

Developing an Emergency Medical Services Resilience Assessment Tool in Climate Change: A Study Protocol

Abstract

Background: Climate change poses significant threats to the health and safety of communities worldwide. Extreme weather events can disrupt critical infrastructure and overwhelm emergency medical services (EMS) systems. As the frequency and intensity of these climate-related disasters continue to increase, it is essential that EMS organizations develop robust strategies to enhance their resilience. One important step in building climate-resilient EMS systems is the development of comprehensive assessment tools. Developing a comprehensive tool for assessing the resilience of EMS in the face of climate change. **Methods:** This research employs an applied, mixed-methods approach to investigate the development and validation of the Emergency Medical Services Resilience Assessment (EMSRA) tool. The study will be executed across four key phases: (a) A scoping review will be conducted to identify the global dimensions and components of EMS systems that demonstrate resilience to the impacts of climate change. (b) A qualitative study, involving semistructured interviews, will be undertaken to explore the specific dimensions and components of EMS resilience within the Iranian context. (c) Based on the findings from the scoping review and qualitative inquiry, assessment items related to EMS resilience in climate change will be extracted and synthesized to develop a pilot version of the EMSRA tool. (d) The pilot EMSRA tool will undergo a rigorous process of quantitative and qualitative validation, including an evaluation of its psychometric properties, to assess the resilience of EMS systems in the face of climate-related challenges. **Conclusions:** The development of EMSRA tool will enable the assessment and enhancement of climate change resilience within the national and provincial EMS systems, providing critical data to inform evidence-based strategies and plans for strengthening EMS against the impacts of severe climate changes.

Keywords: Assessment tool, climate change, emergency medical services, resilience

Introduction

The impacts of climate change present substantial threats to the health and wellbeing of populations globally.^[1] Extreme weather events can disrupt critical infrastructure and overwhelm emergency medical services (EMS) systems. As the frequency and intensity of these climate-related disasters continue to increase, it is essential that EMS systems develop robust strategies to enhance their resilience.^[2] One important step in building climate-resilient EMS systems is the development of comprehensive assessment tools.^[3] Climate change represents a global public health emergency with implications for access to care and disruptions in EMS.^[4] The Intergovernmental Panel on Climate Change classifies climate change into two categories: extreme weather events,

such as hurricanes and flash floods, and gradual weather events, such as sea-level rise and reduced access to fresh water resources.^[5] Given the expected escalation in the severity and prevalence of climate change and its impact on the healthcare system, it is crucial to adequately prepare EMS to respond to the rising demand for emergency medical services and ensure their continued provision. EMS, with a focus on acute care, plays a pivotal role in caring for patients affected by climate change.^[6] One immediate consequence of climate change for EMS is an increase in the number of emergency missions.^[7,8] As the first healthcare providers in emergency situations, Emergency Ambulance Services (EAS) are integral to the healthcare delivery system. Understanding the effects of climate on the demand for EMS is critical for formulating health and treatment policies and providing care

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to individuals before adverse climatic conditions occur. Reports indicate that the demand for emergency medical services is increasing in various countries due to the effects of climate change. Therefore, comprehending the effects of climate change can assist healthcare system policymakers in adapting to sudden and unexpected surges in demand for EMS when resources may be limited. For instance, some studies have employed predictive systems based on weather forecasts to anticipate the demand for EMS over a 7-day period, demonstrating that the demand increases with climate change.^[9] Such predictive systems can aid EMS managers in delivering timely and effective responses.^[10] Nevertheless, it seems that a few studies worldwide have explored the relationship between climate change and the demand for EMS.^[11] Strategic planning for extreme climate events and their impact on the healthcare system necessitates tailored adaptations within each country. Adaptation requires changes in the fundamental and social systems that support the healthcare system. Consequently, the structures and organizations within the health system, as well as communities and individuals, must adapt to climate change.^[7] Resilience, defined as the ability of organizations and societies to cope with crises, threats, and sudden shocks, has gained prominence in the context of climate change adaptation, disaster risk management, and sustainable development.^[12] In the field of pre-hospital emergency care, resilience is of paramount importance as these units are consistently confronted with emergency events and sudden shocks related to climate change. Consequently, building resilience within EMS to provide emergency medical services in response to climate change has become a focal point for policymakers, researchers, and emergency responders.^[13] One important step in building climate-resilient EMS systems is the development of comprehensive assessment tools.

Therefore, the aim of the current research will be developing an EMS resilience assessment tool in climate change.

