Research Paper

The Knowledge of Safe Emergency Evacuation During an Earthquake Among the Residents of Tehran, Iran

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Citation Soltani A, Nikseresht M, Rajabpour M, Khoundabi B. The Knowledge of Safe Emergency Evacuation During an Earthquake Among the Residents of Tehran, Iran. Health in Emergencies and Disasters Quarterly. 2024; 10(1):21-28. http://dx.doi.org/10.32598/hdq.10.1.135.3

http://dx.doi.org/10.32598/hdq.10.1.135.3

Article info:
Received: 05 Feb 2024
Accepted: 15 Apr 2024
Available Online: 01 Oct 2024

Keywords:
Knowledge, Disaster, Emergency evacuation, Earthquake, Tehran

ABSTRACT

Background: Earthquake is a natural disaster that threaten large parts of Iran. In addition to the preparedness of relief organizations, people should know how to protect themselves from possible damages. Tehran, the capital of Iran, is prone to earthquakes and citizens' preparedness for possible earthquakes should be improved. This study aims to measure the safe emergency evacuation knowledge of citizens in Tehran, in case of an earthquake.

Materials and Methods: This is a cross-sectional study that was conducted on 602 residents of Tehran (all 22 districts) aged ≥15 years in 2022. Data were collected using a researcher-made questionnaire with acceptable validity and reliability to measure the knowledge of safe placement and safe evacuation.

Results: The mean knowledge score of citizens was 8.8 out of 20. The knowledge score was significantly higher in women than in men, in people under the age of 64, in those with higher level of education, in students/housekeepers and employed people, in people who had received relevant information from the educational programs prepared by the municipality and educational textbooks, and in those living in privileged urban areas. Nearly 25% of people had not received any education related to earthquake. Radio/TV programs and educational textbooks were the most common sources of information.

Conclusion: There is a need to improve the knowledge of safe emergency evacuation during an earthquake among the residents of Tehran. In addition to formal education in schools/universities, citizens need appropriate training courses in other centers with the help of social media. Planning in this area should be attractive to motivate citizens to acquire more disaster knowledge.

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Introduction

Natural disasters such as earthquakes threaten large parts of Iran and this country is the third most affected country by destructive earthquakes in recent years after China and Indonesia, accounting for 8 of all destructive earthquakes. Tehran, the capital of Iran and one of the largest cities in the Middle East, is one of 20 most earthquake-prone megacities in the world [1-3]. Appropriate behavior or response of people during an earthquake, i.e. appropriate placement and safe evacuation, are the most effective responses that can significantly reduce the loss of life in the event of destructive earthquakes. It is recommended that people move to a suitable and safe place as soon as the earthquake starts. In a suitable place, people should protect their heads and bodies from possible injuries caused by falling ceilings, walls, and objects. When the shaking stops, they should leave the building immediately, which is called an emergency evacuation. Proper emergency evacuation during and after the end of the earthquake is one of the most important factors in reducing damage and casualties [4, 5].

For community resilience and disaster management planning, it is necessary to use appropriate information, models, and structures. In this context, it is necessary to survey peoples' perceptions to find ways to reduce the above-mentioned damages [6-8]. There are no studies on measuring the knowledge of appropriate behaviors or responses in people during an earthquake in Tehran, although there are studies on the resilience, preparedness, and awareness of earthquakes. Farzanegan et al. found that over 50% of people did not have sufficient disaster knowledge. Based on their survey, household income, fear of natural disasters, trust in the responsible organizations, perceived frequency of natural disasters, employment, and participation in educational courses are positively related to people's disaster literacy level [9]. Jahangiri et al. investigated the factors affecting the earthquake preparedness of people in Tehran and suggested that the number of damages can be significantly reduced by acquiring preparedness skills. They assessed people's knowledge, attitude, and practice and investigated their educational needs and requirements. Their study showed that retired and unemployed people, housewives, elderly people, illiterate and low-educated people, and large families had a lack of adequate knowledge and needed education [10]. Taghvaei et al. found that the disaster resilience of schools in Isfahan is very low. They are vulnerable and are in an unfavorable situation [11].

Planning for the institutionalization of safe behaviors for vulnerable communities requires proper knowledge and attitudes. Therefore, in this study, we aimed to investigate the extent to which the citizens of Tehran know how to leave their houses safely during an earthquake. Their knowledge was analyzed based on some demographic factors including age, gender, occupation, educational, and place of residence. The results can be useful for preventing or reducing possible damages caused by earthquakes in Tehran.

