Earthquake safety culture scale development study

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Abstract

Earthquakes have been one of the most significant natural hazards threatening humanity throughout history. In this study, we aimed to develop an earthquake safety culture scale to psychometrically measure individuals' attitudes and behaviors regarding their personal life safety before and after an earthquake. During the scale development phase, two different surveys were administered for exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The study population consisted of individuals aged 18 and over living in Türkiye. 445 Individuals participated in the EFA and 309 in the CFA. The earthquake safety culture scale, a two-factor structure ("pre-earthquake" and "during and after earthquake"), yielded highly reliable and valid results. It is believed that the resulting scale will contribute to disaster managers in the process of building an earthquake-resilient society, as well as to local and national disaster management policies such as training, awareness, planning, and exercises for community-supported disaster management. It is recommended that this developed scale be retested in different cultures and its relationship with various variables that may influence "pre-earthquake" and "during and after earthquake" attitudes regarding disaster management be investigated.

1 Introduction

Earthquakes cause many negative impacts, particularly loss of life, in the regions where they occur. While it is impossible to predict their timing, effective risk mitigation strategies can minimize damage from potential earthquakes (Ao et al. 2021; Kiani et al. 2022). It has been reported that social preparedness and legislative regulations for earthquakes reduce earthquake-related mortality rates (Shapira et al. 2015). Earthquakes are the third most common disaster type affecting the world and account for the highest number of deaths due to disasters (Atando and Sugawara 2024). Earthquakes are not infrequent disasters because they occur at long intervals of 10, 50, or even 100 years in many countries. This negatively impacts societies' prioritization of earthquake precautions and preparedness. Because peo-

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Extended author information available on the last page of the article

ple perceive the possibility of an earthquake recurring as a remote possibility, they have difficulty taking the necessary precautions and being prepared (Shaw et al. 2004; Musacchio et al. 2016). Individuals tend to prioritize their awareness and risk perceptions toward threats they are most familiar with. They also prioritize and prioritize threats they are constantly researching or are exposed to through various means (Donovan et al. 2014; Muttarak and Lutz 2014). In a study conducted with nursing students, it was reported that students with disaster experience had higher disaster risk perceptions (Kolaç et al. 2025). Another study found that knowledge of earthquake effects was statistically significantly higher in people who experienced an earthquake and lost loved ones in the earthquake. Additionally, it has been stated that there is a positive relationship between earthquake knowledge level and sustainable earthquake awareness (Turan Bayraktar et al. 2024).

It is known that people's knowledge and perceptions about earthquakes, as well as their previous earthquake experiences, significantly influence their earthquake preparedness actions. Studies emphasize the importance of being informed about earthquakes and potential risk reduction efforts, and highlight the need to develop effective awareness programs accordingly (Soffer et al. 2011; Tekeli-Yeşil et al. 2010; Han et al. 2021). A recent study conducted in a high earthquake risk region determined that there is a positive relationship between earthquake knowledge and sustainable earthquake awareness (Sözen and Genç 2025). During the 2017 earthquake in South Korea, citizens were reported to be in a state of great chaos and anxiety, and this was attributed to low preparedness. A study conducted in the post-earthquake region indicated that knowledge, awareness, and literacy about earthquakes were low, and that they were not adequately prepared for earthquakes (Han et al. 2021). Disaster preparedness is shaped by how people perceive their environment and their attitudes based on these perceptions. Preparedness for natural disasters, especially earthquakes, is a behavioral process largely based on society's perceptions and attitudes (Azim and Islam 2016). An important component of earthquake disaster risk reduction is the promotion of preparedness at the household level. In developed countries, this preparedness is seen as a part of risk management, and individuals are encouraged to be earthquake resilient (Becker et al. 2012, 2017; Spittal et al. 2008). Earthquake precautions are based on hazard awareness and aim to increase individual resilience. These measures include insurance, strengthening structures, stockpiling essential supplies, and securing belongings. Factors such as risk perception, experience, and social interaction are key factors influencing these preparedness processes (Lindell and Perry 2000). Personal and household characteristics influence the potential impact of earthquakes. A person's negative behavior during an earthquake directly impacts the risk of death and injury (Shapira et al. 2018). For example, it is important for individuals to adopt a drop-cover-and-hold on behavior to reduce their risk of injury during an earthquake. Therefore, the ability to quickly assess these hazards and identify a safe area is key to avoiding major injuries (Li et al. 2017). Risk perception and disaster risk reduction awareness are positively correlated with individuals' willingness to choose safe residential areas. Furthermore, earthquake risk knowledge, through risk perception and disaster risk reduction awareness, positively influences citizens' earthquake insurance purchasing behavior (Xu et al. 2019).

