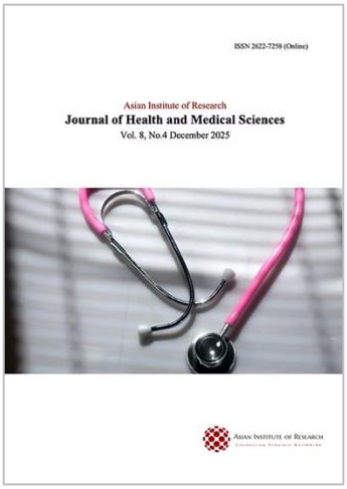

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How to Assess a Country's Preparedness to Face a Public Health Emergency? A Scoping Review

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Abstract
Disasters and emergencies significantly affect public health, making preparedness assessments essential to demonstrate progress and identify gaps for decision-makers. However, knowledge of how countries assess their preparedness is limited. Tools created by national authorities often cater to specific evaluation needs and may not apply to others due to unique health system characteristics. This checklist evaluates parameters used to measure a region's preparedness for emergencies based on data collected from article searches. We searched various databases online using keywords related to public health, tools, and preparedness. The databases used included Proquest, Pubmed, Sage, ScienceDirect, and Scopus. The data were analyzed using thematic analysis to identify parameters used to assess preparedness and epidemic vulnerability. 13 articles were used in this analysis, most of which were assessed on the African continent. The most widely used instruments in the articles were JEE and GHSI. Preparedness parameters that almost appeared in most of the instruments included surveillance preparedness, financing, physical infrastructure, emergency response operations, coordination, and health workforce. Regularly assessing a country's health preparedness is crucial for effective responses to health emergencies. Evaluations identify strengths and weaknesses in the health system and highlight needed improvements. Tools like the Joint External Evaluation (JEE) and WHO Toolkit focus on key areas, including surveillance, funding, infrastructure, collaboration, workforce, and emergency preparedness. These assessments enhance a nation's ability to tackle future health challenges and strengthen the global health system.

Keywords: Preparedness, Emergency, Public Health, Country, Health Crisis

1. Introduction

A health crisis can impact a country's morbidity and mortality and can even spread quickly to other countries. This situation requires every country to be prepared to deal with emergencies caused by health crises. Assessing a country's emergency preparedness involves technical aspects or resources and diverse social, cultural, and political dynamics. It is, therefore, challenging for a country to assess its preparedness because emergencies are often

unpredictable (Khan et al., 2018). Various health system preparedness assessment concepts are used to measure the preparedness of health system actors, such as health facilities, to be prepared for infectious disease outbreaks and other health emergencies.(Nuzzo et al., 2019). Preparedness assessments illustrate progress, identify gaps, inform decision-makers, and indicate where investment in preparedness is needed. (Institute, 2018).

The International Health Regulations (IHR), revised in 2005 due to the global health crisis, are designed as a key health security instrument to prevent and address significant health threats internationally. Preparedness assessments serve several important purposes. They help demonstrate progress, identify gaps, inform decision-makers, and indicate areas where investment in preparedness is necessary.(Kluge et al., 2018). More than 100 countries have adopted the Joint External Evaluation (JEE) process, and WHO assessments are now used to measure global preparedness for infectious disease outbreaks and other public health emergencies. However, the JEE only assesses a few capacities and capabilities required for health system preparedness and response. Health systems play a direct role in supporting countries' ability to respond quickly and efficiently to infectious disease outbreaks, so it is important to consider health system preparedness for these events as countries assess their overall preparedness. A framework or tool that comprehensively identifies the health system capacities and capabilities required for effective outbreak preparedness and response is needed. (Nuzzo et al., 2019). The COVID-19 pandemic at the global level shows the importance of evaluating the Government's preparedness in responding to emergencies (Meyer et al., 2020). Until 3 years have passed globally, 676,609,955 people have been confirmed infected with COVID-19, and 6,881,955 people have died (University, 2023). The emergence of these pandemics highlights new threats related to public health. Emerging disease events like this have challenges to handle because the Government must meet the high demand for resources in the community. However, this fulfillment cannot be achieved in the short term because virus transmission is unpredictable, and the virus's situation cannot be known due to its effects and weaknesses (Hossain, Akter, Rashid, Khair, & Alam, 2022). A country's emergency response capacity requires improvement to control the threat effectively (Haider et al., 2020).

Various parameters are used to evaluate and assess a country's preparedness for health emergencies. Various instruments have been developed to evaluate national and subnational (regional/local) country-specific preparedness that may only apply to some countries, given the specific characteristics of a country's health and public health emergency response system (Haeberer et al., 2021). Using data from the article search, this checklist analyzes the parameters used to assess the Government's preparedness for health crisis emergencies.

2. Method

A team of pharmacists and public health officials conducted the scoping review. Four authors (ESS, DA, PJ, SS) were responsible for data extraction and analysis.

2.1. Search strategy

Article search strategy through online search on electronic databases conducted in February - March 2024. The databases used were Proquest, Pubmed, Sage, ScienceDirect, and Scopus. The stages carried out include (a) identifying research questions, (b) identifying relevant research in predetermined databases, (c) selecting studies that match the predetermined criteria, (d) extracting and charting data, and (e) summarising and reporting results. The search used specific and uniform keywords, as in Table 1.

