



Factors Affecting the Functional Preparedness of Hospitals in Response to Disasters: A Systematic Review

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ABSTRACT

Objective: This study aimed to comprehensively determine the factors that affect the hospitals' functional preparedness in response to disasters.

Methods: A systematic review of studies published in English and Persian up to the end of 2022 was performed by searching PubMed Central, Web of Science, Scopus, ProQuest, SID, and Elmet databases. Articles that assessed hospitals' functional preparedness were searched by using a combination of medical subject heading terms and keywords including disaster, emergency, preparedness, hospital preparedness, health care facilities preparedness, hospital functional preparedness, health care facilities functional preparedness, readiness, and effective factors. Additionally, journals and gray literature were manually searched. Two independent reviewers screened the eligible papers. The inclusion criteria were the full text should be published up to the end of 2022, in both Persian and English, and focus on hospital preparedness. The extracted data were manually analyzed, summarized, and reported using the content analysis method.

Results: Of the 3465 articles, 105 studies were eventually included in the final analysis. Eighty-two influential factors were identified and classified into seven categories: government, coordination, control, and commanding (7 factors), existing guidelines and preparedness plans (12 factors), regulations (6 factors), supplying of resources (37 factors), education and training (8 factors), multi-layered information management and communication systems (8 factors), and contextual factors (4 factors).

Conclusion: There are different dimensions of hospital preparedness for disasters, each of which is influenced by several independent factors. Addressing these factors will enhance the actual functional preparedness of hospitals encountering disasters.

Keywords: Disasters; Hospitals; Emergencies; Workforce.

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Introduction

Nowadays, disasters degrade a major portion of a country's resources and affect human life by interfering with community functions [1-3]. Regardless of political borders, some disasters immediately claimed more than thousands of lives [4, 5]. According to the World Health Organization (WHO), disasters can occur at any time and are dangerous. However, there is a clear lack of interest among individuals and authorities, and there is inadequate motivation to prevent disasters [6-10]. Communities have made substantial progress, however, it is still impossible to completely prevent disasters [11]. In addition, disaster effects have increased in both frequency and intensity in recent years [6], which has resulted in millions of deaths and the loss of billions of dollars [12-15].

The main prerequisites in response to disasters are the responsibility and preparedness of all community components. One of the essential sectors of any disaster response is health care provider organizations. Evidence suggests that the effective organization and management of healthcare facilities in the time of a disaster have a significant impact on reducing mortality and complications [6]. Therefore, the necessity for healthcare system preparedness is undeniable [12].

Hospitals, as the initial medical service providers [6], play a more vital role in reducing complications and casualties by providing fast and efficient treatment services [16, 17]. Hospitals' safety and preparedness are required to provide services in times of disaster. Therefore, in addition to being resistant to disasters, destruction, and disruption in function, hospitals should provide services with maximum capacity during disasters [18]. The functional preparedness of the hospitals enables them to perform their regular duties and respond to a large number of victims and injured [19, 20]. Preparedness includes a set of pre-disaster measures to ensure appropriate and effective responses to disasters [21].

Hospital preparedness is usually investigated and evaluated in three categories including structural, non-structural, and functional. Previous studies mainly evaluated structural and non-structural areas, and the functional field was overlooked [22, 23]. This is while the low level of functional preparedness of hospitals is reasonable. The first step in enhancing preparedness is to recognize the factors that affect functional preparedness. Accordingly, the present study was designed to perform a systematic

evaluation of the literature and extract the factors affecting the functional preparedness of hospitals to deal with disasters.

Materials and Methods

The search strategy was developed with the assistance and supervision of a specialist. A literature search was performed using electronic databases such as PubMed Central, Web of Science, Scopus, ProQuest, SID, and Elmnet. The search was performed using a combination of medical subject heading (MeSH) terms and keywords. The keywords included "disaster, emergency, preparedness, hospital preparedness, health care facilities preparedness, hospital functional preparedness, health care facilities functional preparedness, readiness, and effective factors" (Table 1).