Materials and Methods

This is a cross-sectional study. The study population consists of all residents of Tehran in 2022 who had at least 15 years of age. Based on the central limit theorem, the sampling distribution of the mean is normally distributed with 25 samples. Therefore, the required sample size was estimated to be at least 550. A stratified random sampling method was used to select the samples. Each district was considered a stratum. In each district, five neighborhoods were selected as clusters using a table of random numbers. From the first main street of each neighborhood, five alleys with even numbers were selected. Participants were recruited from among those living in the fifth house number of each alley. Finally, 602 samples were included in the study. Informed consent was obtained from all participants.

Data collection was done using a researcher-made questionnaire in Persian (Table 1) which measures the knowledge of safest places and safe evacuation during an earthquake. It was designed according to the opinions of 13 experts in disaster management and earthquake response training. The questionnaire had 20 items. The validity of the questionnaire was confirmed based on a content validity ratio of 0.69. The reliability was evaluated by distributing the questionnaire among 30 samples and calculating the Cronbach's α, which showed a value of 0.702, indicating an acceptable reliability. The correct answers to each question had 1 point, while the wrong answers had 0 points. Therefore, the total score ranges from 0 to 20.

Statistical analysis

Collected data were entered into SPSS software, Version 26 for analysis. The quantitative variables were expressed using Mean±SD and qualitative variables were expressed using frequency and percentage. The normality of the data was examined by the Kolmogorov-Smirnov test. T-test or the Mann-Whitney U test was used for finding the difference in variables between the two groups. Chi-square test and Fisher's exact test

Table 1. The safe emergency evacuation knowledge scale during an earthquake

No.	Item	Option 1	Option 2	Option 3	Option 4
1	In case of an earthquake, what should be your 1st reaction?	I leave the place immediately	I stay and take a safe position until the shaking stops	I run to the staircase and take a safe position there	I do not know
2	What do you do if you are on the street during an earthquake?	I take a safe place under trees or electric cables	I take a safe place under a car or a bridge	I stay away from the buildings	I do not know
3	People's sleeping places should:	Be away from windows, hanging objects, mirrors, tall furniture, large appliances, and cabinets filled with heavy objects	Have no hanging objects over bed	Both options are correct	I do not know
4	How do you help blind/deaf, elderly, or disabled family members during an earthquake?	I ask them to run outside	I ask them to take a safe position	I get them out of the building	I do not know
5	In case of an earthquake, which option is more correct?	If you are near a table, hide under it, cover your head and neck, and hang on to the legs firmly	If you are not near a table, sit on the floor, cover your head and neck, and hold on to something sturdy if available.	Both options are correct	I do not know
6	Do you know the location of emergency exits in the house or workplace?	Yes	No	I do not know	-
7	What do you do if you are in bed during an earthquake?	I stay there and cover my head with a pillow	I leave the bed and the building	I leave the bed and hide under a table or under the doorway	I do not know
8	What do you do if you are in a car during an earthquake?	I leave the car and take a safe position on the side of the street	I quickly leave the area	I stop at the 1st possible place on the right side of the street and take a safe position	I do not know
9	What do you do if you are inside an elevator during an earthquake?	I stay inside until the shaking stops and when it is safe to leave	I press the floor number button to get out of the elevator in the selected floor	I get out of the elevator immediately at the next floor	I do not know
10	During an earthquake, what should a wheelchair user do?	Drop immediately to the ground and sleep on the floor	Get out of the place quickly.	Lock the wheels and cover the head	I do not know
11	What do you do if you are in the basement of a house with a yard during an earthquake?	It doesn't matter where I am. I take a safe position	If I am near the exit door, I quickly run outside to the yard.	If I am near the exit door, I stand under the doorway.	I do not know
12	Have you talked to your family members about the emergency exit?	Yes	No	I do not know	-
13	Which statement is correct regarding the appropriate response during an earthquake?	Avoid bookshelves and other items that may fall on you	Stay away from windows and lighting fixtures	Both options are correct.	I do not know
14	Are you familiar with the safe places to be during an earthquake?	Yes	No	I do not know	-
15	What should you do after the end of the earthquake?	Leave the building immediately	If the building is not safe, go outside carefully	If the building is not damaged, no special action is needed	I do not know
16	If you had to leave your house immediately after the earthquake, what would you do?	When I wanted to leave, I would take the 1st-aid kit with me	I shut off the electricity, water, and gas	Both options are correct.	I do not know