Table 1: Searches strings

No	Databased and Keywords
1	Proquest (n = 1.516)
	Abstract (("public health" OR "health system") AND (emergency OR disaster OR pandemic) AND (planning OR preparedness OR response) AND (evaluation OR assessment OR measurement OR tool OR toolkit OR checklist OR standard))
2	Pubmed (n = 37)
	("public health" OR "health system") AND (emergency OR disaster OR pandemic) AND (planning OR preparedness OR response) AND (evaluation OR assessment OR measurement OR tool OR toolkit OR checklist OR standard)

3	Sage (n = 1.315)
	assessment OR Evaluation OR Measurement OR tool OR Toolkit OR Checklist OR Standard AND emergency OR Emergencies OR Disasters OR Disaster OR Pandemic OR Pandemics AND preparedness OR Response AND public health OR Health System AND country OR subnational OR Regional OR government
4	ScienceDirect (n = 205)
	("public health") AND (emergency OR pandemic) AND (planning OR preparedness) AND (evaluation OR assessment OR toolkit)
5	Scopus (n = 786)
	assessment OR evaluation OR measurement OR tool OR toolkit OR checklist OR standard AND emergency OR emergencies OR disasters OR disaster OR pandemic OR pandemics AND preparedness OR response AND public AND health OR health AND system AND country OR subnational OR regional OR government

2.2. Inclusion criteria

The article search results were processed and analyzed using the Endnote X9 application. The article search criteria used included: (1) all articles related to the assessment or evaluation of government preparedness for health emergencies; (2) original research full-text written in English; (3) all design studies; (4) articles published from 1 January 2018 to 31 December 2023.

2.3. Exclusion criteria

Exclusion criteria used were (1) articles that did not contain parameters or assessments of state preparedness in facing health emergencies; (2) articles in the form of review articles, study protocols, conference paper commentaries, series, letters to the editor, news, books, guidance or other types of articles not based on primary data collection; (3) publications in non-English journals; (4) abstract only.

The total number of articles obtained from 5 databases is 3,919. After screening using the PRISMA flow diagram, selected articles were reduced due to duplication, incompatibility of titles and abstracts with themes, and screening of full text needed an instrument or component of measuring preparedness, so 13 suitable articles were obtained. (Aceng et al., 2020; Bakiika et al., 2023; Coccia, 2022; Guyo et al., 2022; Huang & Yu, 2023; Neogi & Preetha, 2020; Oppenheim et al., 2019; Sajjad, Raza, & Shah, 2022; Talisuna et al., 2019; Kyeng Mercy Tetuh et al., 2023; Ul-Haq et al., 2019; Van Hoang, Tran, Vu, & Duong, 2021; Zhao et al., 2023). The results of the article screening can be seen in Figure 1.

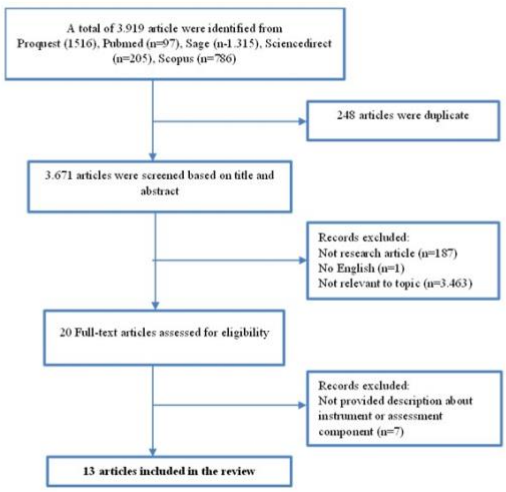

Figure 1: PRISMA flow diagram showing screening and selection of published articles

3. Results

A comprehensive search was conducted on five sources: Proquest, Pubmed, Sage, ScienceDirect, and Scopus. The results of the articles obtained were 3,919 relevant articles according to the keywords that have been determined. After screening this scoping review, 13 articles met the predetermined inclusion and exclusion criteria. The data for each study was mapped using the following headings: first author, year of publication, title, country, research objectives, research design, tools/instruments, and research results. The results of the data extraction can be seen in Table 2.

Based on the screening results, all articles (n=13) discussed government preparedness in dealing with emergencies in infectious disease hazard situations. Most of the infectious disease hazards in this article are exposure to infectious diseases such as the Ebola virus, MERS, SARS, and COVID-19. Most articles discussing indicators of a region's preparedness in facing health emergencies were published in 2023 (n=4), and the rest were divided into 2019-2022. There has been an increase in research in these years because, at that time, the global situation had just faced the COVID-19 pandemic, so an evaluation was carried out on the preparedness and preparation of a country and government to deal with emerging diseases. This pandemic event is a starting point for governments globally to evaluate how prepared their countries are in the face of disasters. The study design in this research mainly uses a quantitative approach (n=9), and the rest uses a mixed methods approach. The search results showed that 11 instruments/assessments are used to assess preparedness for health emergencies. The characteristics and explanations of each article can be seen in Table 2.

Each instrument used has parameters that become a reference for assessing the preparedness of an area in the face of a disaster or emergency. The parameters used, although different instruments and limitations and strengths of each instrument, can be seen in Table 3. In table 3 it describes the use of instruments from the reviewed articles, objectives, usage topics, scope, strength, limitation, and validity. A total of 12 articles used instruments, and one other article was analyzed without instruments. The instruments used can measure various regional, national, and global levels. Most of the instruments used in the above articles are Joint External Evaluation and WHO's toolkit for assessing health system capacity for crisis management. The indicators or parameters used in each instrument have a different number of domain items or indicators, which can be seen in Table 4.

There are 11 instruments used to assess the preparedness of an area for emergencies, especially health crises. Overall, there are no parameters that cover all instruments. Based on this data, factors commonly found as indicators in assessing the preparedness of an area in the face of a disaster can be extracted. The most common indicators include surveillance, financing, physical infrastructure preparedness, emergency response operations, coordination, and the health workforce. The different indicator domains for each instrument can be seen in Table 5.