There was no time limit. However, a keyword search was restricted to titles and abstracts. The search strategies were adjusted to the specific features of each database. The majority of the existing relevant publications were searched in Google Scholar. To ensure maximum coverage of the literature, the list of the selected article references and gray literature were also searched. The inclusion criteria were full text should be published up to the end of 2022 in Persian and English, and focused on hospital preparedness. Abstracts of articles published at conferences, articles that were not related to hospitals, and papers focusing on hospital staff preparedness were all excluded. Two members of the study team independently screened the articles. First, two researchers reviewed the titles and eliminated the unrelated titles. Any inconsistencies were resolved by a third researcher. Following the removal of irrelevant titles, the abstracts were evaluated again by two researchers, and unrelated articles were excluded. Finally, the full text of the remaining articles was assessed. The final evaluation included the relevant articles and the influential factors on the functional preparedness of hospitals. The quality of all selected articles was assessed by two researchers using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist. At the discretion of the research team members, four relevant checklist items related to the case and cohort studies were removed from the checklist, and finally, 18 items were evaluated. The mean scores of 0 to 12, 12 to 24, and 24 to 36 were considered poor, average, and good, respectively.

Table 1. An example of a search syntax for PubMed

#1:	((((disaster [Title/Abstract]) OR (emergency [Title/Abstract])) AND (preparedness [Title/Abstract])) OR (hospital preparedness [Title/Abstract])) OR (health care facilities preparedness [Title/Abstract])) OR (hospital functional preparedness [Title/Abstract])) OR (health care facilities functional preparedness [Title/Abstract])
#2:	((((disaster [Title/Abstract]) OR (emergency [Title/Abstract])) AND (readiness [Title/Abstract])) OR (hospital readiness [Title/Abstract])) OR (health care facilities readiness [Title/Abstract])) OR (hospital functional readiness [Title/Abstract])) OR (health care facilities functional readiness [Title/Abstract])
#3:	#1 AND #2

Two researchers performed the initial evaluation process on five articles to establish a consensus. The remaining studies were then assessed independently by each evaluator. Finally, the ambiguous cases were referred to a third person with more expertise in the research methodology. A data extraction form was manually designed in Microsoft Office Word 2019.

The information about the title, author, journal, year, country, study design, setting, participants, criteria, and influential factors were extracted. Based on these forms, data from five studies were experimentally retrieved to address the weaknesses and problems of the initial form. Finally, two researchers independently extracted the data. Using content analysis, the extracted data were manually analyzed, summarized, and reported using content analysis.

Results

Totally 3465 articles were found through database search processes (PubMed: 2123, Scopus: 358, ProQuest: 345, Web of Science: 277, Elmnet: 84, and SID: 278). Of them, 612 were eliminated due to redundancy. After an assessment of the titles and abstracts, 2680 studies were excluded. Following the full-text review, 67 articles were removed. In addition, in the quality appraisal stage, one paper was excluded. Finally, 105 articles were included in the systematic evaluation (Figure 1).

The majority of the studies were conducted in the United States, Iran, Italy, Sweden, and Saudi Arabia. Based on the content analysis results, 83 influential factors were retrieved and classified into seven categories. Table 2 summarizes the list of identified influential factors.

Government, Coordination, Control, and Command

Coordination, control, and command were among the most often mentioned factors that affected the hospital's preparedness. Making the appropriate provisions both inside and outside of hospitals, as well as arranging bilateral and multilateral inter-organizational memos to share available resources and facilities is considered critical and can have an impact on the level of preparedness. Improving internal relations is dependent on the presence of the unity of command principles, the establishment of a single control line and a chain of command, conflict reconciliation, defining duties and responsibilities, and developing policies for employing hospital staff.

Guidelines and Preparedness Plans

In the reviewed articles, planning was identified as one of the most critical and hospital-specific factors affecting the hospitals' preparedness. It is possible to achieve the desired level of preparedness with comprehensive results-based planning and attention to existing and expandable capacities.

