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Educated Youngsters' Risk Perception and Seismic Preparedness – Lessons for Crisis Communication in the Case of Earthquake-prone Greece

Anna Fokaeus, Kalliopi Sapountzaki

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Educated Youngsters' Risk Perception and Seismic Preparedness – Lessons for Crisis Communication in the Case of Earthquake-prone Greece

Anna Fokaefs[1] and Kalliopi Sapountzaki

Department of Geography

Harokopio University of Athens

Abstract. Responding effectively to a destructive seismic event remains an important challenge and preparedness is considered a key element. Risk perception has been well documented to predict the willingness to adopt and carry out preparedness measures. This research focuses on seismic risk perception, in particular if and how it motivates protection behaviors and preparedness actions of youngsters and especially students of the Universities in Greece. The communication preferences of this population group during a seismic crisis as well as the level of the students' trust towards competent authorities are also investigated. An online survey has been conducted targeting the students of the Universities in Greece using social media and email communication channels/ 601 answers have been collected. The results show that (a) although participants have good knowledge on protective measures during a seismic crisis, preparedness protective actions have been undertaken by only a small portion; (b) the dominant factors motivating preparedness responses are personal psychology factors, level of worry and previous experience of a strong seismic event; (c) women are featured by higher risk perception which however does not translate into undertaking more preparedness actions (d) participants are by priority concerned with forest fires, they are less and equally worried about heat waves, earthquakes, and pandemics; (e) participants put their trust more in scientists and emergency operators (than in Governmental authorities –central and local) for guiding information during a seismic crisis, and (f) internet sources (social media and news websites) are the most popular means for receiving and sending information, (g) there is evident tendency to focus on reacting and responding rather than preventing against earthquakes and earthquake disasters.

Key words: Seismic risk perception, preparedness, self-protection measures, crisis communication.

1. Introduction

Europe has a long history of damaging earthquakes, even though the world's deadliest seismic events occur in other regions, mainly in Indonesia, China, Japan and Chile (USGS 2002). The

[1] Corresponding author: afokaeus@hua.gr

highest seismicity rate in Europe is concentrated in the southern part, particularly Italy, Greece, Albania and Romania. According to the Emergency Event Database (EM-DAT), between 2010 and 2023, earthquakes have been the second, mostly affecting natural-related disaster in Southern Europe.

In the aftermath of destructive earthquakes, apart from judgments on the efficacy of the countries' response mechanisms, concerns about the levels of preparedness of the victimized communities are raised. Enhancing preparedness to effective responding is among the four priority targets of the Sendai Framework for Disaster Risk Reduction 2015-2030 (UNISDR, 2015). The objective of the present research is to investigate the multi-dimensional concept of preparedness and response behavior of individuals in anticipation of and during an earthquake disaster in Greece. The focus is on young adults between 18-40, exploring youth's perception regarding seismic risk and highlighting the respective components (worry, trust, experience, knowledge) that motivate/impede protection behaviors and disaster preparedness. The youngsters are, after all, acknowledged as *agents of change* by the people-centered preventive approach to disaster risk of UNISDR, 2015 and *should be given the space and modalities to contribute to disaster risk reduction, in accordance with legislation, national practice and educational curricula*" (UNISDR, 2015, p. 23).

