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Challenges of prehospital aerial operations in response to earthquake hazards: A qualitative study

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Abstract:

BACKGROUNDS: Due to the severity of the earthquake, it may need immediate treatment and transfer of the injured people to advanced medical centers, as well as dispatch of the expert team and specialized health equipment to the accident-affected area. Aerial emergency is an important responsibility of the health care system in this situation. The study aimed to extract the prehospital emergency challenges of Iran aerial operations emergency in response to the earthquake.

MATERIALS AND METHODS: The study was qualitative content analysis with conventional approach. Sampling was done in a purposive method and data were collected through semi-structured interview. The panel involved consists of 26 health professionals in medical emergencies. Recorded interviews were transcribed into written and then conventional content analysis was used to derive coding categories directly from the text data.

RESULTS: Content analysis is provided 97 initial codes, 20 subcategories and 4 main categories including challenges of "response assessment," "support," "pre-hospital staff-management," and "response operation," respectively.

CONCLUSIONS: The results showed that the necessity to assess the affected area, staffing, and management actions, including integrated operations command and the development of a dedicated response plan, as well as the use of strategies inter-organizational coordination in the response phase to earthquake. This study also emphasized that providing standard equipment, support actions, and strengthening communication infrastructure, and updating the aerial emergency system should be considered as one of the priorities of the emergency organization of Iran to provide a desired response to the earthquake.

Keywords:

Aerial emergency, challenges, disasters, earthquake, Iran

Introduction

Earthquake is one of the catastrophic natural disasters leading to remarkable casualties. Over a thousand destructive earthquakes occurred in 70 countries during the last century, accounting for hundreds of thousands of mortalities and extreme material damages. Moreover, 80% of the earthquake mortalities are reported in six countries, including Iran.[1-3] Various parts of the healthcare system and medical centers have to deal with a large number of patients following an earthquake.[4] In this regard, Emergency Medical Services (EMSs) as one of the main components of the healthcare system mainly aim to respond to such disasters to manage, coordinate, and offer healthcare services by rescue operations, triage, and the quick diagnosis and treatment or transfer of the injured to the emergency wards.[5,6] Timely emergency services have proved to improve the medical situation of critically-injured patients.[7,8] Aerial EMS (AEMSs) are provided more

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immediately than ground emergency services for transferring patients far from the medical centers and are prioritized for the transfer of critically injured patients, transfer of blood products, dispatch of mobile trained medical teams.[9,10] HEMSs provide services to improve the outcomes of therapeutic procedures, increase survival rates, and provide pre-hospital care for critically injured patients worldwide. The difference between trauma patients transferred through the ground and aerial ways is evident, and the survival rate of trauma patients transferred through aerial medical transport is higher than those transferred by ambulances.[11,12] The faster and better pre-hospital care is delivered, the lower the mortality and casualty rates are, and more individuals trust this system. Accordingly, there is an urgent need to promote care by offering updated and fast relief services. Aerial lines have many advantages since they are fast, save time, thereby decreasing the patients' hospitalization period and enjoy high security.[7,13] Many studies have been done in this regard as refer to Thomas *et al*., the frequency of HEMS has increased remarkably in the US, resulting in the enhanced quality of emergency medical services provided for patients.[14,15] The prehospital Services Organization in Norway has transformed over the past decades to meet the requirements of the new medical algorithms and the medical and health codes.[15] Studied showed that the HEMS care at the disaster scene positively affected the survival rate of poly-trauma patients with abnormal vital signs (hemodynamic and respiratory).[16,17] Ringburg *et al*.'s study entitled "Rescue operations using helicopter emergency medical services" demonstrated that HEMS significantly influenced the survival rate of patients suffering from severe injuries. Their findings revealed the significance of the dispatch triage criteria for pre-hospital service providers classifying patients into groups with severe-to-mild injuries.[11] The post-earthquake responses by small drones can be provided when the roads are closed, and there is rime constraint as such small Unmanned Aerial Vehicles (VAV) are used as medical and pharmaceutical equipment distributors and relief forces. The use of helicopters as UAVs for humanitarian and even commercial purposes has been proposed by several companies in some journals.[18] The drone helicopters can even transport equipment to mobile medical centers. In this regard, medication, blood, and other medical equipment are transported much faster using small helicopters. Medium-sized helicopters can reduce the load of land transfer and compensate for the shortages of emergency response systems at a lower cost and enjoy better and more powerful maneuverability than large-sized ones.[11]

