

Research Paper

Preparedness Assessment of Teaching Hospitals Affiliated With Shahid Beheshti University of Medical Sciences in Response to Biological Incidents



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ABSTRACT

Background: During disasters and emergencies, healthcare systems, particularly hospitals, as the leading providers of care, play an important role; accordingly, this study examines the preparedness of hospitals affiliated with Shahid Beheshti University of Medical Sciences for biological incidents.

Materials and Methods: This descriptive cross-sectional study assessed the preparedness level of 14 teaching hospitals in response to biological incidents in 2022. The preparedness of the hospitals in facing biological incidents was evaluated by the secretaries of the hospitals' risk and disaster management committees using a standard questionnaire (hospital preparedness questionnaire in response to biological incidents) to assess different dimensions of hospital preparedness, including the development of managerial structures, capacity building, training and practice, information and communication management, healthcare system and laboratory, safety and security, patient management, and hospital resilience.

Results: The assessment of different hospital preparedness dimensions in facing biological incidents showed that the mean scores of the managerial structure development, capacity building, training and practice, information and communication management, safety and security, healthcare system and laboratory, patient management, and hospital resilience were 20.12, 44.71, 14.14, 19.21, 46.64, 20.42, 27.42, 15.92, respectively. The highest score was related to safety and security and information and communication management, with average scores of 50.78 and 22, respectively. Also, the dimension of training and practice, with an average score of 16.28 and an average percentage of 64.29%, attained the lowest score among the eight dimensions of hospital preparedness. The net score of hospital preparedness in response to biological incidents was obtained at 230.28. According to the final score of hospital preparedness, 9(64.3%) hospitals had a good preparedness status, while 5(35.7%) hospitals acquired an average level of preparedness.

Conclusion: The preparedness of the investigated hospitals in response to biological events was favorable. However, coping with biological incidents mandates the highest level of preparedness; therefore, it is necessary to maintain good preparedness and try to improve the condition to an optimal level by focusing on all dimensions, especially those acquiring lower scores.

Keywords:

Hospital emergency services,
Biological incidents, Disasters,
Emergency preparedness

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Introduction

Biological hazards refer to events that can endanger human health, among which are microorganisms or toxins derived from biological sources that can be used in bioterrorism to propagate infectious diseases in a society [1]. Regarding the type and source, biological hazards can be classified into natural, accidental, and intentional categories [2]. Natural biological hazards cause epidemics, pandemics, and emerging infectious diseases, which can be associated with a considerable death toll in different societies [3].

In recent decades, fatal pandemics of infectious diseases have been on the rise at a global scale [4, 5], causing the world to witness various biological incidents in different regions, some of which lead to global biological disasters. The Ebola epidemic in 2014 in East Africa [6], the outbreak of severe acute respiratory syndrome in 2002 in more than 40 countries [7], and the HIV epidemic has affected people worldwide for years [8, 9]. Examples of global biological incidents include the influenza virus pandemic in 2009, claiming the lives of more than 300 000 people worldwide [10]. Meanwhile, the COVID-19 pandemic has been a global health threat since 2019 [11]. Biological hazards are considered severe threats to societies and health systems by imposing enormous financial and social burdens; therefore, the potential ramifications and costs of not being prepared to face such events can be significant and beyond repair [12].

In response to biological disasters at the national level, health systems, especially hospitals, are considered the primary providers of care and play the most important roles [13]. When a biological incident occurs, vital community services must support people in the initial moments and hours. The existence of skilled and knowledgeable specialists and employees, along with having the necessary infrastructure and facilities to manage biological incidents and use them in the early stages (golden time), can significantly reduce the deaths and injuries caused by biological incidents [14].

Improving hospital preparedness in response to biological incidents is one of the main concerns of health system managers. Disaster preparedness is an essential area of study in all parts of society that instructs the public on preparing for man-made and natural disasters. Preparedness in response to threats, especially biological hazards, consists of several components, including analyzing the status quo, planning, building an organizational framework, information documentation systems,

basic resources, early warning systems, training, and conducting exercises. All those responding to biological incidents should pay special attention to preparedness as one of the most critical components of hospital disaster management. Hospital preparedness is an essential part of every emergency management plan to deal with all possible biological hazards, such as biological incidents, bioterrorism threats, emerging infectious diseases, and epidemics [15]. The lack of implementing standards or guidelines for preparing healthcare centers impedes effective planning for biological incidents [13, 16]. Accordingly, assessing hospitals' preparedness in facing biological incidents is an essential step to increasing the capacity and power of hospitals in dealing with such events. Recognizing the gaps and shortcomings in hospitals' performance can help identify strengths and weaknesses, ultimately leading to better preparation for biological incidents [17, 18]. In addition, preparedness in response to disasters augments health systems and their resilience in providing health services. Therefore, a quick and appropriate response to such incidents can be crucial in mitigating their adverse effects on physical health and psychological status [19]. Most studies in the field of hospital preparedness in Iran have only focused on assessing the functional, structural, and non-structural preparedness of healthcare centers in response to disasters. However, far too little attention has been paid to hospitals' preparedness assessments in response to biological incidents. This study investigates hospital preparedness in response to biological incidents in the hospitals affiliated with [Shahid Beheshti University of Medical Sciences](#). The data obtained from this study can draw a perspective for health policymakers and managers in future planning to prevent the challenges faced by hospitals and empower them in issuing effective local and national responses to biological incidents.

