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Operational Strategies for Establishing Disaster-Resilient Schools: A Qualitative Study

Samaneh Mirzaei[1], Abbas Ali Dehghani Tafti[1], Leila Mohammadinia[2], Khadijeh Nasiriani[3]*, Zohreh Rahaei[4], Hossein Falahzadeh[5], Hamid Reza Amiri[6]

1. Department of Health in Emergencies and Disasters, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.
2. Health Human Resource Research Center, Department of Health in Disasters and Emergencies, School of Management and Information Sciences, Shiraz University of Medical Sciences, Shiraz, Iran.
3. Department of Nursing, Nursing and Midwifery School, Shahid Sadoughi University of Medical Sciences and Health Services, Yazd, Iran.
4. Department of Health Education and Promotion, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.
5. Department of Biostatistics and Epidemiology, School of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.
6. Department of Civil Engineering, Yazd Branch, Islamic Azad University, Yazd, Iran.

***Corresponding author:** Khadijeh Nasiriani; **Email:** nasiriani@gmail.com

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Abstract

Introduction: Resilient schools can warranty students' health and survival at disasters. It is obligatory that schools be prepared for natural challenges through local programs. Considering the great population of students, disaster-resilient schools can be a safe and suitable environment for students at the time of disaster.

Objective: This study aims to identify certain operational strategies for establishing schools resilient to natural disasters.

Method: This qualitative study was based on conventional content analysis. Using purposive sampling method, 24 experts in the fields of health in disasters, construction engineering, psychology, teaching, and administrative management participated in the study. Maximum variation sampling continued until data saturation was achieved. The data collected via unstructured interviews were analyzed with Graneheim and Lundmen's conventional content analysis.

Results: Content analysis resulted in four main categories as operational strategies for establishing disaster-resilient schools including: 1) "construction and non-construction optimization", with four subcategories of construct risk management, optimization of construct architecture and physical structure, correct construct localization, and promotion of non-construct safety, 2) "promotion of organizational coordination and interactions" with two subcategories, namely improvement in intra-organizational communication and improvement in extra-organizational communication, 3) "improvement in education" with three subcategories of holding educational courses for families and students, holding educational courses for managers and personnel, and holding simulated exercises, and 4) "process promotion" with four subcategories of increased preparedness, correct planning, creation of organizational structure, and rehabilitation facilitation.

Conclusion: Various factors affecting schools' response to disasters form operational strategies to establish disaster-resilient schools. These strategies influence pre- and post-disaster preparedness. Awareness of these components followed by preparedness prior to disasters can save students' lives, improve school performance after disasters, and aid in establishing disaster-resilient schools as safe lodgings.

Key words: Disasters; Emergencies; Resilience; Schools

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INTRODUCTION

Disasters can seriously damage buildings, the transportation system and infrastructures, leading to social disturbances and mortalities. Schools are directly or indirectly influenced by such incidents (1, 2). Globally, disasters induce considerable damage to schools and mortalities among school children, and impair the activities of schools, hence affecting educational quality. This predisposes to the destruction of sociocultural life and resources after disasters (3). For example, the Sichuan earthquake in China in 2008 killed 10000 students and ruined 7000 classrooms. Also, 17000 students died and 10000 schools were destroyed in Kashmir earthquake in the north of Pakistan in 2005 (4). Moreover, 604 primary schools and 92 high schools sustained damage during Bohol's, an

earthquake measuring 7.2 on the Richter Scale in 2013 (5, 6). Almost 1.2 billion students are enrolled in primary and high schools, among whom 875 million study in schools with high risk of earthquake (7). Examination of natural disasters indicates that school-age children, as the most vulnerable group, are mostly exposed to natural disaster damages, especially when they are at school (8). For instance, 18 million children are studying at various levels in Iranian educational centers forming one quarter of the Iranian population (9). Moreover, these students spend 35-40% of their time at school, meaning that the vulnerability of students to disasters is high (10).

Establishment of disaster-resilient schools as a safe milieu for counteracting disasters is among the risk reduction strategies, which includes the two principles of risk reduction and creation of resilience in the school environment (11, 12). Resilience to and preparedness for disasters are the first elements of decision-making on the basis of humanistic, social, economic, and infrastructural wealth according to steps in approaching natural disasters (13). Although the nature of resilience has been discussed for many years, its application in natural disasters is quite innovative (14). In the Third International Conference of Reduction of Natural Disaster Risks in 2015, the Sandy Document approved three facilities of "safe schools, effective management of school disasters, and reduced disaster risk and training of resilience" as "comprehensive school safety" (15). Risk prevention and reduction prior to disasters is a required step for achieving stable development that ought to be generalized at various levels from school to home, and from there to the community (9).