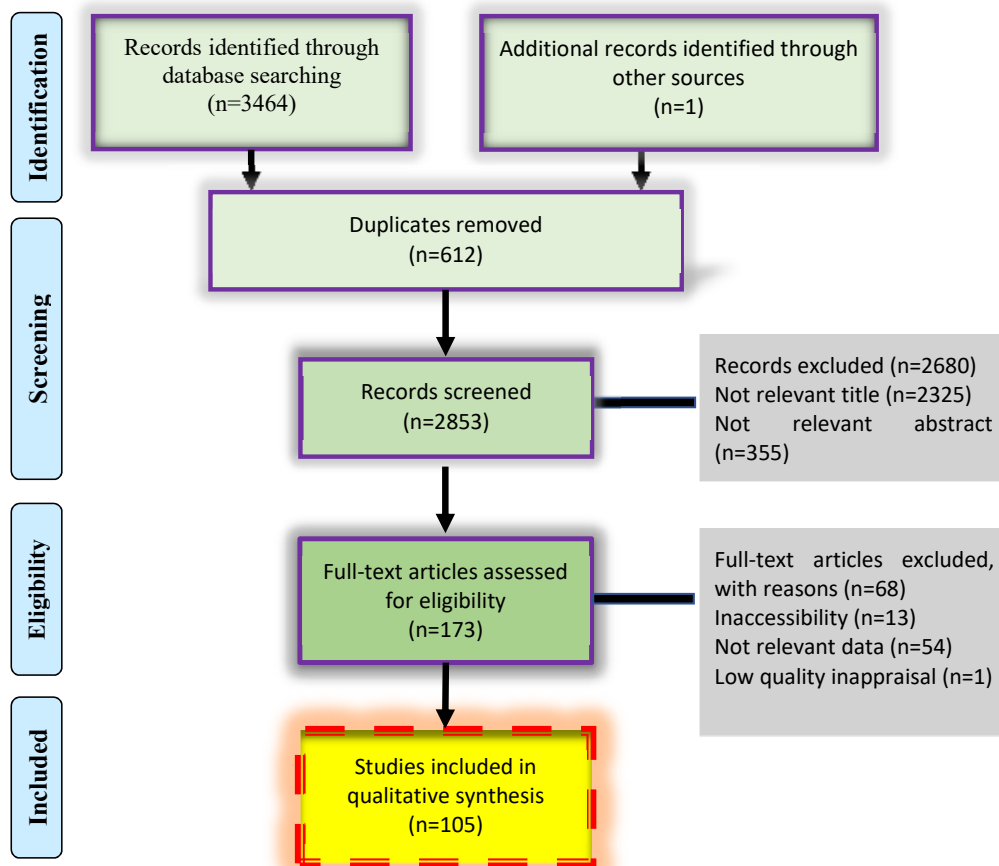


Fig. 1. PRISMA flow diagram of the search strategy and included studies.

Due to the multiplicity of risks and consequences, all potential risks and health issues should be incorporated into a hospital preparedness plan as realistically as possible at different national, regional, and local levels. In this category, various aspects of the planning program were addressed including the development of the Emergency Operation Plan (EOP), the existence of Standard Operating Procedures (SOP), and updating and revising hospital preparation plans, documents, and plans. Protocols and instructions, in addition to preparation programs, are required. Integrating protocols and instructions with SOP is crucial for identifying, prioritizing, and consolidating essential functions and ensuring consistency in implementing these procedures.

Regulations

Effective disaster management requires acceptance and commitment to risk reduction and safety improvement by senior managers. The existence of national, regional, and local hazard management laws, the integration of preparation plans in the curriculum of different academic disciplines, and the provision of adequate legal authority for hospital disaster managers were all considered effective in facilitating the implementation of preparedness programs.