Materials and Methods

This descriptive cross-sectional study assessed the preparedness level of hospitals affiliated with the [Shahid Beheshti University of Medical Sciences](#) for biological incidents. A total of 14 hospitals of this university were selected by the census method. The hospitals investigated possessed 3260 beds and were among COVID-19 referral centers in Tehran City, Iran.

To assess hospital preparedness in response to biological incidents, a structured questionnaire (hospital preparedness questionnaire in response to biological incidents) was used. This questionnaire developed by Aminizadeh et al. [20] is used to investigate the level of hospital preparedness in response to biological inci-

dents. This questionnaire contains 147 items under three sections (capacity, ability, and competency), eight main categories, and 20 subcategories, including management structure development (planning, organization, legal requirements), capacity building (structure, drug management, medical equipment and supplies, and employees and volunteers), training and practice (education, training, and maneuvers), information and communication management (communication and information during disasters, communication and coordination), healthcare and laboratory system (laboratory diagnosis capacity, early warning system, and syndromic surveillance system), safety and security (environmental safety and health, infection safety, prevention, and control), patient management (biological triage, diagnosis and treatment management, and corpse management), and hospital resilience (functional continuity, essential support services). The inter-evaluator and intra-evaluator reliability of this tool were investigated using the Intra-class correlation coefficient (ICC), rendering the values of 0.92 and 0.94, respectively. The tool's mean content validity index was reported at 0.92 [20]. These findings confirmed the high reliability and validity of this questionnaire in determining hospital preparedness in response to biological incidents. In this questionnaire, a 3-point Likert scale (always, sometimes, never) was used, and the experts should have specified the correct option according to available documents. Finally, the score of each subscale was calculated by summing up the scores of its items, and the overall score was the sum of the subscales' scores. Then, the final score obtained from the questionnaire was converted into a percentage, which was used as a basis for comparing and interpreting the level of preparedness of different hospitals. The minimum and maximum scores obtained from this questionnaire were 0 and 294, respectively [20]. At last, the final score of the questionnaire was calculated and interpreted as follows: For a preparedness level in response to biological incidents of <0.33 (a score between 0 and 98), the hospital's level of preparedness was regarded as poor; for the levels of preparation between 0.33 and 0.66 (a score between 98 and 197) and >0.66 and close to 1 (a score higher than 197 and close to 294), the level of hospital preparation was interpreted as moderate and satisfactory, respectively. Different dimensions of hospital preparation in response to biological incidents and their score ranges are provided in Table 1. In the present study, the questionnaire was completed in two stages.

Stage one: Internal assessment (self-reporting)

Internal assessment was performed by the secretaries of the risk and disaster management committees of hospitals with sufficient expertise in crisis management and hospital preparedness assessment. First, a training session was held in which the objectives and phases of the study were explained to the participants, and they were trained on how to complete and score the questionnaires used in the study. Accordingly, we ensured that all people gathering the data were sufficiently trained. The first checklist used was related to the hospital's specifications under study (i.e. the type of hospital, number of beds, number of annual admissions, number of employees, variety of services, intensive care unit beds, isolation rooms, etc.). The secretaries were educated on collecting this information by interviewing employees in different hospital wards and relevant departments. The second part of the training was related to completing the hospital preparedness in response to the biological incidents questionnaire. At this phase, all evaluators became acquainted with different parts of the questionnaire and their scoring instructions. After training, the secretaries were requested to review the documents, processes, and resources available in their hospitals and to complete different parts of the hospital preparedness questionnaire by interviewing authorities in various wards.

Step two: External assessment (verification)

Internal assessment by the hospital's personnel may be subject to false results. As a result, to validate the data and determine the conformity of the effects of internal evaluators with the results of neutral evaluators, the external assessment was performed by the researchers. In other words, external assessment was considered to increase the rigor of the data and assessments. For this purpose, the preparedness of the hospitals was again carried out by three researchers of this study (an expert in healthcare services management, an occupational health and safety specialist, and a specialist in health in disasters and emergencies), similar to the internal assessment. All these people had sufficient expertise in crisis management and hospital preparedness assessment. The hospital preparedness questionnaire was completed using the documents available in the hospitals, and the final score of the hospitals' preparedness in response to biological incidents was calculated.

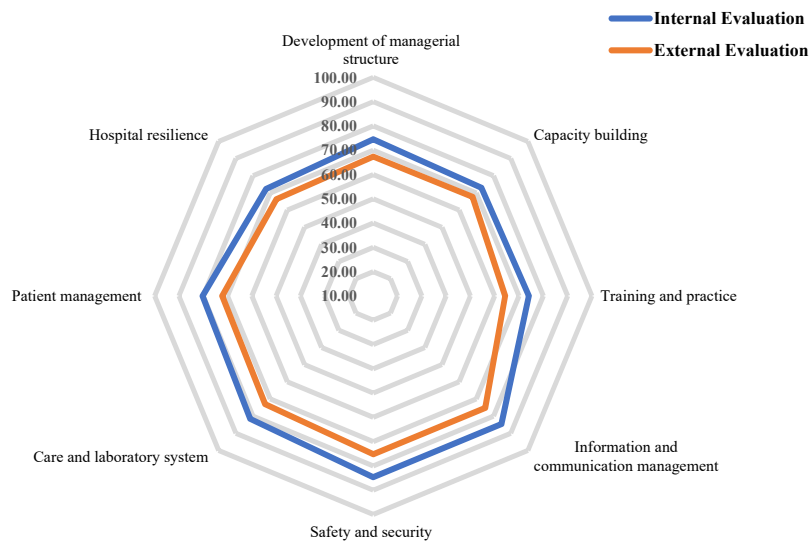


Figure 1. Comparative chart of the assessed hospitals' different dimensions of preparedness in response to biological incidents