Table 2: Characteristics of the included studies

No	Authors (year)	Title	Study design	Country	Tools	Results of the study
1.	Talisuna, *et.al* (2019)	Joint external evaluation of the International Health Regulation (2005) capacities: current status and lessons learned in the WHO African region	Quantitative	WHO African Region (47 countries)	Joint External Evaluation (JEE)	1. JEE findings are a red flag' about the inadequate public health emergency preparedness and response capacities in the WHO African region. 2. Most countries (>80%) had an IHR capacity level at score 1 (no capacity) or 2 (limited capacity) 3. There is a need to build a more robust national public health capacity and infrastructure to protect against epidemics and health emergencies
2.	Ul-Haq, *et.al* (2019)	Health system preparedness in Pakistan for crisis management: a	Quantitative	Evaluated 12 districts in Khyber Pakhtunkhwa and six	Six Core Functions of the WHO Health	1. 72% of indicators in vulnerable districts must be more prepared for crisis management. 2. None of the 16 Key Components scored at an acceptable level of preparedness

		cross-sectional evaluation study		districts in Punjab, Pakistan	Systems Framework	3. The study detected, in addition to the overall poor preparedness of the health system for crisis management, a consistent pattern of poorer performance in process, coordination, and operational aspects compared to structural elements
3.	Oppenheim, *et al.* (2019)	Assessing global preparedness for the next pandemic: development and application of an Epidemic Preparedness Index	Quantitative	188 countries	Epidemic Preparedness Index (EPI)	1. The analysis found that the most prepared countries are concentrated in Europe and North America 2. the least prepared are in Central and West Africa and Southeast Asia - regions known to have a high risk for the emergence of pathogens with pandemic potential. The capacity to detect and respond to epidemics and pandemics is weak in West and Central Africa and Southeast Asia, regions known to have a high risk for the emergence of pathogens with pandemic potential. 3. There were 36 countries with EPI cluster 1 score (most prepared) and 18 countries with EPI cluster 5 score (least prepared) out of 188 analyzed.
4.	Neogi, *et.al* (2020)	Assessing health systems responsiveness in tackling COVID-19 pandemic	Quantitative	Europe (Italy and Spain) Western Pacific (Australia, China, and Singapore), South East Asia (South Korea and India), Eastern Mediterranean (Saudi Arabia and Egypt), Americas (the USA and Brazil), and Africa (Nigeria and South Africa).	1. Global Health Security Index 2. WHO Health System Framework	1. The health systems of high-income countries are more potent than their counterparts from low- and middle-income countries. 2. As per the GHS Index 2019, the analysis indicated that no country was fully prepared for global emergencies such as pandemics. 3. The responsiveness of the countries is different from the results emerging from the assessment as per the health systems framework. 4. Analyzing the health systems shows that public health systems are much stronger in higher economies. However, that only sometimes translates into health systems' responsiveness when dealing with global health emergencies.
5.	Jane, *et.al*, (2020)	Uganda's experience in Ebola virus disease outbreak preparedness, 2018–2019	Mixed Methods	Uganda	The eleven key WHO Ebola Virus Disease Preparedness component	1. The results of the initial risk assessment show that 20 districts are at high risk and 10 districts are at medium risk for Ebola Virus Disease. 2. The preparedness assessment found that all 30 high- and moderate-risk Ugandan districts scored less than 50% for EVD preparedness at baseline.
6.	Van Hoang, *et.al* (2021)	Covid-19 Preparedness and Response Capability: A Case Study of the Primary Healthcare System	Mixed Methods	Four districts of Hanoi, Vietnam	Public Health Emergency Preparedness and Response Capabilities Framework	1. COVID-19 preparedness and response at the primary healthcare level must be consistently fully implemented or sometimes not. The results of this study revealed that in the first wave of COVID-19, primary healthcare facilities needed to prepare for prevention and control. 2. With the existing health workforce, coping with the future disease burden is impossible. 3. The role of the police and military is crucial in terms of cross-sector collaboration.

						4. A robust health information system (HIS) that is adequately funded and developed before future outbreaks can cyclically strengthen health systems, pandemic preparedness, and response capacity. 5. Enabling factors at the health system level include adequate infrastructure and equipment to respond rapidly to the COVID-19 pandemic, strong leadership from higher to lower levels, and good collaboration across public sectors (police and military engagement).
7.	Coccia, *el.al* (2022)	Preparedness of countries to face COVID-19 pandemic crisis: strategic positioning and factors supporting effective strategies of prevention of pandemic threats	Quantitative	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.	Robustness Index (r) Readiness Index/prevention (p)	1. No country is highly prepared for a significant outbreak/pandemic. 2. The best-performing countries tend to have smaller populations and better public governance associated with high health expenditure.
8.	Shahid, *et al.* (2022)	Joint external evaluation of the international health regulations (2005) capacity in South Sudan: assessing the country´s capacity for health security	Quantitative	Sudan Selatan	JEE	South Sudan's overall mean score across 48 indicators was 1.5 (with a maximum score of 4), indicating a weak health system. This could be due to the civil conflicts experienced, which have negatively impacted the health system.
9.	Sajjad, *et.al* (2022)	Assessing Response Readiness to Health Emergencies: A Spatial Evaluation of Health and Socio-Economic Justice in Pakistan	Quantitative	Province Punjab, Pakistan	Response Readiness Index (RRI)	1. There is a difference in preparedness between the southern and northern regions of Punjab, with the southern region being more vulnerable. 2. As many as 45% of indicators scored below average, including shortages of health facilities, hospital beds, health insurance coverage, and low communication and literacy levels.