Objectives

1. To identify the global dimensions and components of EMS systems that exhibit resilience to the impacts of climate change.
2. To explore the specific dimensions and components of EMS resilience within the Iranian context.
3. To extract assessment items related to EMS resilience in climate change and develop a pilot version of the EMSRA tool.
4. To validate the EMSRA tool, including an evaluation of its psychometric properties, to assess the resilience of EMS in the face of climate-related events.

Method and Materials

Study design

The aim of the present research is to develop an EMSRA tool in climate change. In this study, the term “climate change” encompasses the effects of extreme weather events, including both cold waves and heat waves, on EMS. The research is of an applied nature, and in terms of methodology, it adopts a mixed study design. The study will be conducted in four stages, with the findings of each stage informing the subsequent stages [Figure 1].

Data collection and analyses

Phase 1: Scoping review

Identifying the dimensions and components of EMS resilience to climate change globally by using scoping review.

A scoping review, also known as a mapping review, consists of six steps. Scoping review involves systematically updating the literature on a topic by identifying key

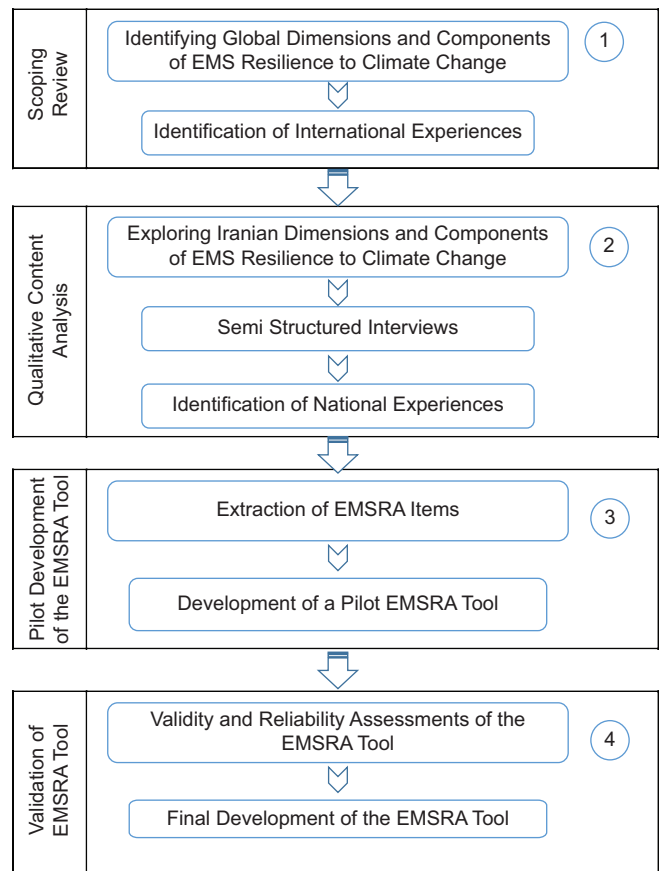


Figure 1: Study Phases

concepts and definitions, theories, sources, and evidence of activities in the field.^[14]

A scoping review is a secondary study to synthesize the findings of original research studies. The scoping review method is a good way to find answers to the questions “What?” and “why?” It is in a specific subject area. The reasons for using a scoping review study include expressing the generality of the subject and identifying its key concepts such as definitions, conceptual models, and evaluation indicators. It also involves drawing a literature map of the relevant subject, identifying the research methods used in the desired field, and examining the nature and scope of the research conducted and research evidence produced. Additionally, the purposes of a scoping review are to enable purification and dissemination of research findings, identify and analyze research gaps in relevant subject literature, and determine the necessity of conducting such a review. A scoping review, like a systematic review, uses a structured process and a systematic search method, but it does not have some of the limitations of a systematic review, such as evaluating the quality of the reviewed articles. Also, scoping review is not limited to peer-reviewed original research articles and includes gray literature such as organizational reports, abstracts of conference articles, theses, and review articles. As a result, it examines more sources in less time.^[15] In fact, this type of study leads to the generation of research hypotheses, unlike a systematic review study that tests a hypothesis.^[16]

Study population

The study population for this research will encompass a variety of sources, including articles, studies, books, work guides, reports, and instructions related to EMS resilience to climate change. These sources will be considered if they are published in either English or Persian.

Research sample

For this stage of the research, the research sample will consist of published articles specifically addressing EMS resilience to climate change since the year 2000. Additionally, gray literature, books, reports, and guidelines related to EMS will be included as part of the research sample.