Earthquake safety is of vital importance in regions prone to frequent earthquakes. Various educational methods, such as organizing drills, reviewing earthquake guidelines, watching informative videos, and participating in virtual earthquake simulations, are being used to raise public awareness (Li et al. 2017). The primary goal of such training is to prepare

people and reinforce safe behaviors. Education can directly impact risk perception, skills, and knowledge. It is known that individuals who are educated about risks are more resilient and adaptable when faced with disasters, responding to, preparing for, and recovering from disasters. Those with high awareness can respond quickly and accurately in an earthquake without forgetting what to do or experiencing indecision. This is because when an earthquake strikes, many people hesitate and struggle to remember what they should do (Occupational Safety and Health Administration 2025; Musacchio et al. 2016). It is known that individuals with a high awareness of earthquakes will implement more appropriate behavioral strategies during an earthquake. For example, a study examining emergency behavioral responses to earthquakes in New Zealand and Japan found a positive relationship between household emergency preparedness and appropriate behaviors (Lindell et al. 2016). While emphasizing the importance of earthquake awareness, Lindell et al. (2015) also emphasized the need to understand how individuals behave during sudden earthquakes and subsequent tsunamis (Lindell et al. 2015).

Various measurement tools have been developed in the literature to measure disaster risk reduction awareness (Xu et al. 2019), high school students' disaster safety awareness (Lee and Kong 2021), sustainable earthquake awareness (Genç and Sözen 2021), earthquake knowledge level (Genç and Sözen 2022), and middle school students' earthquake awareness (Mahanoğlu and Balcı 2025). However, it has been determined that these developed measurement tools do not sufficiently examine individuals' perceptions of safety against earthquake hazards. Therefore, this study planned to develop a measurement tool to assess individual safety culture perceptions regarding earthquake hazards. In this respect, it differs from other measurement tools.

2 Method

2.1 Research model

This methodological study aims to develop a valid and reliable earthquake safety culture scale. The scale development process involved the following steps. In the first stage, a pool of items and questions for the scale was created based on literature. In the next stage, the draft form of the measurement instrument was prepared based on the pool of questions. In the final stage, exploratory factor analyses, confirmatory factor analyses, and reliability analyses were applied.

2.2 Research process and measurement tool design

The scale development process was shaped based on literature (AFAD 2018; American Red Cross 2022; Occupational Safety and Health Administration 2025; Becker et al. 2012; 2017; Lindell and Perry 2000; Li et al. 2017; Usta 2022), and the scale development steps followed in the current study were established. Accordingly, each stage of the study is presented in Fig. 1.

In the first phase, a detailed literature review was conducted on the subject area, examining articles, theses, measurement tools, guides, and guides related to disasters and earthquakes. The scale items were written to cover the "pre-earthquake" and "during and after
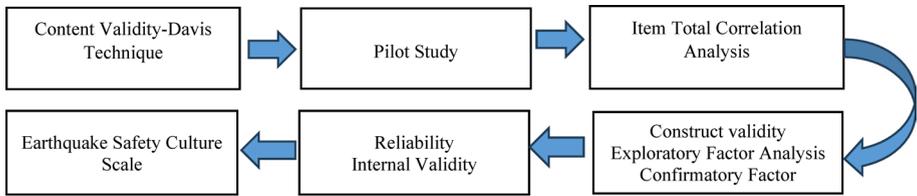
Fig. 1 Development steps of the earthquake safety culture scale

earthquake" processes (basic information, protection methods, necessary precautions, etc.), taking into account individuals' cognitive, affective, and behavioral domains.