10.	Tetuh, *et.al* (2023)	Evaluating event-based surveillance capacity in Africa: Use of the Africa CDC scorecard	Quantitative	African Union (AU)	Event-Based Surveillance (EBS)	1. The score results show that EBS capacity in most member countries is at a minimal (score <60%) to the average level (score 60-80%), 2. There is a need to strengthen EBS capacity in Africa to ensure preparedness for future public health threats.
11.	Huang, *et.al* (2023)	Assessment of Regional Health Resource Carrying Capacity and Security in Public Health Emergencies Based on the COVID-19 Outbreak	Quantitative	31 provinces in China 150 Country	COVID-19 Safety Index	1. The results of the two indicators reveal the weaknesses of epidemic prevention in mainland China, which will provide a strong basis for formulating epidemic prevention policies and deploying medical resources in the next round of outbreaks caused by the omicron variant. 2. There are significant differences in the financial and demographic distributions of the countries worldwide when responding to public health emergencies. 3. The physical control of the epidemic, vaccination rates, and adequate medical supplies are the most important measures to prevent and control the current epidemic. 4. The carrying capacity of healthcare resources is generally high in eastern Asia, northern Europe, and most North American and Australian regions. 5. The carrying capacity of healthcare resources could be higher in regions such as Africa, South America, and Southeast Asia, with African countries generally having low carrying capacity for healthcare resources. 6. Countries with higher HRCCs tend to be safer.
12.	Zhao, *et.al* (2023)	Evaluation of health system resilience in 60 countries based on their responses to COVID-19	Mixed Methods	1. Twenty countries with the highest number of COVID-19 deaths per million citizens. 2. Twenty countries with the lowest number of deaths. 3. Twenty countries from different regions have intermediate tolls, large populations, and very different health systems.	Health System Resilience Evaluation	1. Government governance, coordination, and prevention are essential for any country and are the most important first-level indicators. 2. Switzerland, Japan, Germany, Australia, South Korea, Canada, New Zealand, Finland, the United States, and the United Kingdom were the ten countries with the highest health system resilience. 3. The ten countries with the lowest health system resilience were (from best to worst) Liberia, Tanzania, Burundi, Mozambique, Nigeria, Benin, Côte d'Ivoire, Guinea, South Sudan, and Burkina Faso. 4. Moderate resilience levels dominated South America, South Asia, and Eastern Europe. 5. Based on data from 60 countries worldwide, the evaluation showed that increasing health system resilience will improve responses to future public health emergencies. 6. All four first-level indicators contributed to resilience and success in achieving resilience required high scores for all indicators. 7. Each indicator was needed to compensate for low scores in other indicators.

13.	Bakiika, *et.al* (2023)	Contribution of the one health approach to strengthening health security in Uganda: a case study	Mixed Methods	Uganda	Not available	1. The study demonstrated that a One Health framework was used to implement multiple activities in the National Action Plan for Health Security. 2. The National One Health Platform approach strengthened Uganda's outbreak detection, preparedness, and response for prioritized zoonotic diseases through effective multisectoral coordination and synergies decentralized to sub-national levels.

Table 3: Instruments that can be used to assess government preparedness for health crisis emergencies

No	Instrument	Objectives	Topics of usage	Scope	Strengths	Limitation
1	Global Health Security Index (GHSI) Score	Evaluate health security and capacities across 195 countries using a broad framework that includes six categories and 37 indicators.	Analysis of each country's Preparedness and response risk of pandemics or epidemics such as infectious disease outbreaks.	Country	1) Somewhat valid measure of health security; 2) Covers a wide range of countries 3) Comprehensive assessment; 4) Large number of indicators; 5) High availability of indicators that improve the comparability across nations; 6) The index is based on publicity available data ensuring transparency and objectivity 7) Assess additional variables that may influence preparedness; 8) Enabling countries to compare their health security capabilities against others	1) Some countries may be underestimated due to unavailable data; 2) Depending on public and published information, some information may not published 3) The quantitative and qualitative results are different when calculated as the arithmetic-geometric (GM) and harmonic (HM) are used 4) Have little correlation with the experience in various countries; 5) Inadequate in assessing the unique history of structuring public health responses
2.	Joint External Evaluation (JEE)	Measure a country´s status in building the necessary capacities to prevent, detect, and respond to infectious disease threats and establish a baseline measurement of capacities and capabilities.	Preparedness and Response in pandemic and other hazards	Country	1) External validation and objective measurement 2) IHR-based assessment; 3) It is accepted among WHO member states and agencies; 4) It promotes transparency, openness, and data sharing, and it serves as an objective basis for formulating National Action Plans for Health Security (NAPHS) 5) Provide various aspects of emergency response 6) Specific indicators in accurately assessing response capacity 7) Multisectoral approach 8) Evidence-based recommendations 9) Support for policy development	1) Only 90 countries have undergone joint external evaluation 2) Inadequate human resources for self-assessment in some countries. 3) Self-assessment bias 4) ERCT scores were often lower than transformed JEE scores, indicating discrepancies in the assessment of response capacity. 5) Inadequate coverage of emerging threats
3.	Index Preparedness & Index Resilience	Measuring the performance of countries to cope with	Preparedness of countries and ranking of their performance	Country	1) Simple indicators to assess the performance of countries; 2) Compare different units;	Potential bias between countries in detecting and reporting due to different approaches for counting

