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Hospital safety index: evaluation of the readiness and safety of hospitals in Isfahan province, Iran

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Abstract: **Objective:** Hospitals play a vital role in disaster management and their function must be maintained during crises. Isfahan province is susceptible to major crises and disasters at any time of the year. The study aimed to investigate the hospital safety index (HSI) in hospitals in Isfahan province.

Methods: This cross-sectional study was conducted using the HSI questionnaire of the world health organization. The safety of all 55 hospitals in Isfahan province was evaluated with the Persian version of the questionnaire from 2017 to 2022. In this study, all hospitals were evaluated by a group of experts from the emergency operations center (EOC) of Isfahan University of Medical Sciences, and the checklists were completed with the cooperation of the hospital disaster committee, visiting the hospitals, and interviewing the personnel.

Results: The safety level of hospitals has improved from 2017 to 2022 so in 2022, 38 hospitals (69.09%) had a high safety level, and 17 hospitals (30.91%) had a medium safety level. This increase in safety has happened in all three components of safety (functional, non-structural, and structural safety). There was no significant difference in the overall hospital safety score between academic-educational, non-academic governmental, social security and military, and private and charity hospitals ($P<0.05$).

Conclusion: Although the safety in the hospitals of Isfahan province has improved due to the continuous disaster prevention and preparedness activities, hospitals still need to improve to achieve higher levels of safety. The HSI shows how well a hospital can maintain its organization and performance during disasters. This index will be useful for decision-making and policy-making to prioritize administrative and civil interventions.

Keywords: Disasters; Hospitals; Hospital Safety Index; Safety

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1. Introduction

Disasters and crises affect vulnerable communities and cause infrastructure destruction and environmental pollution. Nowadays, crises and disasters have taken up a large part of government resources and programs (1). There is frequent news about the occurrence of various disasters all over the world. Climate changes, human manipulations in nature and the rapid growth of technology have increased the vulnerability of societies and the chance of disasters (1,2).

Human societies are always exposed to natural disasters or destructive human tendencies that cause various disasters. In disasters of the last decade, it is estimated that about 2 million people have been killed, 4.2 million people have been injured, 33 million people have been left homeless and about 3 billion people have been affected by disasters (1-3). The consequences of these incidents are not only in the short term of injury, loss of life, destruction of infrastructure, but also in the long term with the change in the economic and social situation (3).

Iran is ranked among the 10 most impoverished countries in the world (2). Even though, it contains only one percent of the world's population, it accounts for more than 6 percent of the losses caused by natural disasters in the world (4). Surveys show that 31 of the 40 types of natural disasters known in the world occur in Iran. In the meantime, earthquake is one of the common disasters all over the world which also causes many human casualties in Iran. Iran is the fourth country in Asia and the sixth country in the world in terms of the occurrence of natural disasters (1-5).

Emergencies and disasters are conditions that cannot be controlled with conventional methods and resources because they are very severe in terms of social, economic, emergency, casualties, and destruction of infrastructure (5). Because these events have the potential to cause injury and

harm, they often lead to widespread health and medical challenges (2,4). After disasters, the first concern is to protect people's health, and hospitals and medical centers play a significant role in this field. Among the organizations and institutions involved in responding to disasters, healthcare systems, especially hospitals, have the most and most important role (5,6). The importance of hospitals goes beyond the direct role they play in treating patients. They are a powerful symbol of social progress and a necessary condition for economic development and stability (7).

According to previous studies, hospitals are vulnerable to disasters and many of them lose their efficiency due to disasters (7-9). Disasters can affect hospitals in different ways, inpatients, outpatients, medical staff, and clients may suffer in hospitals (6,7). At the time of crises, when the hospitals and centers providing health-medical services are structurally or functionally damaged, they will no longer be able to treat and manage the injured people. This inefficiency created in healthcare centers causes a secondary crisis (7,10).