No.	Item	Option 1	Option 2	Option 3	Option 4
17	Have you discussed about emergency calls during earthquakes with your family ?	Yes	No	I do not know	-
18	What should you do after the end of the earthquake?	If there is no danger, check the people around you for injuries and provide 1st aid.	Check your surroundings for hazardous conditions such as fire, downed power lines, and structural failure.	Both options are correct.	I do not know
19	Are you familiar with the "triangle of life" theory?	Yes	No	I do not know	-
20	Are you familiar with the DCH (drop, cover and hold) strategy?	Yes	No	I do not know	-

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were used for finding the difference in categorical variables between the two groups, if necessary. ANOVA or Kruskal Wallis test was used for comparing quantitative variables within more than two groups. The significance level was set at 0.05.

Results

Among 602 participants, there were 301(50.0%) males and 301(50.0%) females. Table 2 summarizes the demographic information of all participants. The total mean score of the knowledge scale regarding emergency evacuation during an earthquake was 8.8±3.2, out of 20. It was found that 157 citizens (26.1%) did not have any source of knowledge for the emergency evacuation during the earthquake. Among the sources of information, radio and TV programs had the most important role (33.6%) followed by educational textbooks (14.1%) and educational programs prepared by the municipality (13.1%). The score of the participants who had obtained relevant information from educational programs prepared by the municipality or educational textbooks were higher than that obtained from other sources. The mean knowledge scores based on different demographic variables are presented in Table 2.

Figure 1 shows the rate of correct answers to the questions. The items 13, 3, and 18 which were about the safe places in the house, self-protection, and helping others after the end of the earthquake, respectively, had the highest correct answers (79.9%, 78.2%, and 69.9%, respectively). On the other hand, the percentage of correct answers to items 11, 10, and 19 were low (9.3%, 9.5%, and 14.1%, respectively). These questions were about the correct reaction in case of being in the basement, using a wheelchair, and familiarity with the "triangle of life" theory.

In comparing the knowledge scores between males and females, the results showed that females had significantly higher knowledge of emergency evacuation than males (P<0.05). This difference was also significant in terms of occupation (P<0.05). Also, those aged 45-64 years had the highest knowledge score (9.2±3.4), followed by the age

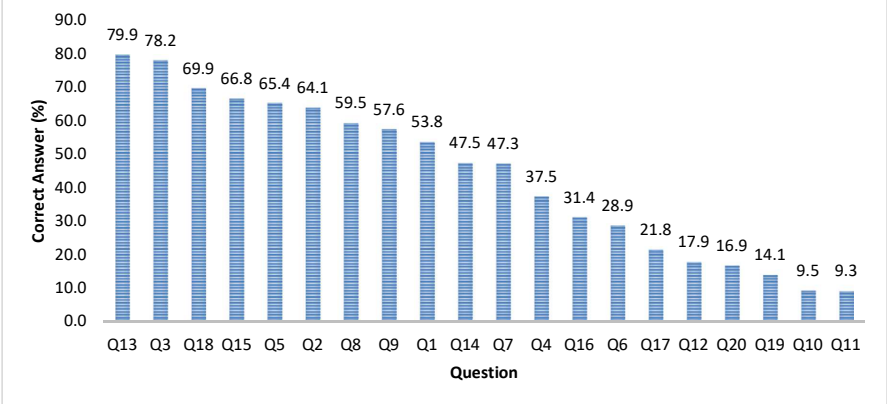

Figure 1. Ranking the percentage of correct answers based on the questionnaire items

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Table 2. Demographic characteristics of the participants