		pandemic threat			3) Its ability to provide comprehensive information; 4) Supporting effective vaccination plans	deaths and variations in data quality and healthcare system
4.	WHO's toolkit for assessing health-system capacity for crisis management	Assessing health-system capacity for crisis management includes evaluating and implementing to enhance health-system resilience during emergencies	Preparedness in disaster for crisis management	Country, regional	1) Include its comprehensive coverage of the six core functions; 2) Standardized assessment 3) Cover essential attributes and indicators; 4) The ability to assess readiness levels through a structured evaluation process conducted by trained personnel 5) User-friendly design 6) Support for multisectoral collaboration	1) Cannot be generalized to the entire country as the evaluation was limited to high-risk districts 2) Implementing the toolkit may require significant time and resources 3) Potential for subjectivity 4) Limited scope for emerging threat 5) Need for training
5.	Epidemic Preparedness Index (EPI)	Measure national preparedness capacity to detect and respond to future disease outbreaks	Preparedness to respond to the epidemic	Country	1) Includes non-health system factors; 2) Developed from JEE and covers 188 countries; 3) Able to update quickly the change of countries	1) Not cover disease-specific elements
6.	Response Readiness Index (RRI)	The measure of competency/incompetency of different regions in health crises based on their health system and socio-economic vulnerability	Emergency response readiness in bio-hazard and pandemic	Regional	1) The indicator data are collected from several resources; 2) Development indicators; 3) Compare indicators on the same scale; 4) Include cross-regional health and socio-economic vulnerability aspect	1) Some regions may be unavailability of the data on several health system indicators; 2) Not cover the indicator of IHR
7.	Event-based surveillance (EBS) scorecard	Monitoring, assessment, and interpretation of primarily unstructured ad hoc information regarding health-related events or risks that may represent an acute risk to human, animal, plant, or environment health	Detection and reporting of capacity needed for outbreak	Country	1) Addressed several gaps such as early capturing, tracking, analysis, and reporting of public health events 2) Used a multisectoral approach 3) Integrating several sources at different levels of the system. 4) Comprehensive evaluation framework	1) Potential biases in self-reporting 2) Lack of comprehensive support components for Early Warning Systems (EBS) implementation 3) Focus on national levels 4) Gaps in sensitivity
8.	COVID-19 Safety Index	Evaluate and analyze various aspects of decision-making, economic evaluation, water	Preparedness for epidemic risk and guide future epidemic prevention	Country Regional	1) shown significant correlation results with the performance of resistance to epidemics 2) Reliable and objective approach for assessing epidemic safety indexes	1) Inconsistency in the statistical caliber of medical resources in each country

		resources management, human resources evaluation, and disease forecasting models.					
9.	Public Health Emergency Preparedness and Response (PHEPR) Capabilities Framework	to assess and enhance the prepared ness public health systems' readiness to effectively respond to emergencies.	Preparedness to respond to emergencies	Count ry Sub-region al/loca l	1) Comprehensive evaluation framework 2) Evidence-based practices 3) Multisectoral collaboration 4) Support for policy development 5) Easily adjustable system to different contexts and types of emergencies	1) Complexity of the system 2) Fragmented research and funding 3) Insufficient evidence base 4) Communication challenges 5) Limited access to data
10.	The eleven key WHO Ebola Virus Disease Preparedness Component	To enhance the readiness of countries to effectively respond to potential Ebola outbreaks.	Preparedness to respond to Ebola outbreaks	Count ry	1) Objective Evaluation 2) Multisectoral coordination 3) International Collaboration: collaboration between WHO teams and Ministries of Health in at-risk countries	1) Key reference documents such as guidelines, training manuals, and guidance notes to support the implementation of key activities for each component. 2) Snapshots of dynamic situations 3) Reliance on previous experience 4) Limited risk assessment 5) Lack of adequate data and analyses
11.	Health System Resilience Assessment Analysis	To assess health system resilience the world with a quantitative evaluation system	to assess differences in health system resilience in response to COVID-19 across countries.	Count ry	1) It is easier because the assessment only consists of 4 domains. 2) Developed from WHO indicators of six building blocks. 3) A resilient health system can respond effectively to epidemics. 4) Provide strong national protection and reduce the negative impact of the epidemic. 5) Our results show that all four first-level indicators contribute to resilience and that success in achieving resilience requires high scores for all indicators; more than one indicator is required to compensate for low scores on the others.	1). The indicators are limited, so other factors are not analyzed despite contributing to a country's resilience. 2) The study focuses only on quantitative analysis, not including qualitative analysis, which could provide additional insight into the contextual factors influencing each country's response.

Table 4: Indicators used in each of the Health Crisis Emergency Preparedness Assessment Instrument

Global Health Security Index (GHSI) Score	Joint External Evaluation (JEE)	Epidemic Preparedness Index (EPI)	Response Readiness Index (RRI)	Health System Resilience Assessment Analysis	Health System Resilience Assessment Analysis
1. Prevention	1. Prevent		1. Health System		1. Government

a. Antimicrobial resistance
b. Zoonotic disease
c. Biosecurity
d. Biosafety
e. Dual-use research and the culture-responsible science
f. Immunization

2. Detection and Reporting
a. Laboratory systems strength and quality
b. Laboratory supply chains
c. Real-time surveillance and reporting
d. Surveillance data accessibility and transparency
e. Case-based investigation
f. Epidemiology workforce

3. Rapid Response
a. Emergency preparedness and response planning
b. Exercising response plans
c. Emergency response operation
d. Linking public health and security authorities
e. Risk communication
f. Access to communications infrastructure
g. Trade and travel restrictions

4. Health System
a. Health capacity in clinics, hospital, and community care centers
b. Supply chain or health system and healthcare workers
c. Medical countermeasures and personnel deployment
d. Healthcare access
e. Communication with healthcare workers during a public health emergency

a. National, legislation, policy and financing
b. IHR coordination, communication and advocacy
c. Antimicrobial resistance
d. Zoonotic disease
e. Food safety
f. Biosafety and biosecurity
g. Immunization