Results

A total of 14 hospitals were assessed in the present study, all of which were government hospitals operating under the supervision of Shahid Beheshti University of Medical Sciences. Table 2 presents the results obtained from the specifications of the hospital checklist. The specifications of these hospitals, including the number of beds, the number of annual admissions, the number of

employees, the type of services, the number of intensive care unit beds, and so on, showed that the hospitals had different conditions in terms of infrastructure, structural instructs, and number of beds.

The results of internal and external assessments for different aspects of hospital preparedness in response to biological incidents have been displayed in Table 3 and Figure 1. As shown, internal evaluators attributed higher

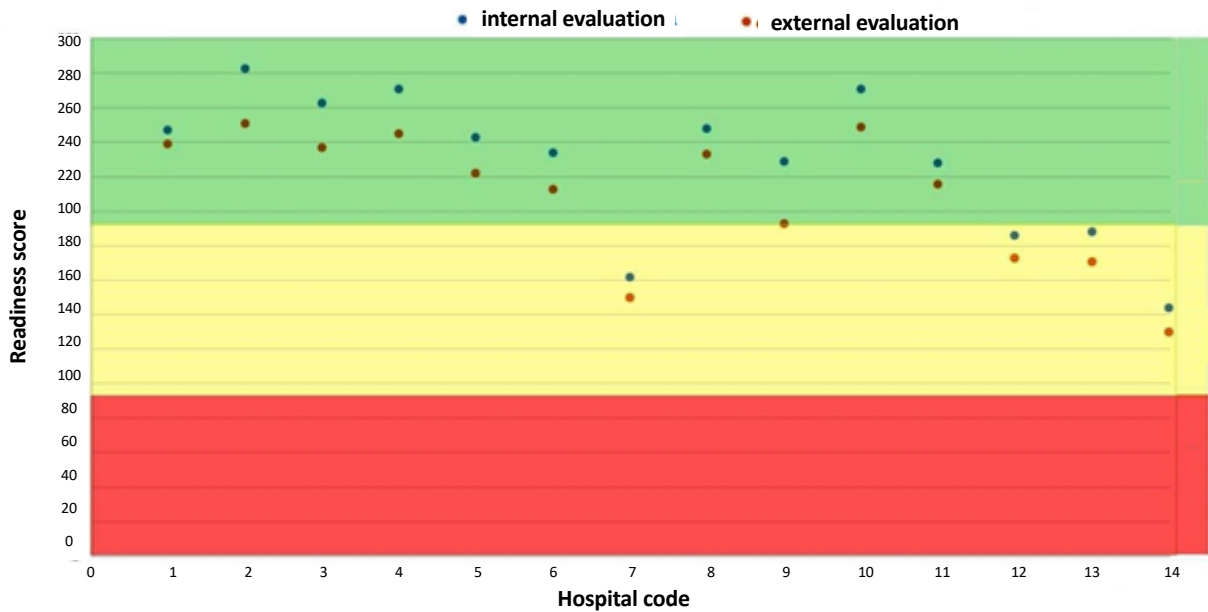


Figure 2. The status of the hospitals analyzed in terms of the level of preparation in response to biological incidents