Research environment

Five English databases, namely, Google scholar, PubMed, Scopus, ProQuest, and Web of Science, will be utilized. In addition, three Persian databases, including SID, Iranmedex, and Magiran, will be accessed. The search will also extend to the Google and Google Scholar search engines. The research environment will encompass various resources, such as rules and regulations, meeting minutes, administrative documents, and other accessible sources.

Data collection tools

A checklist, developed by the researcher, will be employed as the data collection tool to extract relevant information from the identified resources. To manage the collected resources, EndNote and Mendeley software will be utilized. These tools will facilitate the organization and documentation of the retrieved resources for further analysis and evaluation.

Data collection method

The data collection for this research will involve searching the databases and search engines mentioned earlier. To develop an effective search strategy, the following keywords have been identified in consultation with subject matter experts, respected professors, and advisors.

Search strategy

The keywords will include both English and Persian equivalents, and additional terms suggested by experts during the research process will also be considered. The keywords are as follows:

Climate change, Climate disaster, Climate crisis, Climatological disaster, Prehospital emergency, Emergency medical services, EMS, Resiliency, and Adaption

The identified keywords, along with any additional relevant terms, will be combined using Boolean operators to form the search strategy for this study. The search strategy will follow a systematic approach in order to retrieve relevant and comprehensive information for analysis and evaluation [Table 1].

Inclusion and exclusion criteria

The inclusion criteria for articles in the study are as follows:

1. Full-text availability.
2. Articles written in either Persian or English.
3. Studies, books, work guides, reports, and related instructions, including gray literature.
4. Articles published since 2000.

The following criteria will be used for exclusion:

1. Studies that do not address the impact of climate change on EMS.
2. Studies that do not provide sufficient details on the design and development of tools for assessing the resilience of EMS systems.

The identified studies will undergo evaluation as part of the search process. Articles having inclusion criteria will be selected for the main review based on a sequential assessment of the title, abstract, and full text, following the guidelines provided by the PRISMA checklist.

It is important to note that this search strategy will be continuously refined and improved throughout the research process. At each stage, the working method

Table 1: Search strategy for scoping review

Database/ Search engine	Search Strategy
Google scholar	(“Adaptive capacity” OR Adapt OR Cop* OR Resilienc*) AND (“Climate change” OR “global warming” OR “increased greenhouse gas emission*” OR “temperature change” OR “climate crisis” OR “climate emergen*” OR “global heating” OR “global heat*” OR “climatological disaster”) AND (“Prehospital emergency care” OR “Emergency Medical Services” OR EMS OR “Emergency Ambulance Service*” OR Emergency Health Service*” OR “Prehospital Emergenc*”)
PubMed	(Adaptive capacity OR Adapt OR Coping OR Resilience) AND (Climate change OR global warming OR increased greenhouse gas emissions OR temperature change OR climate crisis OR climate emergency OR global heating OR climatological hazard OR climate disaster) AND (Prehospital emergency care OR Emergency Medical Services OR EMS OR Emergency Ambulance Services OR Emergency Health Services OR Prehospital Emergency)
Scopus	(ALL ("Adaptive capacity" OR adapt OR cop* OR resilienc*) AND ALL ("Climate change" OR "global warming" OR "increased greenhouse gas emission*" OR "temperature change" OR "climate crisis" OR "climate emergen*" OR "global heating" OR "global heat*" OR "climatological disaster") AND ALL ("Prehospital emergency care" OR "Emergency Medical Services" OR ems OR "Emergency Ambulance Service*" OR emergency AND health AND service* " OR " prehospital AND emergenc*))
ProQuest	noft (Adaptive capacity OR Adapt OR Coping OR Resiliency) AND noft (Climate change OR global warming OR increased greenhouse gas emission OR temperature change OR climate crisis OR climate emergency OR global heating OR global heat OR climatological disaster) AND noft (Prehospital emergency care OR Emergency Medical Services OR EMS OR Emergency Ambulance Services OR Emergency Health Services OR Prehospital Emergency)
WOS	Adaptive capacity OR Adapt OR Coping OR Resilience (Topic) AND Climate change OR global warming OR increased greenhouse gas emission OR temperature change OR climate crisis OR climate emergency OR global heating OR global heat OR climatological disaster (Topic) AND Prehospital emergency care OR Emergency Medical Services OR EMS OR Emergency Ambulance Services OR Emergency Health Services OR Prehospital Emergency (Topic)

and results will be documented for final evaluation and reporting.