2. Theoretical background

Preparation behaviors towards a risk -also referred to as *(seismic) adjustment behaviors* (Solberg et al. 2010) or *attitudes* towards risk (Toma-Danila et al., 2021)- as well as response behaviors, result from the way the risk is subjectively perceived (Plapp and Werner 2006; Cisternas et al 2023; Shapira et al., 2018; Kung and Chen 2011). According to Paek & Hove, 2017 and Slovic & Peters, 2006 there are two dimensions of risk perception: the cognitive and the emotional dimension. The cognitive dimension links people's protective behaviors and reactions to their level of knowledge, and understanding of risks (Slovic & Peters, 2006). According to the Information Deficit Model-IDM (Miller 1983) public's perception, beliefs and attitudes may be (re)formulated when the public receive relevant information, thus highlighting the close relationship between knowledge and behaviors. In fact, in the absence of a previous experience, disaster knowledge and awareness may fill the gap in adopting mitigation/preparedness measures and provide/ improve skills to respond properly (Ao et al 2021; Tekeli-Yeşil et al., 2010). IDM has been criticized to overpass critical factors including psychological drivers (Ecker et al 2022). According to the scholars focusing on the emotional dimension, peoples' protective behaviors and reactions are driven by emotions such as worry or fear (Slovic et al., 2002). The results of numerous studies on the effect of worry on disaster preparedness are not always consistent; Takao et al., 2004; Rüstemli and Karanci, 1999 argue that worry affects positively disaster preparedness, while Lindell and Whitney, 2000; Siegrist and Gutscher, 2006 find no correlation at all. Moreover, academic literature in natural disasters associates emotions with past experience (Plapp & Werner, 2006) . The severity or the frequency of a disaster experience influences the levels of worry and concern

with an indirect positive impact to the relationship of experience with preparedness (Siegel et al 2003; Miceli et al 2008). Other studies though do not support the idea that experience necessarily reinforces precautionary behaviors (Lindel and Perrey 2000; Becker et al 2017). In fact, it may lead to overestimation of coping abilities (Wachinger et al. 2013) or a false sense of security (Ruin et al 2007).

The impact of personal characteristics (age, gender, education, income etc.) on risk perception has been investigated also. Men and women perceive risks differently (Gustafsod 2006): while women are reported to perceive higher risks than men (Barker et al 1997; Funicane et al 2000; Subiza-Pérez et al 2020) and have better knowledge on protective measures, they seem to be less willing to adopt preparedness actions (Cvetković et al 2018; Ekenga et al 2019; Cuesta et al 2022). The role of (formal) education has been often documented by several researchers to improve disaster preparedness especially in terms of increasing the ability to access information (Hoffman and Muttarak 2017, Kirchenabum et al 2017). Geographical variables, such as physical proximity, are also reported to influence disaster/ hazard preparedness behaviors. People living in disaster prone areas show higher levels of preparedness (Baker 2011).

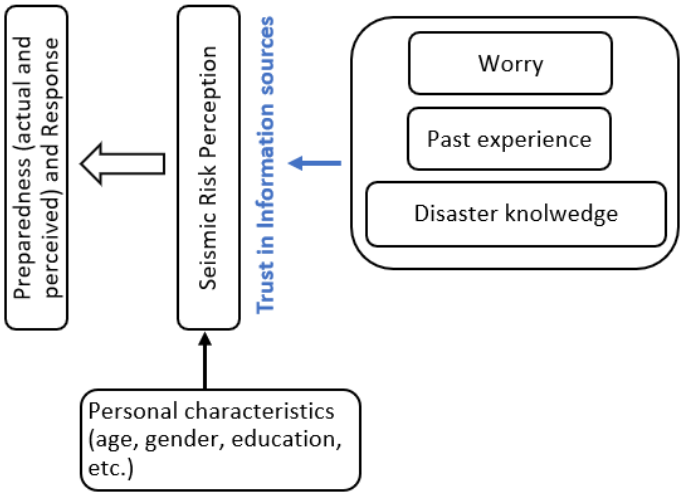


Figure 1. Variables of seismic risk perception and preparedness and relevant impact on preparedness levels mentioned in Section 2. Source: authors' elaboration for the needs of the present research.

As already analyzed, risk perception is considered a keystone for preparedness. An interconnected critical issue is identification of the appropriate communication strategy that fosters preparedness levels and appropriate behaviors during earthquake emergencies. A consequent query refers to the trustworthy sources and channels accessible by the public in times of earthquake emergency. The Media is the principal link between science and the public and the Media's effect on risk

perception, as risk amplifier or attenuator, has been argued for long by researchers (Beck 1992; Kasperson et al 1988). This effect has received an increased interest in modern studies as well (Kim et al 2020; Tekeli-Yesil et al 2019). Especially the interplay between social media and risk/crisis communication and disaster preparedness has been captured by numerous research studies (Pignone et al 2022; Gulesan et al 2021).