Resource Supply

Resource supply was another important category

of the most influential factors in the hospital's functional preparedness. This category consisted of 37 influential factors classified into six subcategories, including supply of required equipment, providing the necessary supplies, providing facilities and infrastructure, anticipating and supplying human resources, supporting response operations, and emergency financing. These resources included laboratory supplies and equipment, imaging and personal protection equipment, hospital beds, medicines, food, and disinfectants, reliable systems to vital routes and their supports, space for emergency evacuation, helipad facilities, ventilation, cooling, and heating systems and their supports, backup personnel to support the main forces, Disaster Medical Assistance Team (DMAT), setting up a system for recruiting personnel, concluding emergency procurement and support contracts, and financing.

Education and Training

Personnel education and training played a significant role in the functional preparedness of hospitals. Additional factors in this category were holding general and specialized training courses for the staff, justification, functional and full-scale training, using simulators to hold exercises and training through knowledgeable individuals, using online and virtual training if necessary, teaching ethical and legal obligations, and utilizing the capabilities of the volunteers.

Table 2. Identified effective factors on hospitals' functional preparedness

Classification of affective factors	Examples (code)
Governance, coordination, control, and command	Establishing an incident command system (chain of command)
	Signing bilateral and multilateral agreements
	Carrying out internal and external coordination
	Setting up a coordination and management center
	Defining responsibilities of all stakeholders
	Launching a unified command and management unit
Existing of guidelines and preparedness plans	VIP management
	Hazard-specific management guides
	Hospital response guides
	SOP ^a and MSDS ^b
	Triage and prioritization of the injured
	Patient referral and distribution protocol
	Existing of contingency plans
	Business/services continuity protocols
	Disaster Command System Activation Protocol
	Evacuation protocol
	Updated Comprehensive hospital preparedness plans
Compilation of emergency response plan	
Existing post-disaster recovery plan	
Regulations	Existence of policies guiding disaster preparedness
	Providing sufficient legal authority for hospital disaster managers
	The commitment to risk reduction and safety promotion by senior managers
	Requiring hospital managers to design and implement preparedness plans through accreditation programs
	Applying the all-hazard policy
	Integration of preparedness plans in the curriculum of academic disciplines

Supplying of resources	Supplying equipment	Supply and storage of personal protective equipment
		Supply and storage of hospital beds
		Supply of portable laboratory
		Anticipating and providing imaging facilities and backup systems
	Providing supplies	Medicine supply and storage
		Food supply and storage
		Consumables medical supplies and storage
	Providing facilities and infrastructure	Reliable communication systems and multilayer backup systems
		The reliable power supply system and backup systems
		Reliable fuel supply system and fuel backup systems
		Reliable water supply system and water support systems
		Reliable blood supply systems and blood support systems
		Supplying of hospital surge capacity requirements
		Disinfection facilities
		Physical space for emergency evacuation
		Infrastructure for utilizing helipad features
		Supplies and equipment storage infrastructure
		Facilities and space for isolation and quarantine
		Morgue facilities
		Hazard detection and early warning systems
		Ventilation, cooling, and heating systems and support systems
		Space and equipment to store dead bodies
		Waste management systems and backup systems
		Anticipating emergency access routes to hospitals
	Reliable fire extinguishing system	
	Anticipating and Supplying Human Resources	Estimating the required human resources and workforce supply
		Anticipating backup personnel for core forces
		Setting up DMAT ^a teams
		Setting up a personnel recall system
	Supporting response operation	Staff well-being and psychosocial supports
		Signing purchase and support contracts in case of emergency
Developing programs for volunteers' involvement		
Emergency financing	Anticipating the process of resource mobilization	
	Anticipating and providing an emergency budget	
	Anticipating and providing budget Surplus	
	Foreign financing programs	
Financing preparedness programs	Financing preparedness programs	
Education and training of personnel	Educating and improving staff knowledge	
	Holding periodic and specialized training sessions	
	Holding functional, and full-scale exercises	
	Improving the managerial capability of personnel	
	Improving the risk understanding of staff and managers	
	Teaching ethical and legal issues	
	Using simulators to conduct exercises	
	Training and empowerment of volunteers	
Multilayer information and communication systems	Radio communication system and backup system	
	Hospital information system and backup system	
	Patient and wounded tracking system and responding to clients	
	Anticipating and providing the location for journalists and media	
	Setting up telemedicine systems and backup systems	
	Providing facilities for using GPS and GIS and smart applications	
	Developing an early warning system	
	Updating the main contact numbers and personnel support	
Contextual factors	Socioeconomic status of the community	
	Developing short-term and long-term strategies to improve the situation of the community in different aspects	
	Cultural considerations	
	The development status of the community	