Schools play a vital role in the formation of values and culture in the society, bringing about positive outcomes for the community via establishing skills, attitudes, and values for individuals at ordinary and critical times (16). Reconstruction of ruined schools and resuming classes can serve as one of the most effective methods of returning to normal condition and survival of the community (17, 18). On the other hand, appropriate training via schools is transferred to the depths of the society not only by students but also through parents and teachers. Accordingly, schools can play a pivotal role in both critical situations and before and after disasters by promoting collaboration among various social groups (19). In addition to their educational role, resilient schools can serve as safe emergency shelters immediately after disasters (3, 19). Furthermore, the strong leadership of teachers and managers in approaching critical situations and their life-saving interventions is highly useful (1). School safety has many aspects such as physical traits and construction reinforcement, and education and training for students, teachers, and communities through efforts for establishing awareness and capacity-making in the communities (19). Specifically, proper designing of school buildings and their regular supervision can reduce damages induced by disasters and maintain students' health (20). Obviously, school preparedness can be enhanced via promoted education, increased awareness of children, and through personnel, official staff, teachers, and managers. In this regard, the development of a comprehensive disaster management plan is mandatory for important organizations, especially educational institutes such as schools, to reduce risks and increase public awareness (9). To create preparedness in schools for proper response at disasters, managers and policy-makers should know the effective components of operational strategies at schools. It is highly important for schools to prepare separate specialized programs for their own challenges and for all local critical situations. To do so, identifying the operational strategies for resilient schools is mandatory. The current research identified such strategies so as to create resilient schools.

METHODS

Study design

This qualitative study culled by unstructured interviews from May to December 2018. The study was approved by the Ethics Committee of Human Research at Shahid Sadoughi University of Medical Sciences, Yazd, Iran (IR.SSU.SPH.REC.1397.046). The interview location was set to observe the interviewee's convenience. The research goals were primarily elucidated for the participants, their consent was obtained for voice recording, and they were assured of interview information anonymity and confidentiality.

Participants

The population under study consisted of 3 specialists in health in disasters, 5 construction engineers, 3 psychologists, 7 teachers, and 6 administrative managers selected with purposive sampling method. The inclusion criteria were: earthquake experience during employment, specialty in natural disasters, experience of scene attendance, rescuing experience, and rescue at schools. In addition to experts in disasters and emergencies, teachers, deputies, and managers experiencing earthquake over the past ten years

were further interviewed. Maximum variation sampling continued until data saturation.

Data collection

First, two cases of data collection were performed using unstructured deep interviews from April to December 2018. The researcher primarily explained the research goals to the participants as the identification of operational strategies for establishing disaster-resilient schools. The interviews began with this question: "What are the characteristics of disaster-resilient schools in your opinion?" The following questions were co-constructed on the basis of the interviewees' responses using co-construction technique. The next questions were based on the concepts extracted from the responses as open semi-structured questions. The interview items dealt with identifying the operational strategies for establishing disaster-resilient schools and included: "Please explain your experience of recent disasters at your school", "What kind of school can be classified as disaster-resilient?", "What kind of school is not disaster-resilient?", and "What kind of school is ready to cope with disasters?" The questions were developed in the course of the interviews to reach goals. When necessary, the interviewees were asked to clarify and exemplify their responses. The interviews lasted 30-60 min with a mean time of 30 min. The interview location was determined according to the interviewees' convenience mainly at their work place.

Trustworthiness

Guba and Lincoln criteria were used in this study to increase data accuracy and stability (22). To increase data credibility, the researcher engaged in long-term contact with the participants. It was also tried to select participants with varying knowledge, experience, work experience, work location, age, and gender. To identify the operational strategies for establishing disaster-resilient schools, the voice files were listened to repeatedly, a long time was spent on data analysis and interpretation, and the findings were classified and coded manually. Data dependability was enhanced through repeated data collection and analysis and expert opinion. Further performed was constant comparative analysis and the data were culled, coded, and analyzed simultaneously. Prolonged engagement was employed to secure data credibility. Member check was used to compare the researcher's perception with the participants' intended meaning. The interview summaries were returned to the participants after transcription for approval. Additionally, the codes were assessed during the coding process by the corresponding author and quality technicians, and peer check was then conducted. The greatest portion of time for code extraction was allocated to technicians with different views. To do so, several sessions were held to find a logical relation between codes and classes. Moreover, to cover the resilience issue from the perspective of experts, specialists in different fields, including health in disasters, construction engineering, psychology, teaching, and administrative management were interviewed.

Data analysis

The collected data were analyzed using Graneheim and Lundmen's content analysis. The interviews were recorded digitally with cell phone after the participants' consent was obtained, goals were explained, and a confidential rapport was established. At the end of each interview, all the content (notes and voice files) was transcribed verbatim and data analysis was commenced. In so doing, the notes were reviewed several times to arrive at a general understanding of the content. The transcriptions were then broken into smallest semantic units or codes. The primary codes were compared and contrasted and the similar ones were merged into subcategories. Subsequently, the subcategories were continually compared and the main categories were distilled on the basis of similarities.