Initially, 30 scale items were prepared for the developed scale. Considering that the number of items might decrease as a result of further factor analyses, an effort was made to include as many items as possible. The prepared items were evaluated by nine educators in the fields of emergency aid and disaster management, civil defense, and firefighting. The experts responded to each draft scale item with "not at all appropriate," "partially appropriate," and "appropriate." They were also informed that they were welcome to make various suggestions upon request. Of the items in the draft scale evaluated by the field experts, three items were revised, and six items were removed from the draft form. The resulting item pool comprised 24 items. In the next stage, the scale items were checked for language and expression by a linguist. Unnecessary and inappropriate words were removed, words used incorrectly were replaced, and necessary adjustments were made. The draft scale form was prepared on a 5-point Likert-type scale, with each item rated as follows: "1: strongly disagree," "2: disagree," "3: undecided," "4: agree," and "5: strongly agree." A concise guideline explaining the purpose and information about the scale was also included in the draft form. The 24-item draft scale was then piloted by administering it to 30 individuals, along with a voluntary consent form, at a level sufficient to meet the target population of the study. Based on the feedback received, relevant adjustments were made to the draft scale (e.g., items' readability and understandability), and it was ready for application to the main sample.

Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were conducted on the data obtained from the sample. During the exploratory factor analysis, decisions were made regarding the items to be included and those to be removed from the scale. Items with factor loadings above 0.30 were deemed appropriate to remain in the scale (Büyüköztürk 2005; Akgül 2005). Furthermore, items distributed across multiple factors (overlapping) were subsequently removed. Nine items were removed from the scale as a result of the factor analysis. In the final stage, the factors within which the remaining items were distributed, as well as their similarities and differences, were examined. Accordingly, it was determined that one factor contained information about the pre-earthquake period, while the other contained items about during and after earthquake behaviors. Therefore, the factors within the scale were appropriately categorized as "pre-earthquake" and "during and after earthquake" , taking into account the content of the items comprising the factors.

In the next stage, confirmatory factor analysis was conducted to validate the resulting 15-item, two-dimensional structure. The scale, with its confirmed two-factor structure, was finalized, and the scale instructions were revised. Consequently, an earthquake safety culture scale was developed, demonstrating both validity and reliability. The minimum score

possible from the scale is 15, while the maximum is 75. As the scale scores increase, individuals' earthquake safety culture increases.

2.3 Research universe and sample

The study population consisted of individuals over the age of 18 in Türkiye who volunteered to participate. The sample size was calculated as 384 individuals using the formula n = Nt2pq/d2(N-1) + t2pq (Büyüköztürk et al. 2014). However, in scale development studies, the sample size is recommended to be 5–10 times the number of items (Tavşancıl 2006) or a minimum of 300 (Tabachnick and Fidel 2019). Furthermore, for confirmatory factor analysis, an appropriate sample size of 250 or more is expected (Hu and Bentler 1999). Therefore, data collected from 445 individuals for exploratory factor analysis and 309 individuals for confirmatory factor analysis were included in the analysis. A sufficient sample size was achieved for both exploratory factor analysis and confirmatory factor analysis.

2.4 Data collection process

A three-part survey form was used to collect data. The first part included an informed consent form. Participants were informed about the purpose, scope, and ethical aspects of the study. The second part included 10 personal information questions (age, gender, marital status, education level, income level, disaster experience, disaster training, disaster legislation, disaster preparedness level, and participation in volunteering activities). The third part included the "Draft Earthquake Safety Culture Scale." Data were collected between January and March 2025. The online survey form was shared with individuals via email and WhatsApp. The online survey form was limited to a single response option. This practice prevented the same participant from completing the form multiple times. Furthermore, the researchers checked whether the completed survey forms contained sociodemographic variables for the same participant. The survey response time ranged from 5 to 8 min for each participant. Individuals who were over 18 years of age, living in Türkiye, agreeing to participate voluntarily in the study, and meeting the conditions of being able to speak Turkish and be literate were included in the study.