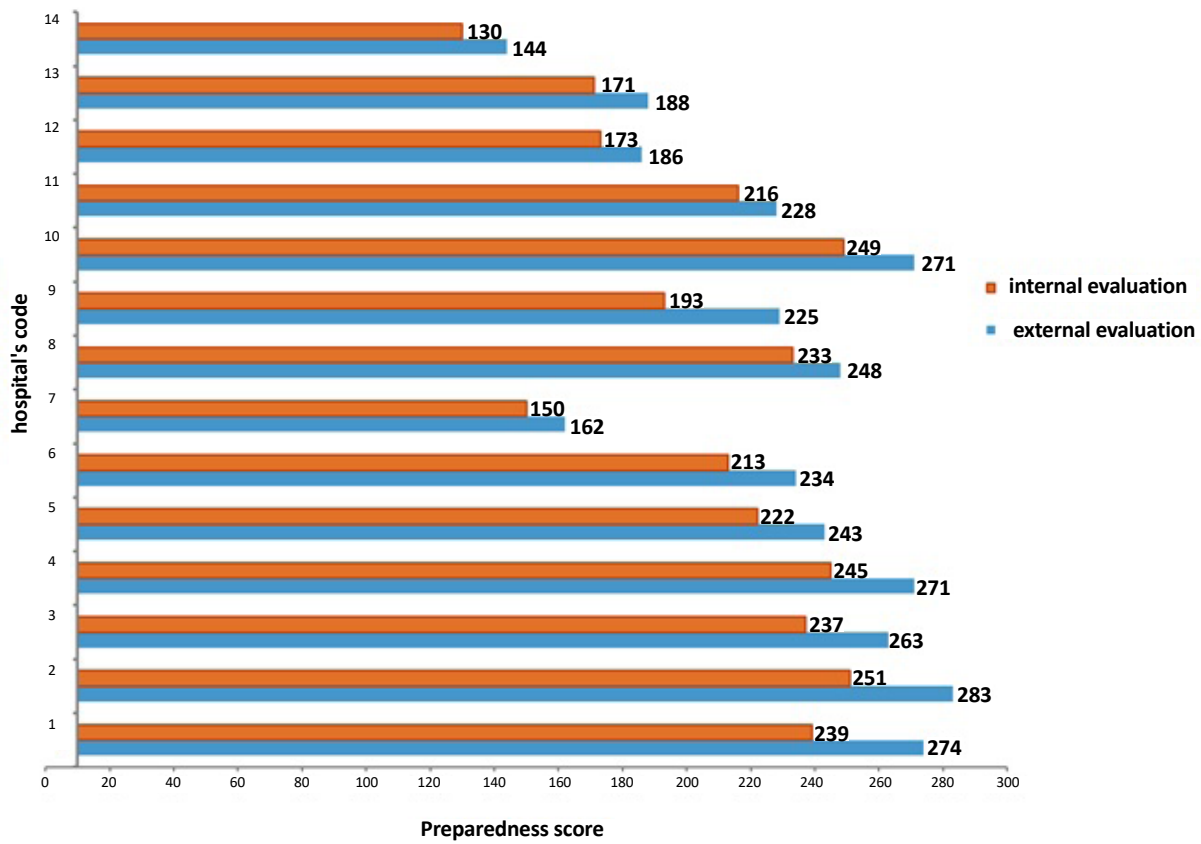


Figure 3. Comparison of the internal and external evaluation final scores of preparedness in response to biological incidents in the investigated hospitals

scores in all dimensions of hospital preparedness compared to external evaluators. In other words, if external assessment is considered a valid criterion, overestimation has occurred in all hospital preparedness dimensions. Among the eight dimensions of hospital preparedness in response to biological incidents, the lowest mean difference (-1.42) between internal and external assessments was related to the resilience dimension and the highest difference was related to the safety and security dimension (a mean difference of -4.14).

The results of the internal assessment of various dimensions of hospital preparedness in response to biological incidents revealed average scores of 22.35, 48.14, 16.28, 22, 50.78, 22.85, 30.50, and 17.35 in the dimensions of development of managerial structures, capacity building, training and practice, information and communication management, safety and security, laboratory and healthcare system, patient management, and hospital resilience, respectively, and the respective scores obtained in the external assessment were 20.21, 44.71, 14.14, 19.21, 46.64, 20.42, 27.42, and 15.92. According to internal assessment, the highest score obtained, con-

sidering the maximal attainable score, belonged to the information and communication management (84.62%) and then safety and security (84.64%) dimensions, and the lowest values in this regard were related to the hospital resilience (72.32%) and capacity building (72.94%) measurements. Regarding the scores obtained in external assessment, the highest scores respective to the maximum attainable scores were achieved in the safety and security (75.19%) followed by information and communication management (73.90%) dimensions, and the lowest scores were related to the training and practice (64.29%) and hospital resilience (66.37%) dimensions (Table 3).

The final scores of the hospital's preparedness in response to biological incidents according to external and internal assessments and their categories are shown in Table 4 and Figure 2. The internal assessment results showed that 10(71.5%) and 4(28.5%) hospitals had satisfactory and moderate preparedness in response to biological incidents, respectively; therefore, none had unsatisfactory status. The external assessment results were similar to the internal assessment, where 9(64.3%)

Table 1. The ranges of scores of different dimensions of the hospital preparedness in response to the biological incidents questionnaire

	Main Themes	Subscales	No.	Min-Max
1	Development of managerial structure (B=30)	Planning	7	0-14
		Organization	5	0-10
		Legal requirements	3	0-6
2	Capacity building (B=66)	Structure	14	0-28
		Drugs, equipment, and medical appliances	8	0-16
3	Training and practice (B=22)	Employees and volunteers	11	0-22
		Training and education	6	0-12
		Practice and maneuver	5	0-10
4	Information and communication management (B=24)	Information and risk communication	8	0-16
		Communication and coordination	4	0-8
		Safety and environmental hygiene	5	0-10
5	Safety and security (B=60)	Security	6	0-12
		Infection prevention and control	19	0-38
6	Health care and laboratory system (B=30)	Laboratory diagnosis capacity	6	0-12
		Early warning and syndromic surveillance system	9	0-18
7	Patient management (B=38)	Biological triage	6	0-12
		Diagnosis and treatment management	9	0-18
		Corpse management	4	0-8
8	Hospital resilience (B=24)	Continuity of function	7	0-14
		Necessary support services	5	0-10
Total			147	0-294

B: Maximum score attainable in each dimension.

and 5(35.7%) hospitals were placed in satisfactory and moderate levels of preparedness in response to biological incidents, respectively.