RESULTS

Given the importance of the topic under study, a wide spectrum of experts were involved in this study with their demographics presented in table 1. There were a total of 24 participants aged 32-65 years with a mean age of 42 years. All participants had a work experience of more than 5 years in disaster-prone regions with a work experience range of 5-40 years and a mean work experience of 16.5 years

The data analysis resulted in four major categories:

- Construction and non-construction optimization
- Promotion of organizational coordination and interactions
- Improvement in education
- Process promotion

The first category consisted of four subcategories, namely construct risk management, optimization of construct architecture and physical structure, correct construct localization, and promotion of non-construct safety. The second category included the subcategories of improvement in intra-organizational communication and improvement in extra-organizational communication. The third category comprised the subcategories of holding educational courses for

Table 1: Demographics of participants in the interview

Demographic variables	Frequency (%)	Experiences
Age		-School psychologist -Construction Engineer -Specialist of health in disasters -School manager -Head of Charity School Builders Institute -School educational deputy -Architectural engineer of School Reconstruction Organization -School counselor -School teacher -Manager of counseling center -Head of training and education office -School construction supervisor
<40	4 (17)	
40-50	13 (54)	
>50	7 (29)	
Gender		
Male	17 (70)	
Female	7 (30)	
Education level		
BA/BS	10 (42)	
MA/MSc	8 (33)	
PhD	6 (25)	
Work experience		
<10 years	6 (25)	
10-12	12 (50)	
>20 years	6 (25)	

BA/BSc: Bachelor of Art/Bachelor of Science; MA/MSc: Master of Arts/Master of Science; PhD: Doctor of Philosophy

families and students, holding educational courses for managers and personnel, and holding simulated exercises. The final category included four subcategories, namely increased preparedness, correct planning, creation of organizational structure, and facilitation of rehabilitation. Table 2 presents the categories and subcategories of operational strategies for establishing disaster-resilient schools from experts' perspectives.

Construction and non-construction Optimization

- **Construction risk management**

Construct risk management is one of the operational strategies for establishing disaster-resilient schools. In this regard, observance of safe building principles and risk assessment at schools is to be considered. This should be followed by building reinforcement and reconstruction through seeking help from experts and supervisors. Allocation of building codes for obtaining school activity permission and renewal of these codes through technical checkups of school buildings can result in the formation of annual school construct supervision programs including development of resilient school building programs and implementation of school building standards.

"…schools ought to be resilient and reconstructed because even if students and personnel are resilient and the building is not, it will easily collapse…" (P.5).

"…if, as practiced in some countries, a series of building codes are allocated for school activity commencement and renewed for resuming school activity, schools will be obligated to have an annual program for building reinforcement…" (P.2).

- **Optimization of Construction Architecture and Physical structure**

Optimization of construct architecture and physical structure helps establish disaster-resilient schools. In this regard, it is important to pay attention to the structure of doors (opening outwards), windows, stairs, and emergency exit doors and devoting a safe location as an emergency shelter. Moreover, schools should provide sufficient space for rescuers' and fire-fighters' access.

"…once there was a fire in the classroom; since the doors were wide and opened outward, the students were able to escape the fire …" (P.7).

"…we *were about to hold a fire-fighting maneuver. But, when the fire engine arrived, the yard was so small and crowded that it could not move forward or make a turn; however, they were able to reach the building by a long ladder…"* (P.11).

- **Correct localization of construction**

Building schools in the right location and correct construction localization are among the significant components of resilience in schools. When localizing schools, due attention should be paid to access to the main routes and ramps, distance from religious places, gas stations, main crowded routes, routes with environmental pollutants, chemical factories, railways, unpleasant noises and highways, and long dead ends. On the other hand, climatic conditions and earth resilience (earth quality) are among the operational strategies of designing and building disaster-resilient schools.

"…since the school was easily accessible, the ambulance arrived at the scene quickly and transferred the students to the hospital…" (P.9).