Hospitals must continue their routine operations during disasters and when their services are in dire need. Also, during disasters the safety of all hospital personnel must be guaranteed, and they can maintain their efficiency and performance in times of crisis. Hospitals' safety and protection against disasters save lives, protect capital assets, and ultimately maintain performance (7-10). It is necessary to ensure the physical and functional ability of hospitals in emergency situations, so an important criterion in hospital risk reduction strategies is to determine the current safety levels of hospitals. The hospital safety index (HSI) presented by the world health organization (WHO) is a new step in the field of crisis management in the health sector (5). The HSI can obtain the safety level of hospitals in terms of structural, non-structural and functional dimensions during disasters. These indicators can get a picture of the current situation and possible scenarios at the time of crisis (5,11). The responsiveness of this system to major disasters and crises is measured and necessary information is provided to policymakers and decision-makers (11).

In crisis management, risk assessment is the first step from the stage before the crisis. Risk assessment consists of two main components: hazard analysis and vulnerability analysis. It is impossible to eliminate risks, but they can be reduced by reducing the vulnerability of injuries and damages; In this regard, we should look for a mechanism that minimizes the damages and increases the speed of returning to the initial situation (10,11). Therefore, strengthening the structural, non-structural, and functional components of hospitals as one of the most important centers involved immediately after the crisis is very important.

Iran, with a population of over 80 million people, is exposed to a wide range of natural and man-made disasters (2,5). Isfahan with a population of 5,386,437 inhabitants is in the center of Iran and on the main transit route of the country. It is affected by many road traffic accidents, and it is also one of the provinces that are exposed to many natural and man-made disasters (2,9). Therefore, this study was conducted to investigate the hospital safety index in the hospitals of Isfahan province.

2. Methods

2.1. Study design

This was a descriptive cross-sectional study to investigate the safety situation of hospitals in Isfahan province against disasters. The study protocol was approved by the ethics committee of Isfahan University of Medical Sciences (code: IR.MUI.MED.REC.1401.347). The WHO HSI questionnaire was used to record and check the safety status of hospitals. This questionnaire has been localized by Ardalan et al. (5). The Farsi version of the hospital safety assessment tool against disasters, which was called the Farsi Hospital Safety Index (FHSI), includes 145 items in 3 dimensions of structural, non-structural, and functional safety. Previous studies confirmed the validity of the FHSI (3,5).

The safety of hospitals is divided into three levels: low, medium, and high. To determine the overall weight of the 3 main components of the questionnaire, including structural, non-structural, and functional safety in accordance with the original version of the index, weights of 0.5, 0.3, and 0.2 have been considered respectively (10).

As a result, 50% of the hospital's safety level is related to structural safety, which has 13 questions and two elements. 30% of the score was related to non-structural safety, which includes 71 questions and 12 elements, and 20% of the score was related to functional safety, which includes 61 questions and seven elements. The level of vulnerability of each hospital is scored in three levels with low (score 0), medium (score 1), and high scores (score 2). To calculate the total safety score, all structural, non-structural, and functional safety scores were normalized to 100 and finally, the safety level of each area was expressed as a percentage (10,12).

In the end, the safety scores of all three sections are added up with the coefficients mentioned above, and based on that, the safety of the hospital is placed in one of the levels A (low), B (medium), and C (high) (Table 1). Each of these levels requires special measures and equipment to secure the hospital (12).

All hospitals in Isfahan province (55 hospitals) were evaluated by a group of experts from the Emergency Operation Center (EOC) of Isfahan University of Medical Sciences and the data of the last six years of the HSI were collected. HSI has become an information management system in Iran and was introduced as an HFA case study by international strategy for disaster reduction (ISDR) of the United Nations in 2015.

Checklists with the cooperation of the hospital disaster committee (hospital head, hospital vice president, hospital director, nursing director, emergency specialist, service manager, facility manager, quality assurance officer, financial officer, head of the emergency department and safety officer and,

etc.) and visits to hospitals and interviews with personnel were completed.

2.2. Statistical analysis

Data were analyzed using SPSS software version 25 (SPSS Inc., Chicago, IL, USA). Mean± standard deviation (SD) and frequency (percentage) were used to report the results. One-way analysis of variance, independent t test, and chi-squared tests were used.