Figure 3 compares the results of the final scores of the hospitals' preparedness in response to biological incidents. According to this graph, the external assessment scores were lower than the internal assessment scores in all hospitals. The highest internal and external assessment scores of preparedness in response to biological incidents were related to hospital number 2 (283 and 251, respectively), followed by hospitals number 4 (271 and 245, respectively) and number 10 (271 and 249,

respectively). The lowest preparedness score belonged to hospitals number 14 (144 and 130, respectively) and number 7 (162 and 150, respectively).

Table 5 summarizes the final mean score and the mean scores of different dimensions of hospital preparedness in response to biological incidents. The results of the external assessment as the primary score showed that the dimensions of safety and security and information and communication management achieved the highest mean scores (46.64 and 19.21, respectively) and mean percentages (75.19% and 73.90%, respectively; that is, the highest ratio respective to mean score and the maxi-

Table 2. General features of the hospitals assessed in this study

Hospital's Code	No.			
	Beds	Annual Admissions	Employees	Intensive Care Unit Beds
1	120	122760	388	22
2	592	305511	1490	58
3	270	12000	612	53
4	62	110425	250	8
5	75	113457	271	12
6	307	15401	892	27
7	132	421891	540	7
8	418	488808	1716	82
9	488	17757	1031	30
10	158	143225	380	17
11	409	1518505	1660	51
12	60	142200	328	0
13	90	120425	300	8
14	79	80000	296	5

imum attainable score in the dimension) among others. Also, the training and practice dimension (with a mean score of 14.14 and a mean percentage of 64.29%) attained the lowest scores among the eight dimensions of hospital preparedness. The final mean score of hospital preparedness in response to biological incidents was obtained at 208.71, indicating that the hospitals were in a satisfactory status regarding preparedness in response to biological incidents.

Discussion

During disasters, due to the increased demand for medical services, all departments of hospitals should operate 24 h for seven days a week to maintain their ability to respond appropriately to the disaster. In recent years, comprehensive investigations have been conducted in Iran to assess the level of preparedness of healthcare centers and hospitals in response to disasters, most of which address functional, structural, and nonstructural safety preparedness in response to disasters. However, few studies have been conducted on the preparedness of hospitals in dealing with biological incidents. This study investigated the hospital's preparedness in response to biological

incidents in the hospitals affiliated with [Shahid Beheshti University of Medical Sciences](#). The results of the present study showed that internal evaluators reported higher levels of preparedness in all dimensions compared to external evaluators, indicating an overestimation in all of the preparedness dimensions. The final mean score of hospital preparedness in response to biological incidents revealed that the hospitals enrolled had a satisfactory level of preparedness in response to biological incidents.

A total of 14 hospitals were analyzed in the present study, all of which were state hospitals operating under the supervision of [Shahid Beheshti University of Medical Sciences](#). As observed, internal evaluators reported higher levels of preparedness than external assessment in all dimensions of hospital preparedness. However, this difference seemed to be negligible in total. Hospital preparedness in response to biological incidents has been one of the most critical challenges hospitals face in recent years, especially after the COVID-19 outbreak at the national and international levels. Providing appropriate training in different fields of hospital preparedness is a crucial tool for empowering human resources, particularly staff contributing to disaster management. Accord-

Table 3. Comparison of the results of external and internal assessments of hospitals' preparedness in response to biological incidents in the dimensions of managerial structure development, capacity building, training and practice, and information and communication management

Hospital's Code	Managerial Structure Development			Capacity Building			Training and Practice			Information and Communication Management		
	No. (%)		Difference	No. (%)		Difference	No. (%)		Difference	No. (%)		Difference
	Self-report	Verification		Self-report	Verification		Self-report	Verification		Self-report	Verification	
1	27(90)	23(76.7)	-4	65(98.5)	57(86.4)	-8	22(100)	18(81.8)	-4	25(96.1)	21(80.8)	-4
2	30(100)	25(83.4)	-5	64(97)	59(89.4)	-5	20(90.9)	18(81.8)	-2	25(96.1)	21(80.8)	-4
3	24(80)	21(70)	-3	50(75.8)	46(69.7)	-4	14(63.6)	13(59.1)	-1	25(96.1)	22(84.6)	-3
4	27(90)	26(86.7)	-1	54(81.8)	50(75.8)	-4	19(86.4)	18(81.8)	-1	25(96.1)	22(84.6)	-3
5	22(73.3)	21(70)	-1	52(78.8)	48(72.7)	-4	19(86.4)	17(77.3)	-2	24(92.3)	21(80.8)	-3
6	27(90)	23(76.7)	-4	50(75.8)	47(71.2)	-3	18(81.8)	16(72.7)	-2	24(92.3)	20(76.9)	-4
7	15(50)	13(43.4)	-2	38(57.6)	35(53)	-3	8(36.4)	7(31.8)	-1	12(46.2)	20(76.9)	0
8	23(76.7)	23(76.7)	0	45(68.2)	42(63.6)	-3	16(72.7)	11(50)	-5	24(92.3)	21(80.8)	-3
9	20(66.7)	19(63.4)	-1	49(74.2)	46(69.7)	-3	18(81.8)	12(54.6)	-6	21(80.8)	19(73.1)	-2
10	27(90)	25(83.4)	-2	54(81.8)	53(80.3)	-1	19(86.4)	17(77.3)	-2	25(96.1)	23(88.5)	-2
11	21(70)	20(66.7)	-1	47(71.2)	45(68.2)	-2	15(68.2)	15(68.2)	0	25(96.1)	23(88.5)	-2
12	14(46.7)	13(43.4)	-1	42(63.6)	39(59.1)	-3	12(54.6)	11(50)	-1	21(80.8)	23(88.5)	-3
13	16(53.4)	13(43.4)	-3	47(71.2)	45(68.2)	-2	16(72.7)	11(50)	-2	16(61.5)	13(50)	-3
14	20(66.7)	18(60)	-2	17(25.8)	14(21.2)	-3	12(54.6)	14(63.6)	-1	16(61.5)	13(50)	-3
A	22.35	20.21	-2.14	48.14	44.71	-3.42	16.28	14.14	-2.14	22	19.21	-2.78
A/B (%)	74.52	67.38	-	72.94	67.75	-	74.03	64.29	-	84.62	73.90	-