Many natural and unnatural disasters in Iran highlight the significance of expanding AEMSs across the country. On the other hand, various factors such as being disaster-prone in terms of a natural disaster (e.g., earthquakes), the wide area of the country, diverse climate, the number of impassable areas, the necessity of fast transfer for some equipment, medications, and medical services during the shortest time possible have highlighted the significance of improving Iran's AEMS centers to offer a 70% national coverage to manage disasters and provide higher-quality emergency medical services.[9] AEMS, a subset of hospital emergency aerial operations (AOs), are the starting point of medical care in response to natural disasters, specifically earthquakes; hence, identifying the current obstacles and challenges to plan for effective response would be of paramount importance.[19,20] On the other hand, considering the expansion of cities and increased urban population and traffic, the occurrence of disasters in suburban areas, which is often associated with large numbers of the injured, and regarding the need to access remote areas such as mountains inaccessible to land ambulances, transferring patients by AEMSs is of great significance.[21] Considering the damages caused by earthquake, the necessity of the timely medical procedures and fast transfer of patients to advanced medical centers, and the transfer of human resources and specialized medical equipment to the incident setting, aerial emergency response is of utmost significance in earthquake.[19,22] To further explore researchers, need to use a flexible approach to detect the challenges and strengths of these pre-hospital aerial operations. Therefore, the study has attempted to deduce and reveal hidden patterns in interviews, observations and written documents or declaration by analyzing qualitative content, concepts, terms, and relations between them. Considering the novelty nature of aerial emergency in Iran and also, researchers did not significant study in this regard, the present study was to detect the challenges aiming to improve the quality of AEMSs to help policymakers and managers and increase the performance and service delivery quality of AEMSs.

Materials and Methods

Study design and setting

This qualitative study was done in 2021, and the content analysis method was used to analyze the collected data.

Study participants and sampling

The participants encompassed 26 experts with practical experiences or theoretical knowledge in the field of medical emergencies or postdisaster aerial relief and rescue operations. The participants were emergency medicine specialists, medical emergency and accident center managers, and experts in the field of disaster health and emergencies at the universities of medical sciences across the country. The participants with maximum diversity were selected using the purposive

sampling method. To this end, sampling continued as long as data saturation was reached.

The participants included nine medical emergency technicians, five faculty members working in the field of emergencies and disasters, two nursery experts, who were the secretaries of the hospital accident committee, three experts in the Emergency Operation Centers (EOC) at universities of medical sciences, three managers of Red Crescent relief and rescue operation, two support vice-chancellors at Universities of Medical Sciences, and two Vice Presidents for Pre-Hospital Emergency Operations.

Data collection tool and technique

In-person and individuals' interviews were conducted with each participant by the corresponding author. The data collection process was conducted under the supervision of D. H. K. and D. M. M. The interviewees responded to the following questions: "What do you think of the AEMS performance in response to earthquakes and similar disasters?", "What are the challenges of Iran AEMS in responding to earthquakes and other disasters?" "What components must be included in aerial medial relief response programs according to your experience?", "What functions and requirements must be considered for aerial relief response to earthquakes?", and "What opportunities would be provided by implementing aerial relief operation system in Iran?" Moreover, the researcher tried to reach data saturation by posing wh-questions and asking the participants to elaborate on their responses by posing statements such as "can you give an example? And "can you explain more?" The interviews lasted 30-60 min, and the time and place were determined with the agreement of the interviewer and interviewees. Notes were taken during the interviews to define and interpret the responses correctly.

Ethical consideration

Informed written and oral consent was taken before the interviews and after explaining the research procedures and objectives. Furthermore, the participants were informed on research methods and interview methods and were insured about information confidentiality and their right to withdraw from the study.