- **Promotion of non-construction safety**

This is another effective component of resilience at schools. In many cases, fixing the non-construction parts of the building such as whiteboards, blackboards, and other instruments or changing their location can reduce damage after disasters. The use of isinglass instead of glass, presence of

Table 2: Categories and subcategories of operational strategies for establishing disaster-resilient schools from experts' perspectives

Categories	Subcategories	Item Summary (integrated codes)
Construction and non-construction optimization	Construction risk management	-Prioritization of vulnerable school building on the basis of the construction or reconstruction year. -Implementation of reinforcement programs, building operations, and annual assessment and identification of all potential risks at schools by technicians. -Observation of national rules and regulations of building, 2800 standard in school building, and the school reconstruction protocol. -Allocation of building codes and technical supervision to obtain school activity permission.
	Optimization of construct architecture and physical structure	-Presence of windows, doors, and standard stairs (height, width, and suitable direction), and observance of building height (number of floors). -Presence of separate entrance, exit, and escape stairs. -Installation of emergency exit doors and their constant openness. -Allocation of a specific place as emergency shelter. -Having tow exits and access to free space. -Sufficient space for fire engines to make a turn in school and rescuer access. -Access to building by ladder in case of limited space.
	Correct construct localization	-School location. -Consideration of climatic conditions and earth resilience (earth type) in designing.
	Promotion of non-construct safety	-Presence and installation of fire extinguishers in critical places and instructions for their use. -Fixing non-construction objects, changing or removing the location of equipment. -Use of isinglass above the doors instead of glass or use of security glass. -Safe storing of lethal and flammable chemicals.
Promotion of organizational coordination and interactions	Improvement in intra-organizational communication	-Interactions between students and school personnel. -Ability to replace key staff with significant others in case of other personnel's absence. -Contribution of teachers and staff to preparing the educational program of preparedness against accidents and effective leadership.
	Improvement in extra-organizational communication	-Signing contracts and presence of agreements with other organizations or local authorities. -Absorption of charity builders and investors in reconstruction and building of quake-resilient buildings. -Contribution of beneficiary parties and identification of their responsibilities. -Contribution of parents to designing and implementing syllabus, and collaboration with parents for post-disaster interventions and interactions with school.
Improvement in education	Holding educational courses for families and students	-Holding simultaneous classes on disasters for students and their families. -Teaching resilience, providing consultation for students and families, and informing them of their role in critical situations and the psychological aftermaths. -Teaching life style skills and topics related to preparedness for coping with accidents as a credit unit and revision of teaching materials in syllabi. -Teaching on the basis of school certificate (primary, junior high, or high school), males or females school, number of students and teachers, and shift variety.

protective iron bars on windows, bookshelves, and fluorescent lamps to prevent the falling of objects, presence and installation of fire extinguishers at critical sites (laboratory, workshop, pantry house, and power boards) and classrooms, instructions on the use and maintenance of extinguishers, and the correct use of hazardous tools are among the factors that increase school resilience and decrease damage after disasters.

"…since the time we replaced the classroom glasses with isinglass, we are no longer worried about breaking and scattering of glasses at quakes. Children are no longer hurt…" (P.2).

"…as soon as there was a fire in the laboratory, we put out the fire since the extinguishers were easily accessible. The fire could not spread out…" (P.20).

Promotion of organizational coordination and interactions

Table 2(in continue): Categories and subcategories of operational strategies for establishing disaster-resilient schools from experts' perspectives

Categories	Subcategories	Item Summary (integrated codes)
Improvement in education	Holding educational courses for managers and personnel	-Training resilience and provision of consultation for teachers, managers, superintendents, and custodians and their awareness of their role in disasters. -Training managers to select various parts of school on the basis of mass and weight of the building. -Training based on a comprehensive and academic plan for crisis management, performance continuation, control, and assessment of the given training. -Simultaneous training of teachers and managers due to the managerial role of teachers in crisis and disaster.
	Holding simulated exercises	-Tabletop drills twice or three times a year in the presence of all students, families, and school neighbors. -Operational and real performance of drills. -Performing familial drills at each single individual family.
Process promotion	Increasing preparedness	-Development, revision, and implementation of school preparedness against accidents and disasters. -Provision of supplies, storage and preservation of supplies and materials and emergency equipment, and identifying the location of protective equipment. -Provision of school map, identification of safe and unsafe places at school, and awareness of personnel, firefighters, and governing school maps. -Provision of a local map of the region, identification of geographical locations, address and phone numbers of important sites, and a list of parents' phone numbers and their special fields. -Selection and identification of the route and site of emergency evacuation. -Knowing the location of water, electricity, and gas counters. -Exploration and correction of infrastructures by experts or experienced parents. -Information about water, sewage, and electricity organizations, crisis management organization, the closest crisis departments so forth. -Preparing the emergency alarm for informing the public and substitute alarm systems in the case of blackout. -Accessibility of emergency equipment in sufficient numbers and students' gathering at different floors.
	Correct planning	-Proper sufficient planning for unexpected school accidents and coordination at school level for preparedness. -Provision of certain processes for informing parents and supporters at critical times. -Planning for promoting infrastructures with respect to communication. -Allocation of resources, budget, and investment, and designing school architecture. -Preservation of backup files of school digital data out of school. -Paying attention to students' age while assigning classrooms.
	Creation of organizational structures	-Having an ICS at schools, primary alarm system. -Formation of safety council and school preparedness committee. -Presence of an assessment team at school and a disasters committee, and holding sessions.
	Facilitation of rehabilitation	-Implementation of rescuer programs to rescue oneself and the students. -Placing student information cards at one's own bag or cervical bags. -Availability of accommodation, preparedness and distribution of food, care services like first aid kits, victim rescuing and transport at schools. -Holding two-shift safe schools and provision of trailers for quick resuming of classes at rural areas after disasters. -Helping victims, fire control, guarding and caring for students, and maintaining school properties at disasters. -Protection of school properties or regulating school management at disasters or unexpected accidents.