2.5 Data analysis

The data obtained from the participants were evaluated through an analysis process using SPSS 23 and JAMOVI programs. First, the data were transferred to SPSS to identify missing data and make the data set suitable for analysis. The normal distribution of the scale and sub-dimension scores was assessed by examining the kurtosis-skewness coefficients using the Kolmogorov–Smirnov test. For variables found to be significant at the end of the Kolmogorov–Smirnov test ($p < 0.05$), skewness (−0.840) and kurtosis (−1.250) values were between ±2.0 (Kline 2011), indicating a normal distribution of the data. Bartlett's test and Kaiser Mayer Olkin (KMO) analyses were then performed. The Kaiser Mayer Olkin (KMO) value indicates the adequacy of the sample size at the point of continuing analyses during scale development. It is also considered an indicator of whether the data set is suitable for exploratory factor analysis (Karaman 2023). At this point, the KMO value obtained for a good sample is expected to be above 0.80 (Tabachnick and Fidel 2019). The KMO

value obtained in this study (0.94 > 0.70) indicates that the sample is sufficient. After this stage, exploratory factor analysis was performed, and items with factor loadings above 0.30 were accepted in this analysis. In addition, the Direct Oblimin rotation method, one of the oblique rotation methods, was used. In this process, items with loading differences between items belonging to more than one factor of 0.10 or less were removed from the scale (Stevens 2002). As a result of the analysis, it was decided to remove a total of nine items from the scale. Following the completion of the exploratory factor analysis, confirmatory factor analysis was conducted to verify the resulting factor structure. The data set obtained from the second sample group was transferred to the JAMOVI program, and confirmatory factor analysis was performed. The results of the confirmatory factor analysis indicated that the hypothetical structure of the earthquake safety culture scale (two-factor model) was confirmed. Furthermore, the scale's reliability was assessed by calculating the Cronbach's alpha internal consistency coefficient and a t-test for independent groups (27% lower and upper groups).

2.6 Ethical ıssues

All procedures in this study comply with the principles of the Declaration of Helsinki. Informed consent was obtained from all participants. The study was approved by the Erzincan Binali Yıldırım University Human Research Ethics Committee (No: E-88012460-050.04-415716 and Date: 26.12.2024).

3 Result

The demographic information of the 445 people who participated in the survey applied for EFA analyses is as follows: Age information ranged from 18 to 55. In terms of gender, 57.3% was female and 42.7% was male. In terms of marital status, 9.9% was married and 90.1% was single. In terms of educational background, the following were primary school (4%), secondary school (2%), high school (9.7%), associate degree (66.7%), undergraduate (18%), and graduate degree (4.9%). In terms of economic status, the following were low (19.1%), medium (75.7%), and high (5.2%). In terms of disaster experience, the following were yes (56%), no (44%). In terms of receiving training on disasters, the following were yes (56.0%), no (44.0%). In terms of voluntary participation in disasters, the following were yes (19.3%), no (80.7%). In terms of knowledge on disaster legislation, the following were yes (44.9%), no (55.1%). In terms of disaster preparedness level perceptions, they are not ready at all (20.7%), partially ready (72.8%), and completely ready (6.5%).

3.1 Exploratory factor analysis

Before conducting exploratory factor analysis for the 24 items obtained from the item pool, the reliability coefficient alpha was examined. Cronbach's alpha was determined to be 0.94. When the KMO and Bartlett's coefficients were examined to test the adequacy of the sample size for the suitability of the data for factor analysis, the KMO value was found to be 0.94, and the Bartlett's coefficient was found to be significant at $p = 0.000$. Principal Component was selected in the Factor Analysis Method section. In the Rotation tab, Direct Oblimin, an

Table 1 Earthquake safety culture scale component matrix

| | Factors | | | |
	1	2	3	4
E21	.804			
E20	.786			
E15	.776			
E24	.757			
E22	.749			
E10	.747			
E12	.745			
E13	.711		−.310	
E5	.707	.334		
E7	.706			−.352
E4	.692	.326		
E18	.683	−.312		
E14	.673			
E6	.668			
E9	.660			
E8	.646			
E23	.633			
E16	.602			
E11	.564			−.482
E3	.544	.384		
E1	.544	.432	.443	
E19	.474	−.391	.349	
E17	.523		.541	
E2	.431	.351		.579

Table 2 Communalities

Items	E3	E4	E5	E6	E7	E8	E14
Initial	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Extraction	.45	.59	.65	.60	.52	.54	.47
Items	E15	E16	E18	E20	E21	E22	E23	E24
Initial	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Extraction	.60	.43	.60	.71	.72	.62	.50	.61

oblique rotation method, was selected because the factors were thought to be related to each other. The analysis initially revealed a four-factor structure.