3. Results

In this study, 55 hospitals in Isfahan province were investigated. The characteristics of the hospitals are shown in table 2. Of these, 49.09% of hospitals are in Isfahan city. The structural, non-structural, and functional safety scores of hospitals in Isfahan province from 2017 to 2022 are shown in table 3. The results showed that from 2017 to 2020, structural safety had the highest score, and functional safety had the lowest score, but in the last two years, with the improvement of the functional safety situation, these conditions changed and in 2022, the functional safety score had the highest score. As it was found out, the structural, non-structural, and functional safety scores of hospitals have increased in all three components during the above years.

There was no significant difference in the overall hospital safety score between academic-educational, non-academic governmental, social security and military, and private and charity hospitals (Table 3). However, in the years 2019 to 2022, there is a significant difference between the types of hospitals in the field of functional safety. The upward progress of the overall safety of hospitals and the three components separately during the years 2017 to 2022 is shown in figure 1.

The hospitals' safety level in Isfahan province is shown in table 4 based on the classification of WHO guidelines. The number of hospitals with high safety levels improved significantly during the years 2017 to 2022, and more of them were in the high safety level group. Also, the number of hospitals with low safety levels had decreased so that there were no hospitals with low safety levels in the last two years.

In the field of non-structural safety, twelve different elements have been examined in different years. The element of fire protection system and the element of office and storeroom furnishings and equipment, including the safety of shelves, cupboards, their contents, as well as the safety of computers and printers, had the lowest score. Also, elements of medical and laboratory equipment and supplies used for diagnosis and treatment (safety of equipment in different parts of the hospital), electrical systems (safety capacity and evaluation of generators, safety of electrical equipment, cables, and ducts, alternative system for local power plant, etc.), waste management systems, and medical gases systems (medical gases storage location, storage safety, availability of alternative sources for medical gases, etc.) had the highest non-structural safety score in different years.

4. Discussion

The FHSI can be used as a useful, quick, and accessible tool to evaluate the preparedness and safety of hospitals against disasters (5). The annual frequent assessment can show the annual progress achieved in the field of hospital safety and the remaining weaknesses. The information obtained from this index and its repetition can facilitate decision-making and policy-making and organization as well as better planning.

Comparing the safety index of hospitals in the past years (2017-2022), showed that the hospitals of Isfahan province have become safer according to the regional needs and the requirements of the directives and policies announced to reduce the risk of disasters by the Ministry of Health & Medical Education. Since 2020, the mean safety level of hospitals in Isfahan province has been placed at high safety level (A) (of course, the lower limit of safety level A), as a result, although these hospitals can withstand major crises, but probably critical equipment and services were at risk and affected.

In 2014, Ardalan et al. (5) conducted a hospital safety evaluation of 224 hospitals in Iran. They showed that the overall HSI of Iranian hospitals was 33%. Safety level was low in 54.5% of hospitals and moderate in 45.5%, while none of the hospitals were in high safety level. The reason for the low HSI of most hospitals in this study could be the novelty of the issue of hospital safety assessment in Iran. The results of the current study showed that hospitals in Isfahan province were at a higher level of safety. The mean HSI of hospitals in Isfahan province in 2017 was about 62% and 40% of hospitals had a high safety level, which indicated the better condition of Isfahan province compared to other provinces in Iran. Of course, considering that the safety level of hospitals in Isfahan province has increased over the past years based on the result of the current study, it is not possible to make an exact comparison between the results of these two studies.

Peyravi et al. (10) showed that the average HSI scores of Fars hospitals (58 hospitals) in 2016 was 55%. In a study conducted on 21 hospitals in Tabriz in 2017, Rajaei-Ghafouri et al. showed that most hospitals (71%) in Tabriz were in the moderate safety level. The average safety level of Tabriz hospitals was 67% (3). In the study by Feizolahzadeh et al., who investigated 9 hospitals of Alborz University of Medical Sciences, more than half of the hospitals were at a moderate level of safety (12).