^aSOP: Standard Operation Procedure; ^bMSDS: Material Safety Data Sheet; ^cDMAT: Disaster Medical Assistant Team

Information Management and Multilayer Communications Systems

The functional preparedness of hospitals depends on the preparation and provision of infrastructure related to information and communication technologies. This category emphasizes various issues, such as hospital information systems (HIS), radio communication systems, patient and injured tracking systems, responding to clients, telemedicine systems and support systems, anticipating and providing the location of reporters and media, providing GPS and GIS and smart applications facilities, and updating the primary contact numbers and staff support.

Contextual Factors

Out of 82 factors affecting the functional preparedness of hospitals in response to disasters, four factors were related to underlying factors: the socio-economic status of the community, the development of short- and long-term strategies to improve community status in various aspects, cultural considerations, and the development status of the community.

Discussion

A systematic literature review was used to identify the factors influencing hospitals' functional preparedness through a systematic literature review. Based on the analysis of included studies, coordination, control and command, guidelines and preparedness plans, regulations, resource provision, education and training, multilayer communication and communication management systems, and contextual factors were found to be factors affecting the functional preparedness of hospitals in response to disasters. The most important factor that affected the functional preparedness of hospitals and proper disaster management was adequate coordination. Efficient management and proper organization of hospitals in emergencies played a critical role in optimal performance [24, 25]. Many studies emphasized the necessity of establishing and operating coordination systems [26] as well as the formation of a single headquarters to deal with disasters effectively.

WHO considers coordination as the primary axis of providing health services in disaster situations, and thus, proposes new approaches to enhancing coordination [27]. Manitoba also found that coordination between different institutions and organizations was essential, and attributed the accomplishment of a disaster management program to the coordination of involved organizations and their activities before, during, and after emergencies [28]. Improvement in hospital preparedness depends on hospital staff performing their tasks coordinately [29], which requires, first and foremost, the mental and psychological readiness of staff as well as stress

management for those involved [30]. However, poor communication and coordination within and outside organizations lead to parallel work, rework, waste of resources, high human casualties, and physical injuries [31]. The most significant advantages of a disaster unit's coordination, control, and command are setting goals and integrated disaster strategies, ensuring a joint plan for tactical and operational activities based on disaster objectives, and ensuring integration of activities, commitment, and optimal use of all allocated resources [32, 33]. The ability of hospitals to enter into cooperative agreements and utilize the capabilities of other organizations can also play an influential role in improving their functional preparedness [34].

An efficient preparedness strategy is to increase hospitals' capacity for rapid response and prompt treatment of disaster-related patients [35]. In order to handle all types of disasters, it is necessary to develop EOP and its availability. Comprehensive annual planning for maneuvers and training at different levels, as well as SOP complementing these programs, are also required [36]. The development of clear and precise protocols, and instructions, ongoing program updating, and raising awareness of all executive agents at different levels with the details of programs all contribute to the successful implementation of preparedness plans [6, 37]. In contrast, the failure of preparedness programs is sometimes caused by a lack of attention to parameters such as lack of financial resources, and time constraints.