An examination of Table 1 reveals that there are overlapping items. Accordingly, the overlapping items were removed from the analysis in this order (E1, E19, E2, E9, E11, E17, E12, E10, E13), and exploratory factor analysis was conducted again after each item was removed. Removing the overlapping items in the factor analysis resulted in a two-factor scale. It is understood that the scale items are above 0.40, and the communalities table is shown in Table 2. The factor loadings for the scale are shown in Table 3.

The factor loadings for the scale presented in Table 3 range from 0.481 to 0.867. The total variance explained for the scale was found to be 57.40%. Detailed information about the total variance explained for the scale is provided in Table 4.

Table 3 Earthquake safety culture scale rotated component distribution

	Factors	
	1	2
E18—Standing on a balcony during an earthquake is dangerous for our safety	.867	
E20—While evacuating the building, matches and lighters should not be lit, and electrical switches should not be touched to prevent gas leaks and explosions	.849	
E21—While evacuating the building, an emergency kit should be taken and a neighborhood assembly point should be visited	.774	
E23—After the earthquake, buildings should not be entered without the approval of the authorities	.746	
E22—When evacuating the building after the tremor has passed, electricity, gas, and water valves should be turned off, and stoves and heaters should be extinguished	.705	
E14—Acting calmly during an earthquake is important for personal safety	.664	
E16—During an earthquake, the "drop, cover, and hold on" maneuver should be performed	.637	
E24- Aftershocks pose a risk of loss of life and property in damaged structures	.634	
E15—It is important for our life safety to stay away from objects that may fall on us and break into pieces during an earthquake (windows, glass materials, etc.)	.578	
E6—It is important to have a fire extinguisher in case of fires that may occur after an earthquake		.769
E5—An emergency kit should be created containing the necessary supplies (water, packaged food, medicine, hygiene pads, etc.) for the first 72 h after the earthquake		.747
E3—Items that may block escape routes during earthquakes should not be kept in corridors and halls		.733
E4—Safe spots where family members can come together after the earthquake should be determined		.718
E8—Houses must be insured against earthquake risk		.687
E7—It is important for individuals to receive training so that they can exhibit correct behavior during an earthquake		.481

Table 4 Eigenvalues of the sub-factors of the scale and the percentages of variance they explain

Initial eigenvalues			
Factors	Total	% of Variance	Cumulative %
1	7.507	50.045	50.045
2	1.103	7.352	57.397

The two-factor structure of the scale also emerged as a Scree Plot and is given in Fig. 2. The Scree Plot method analyzes the sudden drops in the graph created according to the eigenvalues of the relevant factors in factor analysis, and the sharp breaking points in the graph show the important factor numbers (Yaşlıoğlu 2017).
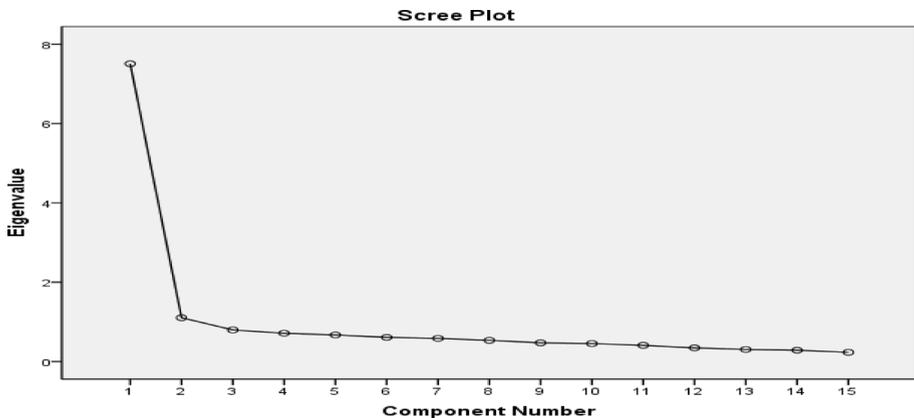
Fig. 2 Factor structure distribution chart