Characteristics		No. (%)	Mean±SD	P
Gender	Male	301(50)	8.2±3.2	<0.001*
	Female	301(50)	9.4±3.1	
Age (y)	15-24	124(20.6)	8.5±2.8	<0.001*
	25-44	283(47)	8.9±2.8	
	45-64	174(28.9)	9.2±3.4	
	>65	21(3.5)	4.3±3.1	
Education	Illiterate	9(1.5)	4.8±2.2	<0.001*
	High school diploma or lower	287(47.7)	7.9±3.1	
	Bachelor's degree or associate's degree	208(34.5)	9.2±2.6	
	Master's degree or PhD	98(16.3)	10.9±2.5	
Employment	Employed	223(37)	8.9±2.5	<0.001*
	Unemployed	56(9.3)	6.7±2.9	
	No job#	323(53.7)	9.4±3.0	
Information source	None	157(26.1)	6.3±2.8	0.026*
	Radio/TV programs	202(33.6)	9.8±2.8	
	Municipality training programs	79(13.1)	10.4±2.7	
	Red Crescent training programs	30(5)	9.5±2.8	
	Educational textbooks	85(14.1)	10.0±2.5	
	Newspapers/Magazines	37(6.1)	8.1±3.2	
	Relatives/Friends	12(2)	7.9±2.9	

#College students, school students, or housekeepers, *Significant at 0.05.

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groups 25-44 and 15-24 years. Therefore, the knowledge of emergency evacuation increases with ageing.

The ANOVA test results showed a significant difference the knowledge score of participants in terms of the educational level; those with higher educational levels had higher knowledge scores, and illiterate people had lower knowledge scores (P<0.001). Those with no occupation (college/school students, housekeepers) and employed people had a higher knowledge score compared to unemployed people (P<0.001). The knowledge score of those who had obtained relevant information from municipality educational programs or educational textbooks had higher knowledge scores (P=0.026).

The total mean score of knowledge for emergency evacuation during an earthquake was also compared based on the living district (Figure 2). There was a statistically significant difference in the knowledge score based on the district (P=0.042). The districts 4, 1, and 2 in Tehran which are privileged urban areas, ranked first to third in this regard, with mean scores of 11.6, 11.0, and 10.4, respectively

Discussion

Unsafe evacuation is the main reason for earthquake-related injuries. In this study, we aimed to determine the knowledge of safe emergency evacuation during an earthquake in citizens of Tehran. We assessed their proper behaviors in taking a safe position and finding a safe

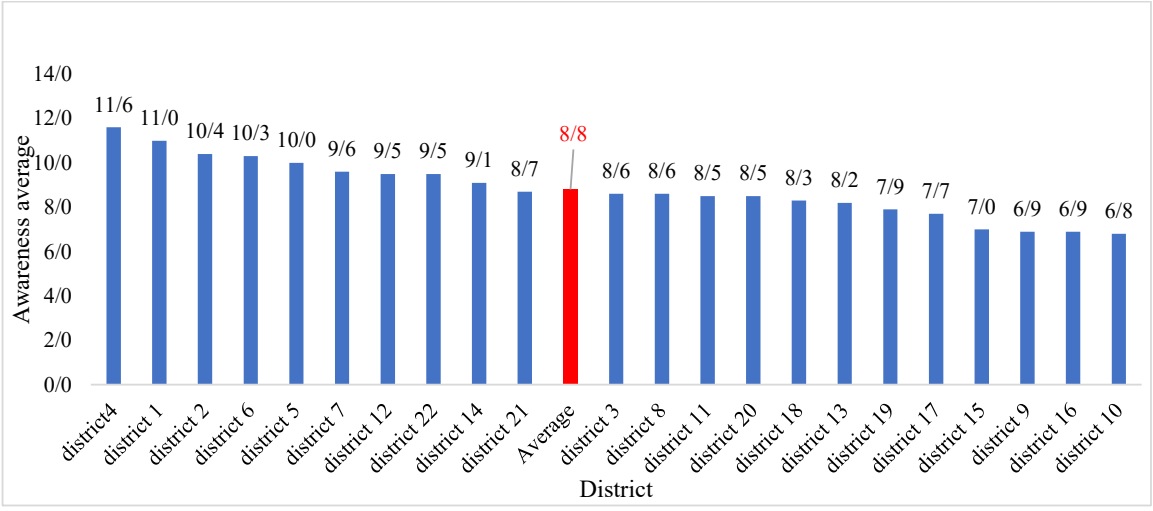

Figure 2. Ranking the knowledge mean scores based on the district

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exit. Our results showed that the knowledge of citizens in Tehran was below the mean score of 10. This result is consistent with other related studies that showed the low knowledge score of people during earthquakes [7, 12, 14-17]. Farzanegan et al. in a study to assess the disaster literacy of citizens in Tehran found that over 50% of people had inadequate disaster literacy [9]. Rakhshani et al. also highlighted the low earthquake preparedness in Fars Province of Iran [18]. Disaster management planners in Iran should pay attention to the disaster risk perception of people.