Factors related to laws and regulations provided the basis for enhancing the functional preparedness of hospitals [6]. For instance, the integration of preparedness programs in the curriculum of different academic disciplines effectively transferred sufficient knowledge and skills to the hospital staff before disasters and resulted in the institutionalization of the preparedness concepts and their potential strengthening [38-41]. However, removing legal barriers and developing appropriate mechanisms, such as granting some legal authority and mandating hospital managers to implement preparedness programs, could be a great method to enhance the hospitals' functional preparedness.

Factors related to the provision of resources were identified as the most critical factors. Allocation of a sufficient budget [6] for anticipating, storing, and updating equipment, supplies, and medicines will improve the hospital's response capacity and functional preparedness in the event of an unexpected surge in demand [42-46]. Several studies emphasized the importance of standard physical space concerning capacity surges [22]. They received insufficient attention from those in charge due to the high expenditures associated with them [47]. According to different references, one of the main concerns of hospital managers was the proper management of human resources as the most

critical organizational assets [48, 49]. This is why, when compared to ordinary conditions, hospitals experience a scarcity of human resources in critical situations [50]. It seems that proper organization and utilization of volunteer potential were effective in resolving the aforementioned issues.

Stronger support of functional response appeared to reduce disaster fatalities [51]. An adequate and integrated organizational structure was one of the strategies for making the optimal use of available resources and achieving predetermined objectives [52]. In this field, many protective and security measures were taken within and outside of the hospital, which had a synergistic effect in conjunction with other identified influential factors [53].

Another important factor was education and training. According to WHO, lack of knowledge was one of the main reasons for the high rate of disaster injuries [54]. Planning and implementing education programs for staff, patients, and companions was one of the most cost-effective approaches to preparedness in various fields [53, 55]. The priority is obviously the education of senior hospital executives and disaster managers [56, 57]. The findings of the majority of studies indicated that if the training is accompanied by retraining and periodic preparation maneuvers, it will have a more significant impact on hospital preparedness [58-60]. Knowledge of disasters and risk perception are effective in proper disaster management [61]. The poor performance of hospital committees in convening meetings on time [62] and failure to specify job descriptions are practical instances of how disaster preparedness is being reduced [63, 64]. In this respect, it is crucial to strengthen the target group's knowledge, skills, and awareness of educational programs [65].

The existence of information and communication systems to manage a disaster is undeniable, and one of the ways to use the available resources is to expand and develop communication systems and their methods [66]. The existence of required and essential telephone numbers in the disaster command center, which is constantly updating, is another practical factor in the expansion of communications [67, 68]. In addition to employees' internal and external communication, the absence of a proper mechanism for employees to communicate with families is one of the significant weaknesses in the communication sector [69]. Due to the significant impact of disasters on information and communication management systems, reliable and efficient support systems can efficiently address issues with communication devices and systems and promote hospitals' responsiveness [70, 71].

According to previous studies, there was a direct relationship between development and comprehensive

disaster preparedness planning [71, 72]. The damage caused by disasters will significantly be reduced, if planners are involved in developing short- and long-term strategies, and utilizing all available resources [72]. Given that the issue of functional preparedness of hospitals includes a wide range of measures and interventions, we attempted to utilize broad and comprehensive keywords.

Investigation of numerous databases, the absence of a time limit, and a comprehensive search were the most significant strengths of the present study, which increased the validity and reliability of its findings. The main limitation was that only English and Persian papers were included in the study, and a significant number of relevant studies in other languages were excluded.

In the aftermath of disasters, one of the most fundamental necessities of individuals is health care services. Since hospitals are the first place to give health care services, they must be prepared for such circumstances. A wide range of independent factors influences hospital preparedness in many ways. Hospitals must be prepared to respond efficiently to disasters and carefully consider all the influential factors. In this study, 82 factors affecting the preparedness of hospitals were identified. The findings can assist decision-makers in hospitals respond to disasters more efficiently by establishing appropriate goals and strategies and implementing relevant measures.

Declaration

Ethics Approval: This research was approved by the ethics committee of Tabriz University of Medical Sciences (ethics approval code: IR.TBZMED.REC.1398.133.)

Consent for Publication: Not applicable.

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