In the exploratory factor analysis for the scale, oblique rotation was applied because it was thought that the factors might be related. The correlation matrix between the items is presented in Table 5, and it was determined that the relationships between the items were significant and the factor loadings were appropriate. Furthermore, the Component Correlation Matrix values for the two factors are presented in Table 6, and it was determined that the factors were related to each other.

3.2 Confirmatory factor analysis

The demographic information of the 309 people who participated in the survey applied for CFA analyses is as follows: Age information ranged from 18 to 57. In terms of gender, 58.6% was female and 41.4% was male. In terms of marital status, 14.9% was married and 85.1% was single. In terms of educational status, the following were secondary school (2.6%), high school (5.2%), associate degree (57.0%), undergraduate (31.7%), and graduate (3.6%). In terms of economic status, the following were low (18.4%), medium (77.3%), and high (4.2%). In terms of disaster experience, the following were yes (54.7%), no (45.3%). The status of having received training on disasters: yes (51.5%), no (48.5%). In terms of participation in volunteer activities related to disasters: yes (22.3%), no (77.7%). In terms of knowledge about disaster legislation, the responses are yes (43.4%) and no (56.6%). In terms of perceptions of disaster preparedness level, the responses are not prepared at all (21.0%), partially prepared (71.5%), and completely prepared (7.4%).

EFA analyses had previously been conducted, and a two-factor structure emerged. To verify the resulting two-factor structure, a 15-item survey was administered to 309 individuals based on data collected from samples at different periods. A reliability analysis of the survey items revealed a high level of reliability of 0.94, with a Cronbach's alpha value of 0.94. The pre-earthquake safety culture scale had a Cronbach's alpha coefficient of 0.88, and the "during and after earthquake" safety culture factor alpha was 0.91. Furthermore, the scale's internal validity is shown in Table 7, using the upper and lower 27% rule.

Accordingly, a statistically significant difference was observed between the mean scores of the upper group representing individuals with the highest earthquake safety culture and

Table 5 Correlation Matrix

Correlation	E3	E4	E5	E6	E7	E8	E14	E15	E16	E18	E20	E21	E22	E23	E24
E3	1.000	.436	.416	.383	.325	.325	.298	.424	.297	.276	.344	.356	.323	.258	.370
E4	.436	1.000	.535	.497	.519	.448	.366	.507	.327	.375	.467	.511	.406	.407	.499
E5	.416	.535	1.000	.575	.529	.533	.356	.515	.402	.406	.474	.520	.495	.399	.556
E6	.383	.497	.575	1.000	.460	.506	.391	.458	.374	.349	.369	.488	.513	.396	.405
E7	.325	.519	.529	.460	1.000	.498	.423	.452	.429	.481	.488	.522	.520	.365	.465
E8	.325	.448	.533	.506	.498	1.000	.360	.452	.321	.336	.479	.491	.465	.322	.463
E14	.298	.366	.356	.391	.423	.360	1.000	.610	.378	.430	.527	.471	.436	.411	.495
E15	.424	.507	.515	.458	.452	.452	.610	1.000	.467	.463	.623	.592	.528	.447	.595
E16	.297	.327	.402	.374	.429	.321	.378	.467	1.000	.481	.453	.500	.455	.376	.414
E18	.276	.375	.406	.349	.481	.336	.430	.463	.481	1.000	.552	.593	.556	.479	.495
E20	.344	.467	.474	.369	.488	.479	.527	.623	.453	.552	1.000	.721	.622	.540	.641
E21	.356	.511	.520	.488	.522	.491	.471	.592	.500	.593	.721	1.000	.720	.521	.631
E22	.323	.406	.495	.513	.520	.465	.436	.528	.455	.556	.622	.720	1.000	.484	.530
E23	.258	.407	.399	.396	.365	.322	.411	.447	.376	.479	.540	.521	.484	1.000	.518
E24	.370	.499	.556	.405	.465	.463	.495	.595	.414	.495	.641	.631	.530	.518	1.000