2. Detect
a. National laboratory systems
b. Real time surveillance
c. Reporting
d. Work force development

3. Respond
a. Emergency preparedness
b. Emergency response operations
c. Linking public health with security authorities
d. Medical countermeasures and personnel deployment
e. Risk communication

1. Other IHR Hazards and points of entry
a. Points of entry
b. Chemical events
c. Radiation emergencies

1. public health infrastructure
a. surveillance
b. immunization
c. medical workforce
d. hospital capacity
e. coordination

2. physical infrastructure
a. water and sanitation
b. roads
c. phones
d. internet
e. logistics

3. institutional Capacity
a. political stability
b. corruption
c. bureaucratic effectiveness
d. armed conflict
e. homicide
f. vital registration

4. economic resources
a. government revenue generation
b. per capita income
c. gross domestic product
d. health spending
e. resource dependency

5. public health comunications
a. public education
b. risk communication

a. Health facilities
b. Number of beds
c. Immunization
d. Access to improved sanitation
e. Sustainable access to improved water
f. Health insurance
g. Mortality rate per 100
h. Hygiene behavior

2. Societal Conditions
a. Total population
b. Population density
c. Literacy rate
d. Access to internet
e. Ownership of assets
f. Access to mobile phone
g. Poverty
h. Acess to electricity
i. Registered as permanent resident
j. Average household size
k. Household dependency ratio

1. Community resilience
a. Community preparedness
b. Community recovery

2. Incident management
a. Emergency operations coordination

3. Information management
a. Emergency public information and warning
b. Information sharing

4. Countermeasures and mitigation
a. Medical material management and distribution
b. Medical countermeasure dispensing and administration
c. Nonpharmaceutical interventions
d. Responder safety health

5. Surge management
a. Fatality management
b. Mass care
c. Medical surge
d. Volunteer management

6. Biosurveillance
a. Public health laboratory testing
b. Public health surveillance and epidemiological investigation

Governance and Prevention
a. Government effectiveness
b. E-government
c. Statistical capacity
d. Information technology
e. Emergency preparedness
f. Stringency index
g. Monitoring and testing

2. Health financing
a. National health expenditure
b. Population health expenditure
c. Insurance coverage

3. Health service provision
a. Health institution
b. Hospital bed
c. Medical access
d. Health coverage
e. Health care
f. Health service supply pressure

4. Health workforce
a. Surgeon
b. Physician
c. Nurse
d. Pharmacist
e. Biomedical technicians

f. Infection control practices
g. Capacity to test and approve new countermeasures

5. Compliance with international norms
a. IHR reporting compliance and disaster risk reduction
b. Cross-border agreement on public health emergency response
c. International commitments
d. Completion and publication of WHO JEE and the OIE PVS
e. Financing
f. commitment to sharing genetic and biological data and specimens.

6) Risk environment
a. Political and security risk
b. Socioeconomic resilience
c. Infrastructure adequacy
d. Environmental risks
e. Public health vulnerabilities

Index Preparedness & Index Resilience	**WHO's toolkit for assessing health-system capacity for crisis management**	**Event-based surveillance (EBS) scorecard**	**COVID-19 Safety Index**	**The eleven key WHO Ebola Virus Disease Preparedness Component**
1. Average mortality rate 2. Hospital occupancy rate per 100,000 people 3. Intensive care unit occupancy rate per 100,000 people 4. COVID-19 vaccination vaccine dose 5. Number of vaccines administered per 100,000 people	1. Health service delivery 2. Health Workforce 3. Health information system 4. Essensial medicines 5. Health financing 6. Governance	1. Surveillance and digital intelligence 2. Information system 3. National laboratory systems and Networks 4. Preparedness and response 5. Public health research and institutes 6. Legislation 7. Finance 8. Workforce 9. Strategic plan 10. Structure	1. Density of medical technicians 2. Density of nursing and midwifery personnel 3. Density of medical doctors 4. Healthcare access and quality index 5. Vaccination rate 6. Average of 13 international health regulations core capacity scores	1. Coordination and leadership 2. Surveillance and Laboratory 3. Case management, Infection Prevention and Control 4. Risk Communicatio n, social mobilization, and community engagement 5. Vaccination and operational research 6. Logistics

		7. Domestic general government health expenditure (GGHE-D) as a percentage of general government expenditure (GGE) 8. General government receipts 9. General government expenditure (GGE) 10. Population density 11. Ageing rate	7. Strategic Information, Research and Innovation 8. Ecological/anthropological studies/investigations 9. Mental Health and Psychosocial support 10. Budget 11. Monitoring and evaluation

Table 5: Differences in each indicator on each preparedness assessment instrument

No	Parameter/indicators	Index Preparedness Index Resilience	Global Health Security Index (GHSI) Score	Joint External Evaluation (JEE)	WHO's toolkit for assessing health-system capacity for crisis management	Epidemic Preparedness Index (EPI)	Response Readiness Index (RRI	Event-based surveillance (EBS) Scorecard	COVID-19 safety index	Public Health Emergency Preparedness and Response Capabilities Framework	WHO Ebola Virus Disease (EBV) Preparedness	Health System Resilience Assessment
1	mortality rate per 100	✓					✓					
2	Hospital occupancy rate	✓										
3	Intensive care unit occupancy rate	✓										
4	Immunization/vaccination rate	✓	✓	✓		✓	✓		✓		✓	
5	The number of vaccine doses administered	✓										
6	physical infrastructure	✓	✓			✓	✓				✓	
7	social condition	✓	✓				✓		✓	✓		
8	Health insurance	✓					✓					✓
9	Antimicrobial resistance	✓	✓	✓								
10	Zoonotic disease	✓	✓	✓								
11	Biosecurity	✓	✓	✓								
12	Biosafety	✓	✓	✓								
13	Food safety	✓		✓								
14	chemical events	✓		✓								
15	radiation emergencies	✓		✓								
16	Research/public health research and institute	✓	✓					✓			✓	
17	Governance and leadership	✓		✓	✓							✓