Health in Emergencies and Disasters Quarterly

A: Mean scores obtained by hospitals in each dimension, B: The maximum score achievable in each dimension.

Hospital's Code	Safety and Security			Healthcare System and Laboratory			Patient Management			Hospital Resilience		
	No. (%)		Difference	No. (%)		Difference	No. (%)		Difference	No. (%)		Difference
	Self-report	Verification		Self-report	Verification		Self-report	Verification		Self-report	Verification	
1	54(90)	50(83.3)	-4	25(89.3)	21(75)	-4	34(89.5)	30(78.9)	-4	22(91.7)	19(79.2)	-3
2	57(95)	52(86.7)	-5	28(100)	24(85.7)	-4	37(97.4)	32(84.2)	-5	22(91.7)	20(83.3)	-2
3	60(100)	55(91.7)	-5	28(100)	25(89.3)	-3	38(100)	34(89.5)	-4	24(100)	21(87.5)	-3
4	58(96.7)	51(85)	-7	28(100)	24(85.7)	-4	38(100)	34(89.5)	-4	22(91.7)	20(83.3)	-2
5	53(88.3)	47(78.3)	-6	25(89.3)	23(82.2)	-2	30(78.9)	28(73.8)	-2	18(75)	17(70.8)	-1
6	52(86.7)	47(78.3)	-5	16(57.1)	15(53.6)	-1	28(73.8)	27(71)	-1	19(79.2)	18(75)	-1
7	38(63.4)	35(58.3)	-3	16(57.1)	15(53.6)	-1	21(55.3)	20(52.6)	-1	14(58.3)	13(54.2)	-1
8	56(93.3)	54(90)	-2	25(89.3)	24(85.7)	-1	37(97.4)	36(94.7)	-1	22(91.7)	22(91.7)	0
9	52(86.7)	46(76.7)	-6	27(96.4)	20(71.4)	-7	31(81.6)	21(55.3)	-01	11(45.8)	10(41.7)	-1
10	58(96.7)	52(86.7)	-6	28(100)	26(92.9)	-2	38(100)	34(89.5)	-4	22(91.7)	19(79.2)	-3
11	55(91.7)	51(85)	-4	22(78.6)	20(71.4)	-2	28(73.8)	27(71)	-1	15(62.5)	15(62.5)	0
12	39(65)	36(60)	-3	20(71.4)	19(67.9)	-1	26(68.4)	25(6+5.8)	-1	12 950)	12(50)	0
13	49(81.7)	48(80)	-1	17(60.7)	16(57.1)	-1	20(52.6)	17(44.7)	-3	7(29.2)	5(20.8)	-2
14	30(50)	29(48.3)	-1	15(53.6)	14(50)	-1	21(55.3)	19(50)	-2	13(54.2)	12(50)	-1
A	50.78	46.64	-4.14	22.85	20.42	-2.42	30.50	27.42	-3.07	17.35	15.92	-1.42
A/B (%)	84.64	75.19	-	81.63	72.96	-	80.26	72.18	-	72.32	66.37	-

A: Mean scores obtained by hospitals in each dimension, B: The maximum score achievable in each dimension.

Table 4. Comparison of the final scores of hospitals' preparedness in response to biological incidents according to internal and external assessment

Hospital's Code	No. (%)				Score Difference
	Internal Assessment	Status Analysis	External Assessment	Status Analysis	
1	247(93.2)	Satisfactory	239(81.29)	Satisfactory	-35
2	283(96.26)	Satisfactory	251(85.37)	Satisfactory	-32
3	263(89.46)	Satisfactory	237(80.61)	Satisfactory	-26
4	271(92.18)	Satisfactory	245(83.33)	Satisfactory	-26
5	243(82.65)	Satisfactory	222(75.51)	Satisfactory	-21
6	234(79.59)	Satisfactory	213(72.45)	Satisfactory	-21
7	162(55.10)	Moderate	150(51.02)	Moderate	-12
8	248(84.35)	Satisfactory	233(79.25)	Satisfactory	-15
9	229(77.89)	Satisfactory	193(65.65)	Moderate	-36
10	271(92.18)	Satisfactory	249(84.69)	Satisfactory	-22
11	228(77.55)	Satisfactory	216(73.47)	Satisfactory	-12
12	186(63.27)	Moderate	173(58.84)	Moderate	-13
13	188(63.95)	Moderate	171(58.16)	Moderate	-17
14	144(48.98)	Moderate	130(44.22)	Moderate	-14