Table 5 (continued)

	E3	E4	E5	E6	E7	E8	E14	E15	E16	E18	E20	E21	E22	E23	E24
Sig. (1-tailed)															
E3															
E4	.000														
E5	.000	.000													
E6	.000	.000	.000												
E7	.000	.000	.000	.000											
E8	.000	.000	.000	.000	.000										
E14	.000	.000	.000	.000	.000	.000									
E15	.000	.000	.000	.000	.000	.000	.000								
E16	.000	.000	.000	.000	.000	.000	.000	.000							
E18	.000	.000	.000	.000	.000	.000	.000	.000	.000						
E20	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000					
E21	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000				
E22	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000			
E23	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000		
E24	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000	

Table 6 Factors correlation matrix

Factors	1	2
1	1.000	.656
2	.656	1.000

Table 7 Upper and lower 27% rule for the internal validity of the scale

Group	n	x	Sd	Statistical	Significance
Upper group	120	75.00	0.00	t: 62.439	$p<0.001$
Lower group		61.25	2.41		

Table 8 CFA fit indices

Model/index	χ^2/df	GFI	CFI	TLI	IFI	RMSEA
	1.23	0.99	0.99	0.99	0.99	0.028
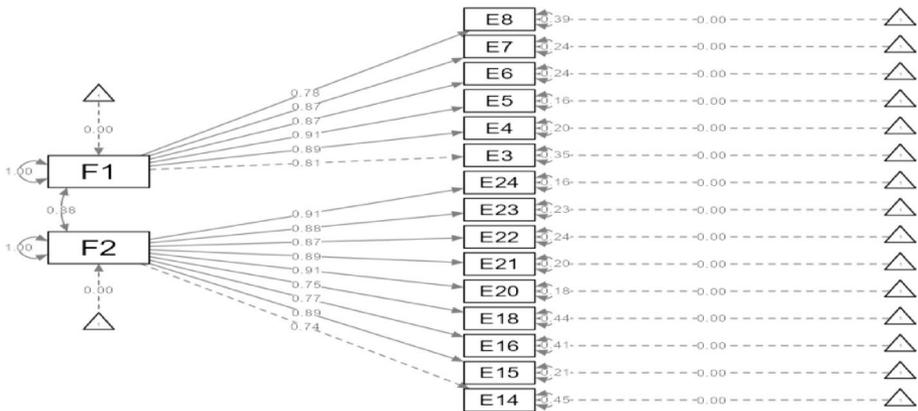
Fig. 3 Confirmatory factor analysis

the lower group representing individuals with the lowest earthquake safety culture (t: 62.439; $p<0.001$). This result demonstrates that the scale has internal validity and can effectively distinguish individuals with high and low earthquake safety culture. When the AVE values of the factors were examined, they were found to be 0.73 and 0.72, respectively. When the KMO and Bartlett's coefficients were examined to test the adequacy of the sample size for the suitability of the data for factor analysis, the KMO value was 0.95, and the Bartlett's value was found to be significant at $p<0.000$. Data for confirmatory factor analysis were analyzed using the JAMOVI program. The goodness-of-fit values for the two-factor scale are presented in Table 8.

In this regard, the 15-item scale called "pre-earthquake" (F1, see Fig. 3) and "during and after earthquake" (F2, see Fig. 3) earthquake safety culture scale was validated.

4 Discussion

The study aimed to develop an earthquake safety culture scale for earthquakes, one of the most devastating natural hazards in the world. Within this framework, safety culture can be defined as the cognitive, affective, and behavioral attitudes individuals adopt to prevent earthquake harm before an earthquake (e.g., "An emergency kit should be prepared containing supplies that may be needed for the first 72 h after an earthquake, such as water, packaged food, medicine, sanitary pads, etc.") and after an earthquake (e.g., "During the evacuation of the building, matches and lighters should not be lit, and electric switches should not be touched, due to the risk of gas leaks and explosions"). Factors such as the disaster training individuals receive, previous earthquakes they have experienced, earthquake drills they have conducted, and their exposure to earthquake news in the media can be considered factors that contribute to the development of an earthquake safety culture. In this respect, earthquake safety culture can be considered an important element for individuals. In our study, procedures were followed to ensure the validity and reliability of the scale. In this context, the research team created the item pool based on literature support, sent the item pool to relevant experts, and received feedback from them to ensure content validity. A pilot study was then conducted, and a survey was administered for EFA.