3. Methodology

An online survey has been conducted between May and July 2023 in Greece targeting the students of the Universities in Greece and covering a wide range of scientific disciplines[2]. The questionnaire consisted of 29 closed-ended questions and was circulated through email communication channels with the support of the University Faculties' Secretariats. The recipients were undergraduate and post-graduate students. Social media have been also used, mainly by posting the questionnaire to the Universities' official Facebook pages. 601 answers have been collected.

3.1. Participants and data collection

The recipients (undergraduate and post-graduate students in Universities in Greece) were recruited by using the Student Email Lists available by the University Secretariats, as well as the currently available Student Group Accounts on Facebook. Young adults between 18-40 are expected to be already informed (especially from their school environment) about natural hazards and safety measures as well as prevention and preparedness responses. This is an assumption under investigation. Learning process on disasters has to be ongoing and lifelong (Dahl and Millora, 2016) and it is possible and feasible not only through formal communication channels and practices, such as training campaigns by institutes, competent authorities etc.; informal social networks have been acknowledged as an alternative means for information transfer even copying behaviors and attitudes (Kirschenbaum et al 2017). University students are by all means members of a large social network facilitating channels of communication for sharing experiences and knowledge that promote earthquake preparedness (Losee et al 2022).

3.2. The questionnaire

[2] Raw data were generated in Greek at https://docs.google.com/forms/d/1WGzSUjPBcMLnjvqWyK1J1Yh9HNZgJzdA2RBEtPnwtQQ/edit
The derived data supporting the findings of this study are available from the corresponding author [A.F.] upon request.

In order to reveal participants' perception and attitudes toward seismic risk the questionnaire was organized into four sections: (i) participants' sociodemographic characteristics (Table 1), (ii) knowledge about earthquakes and earthquake disasters (Table 2) and the level of worry (Figure 3), (iii) knowledge on (self) protective measures (Figure 4) and level of preparedness and preparedness intentions (Table 4), and (iv) communication preferences during seismic crisis (Table 5).

4. Results, data analysis and interpretation

4.1. Socio-demographics

The first section of this research summarizes participants' socio-demographic profile (Table 1). The sample consisted of 375 (62.4%) female, 219 (36.4%) male university students and 7 (1.2%) who preferred not to answer. The majority is between the ages of 18-25 (n383, 63.7%) while most answers were collected by students of Natural and Physical Sciences -Technological and Applied Sciences (n281, 49.3%). Seismology/ Geophysics courses, possibly shaping participants' responses, were undertaken only by the 19.3% of them. A portion of 43.9% (n264) of participants lived in houses built in the period 1960-1995, that is after the first anti-seismic building regulation in Greece in 1959 (Greek Code for Seismic Resistant Structures- EAK 2000). Since 2000, the new Greek Anti-Seismic Code has been in force, after several amendments and modification. In 2003, the Seismic Hazard Zone Map of Greece was modified, to include three (instead of four) Seismic Hazard Zones I, II and III (EAK, 2003), (Figure 2). The map illustrates the expected level of ground shaking at specific locations, after a future potential earthquake. (I indicates the weakest earthquake ground motion and III the strongest). The majority of participants reported that they lived in areas of the lowest seismic hazard (Zone I, n372, 61.9%, Table 1).

Table 1. University students' demographic characteristics (n= number of participants)

Variables	**n**	**%**
Gender		
Male	219	36.4
Female	375	62.4
N/A	7	1.2
Age		
18-25	383	63.7
26-35	104	17.3
>35	114	19
Branches of science/ Scientific Disciplines		
Human, Social, Law and Political Sciences	114	19

Financial and IT Studies	88	14.6
Educational Studies	18	3
Healthcare and Life Sciences	83	13.8
Natural and Physical Sciences -Technological and Applied Sciences	296	49.3
Other	2	0.3
Academic Title (Status)		
Undergraduate students	400	66.6
Graduate students	137	22.8
PhD Candidates	64	10.6
Have you ever taken courses of Seismology/ Geophysics in your University?		
Yes	116	19.3
No	485	80.7
In which seismic hazard zone do you live/study? (see Figure 2)		
Zone I	372	61.9
Zone II	204	33.9
Zone III	20	3.3
I don't know	5	0.8
Age of residential building construction		
Before 1960	36	6
Between 1960-1995	264	43.9
Between 1995-2000	85	14.1
After 2000	154	25.6
I don't know.	62	10.3
Do you work for an authority competent/involved in seismic crisis management/ communication?		
No	561	93.3
Yes	28	4.7
I worked in the past.	9	1.5
Other	3	0.5