Data analysis

The conventional qualitative content analysis method was used to the collected data. The systematic stages were followed, and the analyses were conducted simultaneously. The recorded interviews were first transcribed verbatim. The transcript was then studied several times for further clarification of the content. The participants' words were used in the first coding process, the semantic units were noted down, and the codes appropriate for each semantic unit were then written down. Compact semantic units were created, and the codes were then categorized by their similarities and differences. This process continued for all interviews as long as the main categories were extracted.

Validity and reliability

The strategies proposed by Lincoln and Guba[23,24] were used in the present study to ensure the validity and reliability of the tests. According to them, the four criteria (namely credibility, confirmability, dependability, and transferability) are required to ensure reliability. Credibility was ensured by allocating adequate time. Long interaction with the participant, the constant comparison of their statements, understanding their experiences by the researcher and ensuring maximum diversity among the participants were used to collect data. Confirmability was ensured by member reviews, expert reviews, and peer reviews. Member reviews were conducted by returning the interview transcripts and results in summary to four of the participants to confirm the results. Two qualitative researchers from the research team (expert and peer review) evaluated the validity of data collection and analysis.

Results

The demographic characteristics of the study are presented in Table 1.

Regarding a major AEMS challenges in response to hazards, four main categories, and 20 subcategories, and 97 codes were extracted as follows:

Table 1: Participants demographic characteristics (*n*=25)

Variables	*n* (%)
Age (*n*=24)	
30-40	8 (30.76)
40-50	13 (0.50)
>50	5 (19.23)
Gender	
Male	22
Female	4 (15.38)
Years of experiences in responding to disasters and earthquakes in HEMSs and EMSs	
3-15	10 (38.46)
15-25	12 (46.15)
>25	4 (15.38)
Level of education	
Bachelor	6 (23.07)
Master	4 (15.38)
General physician	6 (23.07)
PhD	9 (34.6)
Postdoctoral	1 (3.84)

HEMSs=Helicopter emergency medical services, EMSs=Emergency medical service

(1) Assessment challenges with four subcategories (namely lack of standard evaluation tools, lack of multidisciplinary experts in AEMS centers, lack of required infrastructures for fast, constant, and accurate assessment in prehospital AEMS centers, and lack of uniform and landmarked maps to guide AOs in response to earthquake hazards); (2) Logistic challenges with four subcategories (viz., lack of required infrastructures and facilities for implementing AOs in response to earthquake hazards, lack of required and trained human resources, standard medical equipment for operations, and deployment of ambulance helicopters in military environments); (3) prehospital management challenges with seven subcategories (viz., lack of managerial stability, lack of a national aerial emergency earthquake response plan, lack of a monitoring plan and response process control, lack of inter-organizational and intra-organizational coordination, lack of an organizational chart for AEMS and temporary use of forces, shortage of credits allocated to AEMS, and unfavorable geographical distribution of medicopters across the country), and RO challenges with five subcategories (viz., use of repurposed military helicopters for AEMS, ineffectiveness of available helicopters in sunrise and dawn hours, lack of specific GPS to track helicopters responding to earthquake hazards, the poor communication network consisting of satellite and wireless phones in earthquakes, and lack of standard landing pads in all hospitals). Table 2 elaborates the main categories and subcategories extracted in the study.

The interviews and the collected data were analyzed using the content analysis method, resulting in 97 primary codes, 20 subcategories, and four main categories (viz., assessment challenges, logistic challenges, prehospital management challenges, and RO challenges).

AEMS challenges in response to earthquake hazards

Iran is a disaster-prone country and predicting aerial ambulance services is imperative to prevent uncalled-for accidents. The critical role of AEMS in improving pre-hospital services, the challenges posed for AEMS in various aspects, and the opportunities for implementing modern AEMS systems highlight the necessity of developing an AEMS service system in Iran. In this regard, exploring the opportunities and challenges of AEMS in recent earthquakes (e.g., Kermanshah earthquake) and considering the necessity of developing the AEMS system in Iran's health system transformation program show that the AEMS challenges are illustrated to improve health service quality and managerial and institutional performance in response to earthquakes.