When our study was evaluated in terms of reliability, the Cronbach's alpha value, which is widely used in the literature, is expected to be greater than 0.70 (Yaşlıoğlu 2017). In this context, the Cronbach's alpha value was determined as 0.94 in the EFA in our study. In the CFA, the reliability value of 15 items was determined as 0.94, the Cronbach's alpha coefficient of the pre-earthquake safety culture scale was 0.88, and the alpha value of the "during and after earthquake" safety culture factor was 0.91. These values obtained indicate that the scale is highly reliable. In both the EFA and CFA analyses, the KMO values were found to be high and appropriate for factor analysis, and Barttlett's tests were also found to be significant (Karaman 2023).

As a result of the analyses, it was understood that the factor loadings of the 2-factor, 15-item scale ranged from 0.481 to 0.867. The total variance explained for the scale was found to be 57.40%. The general opinion in the literature regarding the total variance explained is that a value above 40% would be sufficient (Çokluk et al. 2014). According to some opinions, having a total variance explained above 50% is an important factor for factor analysis (Yaşlıoğlu 2017). In this context, it can be said that the total variance explained in the EFA analysis is within the acceptable range. When the correlation levels are examined both between the items and the factors, it is understood that there are significant relationships and the correlation values are at acceptable levels. When the correlation matrix is examined, it is understood that there is no multicollinearity problem ($r < 0.80$) both between the items of the scale and the factors (Shrestha 2020).

In our study, the fit indices obtained in the CFA analysis conducted to verify the 15-item, 2-factor structure were found to be consistent with widely accepted values in the literature and were found to be excellent indices in terms of fit indices (Hu and Bentler 1999; Schermelleh-Engel et al. 2003; Fan et al. 2016). In this context, the scale was validated as a result of the reliability and validity analyses of the earthquake safety culture scale.

5 Conclusion and recommendations

Our study of the earthquake safety culture scale, conducted content validity, construct validity, and reliability analyses to measure individuals' behaviors, attitudes, and behaviors before and after an earthquake in the context of earthquake preparedness, developed a psychometrically valid and reliable scale, and made a significant contribution to the literature. Following factor analyses, the scale was named "pre-earthquake" and "during and after earthquake."

The earthquake safety culture scale developed in this study is expected to contribute to disaster management policies for a disaster-resilient society. It is believed that it will guide disaster managers at the local and national levels in developing disaster education policies, earthquake drills, disaster preparedness efforts, and disaster response policies, particularly in order to increase earthquake awareness within the context of community-based disaster management.

This scale can be used to determine the effectiveness of earthquake education and awareness programs. It can also be used to investigate the earthquake safety culture of societies from a socio-demographic perspective. The impact of different disaster-related variables on earthquake safety culture can be investigated. The scale can be tested through validity and reliability analyses in different cultures.

Data obtained from the scale application can pave the way for national disaster risk reduction efforts and the building of a disaster-resilient society. It can also contribute to the assessment of security perceptions related to post-disaster response processes and to studies conducted in this direction.

6 Limitations of the study

The earthquake safety culture scale development study was limited to individuals aged 18 and over who volunteered for the EFA and CFA processes. While risk reduction activities and structural earthquake precautions are important for earthquake safety, our study was limited to addressing "pre-earthquake" and "during-after earthquake" attitudes and behaviors. The study was conducted across Türkiye, and recent major earthquakes in the country may have influenced individual responses. The scale was developed in Türkiye to suit Turkish culture. Therefore, its application outside of Türkiye may have limitations due to cultural differences. Therefore, if the scale is applied to a population with different cultural structures, it is recommended that validity and reliability studies be conducted to suit the relevant culture, and cross-cultural validation and adaptation studies be conducted.

Data availability The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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