- **Improvement in intra-organizational communication**

This subcategory is effective in increasing school resilience to disasters and responding properly at the time of natural disasters. Interaction and communication between school personnel and students, the ability to substitute key individuals with other staff in case of their absence, contribution of teachers and staff to planning a preparedness program against disasters, teaching

the method of approaching students, and effective leadership are effective in the promotion of intra-organizational communication.

"…there is a good communication and rapport among colleagues. At the time of earthquake, they helped each other to take the children out without any injuries..." (P. 24).

- **Improvement in extra-organizational communication**

This subcategory is another operational strategy for establishing disaster-resilient schools. Signing contracts with other organizations to receive financial resources and help in emergency situations, coordination and communication with local authorities (police, fire department, and hospitals), parents and supporters of children in critical situations are effective in the promotion of school resilience. Identification of individuals' responsibilities and contribution of beneficiaries (the Red Crescent, fire department, police, rescue teams, supreme office of education and training, hospitals, and other stakeholders) before disasters can increase the responding ability of schools at disasters, information exchange, and achievement of suitable strategies. Besides, the extra-organizational communication is required to promote preparedness to cope with any accidents in collaboration with local people, governing agents, local authorities, and social workers and the cooperation of charity school builders and absorption of their contribution in reconstruction and reinforcement of schools against earthquakes.

"…due to earlier coordination with fire department, they immediately arrived at the scene after fire and our call for help, although the school was located in a difficult route…" (P.16).

"…there was once a quake at our school. Since we had previously held some orientation sessions with families and made the required coordination for interventions after quake, there was no chaotic or crowded mess in the school…" (P.17).

Improvement in education

- **Holding educational courses for students and their families**

Educating students and their families is one of the important parameters in enhancing their skillfulness and efficiency in appropriate response to disasters which plays an outstanding role in establishing disaster-resilient schools. Holding simultaneous classes for students and families in the field of disasters is necessary for their greater sense of cooperation in accidents. Teaching resilience, giving consultation to students and families, and informing them about their role in disasters and the psychological aftermaths improves the response after disasters. Teaching the required coping skills at disasters as a credit unit, including disaster-related topics in the syllabus, introducing pedagogical materials, and revising the teaching materials, all foster the knowledge and skills of students and families. Additionally, disparities in education on the basis of school type and different target groups may influence the education quality.

"…the educational protocols should vary according to school type (primary, junior high, or high school) and the number of students, teachers, and school shifts so as to fit the target group and enable them to benefit from education…" (P.13).

"…at the time of earthquake, they took cover under their desks as they were trained to do so. After the quake, they left the class quickly and nobody was hurt…" (P.20).

- **Holding educational courses for managers and personnel**

Another factor influencing school resilience to disasters is the training of school managers and personnel. Teaching the methods of coping with accidents, fostering resilience, giving consultation to teachers, managers, and custodians and informing them of their role in critical situations before and after disasters improve the performance after accidents. It is also important to instruct managers how to use different parts of school with respect to mass and load of building. For example, it has been recommended to place the library on the ground floor and not on higher floors due to its heavy weight. Teaching useful strategies to personnel to preclude accidents and unexpected events and training specific individuals to providing first aids, fire extinction, search and rescue, guarding, CPR, and wreckage removal can make the personnel resilient at disasters, creating disaster-resilient schools. Furthermore, the simultaneous instruction of teachers and managers is highly important due to the managerial role of teachers at disasters.

"…when the teachers know what to do after accidents, they can help students in such situations. That is why training teachers and managers is important to prevent them from rushing and help them know what to do…" (P.6).

"…we should note that training teachers is as important as training managers. It is not right to hold training classes just for managers since the managerial role of teachers is highlighted at disasters. If they are not trained, they may face untoward consequences…" (P.24).

"…once the children were hurt after they escaped

after earthquake. One of my colleagues who had passed the first aid course was able to stop a bleeding quickly. He helped a lot until the arrival of the rescue team at the scene. This shows that the staff should be trained…" (P.19).