Assessment challenges

The interviews revealed that fast evaluation, initial assessment, and accurate aerial evaluation were the most critical steps in decision-making and fast response of the operation teams dealing with earthquakes. These measures quicken the logistic and relief operations and reduce mortalities and secondary damages due to the earthquake. Furthermore, the participants and scientific resources also referred to risk evaluation as the first step in disaster risk management planning. The fast and preliminary evaluation of the damaged area is among the most significant factors affecting appropriate responses

Table 2: Main categories and subcategories

Main categories	Subcategories
Assessment challenges	Lack of standard evaluation tools
	Lack of multidisciplinary experts in AEMS centers
	Lack of required infrastructures for fast, constant, and accurate assessment in prehospital AEMS
	Lack of uniform and landmarked maps to guide AOS in response to earthquake hazards
Logistic challenges	Lack of required infrastructures and facilities for implementing AOS in response to earthquake hazards
	Lack of required and trained human resources
	Standard medical equipment for operation
	Deployment of ambulance helicopters in military environments
Prehospital management challenges	Lack of managerial stability
	Lack of a national aerial emergency earthquake response plan
	Lack of a monitoring plan and response process control
	Lack of inter-organizational and intra-organizational coordination
	Lack of an organizational chart for AEMS and temporary use of forces
	Shortage of credits allocated to AEMS
	Unfavorable geographical distribution of medicopters across the country
Response operation challenges	Repurposed military helicopters for AEMS
	Ineffectiveness of existing helicopters in sunrise and dawn hours
	Lack of specific GPS to track helicopters responding to earthquake hazards
	The poor communication network consisting of satellite and wireless phones in earthquakes
	Lack of standard landing pads in all hospitals

AEMS=Aerial emergency medical services, AOS=Aerial operations, GPS=Global positioning system

to the earthquake. Aerial evaluation can help collect information regarding the exact number and amounts of damages and casualties and the needs of the area struck by the earthquake.[25-27]

Interviewee P (9(: "Unfortunately, there is no checklist or standard tool to assess the earthquake in Iran. This is why it needs to be designed, and we could also say that the initial and fast evaluation team has not been organized correctly to assess all aspects of an earthquake."

Interviewee P (4): "Our earthquake evaluation was imperfect. There's a need for modern equipment and tools and trained staff in the AEMS center for evaluation, but unfortunately, the required planning is not performed, and no measure has been adopted."

Interviewee P (15): "The landmarked maps only specify the landing point of helicopters in the area struck by an earthquake, or we should observe where our aerial emergency helicopter is on the monitor in the EOC center. The medical centers, crucial areas, schools, and populated areas must be marked on maps using GIS or GPS. There was no airlift in the operations team and headquarters, so we performed poorly in evaluating and executing the operation."

Logistic challenges

The findings confirmed that each operation can accomplish its objectives with proper support since the lack of logistics, up-to-date equipment, and the essential medical requirement in aerial emergency services can seriously disrupt the performance of relief operations and threaten the survival of those injured in the earthquake.

Interviewee P (2): "Unfortunately, the status of the specialized equipment in the aerial emergency system is not acceptable as it borders on equipment shortage. That is, the aerial prehospital ambulance lacks the standard and practical medical appliances to be used in the aerial relief operation, the available appliances are not up-to-date or are incompatible with the requirements of AOs and aerial emergency. Furthermore, there are no technicians trained for relief operation under different conditions and in mountainous areas."

Interviewee P (10): "If you're asking me, one of the weaknesses of my colleagues is that they don't know how to work with the equipment. I believe, before adding a piece of equipment to the base, everyone must be trained to use and test it to make sure that they've learned how to use it, or the technicians in the aerial emergency service must be trained how to work in a helicopter. However, they're using old workforces not suitable to take over such missions."

Interviewee P (4): "One of our problems is that the hospital infrastructures might fail at the earthquake time. For example, the landing pad might be destructed and there are not alternatives for it. Another problem in the system is inappropriate distribution of aerial ambulances. For example, the military and air forces have their bases outside the towns or in the outskirts of the city where there might be no communication paths at the earthquake time to transfer the injured, thereby increasing time to arrive at the disaster place. It'd be better to build special aerial landing bases inside the city for operation. Furthermore, bureaucratic issues might prevent timely operations since the organization is affiliated with the army."