18	Legislation	✓		✓				✓					
19	Policy	✓		✓									
20	Institutional Capacity/political stability	✓	✓			✓							
21	Economic resources	✓	✓			✓			✓				✓
22	Financing/budget	✓	✓	✓	✓			✓				✓	✓
23	Coordination	✓		✓		✓						✓	
24	Communication	✓	✓	✓									
25	Advocacy	✓		✓									
26	Laboratory	✓	✓	✓				✓		✓		✓	
27	Surveillance	✓	✓	✓		✓		✓		✓		✓	
28	Reporting	✓		✓									
29	Emergency Preparedness	✓	✓	✓				✓					✓
30	Emergency strategic/planning	✓	✓					✓				✓	✓
31	Emergency response operations	✓	✓	✓				✓		✓		✓	
32	Linking public health with security authorities	✓	✓	✓									
33	Information management	✓								✓			
34	Public awareness and community engagement	✓				✓						✓	
35	Risk communication	✓	✓	✓		✓						✓	
36	Public education	✓				✓							
37	Trade and travel restrictions	✓	✓										
38	Medical countermeasures and personnel deployment	✓	✓	✓						✓			
39	Surge management	✓								✓			
40	Health capacity in clinics, hospitals, and community care centers	✓	✓			✓							✓
41	Health facilities	✓					✓						✓
42	number of beds	✓					✓						✓
43	Supply chain/ Essential Medicine/logistics	✓	✓		✓							✓	✓
44	Health service delivery	✓			✓								
45	Healthcare access	✓	✓						✓				✓
46	Infection control	✓	✓									✓	✓

47	Capacity to test and approve new countermeasures	✓	✓								✓
48	Health workforce	✓			✓	✓		✓	✓		✓
49	Health information system	✓			✓			✓		✓	✓
50	Compliance with international norms and IHR Score	✓	✓						✓		
51	Environmental risks	✓	✓							✓	
52	Public health vulnerabilities	✓	✓								
53	point of entry	✓		✓						✓	
54	Mental health and psychosocial support									✓	
55	Monitoring and Evaluation									✓	✓
56	Stringency index										✓

4. Discussion

Monitoring the risks and vulnerabilities of a region, whether a country or a city/district, needs to be done regularly. This monitoring is necessary to ensure that each region, government, and community is prepared for emergencies such as health crises. Monitoring in the face of emergencies is necessary to identify weaknesses and strengths of the health and disaster preparedness system. The assessment results are helpful to illustrate and become a reference for decision-making in formulating strategies to improve a region's response to emergencies in the future. The results of this literature search indicate that 11 assessments or measurement tools can be used to assess preparedness at both the country and regional levels for emergencies. This study summarizes the various instruments or assessments to evaluate preparedness and looks at what indicators or factors are the parameters of preparedness. This can determine what factors make up the majority of emergency preparedness assessments, especially in emerging disease situations.

The most common instruments or assessments in the literature search above are the JEE and WHO's toolkit for assessing health-system capacity management. The JEE covers 19 technical areas: national policy, coordination, risk communication, epidemiological surveillance, and emergency response (Kentikelenis & Seabrooke, 2021). The JEE assesses a country's ability to fulfill International Health Regulations (IHR) and preparedness for global threats. The assessment can be done by a country's self-assessment, which conducts a comprehensive evaluation of the country's Health system in its capacity for prevention, detection, and response to epidemics and pandemics, as well as an external assessment from a team that will conduct an in-depth evaluation and provide recommendations. (Nguyen et al., 2021). WHO is Six Building Blocks, an important tool to assess and strengthen a country's health system. Although it has the same purpose, this system analyses the health system as a whole. It is divided into six main components: health service delivery preparedness, health workforce, health information system, essential medicines, health financing, and governance. The assessment is conducted in more depth for each block and evaluated based on specific indicators to see the strengths and weaknesses of the health system. (Organization, 2010). The difference between the two assessments can be seen if the JEE provides recommendations to provide a country's health preparedness capacity so that it can develop action plans against global threats, while the Six Building Blocks model is to develop health policies and improve the efficiency and effectiveness of health services because it assesses the whole health service. (Fall et al., 2023; Organization, 2023). Therefore, if a country evaluates with both, it can complement each other in preparing the country for a health crisis and strengthening the health system to increase global health security.

The most significant number of assessment parameters is found in the GHSI, which assesses preparedness and ability to deal with global health threats, including pandemics and epidemics. This indicator consists of 6 categories and 37 indicators developed to encourage the acceleration of improving national health security and international capabilities in addressing the most dangerous health risks, namely infectious disease outbreaks that can cause international epidemics and pandemics (Nuclear Threat Initiative, 2021). The results of the assessment using the GHSI index in 2019 in 195 countries show that no country is ready to face the threat of future epidemics and pandemics. Each country's national Health security needs to be stronger, and no country is fully prepared for an epidemic or pandemic. However, some studies show the GHSI has poor predictability and does not meet the needs of policymakers in society (Kaiser, Chen, & Gluckman, 2021).