Table 5. Comparison of the final scores of the analyzed hospitals' scores of preparedness in response to biological incidents based on internal and external evaluation

Preparedness Dimensions	No. (%)		Score Difference
	Internal Evaluation	External Evaluation	
Development of managerial structure	22.35(74.52)	20.21(67.38)	-2.14
Capacity building	48.14(72.94)	44.71(67.75)	-3.42
Training and practice	16.28(74.03)	14.14(64.29)	-2.14
Information and communication management	22(84.62)	19.21(73.90)	-2.78
Safety and security	50.78(84.64)	46.64(75.19)	-4.14
Health care and laboratory system	22.85(81.63)	20.42(72.96)	-2.42
Patient management	30.50(80.26)	27.42(72.18)	-3.07
Hospital resilience	17.35(72.32)	15.92(66.37)	-1.42
Final score of preparedness	230.28(78.33)	208.71(70.99)	-21.57

ing to the documents available in the hospitals affiliated with [Shahid Beheshti University of Medical Sciences](#), simultaneous with the COVID-19 outbreak, comprehensive training was presented to hospital employees, especially to the secretaries of the hospitals' risk and disaster management committees. Also, the participants received training on completing the questionnaires, leading to a close compatibility between the results of internal and external assessment, where the largest difference percentage (7%) was seen in the safety and security dimension. Beyramijam et al. (2019) discuss the impacts of the national disaster preparedness program in improving the preparedness of hospitals in response to disasters and concluded that these trainings were necessary and beneficial for hospital employees, especially hospital disaster managers [21].

According to the results of different dimensions of hospital preparedness in response to biological incidents, the scores obtained respectively to the maximum attainable score exceeded 65% in all dimensions, falling in the range of 65% to 85%. In other words, the hospitals obtained at least 2.3 of the maximum attainable score in every dimension, reflecting their satisfactory status in these dimensions. Among the dimensions of hospital preparedness, the highest score compared to the maximum obtainable score was related to the dimension of safety and security, with an average score of 50.78 and an average percentage of 84.64%. The safety and security dimension deals with environmental hygiene, job security, and physical protection of personnel. The high score obtained in this dimension suggested that the hospitals had favorable conditions in terms of infectious waste disposal systems, water and food safety preventive measures, sewage and contaminated effluent monitoring systems, appropriate ventilation systems, supplying personal protective equipment suitable for working in biologically contaminated environments, and indoor and outdoor security measures to ensure the safety of personnel during biological incidents. Security plans for biological incidents guarantee the safety of personnel and patients and prevent the disintegration of health centers during disasters. As noted in studies, one of the critical issues related to hospital preparedness in response to incidents is staffed and equipment security, demanding personnel to be acquainted with and learn security issues and instructions constantly [22]. In the present study, the high score obtained in this dimension compared to others reflected some of the promotions made during the COVID-19 pandemic. Considering the shortage of personnel encountered by hospitals during the coronavirus pandemic in Iran and most countries, the first level of protection in response to COVID-19 was to establish

safety and security measures for the personnel involved in response to the disaster; therefore, most hospitals in various countries paid particular attention to this topic. These results contradicted those reported by the studies conducted before or at the beginning of the COVID-19 pandemic, where, in most cases, the status of hospitals in this dimension was reported to be unfavorable before the outbreak of COVID-19 compared to the post-pandemic period. Aminizadeh et al. (2020) demonstrated that the safety and security of hospital personnel at the onset of the COVID-19 pandemic was one of the critical dimensions of hospital preparedness in response to unwanted biological incidents [20]. In another study, Wu et al. (2020) reported that personnel safety and protection issues were among essential problems in hospitals, rendering the most critical barriers for encouraging staff to respond to COVID-19 [23] effectively. Nevertheless, the results of studies in the post-pandemic era in Iran indicated an improvement in this dimension. Mirzaei et al. (2021) reported that after the third pandemic peak, 96% of hospitals in Iran had a desirable status in the safety and security dimension [24].

Among the dimensions of hospital preparedness, the lowest score compared to the maximum attainable score was related to the training and practice dimension, with a mean score of 16.28 and a mean percentage of 64.29%. This dimension deals with the status of annual training programs, holding specialized courses for personnel responding to biological incidents, and planning and implementing exercises to respond to biological incidents. Training and practice are vital to improving public health emergency responses, such as biological incidents [25, 26]. The lower score obtained in this dimension compared to other dimensions indicates the weakness of the hospitals in this field, requiring authorities to pay more attention to improving the level of employees' training and practice. These results are in line with the findings of previous studies. In a study, Higgins et al. (2004) showed that the staff engaged in responding to biological incidents in hospitals stated that one of their essential requirements was to receive suitable training related to biological incidents [27]. Also, Aminizadeh et al. (2020) found that training and practice are vital challenges for hospitals coping with biological incidents [20]. Overall, although this dimension acquired a low score respective to other preparedness dimensions in the present study, the level of preparedness was found to be satisfactory in all dimensions.