- **Holding simulated exercises**

To make the trainings practical, exercises should be held at schools. Drills and tabletop exercises twice or three times a year in the presence of all students and teachers, and holding purposeful, real, and continual drills during the year in the form of simulated exercises positively affect the learning process. Dividing students into various groups, and teaching "teamwork at disasters" and cooperation during unexpected event exercises help the students better understand their role at disasters. Teaching these exercises along with familial exercises further influences school resilience.

"…after an earthquake, an evacuation maneuver was performed at school and the students were able to understand what to do more easily. Since their families were also present, they had a better feeling…" (P.22).

"…when we were to perform a maneuver, we divided children into groups of 3 and 5 to teach cooperation and better teamwork …" (P.21).

Process promotion

- **Increased preparedness**

Our results indicated that increased preparedness is one of the operational strategies for establishing disaster-resilient schools. One step in establishing preparedness is development, revision, and implementation of school preparedness programs for coping with accidents in a simple way and step-by-step identification of stages. Flexibility of programs on the basis of unexpected events, variability on the basis of school population, changes in the map and regulations, and local policies should be considered. Preparedness of school identification map, introduction of safe and unsafe locations of school, awareness of the personnel, fire-fighters, and governing school maps help promote school preparedness and increase resilience. Besides, preparing geographical and geological maps of schools, and the phone numbers of treatment centers, police, radio station, TV station, the Red Crescent, fire departments, and parents is of utmost importance in assessing vulnerability.

"…our school had plotted a risk map beforehand that showed the safe and unsafe locations of the school, previously seen by students and teachers; so, it greatly helped them to go to the shelter at the time of earthquake…." (P.4).

"…we obtained a list of parents' phone numbers and their special fields at school and held a session with them, agreeing that we could depend on them in the case of emergencies. We also talked to important local organizations; they know the school map and can help us quickly and easily if necessary…" (P.18).

In this regard, supply provision, storage and preservation of materials, emergency equipment at school, identifying the location of protective equipment, availability of necessary instruments in low numbers, density of students at various floors, and selection of route and emergency evacuation site before disasters induce more preparedness after disasters. Knowing the exact place of the master power switch, water, electricity, and natural gas counters before disasters enables us to rapidly turn them off during or after emergency cases. Exploration and correction of power wires, water and gas pipes, and master switches by technicians or experienced parents to prevent their cut-off, equipping the master gas pipe with automatic lock-up switches for their automatic cut-off at disasters, and repairing or changing the defected door locks (reinforcement of infrastructures by correcting water, gas, and communication equipment) were rendered as important in maintaining performance following disasters. Additionally, emergency alarm systems for informing by e-mail, cell phones, or phones, and a substitute alarm system for informing the whole school in case of blackout are to be installed so as to enhance the response after disasters.

"…we put sufficient necessary instruments and equipment for students on both floors on the shelves beside the lobbies to be used if they were trapped…" (P.8).

"…it is very important to know the place of the master switches of power and gas at schools to turn them off in case of fire and prevent explosion. The electricity wire system of the building and the water and gas piping systems should be checked so they are less damaged at earthquakes, or easily and quickly repaired if damaged…" (P.18).

"…we use SMS at school to communicate with parents; in this way, we can easily inform them …" (P.23).

"…it is better to store supplies and equipment at school for three days so students would face no problems in case of disaster. Also, if necessary, a safe emergency evacuation route must be determined to enable students to leave the school without any danger …" (P.3).

- **Correct planning**

Another subcategory of process promotion is correct planning. Appropriate and sufficient

planning for unexpected events at school and coordination at school level are important for improving performance after disasters and establishing disaster-resilient schools. In this regard, it is highly important to identify certain procedures after disasters such as conveying information to students' parents and supporters at emergency times at school (by local radio, TV, internet, telephone, and cell phone), planning for promotion of school infrastructures with respect to communication (substitute communication, wireless system, messenger or communication devices), designing and practicing an escape program, and emergency evacuation of classrooms and school prior to disasters.

"…planning what to do at school before disasters is very helpful; they should know how to inform parents or other organizations if a disaster was to occur or how would they respond to a blackout. They should also know how to escape an earthquake; all these should be thought of beforehand…" (P.13).

Another important issue is the allocation of resources in annual budget for building new schools and reconstruction of damaged spaces. It is to be noted that a backup file of school data should be saved and kept out of school. Also, classrooms should be assigned according to students' age for their better performance after disasters.

"…allocation of resources in annual budget is the prerequisite of building new schools and reconstruction of damaged spaces…" (P.17).

"…since the crisis coping program of school had made a copy of students' data as a backup file and kept it out of school, the destruction of the many documents buried under wreckage did not influence us…" (P.24).

"…we placed the smaller children in the lower floors so that in case of any unexpected event, they could escape the scene more easily…" (P.18).