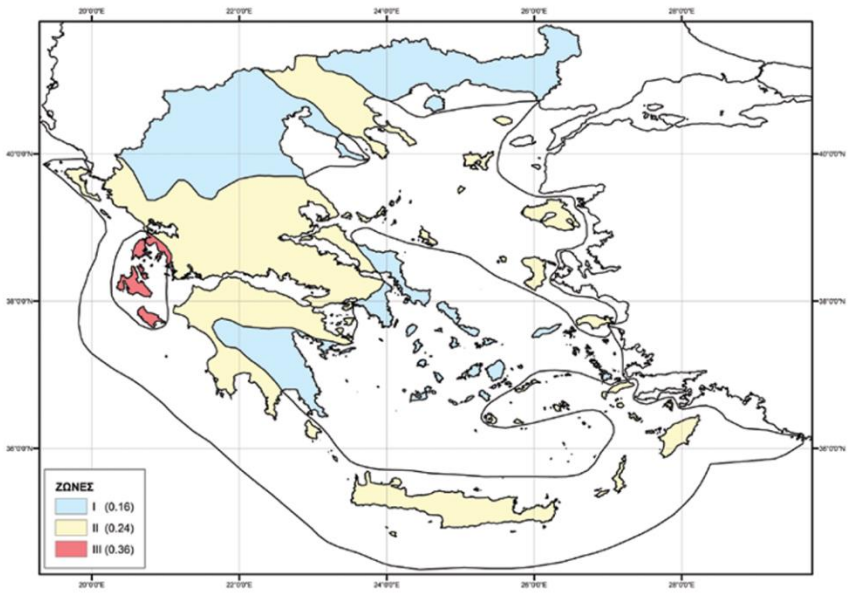


Figure 2. The Seismic Hazard Map of Greece (source: EAK, 2003)

4.2. Basic and empirical knowledge of participants

The present section frames the participants' basic knowledge about earthquakes and earthquake disasters (Table 2). Most participants considered Greece (48.3%) and Türkiye (43.1%) as the most seismically active countries/zones among the five seismically-prone countries of the European part of the Mediterranean region, namely Italy, Greece, Albania, Turkiye and Portugal. Indeed, both countries are characterized by high seismicity rate with a plethora of active faults associated with large and damaging seismic events from antiquity up to the recent past (Ganas et al., 2013; Kassaras et al 2020). In fact, Greece is ranking sixth in the world regarding frequency of earthquake activity (Tsapanos and Burton, 1991). Eastern Mediterranean and Aegean Sea have hosted severe damaging earthquake events (Ambraseys 2008). On the other hand, the very recent double earthquakes of Mw 7.8 and 7.5, that struck southern and central Türkiye and northern and western Syria on February 6th, 2023, are among the strongest and deadliest recorded earthquakes on the Anatolia and Dead Sea area. Rescue efforts as well as the poor building safety standards leading to extensive building collapses have been eloquently illustrated in the media. The influence of this (indirect) empirical knowledge is evident, justifying participants' answers.

Participants were asked to define the causes of earthquake generation from a set of five possible accountable mechanisms described by the literature (Fougler et al 2018, Table 2). Rupture faults have been selected by the 89.2% (n536) of participants as the main cause followed by volcanic eruptions (n348, 57.9%). Underground explosions are also considered accountable for the generation of earthquakes by the 34.3% (n206) of participants and human activities, mainly

associated with industrial processes, by the 32.8% (n197). Participants' answers indicate good knowledge on the mechanisms responsible for earthquake generation.