Prehospital emergency management challenges

The findings indicated that developing an emergency response plan, and unified coordination, command, monitoring, and organization play a crucial part in the advancement of AOs in disasters with mass casualties such as earthquakes. One of the essential responsibilities of the operational commander is to respond to disasters and control and monitor the operation execution.

Moreover, the interviews revealed that the lack of intra-organization and inter-organization communication, caused by destruction of the infrastructures at the time of earthquakes and the incoordination resulting from the earthquake hazards, disrupt the response operation at the commander level.

Interviewee P (12): "We have experienced and capable managers in the field of aerial emergency services who have been invested on. Unfortunately, when the 4-year command of the minister ends, all the expert authorities might be demoted, thereby enhancing the loss of human resources in some ways."

Interviewee P (10): "We must have a specialized national plan for aerial emergency services to respond well to earthquakes. We should practice this program, and it must be on our national plan framework. Well, we practically didn't have a CIS structure in the case of the Kerman earthquake, and there was no action plan either. The evaluation and information system were quite poor too. Furthermore, there practically was no intra-organization coordination."

Interviewee P (17): "I believe that we don't have a specified organizational chart and structure in the field, or that aerial emergency services can trouble our permanent organizational workforce recruitment. Furthermore, nonspecified budgets discourage the forces and managers and prevent us from having a stable aerial emergency force to be invested for the earthquake time."

Interviewee P (20): "Only if an earthquake happens in a pole, a nearby university might have aerial emergency services. Unfortunately, aerial emergency services are not distributed properly in Iran. Sometimes hard-to-reach areas need air support during an earthquake and suffer a lot due to the lack of AEMSs. Anyway, service distribution must be reconsidered with a special focus on such areas."

RO challenges

The present findings indicated the need for an up-to-date aerial fleet to operate in various weathers and times and for equipping the aerial emergency system with airborne tracking equipment considering Iran's distinct geographical conditions. Furthermore, improving radio communication infrastructures and standardizing medical helicopters' landing space in hospitals is also imperative.

Interviewee P (12): "Most of the helicopters are out of order and old, aged above 30 years, but they but are still in operation. We've lost many good technicians in the operation of these helicopters. The aerial relief operation fleet must be modernized so that the staff can safely work at the AEMS center. The technicians should also receive flight training for emergencies."

Interviewee P (5): "There is a lack of modern geographical tracking systems to track emergency service helicopters during an earthquake relief operation in the prehospital emergency services. In other words, there's a lack of the helicopters to operate under different conditions such as in the dark."

Interviewee P (4): "There are horizontally-built and linear hospitals that have taken up a lot of space and left no space for emergency helicopter handling, especially in small towns. This is why the landing pads are small and nonstandard."

Interviewee P (11): "Standard pads or even a medical helicopter hangar must be made in hospitals to transfer patients to the specialized medical centers, and this has been unfortunately disregarded in our country. Landing pads and lighting could result in problems or even secondary accidents for the AO team, and this issue need to be addressed."

Interviewee P (23): "The communication network, wireless towers, and a bunch of other things were destroyed and dismantled in the Kermanshah earthquake, previously in the Ban earthquake. This resulted in the loss of the golden time to coordinate and respond to the earthquake."

Discussion

Results of the study demonstrated that fast and accurate initial evaluation and it is the most critical challenge, other previous studies have emphasized the evaluation of safety concerning evacuation routes and rapid medical response.[28,29] Furthermore, the study of Aghajani *et al*. also emphasized the evaluation of the area struck by an earthquake for navigation and access to the area as well as accurate and fast responses.[30,31] Such evaluations can improve medical responses. According to the participants' experiences, there is a necessity for aerial evaluation indices in aerial medical emergency operations.[32] The findings also emphasized the effective role of the presence of specialized aerial assessment teams and the use of drones to assess earthquake-stricken areas. Similarly, Kornhall *et al*. and Giannakopoulos *et al*. also confirmed the effective role of experienced aerial evaluation teams and drones in evaluating the earthquake-struck areas and the role of specialized medical teams in providing specialized services in the area.[33,34] According to the researchers participating in this study, developing a standard and comprehensive evaluation checklist and establishing a multidisciplinary expert team in the aerial emergency response system facilitate understanding various aspects of earthquake damages.