Data analyzing method

The data analysis method employed at this stage is qualitative content analysis, specifically using the thematic analysis approach. The objective of this analysis is to identify the dimensions and components of EMS resilience to climate change worldwide. The resulting data from this analysis will be utilized in the subsequent stages of the study, specifically for designing semistructured interview questions in the second stage and developing an initial tool in the third stage. All searched articles and documents will be entered into MAXQDA20 software and analyzed through thematic analysis.

Phase 2: Semistructured interviews

Qualitative research is a set of activities such as open interview and semistructured and in-depth interview in research activities, each of which somehow helps the researcher in obtaining first-hand information about the subject under investigation. The information collected in these researches is mainly verbal and textual, analytical-perceptual, and classified descriptions. In other words, qualitative researches are more suitable for understanding and explaining social phenomena, especially in researches whose main problem is multidimensional and the subject of the study is dynamic in nature.^[17] It identifies the gap between what they know and what they should know.

Researchers wish to gain a deeper understanding of health care financing, organization, service delivery, and care outcomes. Policymakers, researchers, and managers in the health system can benefit from the descriptions of contexts and structures for a deeper understanding of what happens in the practical environments of health care delivery.^[18] Therefore, the research at this stage will be conducted in a qualitative way and semistructured interviews.

Study population and research sample

The target population for this research will comprise two groups of participants. The first group will consist of individuals with professional work experience and management responsibilities within the field of EMS, including managers from EMS and the Ministry of Health, Treatment, and Medical Education, as well as officials and clinical staff from EMS centers. These participants will provide valuable insights into their experiences and challenges related to building a resilient EMS structure in the face of climate change.

The second group will include researchers and subject matter experts in the domains of climate change, public health, and resilience at the national level. The study population will specifically include participants from the provinces of Isfahan, Chaharmahal and Bakhtiari, Kashan, and Yazd as these regions represent the diverse climatic conditions prevalent across Iran.

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Sampling

The sampling method employed in this stage will be purposive sampling, aiming to increase diversity among the participants. Additionally, snowball sampling will be utilized as a supplementary method to enhance the quality of the data. Sampling will continue until data saturation is achieved, meaning that new participants will be selected until no new information or insights are obtained from the interviews.

Inclusion criteria

The selection of participants for this stage of the study will be based on:

- Emergency medical technicians (EMTs) with at least 3 years of experience.
- EMTs should have experience of at least one mission in extreme climate events.
- EMS managers with at least 3 years of experience in emergency management.
- Experts and researchers in climate change (extreme weather) and health who have studied in a related field or have published articles.
- Their willingness to participate in the study.

Exclusion criteria

- Participants who are not willing to participate: Individuals who are not willing to participate in the study or do not provide informed consent will be excluded.
- Participants who do not complete the interview: Participants who do not complete the interview or do not provide sufficient data will be excluded.
- Interviews that are incomplete or of poor quality: Data that are incomplete, inconsistent, or of poor quality will be excluded from the analysis.

Data collection tools

Given the semistructured nature of the interviews and the need to incorporate theoretical foundations into the study, a data collection tool (Interview guide) will be developed. This tool will be compiled based on a review of the findings from the first stage of the research, along with input from experts, supervisors, and advisors. The tool will guide the interviews and ensure that relevant information is collected in a systematic manner.

Data analysis

The method of data analysis at this stage is framework analysis, where all interviews conducted after implementation are entered into MAXQDA20 software and then coded and analyzed in the framework extracted from the previous stage.

Phase 3: Items extraction

In the third step of the research, the data obtained from the previous stages, including the dimensions and components of EMS resilience to climate change at the global and

Iran levels, will be combined. Under the supervision of supervisors and advisors, a pilot version of the assessment tool for assessing EMS resilience will be developed.

The design of this assessment tool will entail extracting relevant items or indicators that capture the diverse dimensions and components of EMS resilience. These items will be derived from the findings gathered in the earlier stages and will be carefully selected to ensure comprehensive coverage of the resilience construct. The tool will be designed in a format that allows respondents to rate or provide responses to each item, thereby enabling the quantification of resilience levels.

Phase 4: Validation

Given the complex and multidimensional nature of the problem and the need for confirmation of the assessment tool, the next step focuses on validating the developed tool. Validation methods will be employed to ensure the tool's reliability and validity.

The validation process will involve the following steps:

1. Face validity: Qualitative methods will be used to determine face validity, which assesses the extent to which the tool appears to be suitable and relevant for assessing EMS resilience to climate change. Experts and relevant stakeholders will review the tool and provide feedback on its clarity, comprehensibility, and relevance.
2. Content validity: Both qualitative and quantitative methods will be utilized to determine content validity, which evaluates the extent to which the tool adequately covers the dimensions and components of EMS resilience. Qualitative methods, such as expert reviews and feedback, will be employed to assess content relevance. Additionally, quantitative measures, such as the content validity ratio (CVR) and content validity index (CVI), will be calculated to determine the level of agreement and representativeness of the items.