An important number of participants (n269, 44.8%) believe that severe earthquakes are always destructive. This is a false impression; factors like earthquake epicenter location, depth, compliance with building regulations are mainly the determinants of the destructiveness of an earthquake (Fokaefs and Sapountzaki, 2022).

Empirical knowledge often results from actual experience. In this regard, participants were asked if they have experienced a strong earthquake in the past (Table 2). For those who did (n253, 42.1%), "panic and fear" were what they recollected more than any other memory (n147/253, 58.1%). The next memorable adversity has been problems of communication (n26/253, 10.3%) and coordination of the competent services (n29/253, 11.5%).

Table 2. University Students' basic and empirical (previous experience) knowledge regarding earthquakes.

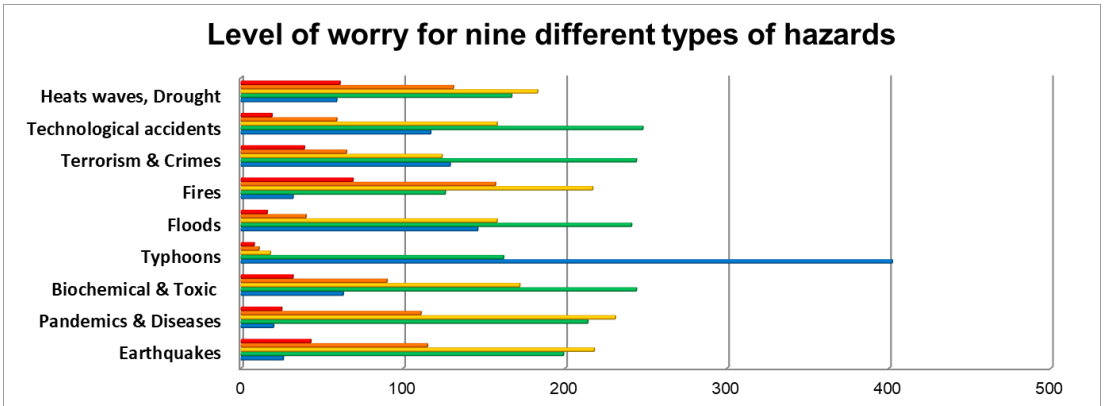
Which is the country with the highest seismicity in Europe-Mediterranean region?		
Answers	n	%
Italy	40	6.7
Greece	290	48.3
Albania	3	0.5
Türkiye	259	43.1
Portugal	3	0.5
Other Answers	2	0.3
I don't know	4	0.7
Are severe earthquakes always destructive?		
Answers	n	%
Yes	269	44.8
No	304	50.6
I don't know	28	4.7
What causes earthquakes? (Multiple choice question)		
Answers	n	%
Rupture faults (plate tectonics)	536	89.2
Volcanic eruptions	348	57.9
Underground explosions	206	34.3
Collapses	118	19.6
Induced Quaking (Human Activities)	197	32.8
Other answers	30	5
Have you experienced a strong earthquake?		
Answers	n	%
Yes	253	42.1
No	348	57.9
If yes, what do you remember the most?		

Answers*(n253, see answers to the previous question)*	n	%
Panic and fear	147	58.1
Relatives' injury	4	1.6
Communication problems	26	10.3
Home damage	16	6.3
The coordination problems of the competent services and the insufficient provision of assistance	29	11.5
Seismologists' controversies	18	7.1
Other answers	8	3.2
No answer	5	2.0

4.3. Worry about earthquakes

Participants were asked to rate their level of worry for nine different types of hazards and the findings are illustrated in Figure 2. It was found that participants are mostly concerned about hazards related to fires (Mean value M3.17) (Table 3), followed by heat waves-droughts (M2.95), earthquakes (M2.92), which generate an almost equal level of worry, and pandemics-diseases (M2.84). Papagiannaki's et al 2019 findings on the level of worry about wildlife fires and earthquakes are similar. Rates of worry for the other hazards are lower than the all-hazards worry average (M2.55). In fact, typhoons induce the lowest level of concern to the participants (M1.44) which is expected given that Greece is rarely hit by typhoons resulting in a low risk perception. The results also show a statistically significant association between gender and the level of worry about earthquakes, suggesting that females express higher level of worry about earthquake hazards (p<0.05).