The findings indicated that the supply and establishment of earthquake-response operation infrastructure increase the speed of tending to the injured and improves the quality of AEMS during earthquake relief. Thus, the present study results are consistent with other previous findings[35-38] The results also showed that attention to the development of pre-hospital emergency staff empowerment measures and functional evaluation to improve the level of care is essential which was in line with[39] the adoption of some logistic measures in aerial response to earthquakes, including the supply and retaining of specialized human forces and establishing the infrastructures required for AOs, are among the requirements of aerial relief response programs. According to the participants, some measures should be adopted to reinforce the infrastructures, support AEMS, and prepare and develop aerial emergency landing pads in different regions of the country. Standard specialized equipment suitable for aerial emergency operations, the development of aerial emergency deployment centers, and training the human resources working in the AEMS system were among the essential subcategories extracted from the interviews. The present findings confirmed that the presence of standard equipment alongside trained and specialized human forces, a sustainable development plan in the field of infrastructures, and deployment centers in urban areas accessible to the aerial emergency fleet would provide more sustainable and effective service to the injured. Haghparast-Bidgoli *et al*. documented that considering the development of empowerment measures among pre-hospital employees and performance assessment

are necessary to improve the quality of the delivered care.[38]

Prehospital management challenges were another main category detected in the present study. The analysis of the participants' opinions revealed that unstable management, the lack of a complete aerial emergency response plan for earthquakes, the lack of monitoring and auditing the response process, the lack of a legal position and specific budget, and unfair distribution of the emergency response helicopter in the earthquake-prone areas of the country were among the obstacles limiting the achievement of the goals of the national AEMS system and thereby enhancing ineffective responses to the earthquake.

The modification of the organizational structures and guidelines must be considered as the priorities of the national emergency organization and other organizations collaborating with them in aerial relief operations. These results are consistent with those suggested by Motomura *et al*.[40] and Chan *et al*.[41] Furthermore, researchers' opinions indicated that integrated management, inter-organization, and intra-organization coordination between the aerial emergency relief teams and the disaster command system and employees' security and safety were among the most critical managerial measures that needed to be taken in aerial response to the earthquake. Furthermore, there was no EOC or aerial traffic management and control center and suggested that an aerial EOC be established to respond to earthquakes in Iran. These findings are in line with. Sorani *et al*. reported that safety and security instructions were effective factors affecting the preparedness and improvement of the quality of the AEMS systems in response to earthquakes.[42] The present study's findings were consistent with those reported by Taylor *et al*. and Sorani *et al*. regarding the Incident Command Systems (ICS), coordination and control of the response reams, and the presence of structures such as IAP, ICS, and EOC in response to earthquakes.[42,43] Researchers confirmed the weakness and lack of an exclusive earthquake response plan and the weakness of the incident command center (ICS) in the field as effective factors in disasters such as earthquakes, resulting in the operation personnel's poor management performance and confusion. The present study revealed the challenges to be the lack of a unified command, the lack of an organizational chart, and financial credit allocation in management. Similarly, Eri *et al*. listed the same challenges.[44] Legal grounds must be provided for the use of medical helicopters, drones, and Quadcopters in the prehospital emergency system of the country to respond to natural disasters such as earthquake.[10] According to the scholars participating in this study, establishing a central coordination center to manage aerial emergency transportation between the various organizations and the Ministry of Health was among the essential priorities. Furthermore, holding integrated educational courses for the team members involved in the process of childbirth in the air transportation system and attention to safety regulations must also be minded.

The analysis of the interviews revealed the challenges of executing aerial emergency response operations as a main category. The challenges of executing aerial emergency response operations in response to an earthquake are among the most significant obstacles for establishing a nimble system with immediate response and coordination to meet the needs posed by the direct and indirect effects of earthquakes in the field of health. According to the participants, an air relief fleet and exclusive medical helicopters are necessary for the prehospital emergency system of Iran. Furthermore, results indicated that establishing and developing standard landing pads in all Iranian hospitals would increase the quality and speed of the services and reduce the technical problems resulting from the landing and transfer of patients to medical centers.