- **Creation of organizational structure**

Formation of a suitable organizational structure prior to disasters is important in establishing resilience at schools. Important organizational interventions include the formation of safety councils, assessment teams, primary alarm systems, and accident commandership systems, and holding sessions.

"…in my opinion, groups should be formed of interested individuals who are trained in holding sessions to find out school problems. Also, they must be prepared in case of an emergency …" (P.1).

"…one of the good things we did was the formation of a safety council. We have more successful in managing school events since the inception of the council. I believe various teams such as assessment teams ought to be formed at school. We should know how to inform the whole school if any unexpected event occurred, hold sessions to get fully prepared and avoid indecisiveness in inevitable situations…" (P.10).

- **Facilitation of rehabilitation**

Facilitation of rehabilitation is another subcategory of process promotion serving as an operational strategy for establishing disaster-resilient schools. Having a plan for the continuation of students' temporary training and the use of schools as shelters are considered as important in returning the school to its normal condition. Implementation of "rescuers program" (trained students for critical days) to support oneself and other students and keeping a card containing students' particulars, home addresses, necessary phone numbers, blood groups, and history of disease or specific drug administration prior to disasters facilitate school rehabilitation. Schools should be ready for temporary accommodation, provision and distribution of food, first aids, victim rescue and transport at school, securing emergency transport for students and personnel, and school rehabilitation.

"…at the time of earthquake, since our school remained sound and intact, we accommodated the neighbors of our school by the help of students …" (P.16).

After disasters, if schools are damaged, it is important to hold two shifts at intact schools, provide temporary trailers for rural areas and resume classes as soon as possible to facilitate school reconstruction.

"…since most schools were destroyed after earthquake, the intact schools were changed to two-shift schools and some trailers were provided for rural areas to be able to resume schools faster…" (P.17)

Discussion

The present study determined the operational strategies for establishing disaster-resilient schools. We indicated such components as "architecture optimization, construction and non-construction optimization, promotion of organizational coordination and interactions, improvement of education, and process promotion as effective in establishing disaster-resilient schools.

One of such operational strategies extracted in this study was construction and non-construction optimization. Construction risk management, optimization of construction architecture and physical structure, construction localization, and

promotion of non-construction safety affect school resilience. Paying due attention to the physical structure of schools and assessing construction architecture are important issues that predispose to maintaining school performance following disasters, and more importantly, saving students' lives. The location of school building ought to be meticulously evaluated prior to construction. Also important are emergency exits for emergency evacuation. According to previous studies, the installation of fire extinguishers at various sites at schools is required for building safety. The number of mortalities has increased over the recent years owing to improper building construction and insufficient safety measures in the neighboring buildings (20). Concerning the physical aspect, building safety, regular checkups of school building (year of construction and reconstruction), emergency exit doors, and evacuation shelter are considered as important (21). Attention must also be paid to natural or man-made threats, conditions such as non-construction parts of schools, and unstable school conditions that increase risks. School resilience may be increased by reducing non-construct risks and construction safety (22). In this regard, safety facilities are considered as important in designing schools (23).

As one of the influential operational strategies for rendering schools resilient against disasters, promotion of organizational coordination and communication has also been extracted in other studies. In the participants' view, intra-organizational and extra-organizational communications are highly significant. Collaboration and interaction among school personnel and the identification of influential response organizations prior to and following disasters predispose to greater school preparedness for a better performance at disasters. The following components were distilled in this study for the promotion of coordination and cooperation: identification of proper substitute individuals prior to disasters, parents' contribution to school activities, charity school builders' contribution to reconstruction and resilience enhancement, identification of duties and responsibilities of individuals, beneficiaries (the Red Crescent, fire department, police, rescue teams, supreme office of education and training, hospitals, and parents) and their contribution. Based on certain evidence, the reason for inappropriate response at disasters was lack of cooperation between schools and their beneficiaries at the time of school preparation for response. Also, the coordination between the internal and external beneficiaries is deemed effective in increasing school preparedness at disasters (24). It should be noted that appropriate communication affect decision-makings at schools. In this regard, flexible organizational structure and unique organizational hierarchy at schools with one major manager and deputy lead to proper cooperation and communication (25). This approves our findings on the importance of establishing suitable communication for proper decision-making at disasters.

Improvement in education is another operational strategy affecting school resilience. Holding educational courses on disasters for students, families, mangers, and personnel, and simulated real operational exercises in other studies are highly important in increasing school resilience after disasters. Other studies have suggested that teaching disaster risk reduction to school personnel further demonstrates the role of education in preparing schools to improve their performance after disasters (11, 26, 27). Teaching disasters through lecturing increases perceived risk, yet cannot enable individuals to fathom the importance of the measures prior to disasters or apply real interventions to reduce disaster risks. Teaching disasters should be in the form of active learning. The effect of training can be enhanced by holding practical exercises (28). Training students in these exercises followed by familial practices plays a major role in school resilience, creating resilient families and communities. Some evidence indicates that both vis-à-vis and community training at schools play significant roles in the promotion of pediatric resilience and immediate transfer of knowledge to families (14). Moreover, updating school curricula and syllabi and including pedagogical programs for students to learn the appropriate performance at difficult times have important parts in promoting students' resilience at schools (29). The topics related to disasters and their update in educational programs of school resilience were extracted in this study.