The catastrophic forest fires of July 2018 and August 2021 may be accountable for the highest level of worry about fires. Worth noticing also is the clear impact of the COVID-19 pandemic crisis on participants answers' indicating that young men and women are equally worried about public health as other types of environmental risks and disasters.



	Earthquakes	Pandemics & Diseases	Biochemical & Toxic	Typhoons	Floods	Fires	Terrorism & Crimes	Technological accidents	Heats waves, Drought
5 (All the time)	43	25	32	8	16	69	39	19	61
4 (Quite often)	115	111	90	11	40	157	65	59	131
3 (Often)	218	231	172	18	158	217	124	158	183
2 (Rarely)	199	214	244	162	241	126	244	248	167
1 (Never)	26	20	63	402	146	32	129	117	59
Number of answers	601	601	601	601	601	601	601	601	601

Figure 3. Bar graphs illustrating participants' level (frequency) of worry about nine different types of hazards (natural, public health and manmade). The number of answers is included in the table attached below the graphs. A 5-point Likert scale was used to rate the level of worry, from 1-"Never" to 5-"All the time".

Table 3. Mean values of participants' worry about nine different types of hazards (n= Number of answers, M=Mean value, SD= Standard deviation).

Type of Hazard	n	M	SD
Pandemics - Diseases	601	2.84	0.90
Biochemical & Toxic	601	2.64	1.03
Earthquakes	601	2.92	0.99
Typhoons	601	1.44	0.76
Floods	601	2.23	0.98
Fires	601	3.17	1.06
Terrorism - Crimes	601	2.40	1.13
Technological accidents	601	2.36	1.00
Heats waves, Drought	601	2.95	1.14
All-hazards worry	601	2.55	0.52

For participants who claimed to worry often, quite often and all the time (frequency of worry≥3, n376) about earthquakes, there has been an attempt to identify the reasons of their worry (multiple choice question). Their answers are illustrated in Figure 3. Personal and the familiars' safety was proved to mainly generate feelings of worry and concern among participants. Lack of trust and confidence in competent authorities' efficacy is also highlighted as a major issue as well as

insecurity related to home damage and financial difficulties to reconstruct. 66.2% of participants with intense worry (n249/376) are women but no statistically significant correlation was found between gender and the adoption of measures (p>0.05). Less than half of them (44%) took at least one protective action against earthquakes in the past year.

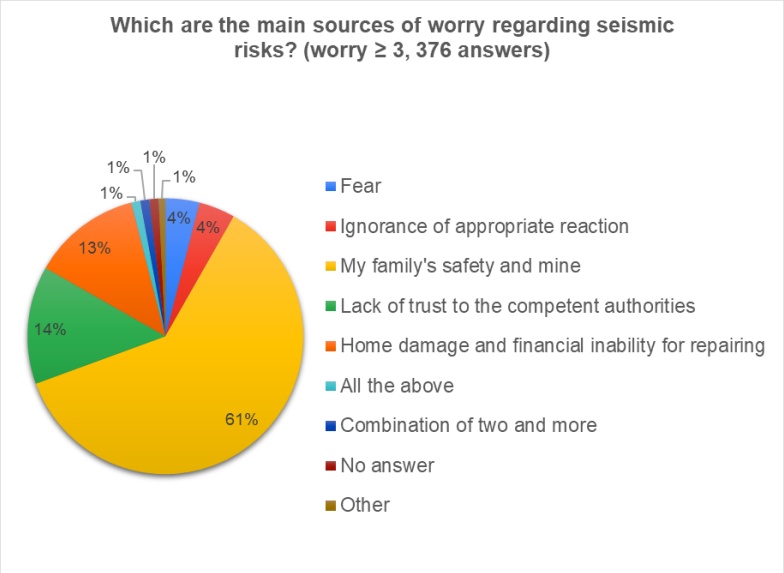


Figure 3. Participants' answers regarding their main sources of intense worry about earthquakes (worry ≥3, multiple choice question)