The present findings highlighted the need to renew and update the aerial fleet, reinforce the infrastructures, and standardize helicopter landing pads in medical centers. This finding is in a similar vein with Thies *et al*.'s findings.[45] According to the experts in the present study, the fast and safe transfer of the injured to hospitals by establishing suitable helicopter landing spaces in hospitals and medical centers increases the likelihood of survival for the injured,[46,47] reduce the time of receiving specialized services, and increase the safety of the AEMS team considering the traumatic injuries as well as the brain, skeletal, and muscle injuries caused by earthquakes.[18,39] According to the experiences of earthquakes in Iran and given the nature of the hazard and regarding the fact that it might happen at any time of the day and damage and destroy structures as well as injuring humans, the necessity of exploiting modern and up-to-date aerial emergency fleet to carry out operations at different day times is highlighted in Iran's pre-hospital emergency system.

The findings of this study indicate the need for stable communications, the use of drone technology, and the creation of aerial operations tracking systems, which is consistent with the study of regarding the effective role of communication in accidents and the use of light and modern.[39] The success of the air emergency response system is made possible by the strengthening and sustainable.

The development of advanced communication facilities and a continuous monitoring system. Infrastructures

have a special role in prehospital aerial emergency operations services in earthquakes due to the destructive effects of earthquakes on communication infrastructure and disruption of telephone and radio communications, strengthening and developing fixed and mobile communication infrastructures and defining alternative communication channels sign contracts with private organizations and companies to establish communication quickly in the event of an earthquake, also, due to the effectiveness of the use of drone technology and their maneuverability in response to earthquakes, there is a need to develop and use them in prehospital emergencies during earthquakes.

Limitations and recommendation

This qualitative study is one of the few studies that has collected the views of various experts on aerial emergencies in response to earthquakes in Iran. The findings point to a number of key challenges that need to be addressed. The heterogeneity of the participants and the inclusion of the experts of health in disasters and emergencies, AEMS experts, and experts with experience in earthquake response were among the strengths of the present study.

The low number of participants is among the limitations of this study. Furthermore, another limitation of the study was that the participants could not participate in in-person interviews due to the geographical limits and the Coronavirus pandemic. Another limitation was that the participants could not elaborate on some issues because of their job positions. However, the rich and well-saturated information from participants could overcome this manner.

Conclusions

The findings highlighted the necessity of fast and accurate evaluation by the aerial emergency to estimate damages to health infrastructures, human casualties, and the needs of the earthquake-struck region and to reinforce the logistics of the aerial emergency operations and its specialized functions. Moreover, the present study results revealed that preparing a standard protocol based on the approved laws to respond and modify the structures and operating procedures and empower the aerial emergency personnel is considered among the priorities of the national emergency organization. Furthermore, alternative radio systems, modern communication technologies, and fast communication by reinforcing communication infrastructure must be addressed prior to earthquakes. Further, the findings of the present study indicated that Iran's aerial emergency system suffers from many shortcomings in response to earthquakes and needs to modify the infrastructures, establish the organizational position of the AEMS system, and exploit specialized and trained personnel to overcome these shortcomings. Furthermore, updating specialized medical helicopters responding to disasters such as earthquakes and using standard and specialized facilities and equipment is necessary for effective responses to the injuries and damages caused by earthquakes.

Given that one of the challenges is the vacuum of the response program and lack of inter-organizational coordination in air operations, it is recommended to establish a central coordinating management center to manage the aerial emergency transportation unit of military organization. The Red Crescent and the Ministry of Health are suggested to develop a specialized national earthquake response plan and establish an IAP considering the geographical conditions and earthquake hazards in different regions of Iran. It is also expected that disaster risk assessment will be considered as a first priority in the operational plan of aerial prehospital emergency centers.

The design of optimal and more advanced UAV helicopters for more effective responses to earthquakes in Iran and establishing the legal grounds for the use of drones and helicopters and the organized use of volunteer medical teams trained in Iran's AEMS system could improve the quality of AEMSs and the speed of medical service delivery during the earthquake and reduce casualties.

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Conflicts of interest

There are no conflicts of interest.

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