Djalali et al. (7) showed that the non-structural safety level of four hospitals studied in Stockholm, Sweden was 90%, which was higher compared to the safety level of 64% in the studied hospitals in Tehran. The average non-structural safety scores of hospitals in Isfahan province in 2022 was about 70%, which was also lower than Stockholm hospitals. Peyravi et al. (10) showed the level of non-structural safety in Fars province at an average level. In another study, Zaboli et al. (13) reported that the level of non-structural safety in the selected hospitals in their study was moderate. The present study also showed the same level of non-structural safety in

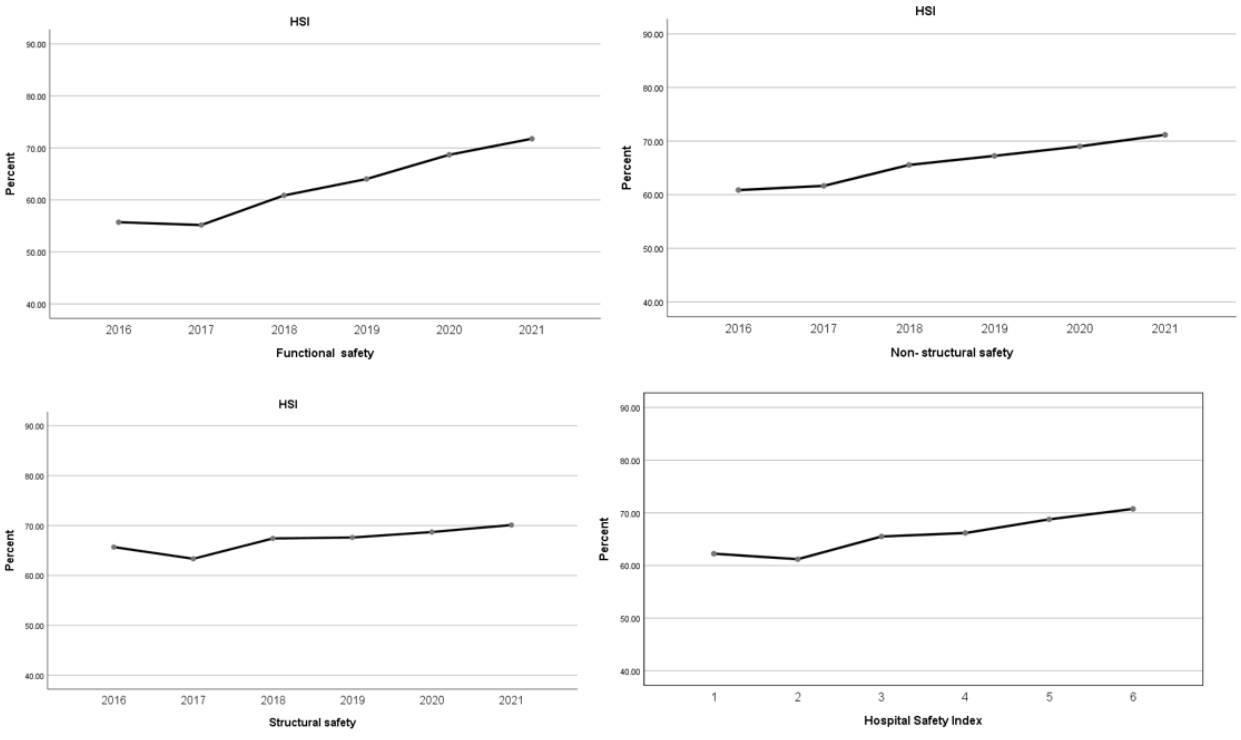

Figure 1 Hospitals safety index and the three components during 2017 to 2022

Table 1 Classification of hospital safety indices levels based on WHO guidelines

Safety index	Group	Safety status of hospitals
0-35	C	Hospitals where the lives and safety of its residents and occupants are at risk during the crisis Immediate action is required to support the lives of patients and staff
36-65	B	Hospitals that can withstand the crisis although their vital equipment and services are at risk Short-term action is required to reduce damages
66-100	A	Hospitals that can apparently keep their residents safe and continue their activities in times of crisis Preventive action is required to maintain and improve safety

Table 2 Characteristics of hospitals in Isfahan province

Variables		Number	Percent
Hospital location	Isfahan	27	49.09
	Other Isfahan cities	28	50.91
Hospital affiliation	Academic-educational	11	20.00
	Non-academic governmental	26	47.27
	Social security and military	6	10.91
	Private and charity	12	21.82
hospital beds	<100 beds	22	40.00
	100-400 beds	30	54.5
	>400 beds	3	5.5
Total		55	100

the hospitals of Isfahan province in 2017 and 2018.