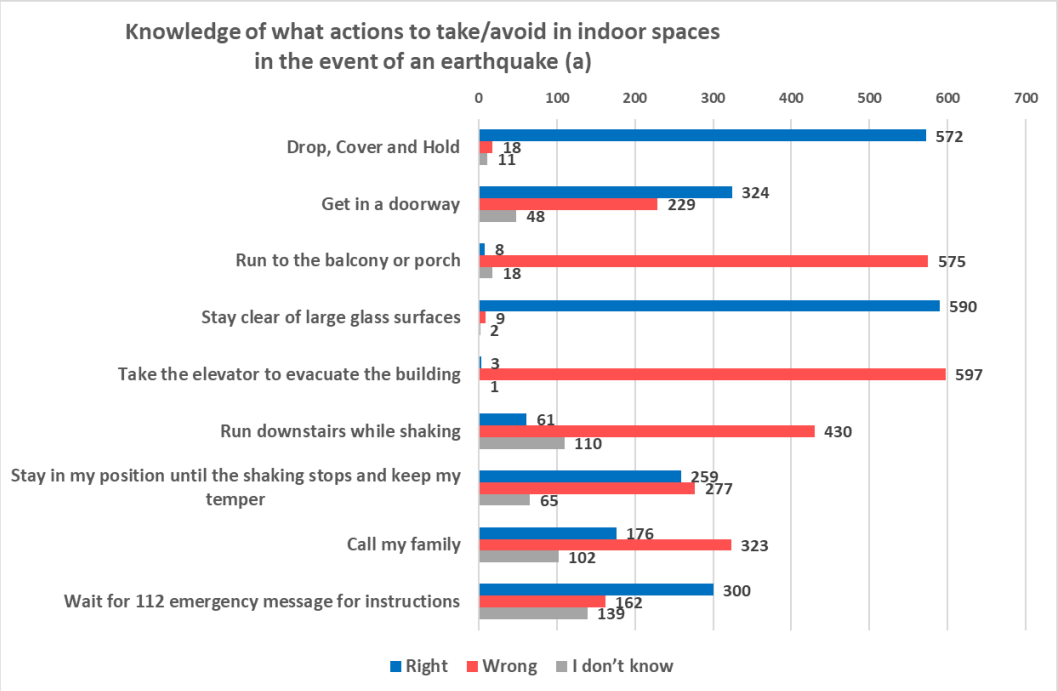
4.4. Preparedness and self-protection measures

It has been argued by several scholars that knowledge influences risk perception, attitudes and self-efficacy (Wachinger et al. 2013; Ao et al., 2021). To evaluate university students' basic knowledge on preparedness and protective measures, we asked them to determine whether a specific protective action is correct or incorrect in the case of an earthquake event while being indoors (Figure 4a) and outdoors (Figure 4b). From a set of fifteen (15) questions, it was found that all participants know at least one correct action to take (or avoid taking) in both cases. We assigned point value 1 to each correct answer to measure participants' knowledge on protective actions. The average score was calculated 11.5/15. Those who scored higher to this set of questions (score ≥13, n199), were women (n120/199, 60.3%) but no significant association between gender and knowledge on protective measures exists according to our results (p>0.05).

"Drop, Cover and Hold" is the current leading official earthquake protection instruction in developed countries to reduce injury and death during earthquakes (Rapaport and Ashkenazi, 2019). This, most widely recommended, earthquake safety action is acknowledged by the majority of university students. It is also recommended by protective action campaigns and implemented in drills and emergency preparedness exercises (Vinnell et al 2020). 95.2% of the participants (n572) considered this action appropriate. The same applies for "Go to an open area" (n592, 98.5%) and

"Move away from the coast" (n511, 85%) recommendations. However, a knowledge gap has been identified. Finding shelter under doorways in closed spaces has been a persistent perception for safety until recently. More than half of the participants believe that they are safe getting in doorways (n324, 53.9%). Doorways though are non-structural systems and are considered by recent literature as weak points that can be often the point of collapse initiation of interior walls (Goltz et al 2020) and should be avoided. While poor standard building constructions are mainly accountable for casualties, there is ample evidence that injuries result also from evacuation attempts during tremors or even immediately after the earthquake (Sari et al 2023).

