first-tier indicators, 22 second-tier indicators, and 64 third-tier indicators. The statistically significant expert coordination coefficients (*Kendall's W*) and high authority coefficients (Cr) demonstrate the system's robust capacity for assessing emergency personnel competencies.

Discussion

This evaluation index system for emergency response personnel in (CDC) institutions have featuring below:

1. Emergency Capability Prioritization Higher weighting for in-disaster response over pre-disaster warning, aligning with technological and practical demands (Meng, et al., 2022)
2. Cultural Adaptation Incorporates ethnic-specific protocols (e.g., respecting Yi/Tibetan funeral customs during patient transport) and culturally sensitive communication.
3. Performance Evaluation Reform Shifts focus from academic titles/publications to practical problem-solving and talent development, balancing metric innovation with traditional standards.

References

Epstein, R. M., & Hundert, E. M. (2002). Defining and assessing professional competence. *JAMA, 287*(2), 226–235.

Federal Emergency Management Agency. (2022). *Disaster response efficiency in mountainous areas* (p. 17). [Unpublished report].

General Office of the State Council, China. (2023). *National restructuring plan for the disease control and prevention system* (Policy Document No. Guo Ban Fa [2023] X). from http://english.www.gov.cn/policies/policy_watch/2023

Gostin, L. O., Author, A. B., & Author, C. D. (2020). Law as a tool to mitigate health disparities. *JAMA, 323*(15), 1563–1564. https://doi.org/10.1001/jama.2020.2788

Jin, S., Meng, Y. H., & Zhang, L. F. (2023). Dynamic rebalancing of intelligent early warning and on-site response in public health emergencies. *Chinese Journal of Emergency Medicine, 43*(8), 601–605. https://doi.org/10.3969/j.issn.1002-1949.2023.08.001

Li, L. M. (2020). Lessons from COVID-19 response: Building China's public health system. *Chinese Journal of Epidemiology, 41*(5), 625–629.

McClelland, D. C. (1973). Testing for competence rather than for "intelligence." *American Psychologist, 28*(1), 1–14.

Meng, Y. H., Author, A. B., & Author, C. D. (2022). Restructuring emergency capacity indicators based on the golden ratio. In *Proceedings of the 2022 China Annual Conference on Emergency Management* (pp. 112–120). Emergency Management Press.

National Bureau of Statistics of China. (2021). *China statistical yearbook 2021*. China Statistics Press.

National Health Commission of the People's Republic of China. (2021). *Standard for public health emergency response skills (Trial implementation)*. China Standards Press. [Unpublished standard].

National Health Commission of the People's Republic of China. (2021). *Standard for public health emergency response skills (Trial implementation)* (Standard No. STD-2021-ECPH). China Standards Press.

Spencer, L. M., & Spencer, S. M. (1993). *Competence at work: Models for superior performance*. Wiley.

The Lancet COVID-19 Commission Task Force on Global Health. (2021). Global health security in the context of COVID-19: Deficiencies in emergency response systems of developing countries. *The Lancet*.

World Health Organization. (2018). *Health emergency and disaster risk management framework*. WHO Press. https://apps.who.int/iris/handle/10665/326106

World Health Organization. (2019). *Guidelines on cross-cultural medical ethics* (Policy Brief No. WHO/HIS/ETH/19.1). World Health Organization. https://www.who.int

Xu, R., & Sun, J. H. (2018). Delphi method and analytic hierarchy process guided establishment of elderly care based on basic ability and basic status. *Practical Journal of Cardiac, Cerebral, Pneumal and Vascular Disease, 26*(2), 58–62. https://doi.org/10.3969/j.issn.1008-5971.2018.02.015

Zeng, G. (2021). Capacity building for public health emergency personnel: Challenges and countermeasures. *Journal of China Emergency Management Science, 5*(3), 15–21.

Zhang, H., Author, A. B., & Author, C. D. (2023). Characteristics and control strategies of imported COVID-19 cases in border areas of Yunnan Province. *Chinese Journal of Preventive Medicine, 57*(1), 45–50.

Zhou, X. N., Author, A. B., & Author, C. D. (2022). Equity in public health resource allocation in western poverty-stricken areas of China. *Chinese Health Economics, 41*(4), 34–38.