In the present study, the total mean score of hospital preparedness in response to biological incidents was obtained at 230.28, indicating that the hospitals investigated had a satisfactory status in terms of preparedness in response to biological incidents. Further analysis revealed that 9(64.3%) and 5(35.7%) hospitals had acceptable and moderate levels of preparedness in response to biological incidents, respectively. In studies that assess hospital preparedness for biological incidents, different tools have been used for this purpose, each of which evaluates various indicators of preparedness [4, 26-34]. Moreover, available tools cannot provide accurate and reliable indicators to estimate hospital preparedness in response to biological incidents [35]. Therefore, comparisons between studies may not be valid because of the differences between these tools. Reidy et al. (2015) investigated the preparedness of hospitals in Ireland in response to biological incidents, such as influenza outbreaks. They concluded that the hospitals were unprepared to respond to epidemics [32]. Mortelmans et al. (2017) also reported serious shortcomings in preparing Dutch hospitals for chemical, biological and nuclear threats [31].

Studies on hospital preparedness in Iran have mainly focused on preparedness in response to natural and man-made disasters, and less attention has been paid to biological incidents. The few studies conducted in this field contradict our observations in the present study, and the findings of the current study do not support the previous research. In an investigation regarding the challenges of hospital preparedness in response to biological incidents, Amininejad et al. (2020) found that Iran's health system would face many difficulties in response to biological incidents, and hospitals in Iran are unprepared to encounter biological incidents [20]. In another study, Sharififar et al. (2022) noted that hospitals in Iran had inadequate and unsatisfactory levels of preparedness in response to biological incidents and highlighted the need for developing a reliable tool to ascertain the level of preparedness in Iranian hospitals [4, 36]. These differences can be attributed to the period of their conduction. All the mentioned studies had been conducted before the COVID-19 pandemic, while the present study was dedicated to assessing hospital preparedness in response to biological incidents after the pandemic. In other words, one of the most important reasons for the satisfactory preparedness of the hospitals investigated in this study could be the COVID-19 outbreak in Iran and worldwide. The results of the studies conducted in Iran during and after the COVID-19 pandemic support this notion. In an investigation into the operational preparedness of hospitals in response to the COVID-19 pandemic in Mazandaran Province in

Iran, Hosseini et al. (2021) found that the investigated hospitals attained good levels of operational readiness [37]. In another study, Mirzaei et al. (2021) investigated the preparedness of hospitals in Yazd City, Iran, after the third peak of COVID-19 and identified that the hospitals acquired a preparedness level of 80% [24].

Finally, several important limitations need to be considered. The major limitation of this study is the time restrictions during implementation. This limitation forces us to include only the hospitals affiliated with one university of medical sciences in Tehran. Thus, the generalizability of our results may be poor; therefore, more studies are required for policymaking in the field of hospital preparedness in response to biological incidents in Tehran City, Iran, and the country. Also, because no similar study has been conducted in Iran to our knowledge and based on our literature review, and studies in other countries had investigated hospital preparedness in response to biological incidents by different methodologies and tools, limited comparisons were made between our observations and the results of other studies. We used a self-reporting questionnaire completed by hospital crisis managers, harboring the risk of incomplete and biased responses, which can be one of the limitations of the present study. The best way to determine the level of preparedness is to conduct an exercise at the operational level in the hospital. On the other hand, we performed external assessments completed by trained and expert evaluators to verify self-reported responses, which is the strength of this study, enhancing the accuracy and reliability of the results. Finally, conducting similar studies to assess the level of preparedness of different types of hospitals (state, private, military, welfare organization, etc.) in the country in response to biological incidents can provide hospital managers and policymakers with more information to identify weaknesses, strengths, and opportunities harbored in hospitals for coping with biological incidents.

Conclusion

Studying the preparedness of hospitals, as a frontline of fighting in response to disasters, in facing biological incidents is essential. Determining the level of hospital preparedness using standard and reliable tools can help hospital managers and authorities designate effective interventional strategies and identify their strengths and weaknesses. The main goal of the current study was to assess different dimensions of hospital preparedness in response to biological incidents. This study has found that general scores of preparedness in response to biological incidents compared to the maximum attainable

score exceeded 65% (the range of 65% to 85%) in all dimensions. In other words, all dimensions of hospital preparedness were satisfactory. The results of this research support the idea that paying attention to various aspects of these dimensions can help upgrade hospitals' preparedness in response to biological incidents. Overall, our results suggested that the hospitals were satisfactorily prepared in response to biological incidents. Nonetheless, the highest level of preparedness is required to deal with biological incidents effectively; therefore, it is necessary to maintain a good level of preparedness and double efforts to improve it by focusing on all its dimensions, especially those with lower scores.

Ethical Considerations

Compliance with ethical guidelines

The present study was approved by the [Shahid Beheshti University of Medical Sciences](#) (Code: IR.SBMU.PHNS.REC.1400.186).

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Authors' contributions

Study design, data gathering and writing the manuscript: Saeed Younesi and Zohreh Ghomian; Data analyses, data interpretation, review of the manuscript: Hossein Hatami and Simintaj Sharififar.

Conflict of interest

The authors declared no conflict of interest.

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