The present study further extracted the role of process promotion in providing suitable functional response at disasters in schools and establishing resilience. This category included increased preparedness, correct planning, creation of organizational structures, and facilitation of rehabilitation. Development of school preparedness programs at disasters, provision of the required equipment for proper response, provision of school and zone maps, identification of organizations contributing to crisis management, lists of phone numbers, and installation of school

alarm systems increase school preparedness for response at disasters. In addition, a safe shelter should be localized at school prior to disasters for emergency evacuation. Knowing the location of power master switches, gas master taps, and their automatic cut-off after disasters also prevent fire, resulting in suitable response after disasters. It is to be noted that reinforcement of infrastructures and improvements in communication further increase preparedness at disasters. Considering the school type as a factor that affects school resilience was another component extracted in this study. Educational beneficiaries should consider school type as a key factor in students' resilience and their educational achievements (30).

Other extracted factors influencing school resilience were improvement in planning, promotion of managerial power, and allocation of sufficient budget which corroborates the findings of other studies (21). Disaster preparedness includes having plans and programs for school emergency situations, awareness of first aids, and having an evacuation program after disasters (31). Additionally, environmental and physical protection, increase in responding skills, formation of school committee of disaster management, and having a continuous education program are also important in increasing school preparedness (22). In this study, suitable planning included the allocation of budget and resources for disaster preparedness, creation of procedures for parental communication at disasters, and planning for infrastructure promotion. Formation of safety council and assessment teams at schools is an important factor that predisposes to the identification of school problems and provision of a suitable program. Preparedness program has been defined as interventions for supporting, personal preparedness, and organizational preparedness at disasters to increase the readiness for proper response to disasters and emergencies (32), approving the findings of this study.

Disaster rehabilitation program is another parameter in disaster preparedness program and proper responding of schools (9). In this study, the facilitative factors included the possibility of quick resumption of school activity after disaster, possible temporary accommodation, and healthcare provision. Other studies also have enumerated facilitative factors at schools such as long-term improvement of school status and returning the school to the normal condition, re-provision of school emergency services, and provision of physical and mental assistance to more sensitive students (9). Similar to our findings, community members and school teachers and mangers ought to be appropriately informed of the type of pre- and post-disaster behaviors. Schools are further required to establish commandership chain, form board of managers for natural disasters, develop programs, analyze risks, cooperate with local authorities, and ensure the preparedness and available resources to increase rehabilitation. Other influential factors are determining the high risk areas, evaluation of emergency exits, emergency evacuation status, maintenance of emergency equipment (shelter and lodging, nutrition, clothing, first aids, rescue and saving), specifying the response teams at disasters, and having a disaster-coping program, and their repetition for proper response after disasters (32). Ultimately, schools should afford their own resources for 3 days after disasters in case of the late arrival of help (32). On the other hand, changes in school pedagogical curricula and syllabi must be updated, and the school staff and healthcare team are to be properly informed of the new protocols and programs (33).

Limitations

The present study was conducted in Iran, where natural disasters such as tsunami do not occur thanks to climatic conditions, hence the necessity of the opinions of experts in the neighboring countries or other places to enrich our data. Moreover, our results suffer from generalizability of results that is common to qualitative studies. Nevertheless, the present findings are consistent with the results of previous studies.

CONCLUSIONS

This study extracted five categories, namely the optimization of school architecture, construction and non-construction promotion, promotion of organizational coordination and interactions, improvement in education, and process promotion to establish school resilience at natural disasters and emergency events. Various factors affect the proper response of schools to disasters. It is to be noted that pre- and post-disaster interventions are effective in establishing resilient schools. Awareness of these components and preparedness prior to disasters can save students' lives, improve their performance after disasters, help establish resilient schools, and return the school to a safe shelter following disasters. The factors extracted in this study are recommended to foster school safety and resilience in disasters, improve risk reduction strategies, and design school infrastructures on the basis of standards. These components are in line with FEMA attempts as a non-for-profit institution

to reinforce schools against disasters and implement special safety programs for multiple challenges (34). They approve the results of previous studies, most of which pertain to high-income countries; however, they have also introduced the influential components at low-income countries.

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All the authors met the standards of authorship based on the recommendations of the International Committee of Medical Journal Editors.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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