The indicators or factors in each measurement become parameters that need to be prepared in each country in the face of emergencies. In general, the preparedness parameters most valued as factors that need to be prepared in an emergency are surveillance and financing preparedness. Instruments that include these two indicators as aspects of preparedness in dealing with emergencies are the assessment instruments using the Preparedness Index and Resilience Index, GHSI, JEE, EBS, and WHO EBV. In addition, parameters that often appear include physical infrastructure preparedness, emergency response operations, coordination, and the health workforce.

Surveillance is important in early detection, rapid response, and resource management. This aspect needs to be guaranteed to provide information related to emergencies and impacts, allowing a country to intervene more quickly before the disaster becomes more severe (Sukardi, Kataren, Rohana, Dachi, & Tarigan, 2022). Data obtained from the surveillance process helps in planning and decision-making, such as allocating resources more efficiently, designing health programs, and developing responsive policies. A robust surveillance system will enhance a country's ability to respond quickly and effectively to emerging health challenges. (Khatri et al., 2023). Then, the financing aspect plays an important role too because it is a source of preparing health resources (McMahon, Peters, Ivers, & Freeman, 2020). Financial resources are a necessary indicator in the event of a disaster because they can fulfill the pandemic preparedness needs. The government should have a long-term vision of financial resources, as the ongoing impact of the pandemic affects the country's budget collection sources. (Boyd, Wilson, & Nelson, 2020). Governance is only effective if there is money to pay for health workers, medicines, and hospitals; all factors can help access them (Ajisegiri, Chughtai, & MacIntyre, 2018).

Health infrastructure also plays an important role in preparing to reduce the impact of the health crisis. Any development in an area must also consider the potential risk of future disasters. Careful planning can make facilities available and ready to deal with emergencies more effectively (Hassan et al., 2023; Radford et al., 2024). Emergency response operations also play an important role in a country's preparedness for a health crisis. This is because preparing for the next epidemic or pandemic is important, as well as knowing the risk factors so that public health and medical emergency plans can be coordinated and activated effectively and timely. In an emergency such as this, it is seen that Rapid Response, Detection, and Reporting have the most impact (Chang & McAleer, 2020; Hassan et al., 2023). One of its greatest strengths in health service delivery is immediate notification following early detection and confirmation of a case. Improving health system resilience is the most fundamental approach to infectious disease prevention and control. In Indonesia, the government delayed the public health emergency response to avoid a sizeable economic impact, and as a result, had the highest number of confirmed cases in March 2020 in Southeast Asia. This exacerbated a significant imbalance in access to health services. (Olivia, Gibson, & Nasrudin, 2020). In managing a country's emergency preparedness, effective cross-sector coordination is essential. The synergy of various agencies can respond quickly to emergencies. The coordination that is formed can equalize perceptions and strategies in dealing with disasters, thereby reducing the risk of overlapping responsibilities (Arslan, Golgeci, Khan, Al-Tabbaa, & Hurmelinna-Laukkanen, 2021). The role of the government and laws and regulations related to outbreak control is very important, including cross-sector cooperation, and serves to sanction violations in pandemic control. (Van Hoang et al., 2021). Good coordination across sectors can ensure that the country is ready to face future health challenges.

Another factor widely valued as a parameter of preparedness is related to the preparedness of health workers. Health workers are a fundamental part of the health system; they perform duties that include carrying out medical research to improve disease prevention, diagnosis and treatment, clinical consultation, and provision of care to safeguard each patient. In practice, health workers are closely related to communication because they act as allies in dealing with the pandemic, especially in raising awareness among the public and fighting the stigma associated with the disease. (Aceng et al., 2020). Health workers face a more significant and stressful workload than usual during an epidemic, so they must be more resilient and adapt quickly to the changing situation (Chen et al, 2020). When faced with a public health crisis, health workers are often the first to respond. Adequate mobilization and coordination of health workers and medical supplies can significantly reduce mortality (Hanefeld et al, 2018).

Evaluating pandemic preparedness and control globally is important because each country has very different policies and practices depending on country-specific conditions. Adapting, validating, and routinely improving the validity of tools in health systems is an important process in disease control and prevention (Tran et al., 2022). Few preparedness assessment tools are available electronically and are user-friendly in facilitating participant and stakeholder data collection, analysis, dissemination, and discussion of results. This should be one of the drivers for developers to produce assessment tools in a more user-friendly manner (Haeberer et al., 2021). The findings in this study also illustrate a need to improve the current tools, such as proposing new fields to develop new tools with parameters customized to country-specific conditions, especially for infectious disease control. Further research is needed to develop specific domains for each country's priorities, given that most current tools may be broad. For example, some important variables for epidemic preparedness, such as community variables (e.g., population density, community interaction, or coverage of different protective measures) and individual factors (e.g., knowledge-attitude-practice, social networks, or trust in government), should be included and measured (Kundu et al., 2021).

5. Conclusion

Regularly monitoring the preparedness of a country and its respective regions is vital to ensure a swift and effective response to health crisis emergencies. This comprehensive assessment not only sheds light on the existing strengths and weaknesses of the health system but also identifies specific strategies that need to be implemented for improvement. Various measurement tools, such as the Joint External Evaluation (JEE) and the World Health Organization's (WHO) Toolkit, can be used to conduct a thorough evaluation. These tools are critical in gauging a country's capacity to prevent and respond to epidemic and pandemic situations. Several key factors are assessed as parameters of preparedness for health crises, including the preparedness of surveillance systems to detect and monitor outbreaks, the availability of sufficient financing to support health initiatives, the robustness of healthcare infrastructure, the effectiveness of cross-sector coordination, the adequacy of the health workforce, and the overall emergency response preparedness capabilities. A preparedness evaluation enhances a nation's ability to tackle future health challenges. Such evaluations bolster individual countries' health systems and strengthen the global health infrastructure, ensuring a more resilient response to upcoming health threats.

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