The knowledge score was higher in females than in males. This indicates that women take more time to learn and are more sensitive to earthquake related issues. Urban planners in Iran should therefore pay attention to men's low knowledge of safe emergency evacuation during an earthquake and encourage women to have a role in improving the related knowledge of family members. Our study showed that the knowledge of citizens increased with ageing and this increase continued until the age of 65. After this age, the related knowledge decreased. This is consistent with studies conducted by Farzanegan et al., Taghvaei and Jovzi Khameslouei, and Jahangiri et al. [9-11]. Considering the upward trend of aging in Iranian population and the greater vulnerability of older people, planning educational programs for older people should be one of the priorities of planners in Iran.

The results of some studies on the knowledge level in schools have shown that school students have low knowledge of earthquakes [11, 12, 16]. This is consistent with our findings and seems to be due to the lack of practical training for students. There is a need to pay more attention to the educational materials of programs for students. In recent years, earthquake preparedness maneuvers have been conducted in some schools in Iran. However, the number of maneuvers is low; it is necessary to hold more training programs in schools (at least once a month or every three months).

We found a significant difference in safe emergency evacuation knowledge between people with different educational levels. The knowledge level was not high even in those with high academic education such as a PhD. Arab et al. investigated the level of preparedness in dealing with unexpected incidents in one of the selected hospitals in Tehran. Their results showed that the level of preparedness in medical staff was at a moderate level. Arab et al. showed that, despite having a high level of education, the earthquake knowledge of managers was very low [19]. Our results support their findings as the knowledge score of participants in the present study was lower than average score 10. Therefore, considering the various occupations of educated people, providing educational materials can help increase the knowledge of people. Farzanegan et al. and Jahangiri et al. showed that employment and participation in continuing education courses are positively associated with people's level of knowledge about natural disasters [9, 10] which is consistent with our results. Kianmehr et al. reported that physicians' knowledge of disasters is not sufficient [20]. Therefore, the job diversity of people should be considered when developing earthquake-related educational packages.

Our results showed that radio/TV program was the most common source of emergency evacuation education for citizen in Tehran. A related study reported the role of social media in earthquake [21]. These media outlets need to take more action to develop earthquake

damage mitigation programs. Due to the popularity of cell phones, it is also advisable to use this platform for public education. The emergency evacuation knowledge scores of people that had received relevant information from the training programs prepared by the Tehran municipality and educational textbooks were higher than that obtained from other sources. The value of scientific resources is clear, but these findings show that in large cities such as Tehran, urban and municipal management programs are of great importance. Considering the responsibility of the Iranian Red Crescent Society (IFRC) in public education, it is necessary to investigate the reasons for the low role of this organization in providing emergency evacuation education to people. The collaboration of this organization with the Tehran municipality can be very helpful in this field.

Finally, we found that the knowledge score was higher in people from privileged urban areas compared to people from other areas in Tehran. This finding, which is consistent with Farzanegan et al.'s findings related to the role of household income level, indicates that relief from livelihood concerns facilitates the ability to pay attention to other things in life, including disaster preparedness [9]. Given the greater vulnerability of people from low-income neighborhoods, it is important to provide appropriate educational programs to them. The city size and population density were the most important limitations of the study, which made sampling difficult. By using stratified random sampling method, we overcame these limitations.

Conclusion

The knowledge of safe emergency evacuation during an earthquake in citizens of Tehran, Iran, is not at appropriate level. Formal education in schools/universities alone does not improve citizens' disaster preparedness; they need specific training programs in this field in other places such as military or health centers, government organizations, and community centers. Planning in this field should be attractive to motivate citizens to be more concerned about the earthquake preparedness. Such plans need to be targeted to low-income households by the cooperation of all responsible organizations. The use of social media is recommended for effective communication and development of public education in the field of earthquake preparedness.

Ethical Considerations

Compliance with ethical guidelines

All participants were provided with information about the study objectives and methods, before the study. The participants were assured of the confidentiality of their information and were free to leave the study at time.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

Conceptualization, and supervision: Ahmad Soltani, and Majid Rajabpour; Data collection: Mohammad Nikseresht; Methodology and data analysis: Batoul Khoundabi; Investigation and writing: All authors.

Conflict of interest

The authors declared no conflict of interest.

Acknowledgments

The authors would like to thank all participants for their cooperation in this research.

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