Heidaranlu et al. (2016) stated that 60% of non-structural safety parameters of hospitals in East Azerbaijan province were in good condition. Electrical and telecommunications systems were at the lower level and water supply, medical gases, and fuel storage were at the higher level of safety (11). In the Northridge, California earthquake (1994), electrical system failure was the main cause of hospital evacuation (14). Any disruption in the hospitals' electrical system affects all electrical-dependent functions and equipment and requires alternative energy sources during crisis management. Among the non-structural components in the hospitals of Isfahan province, electrical systems had the highest level of safety. This finding is consistent with the studies conducted

Table 3 The mean score of hospital safety index for disasters in Isfahan province hospitals

Years	Safety components	Hospital affiliations				All hospitals	P-value
		Academic-educational	Non-academic governmental	Social security and military	Private and charity		
2017	Functional	55.30±17.31	53.86±14.62	65.66± 17.19	55.10±18.35	55.71±17.00	0.508
	Non- structural	63.69± 16.57	56.38±12.72	63.26± 14.96	66.77± 17.20	60.86± 15.05	0.197
	Structural	64.17± 18.40	68.17±17.68	60.00±23.92	64.54±17.71	65.69±18.21	0.765
	Total HSI	62.25±13.80	61.62±12.15	62.11±18.32	63.71±15.44	62.24.13.55	0.991
2018	Functional	56.82±15.45	52.04±13.37	65.99± 17.50	56.03±16.21	55.17± 15.13	0.195
	Non-structural	68.16±16.15	56.22±14.18	62.92± 14.11	68.66±14.25	61.65± 15.49	0.028
	Structural	67.10±19.81	62.26±21.36	59.72± 23.93	64.03±18.67	63.34±20.32	0.890
	Total HSI	65.36±14.18	58.06±14.46	61.94± 18.71	63.82±14.21	61.20±14.75	0.495
2019	Functional	56.66±5.62	56.65±15.02	76.50±12.90	65.36±14.52	60.68±15.88	0.019
	Non- structural	68.90±12.89	60.62±15.06	66.55±11.59	72.67±11.41	65.55±14.14	0.072
	Structural	72.10±20.45	66.04±19.94	66.67±27.31	66.44±15.95	67.41±19.70	0.860
	Total HSI	68.23±12.46	62.52±14.15	68.60±17.72	67.94±12.26	65.51±13.76	0.311
2020	Functional	68.14± 10.79	57.18±13.78	72.79±18.04	70.64±13.30	64.01±14.83	0.009
	Non- structural	70.73±10.12	61.99±14.57	68.12±12.43	74.98±11.94	67.24±13.78	0.035
	Structural	66.97±18.27	66.79±16.90	67.50±27.83	70.00±17.03	67.60±18.07	0.966
	Total HSI	68.33±11.02	61.94±13.65	68.74±19.24	72.07±12.68	66.17±13.92	0.170
2021	Functional	72.41±7.39	61.64± 11.49	82.03± 14.89	73.83± 9.96	68.68± 12.82	0.000
	Non-structural	72.18±10.80	64.63±13.44	68.42±12.51	75.92±12.46	69.02±13.17	0.073
	Structural	71.21±20.67	66.20±20.06	72.50±23.73	69.88±17.50	68.69±19.65	0.841
	Total HSI	71.74±12.63	64.78±12.66	73.18±16.41	72.48±12.61	68.77±13.26	0.213
2022	Functional	74.51±7.94	66.50±12.01	83.30±15.56	74.86±10.45	71.76±12.45	0.008
	Non-structural	72.61±10.14	68.24±11.75	69.61±12.64	76.98±12.74	71.17±11.96	0.201
	Structural	68.33±18.56	67.61±15.49	71.94±23.79	76.19±16.71	70.10±17.22	0.538
	Total HSI	70.58±10.29	67.57±9.62	73.52±16.88	76.16±12.79	70.75±11.59	0.508