The questionnaire items are reviewed by the research team to determine comprehensibility, appropriateness, or possible ambiguity in the meaning of the items, and they are cross-checked by experts to make changes in the questionnaire. The questionnaire items are rated on a 5-point Likert scale (absolutely important, somewhat important, moderately important, somewhat essential, and not at all important), and the final score will be calculated using the following formula:

$$\text{Impact Score} = \text{Frequency (\%)} \times \text{Importance.}^{[19,20]}$$

Experts will be consulted to check grammar, suggest correct words, specify the importance of questions, and arrange of questions in order of importance while filling the developed tool.

Content Validity Ratio (CVR): Experts are asked to review each item based on the spectrum of the three

parts “necessary,” “useful but not necessary,” and “not necessary,” and the items are calculated using Lawshe’s method.^[21]

$$CVR = \frac{n - (\frac{N}{2})}{\frac{N}{2}}$$

In this formula,

n: is the number of specialists who have chosen the necessary option.

N: the total number of specialists.

Content Validity Index (CVI): Experts are asked to rate the three criteria of relevance or specificity, simplicity and fluidity, and clarity or transparency using a four-part Likert scale. For example, to measure the relevance of the options, not relevant = 1, relatively relevant = 2, relevant = 3, and completely relevant = 4 are used. Then, the content validity index is calculated using the CVI formula. Based on previous research, the appropriate CVI value for each item (I-CVI) can be considered greater than 0.79. All the items, whose CVI value is less than this value, are removed. In the next step, the average CVI of the whole instrument (Ave/CVI-S) is calculated based on the mean values of the CVI of all questionnaire items. Polite and Beck recommended a value of 0, 9, or higher for approval.^[22]

3. Reliability: Two approaches will be used to determine reliability. Internal consistency, which assesses the degree of interrelatedness among the items, will be measured using Cronbach’s alpha (alpha coefficient). This indicates the extent to which the items within the tool consistently measure the same construct. Stability or test–retest reliability will also be assessed to determine the consistency of measurements over time.

Internal consistency demonstrates how well the tool’s many aspects agree. The internal consistency is determined by splitting it and comparing the two halves of the instrument or by computing the Cronbach’s alpha coefficient.^[22]

The questionnaire’s stability is measured over time for obtaining external reliability. In this regard, time intervals for test–retest reliability of questionnaire will be 10 days. The term “stability” refers to subjects providing the same findings across time, and the extent of change over time is referred to as stability. As a result, an instrument’s stability is assessed over time.^[22,23] To determine the stability of the final questionnaire, parallel (identical) and precisely the same forms were employed in this investigation. The dependability estimate of the parallel method renders the same output as Cronbach’s alpha. Cronbach’s alpha is used in the model, although it is derived from the difference between the means of the questions.^[24]

Discussion

Building resilience in EMS is crucial to ensure their ability to adapt and provide efficient services during severe climate crises. Climate change can disrupt the provision of timely emergency medical services and hinder the ability to respond effectively to climate-related emergencies. One important step in building climate-resilient EMS systems is the development of a comprehensive assessment tool. The development of this assessment tool will enable the assessment and enhancement of climate change resilience within the national and provincial EMS systems, providing critical data to inform evidence-based strategies and plans for strengthening EMS against the impacts of severe climate changes.

Study limitation

The most important limitation of this research and ways to reduce its effects include the following:

It will be difficult to access the participants to collect information due to the dispersion of people in the country, which can be moderated by holding virtual meetings.

Ethics and dissemination

Ethical approval for this study was granted by the Research Ethics Committee of Isfahan University of Medical Sciences (IR.MUI.REC.1402.035) (<https://ethics.research.ac.ir/IR.MUI.REC.1402.035>). The study findings will be presented to Iran’s Ministry of Health, published in a peer-reviewed journal and disseminated through social media and presentations at national or international conferences related to disaster management and the healthcare sector. Individuals will participate in the study if they consent. We will ensure the participants that all information, without the names and details of the participants, would be analyzed and published. Participants have the right to withdraw from the partnership at any time. Owing to the use of English texts and articles in different stages of the study, researchers will consider fidelity in translation.

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Conflicts of interest

There are no conflicts of interest.

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