HSI: Hospital security index

Table 4 Disaster safety level of hospitals in Isfahan province

Years	Low safety		Moderate safety		High safety	
	Number	Percent	Number	Percent	Number	Percent
2017	3	5.45	30	54.54	22	40.00
2018	2	3.64	30	54.54	23	41.82
2019	1	1.82	25	36.36	29	52.73
2020	1	1.82	22	40.00	32	58.18
2021	0	0.00	23	41.82	32	58.18
2022	0	0.00	17	30.91	38	69.09

in Fars and Tabriz provinces (1,3). This may be due to experiences gained from previous events.

The availability of additional medical equipment is a key principle for hospitals during crisis management (10,15). The use of new telecommunication systems such as satellite, internet, intranet, and special lines has increased, and backup power sources may increase the capacity and preparedness of hospitals during crises and disasters (10,16).

Lari et al. (17) showed that the structural vulnerability of Iranian hospitals is high. However, some areas such as the management office, procurement department, pharmacy, cardiology clinics, and sterilization units had a lower risk level, while others such as the statistics office, laboratory unit, and infectious disease clinic were at higher risk. Modifying and optimizing structural components is more difficult than non-structural components because many structural components such as foundations and columns cannot be observed and modified. Of course, in the current study, the hospitals of Isfahan province had good structural safety, and, in most years, they scored higher than non-structural and functional safety.

One of the most important parts of hospital safety assessment is functional safety review. Ardalan et al. (5) showed some shortcomings in the functional safety of hospitals and their results showed a weak level of functional safety in Iranian hospitals (between 20% and 40%) (5). In Isfahan province, the functional safety of hospitals was more favorable, which could be due to the policies of the Ministry of Health & Medical Education to establish EOC and hospital disaster committees in all Iranian hospitals.

Improving all aspects of hospital safety requires financial and other resources. However, usually, the actions in the field of functional safety do not require a lot of financial resources and costs, because management and training planning can play an important role in improving safety in this field despite structural and non-structural safety. By organization of

hospital disaster committee and EOC, human, logistics, and financial resources can be properly and rationally managed in times of crisis and possible inconsistencies can be avoided (10,18).

Continuous education, training, and maneuvering can improve the safety of hospitals. Previous studies stated that the non-structural and functional safety scores of hospitals can increase after a training course related to crises and disasters (19,20). Another study showed that by increasing the awareness and experience of healthcare workers, the hospital safety level also increased (21). Training may also improve the decision-making process, which is another important part of the crisis management process (16).

Hospitals play a vital role in providing healthcare to the injured during crises and disasters. Building destruction, equipment failure, or medical personnel malfunctioning may result in severe problems for injured citizens. As preventive measures, hospitals should be established according to resilience standards and special attention should be paid to their safety.

5. Limitations

One of the limitations of such studies is that they depend on hospital cooperation. Hospitals' lack of cooperation and response to some issues can affect the results. The reason can be the deliberate bias of some hospitals to hide some problems and deficiencies.

6. Conclusion

In recent years, the hospitals of Isfahan province had a medium and high level of safety. On the other hand, the safety of hospitals in Isfahan province had improved in recent years. Despite this progress, the necessary actions and activities should still be carried out in all fields, especially functional safety, so that in the future, all the hospitals of the province will be at a high level of safety. Also, considering Iran's geographical and social conditions, focusing on reducing and preparing for all kinds of disasters should be encouraged. Improving safety requires the cooperation of all hospital departments. This requires proper policy, coordination, and internal and inter-institutional regulations.

7. Declarations

7.1. Acknowledgement

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7.2. Authors' contribution

All authors of this paper have directly participated in the planning, execution, or analysis of this study, and have approved the final version submitted.

7.3. Conflict of interest

None.

7.4. Funding

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