A knowledge gap in subordinate response actions has been also evident. An important portion of participants (n176, 29.3%, Figure 4a) consider calling their family on the phone as a correct action to undertake in the case of an earthquake. However, official recommendations opt for texting against calling as a wiser way to contact (the message will eventually reach recipient) causing only a light footprint to the telecommunication network, the unobstructed operation of which is crucial for the emergency services. Indeed, text messaging (e.g. SMS, Social Platforms etc) has entered the crisis management practice taking advantage of the asynchronous communication benefits. Most participants acknowledge waiting for instructions from the 112 European Emergency Number in both cases (indoor and outdoor). Nevertheless, an important number of university students do not feel like waiting for the emergency message (n162, 26.9%, Figure 4a and n113, 18.8%, Figure 4b) and it is noteworthy that many of them claim uncertainty about the relevance of instructions through the Emergency Number (n139, 23.1%, Figure 4a and n131, 21.8% Figure 4b).



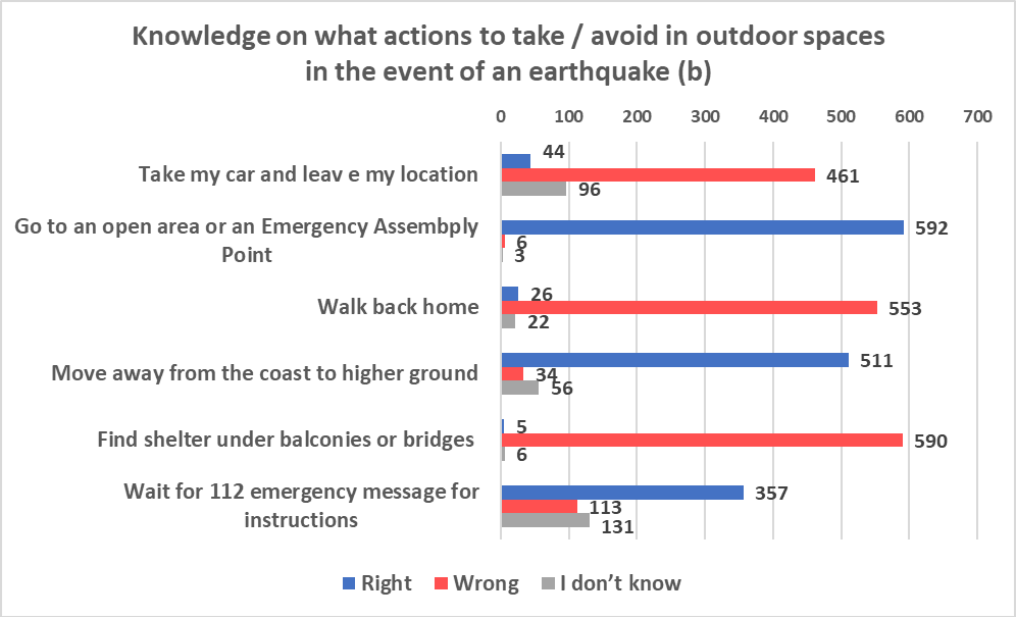


Figure 4. Participants' answers regarding actions to be taken (or not) in the event of an earthquake in indoor (a) and outdoor spaces (b); Right/Wrong quiz type questions.

A principal goal of this research is to identify the dominant factors that motivated university students to take preparedness actions against earthquakes in the past year. 39% of participants (n236) have taken at least one protective action. Their undertaken actions, chosen from a predefined list of answer options, are mentioned in Table 4. The majority of the students who have taken a measure in advance have prepared an evacuation plan for the case of earthquake emergency (n134/236, 56.8%), followed by the preparation of emergency supplies (n104/236, 44.1%) and fixing of hanging objects (n93/236, 39.4%). The majority of these participants were women (60%) and the average level of worry about earthquakes is 3.1 (mean value of worry).-According to the results, there is significant association between past experience and the level of worry to the adoption of protective actions ($p<0.001$, $p=0.001$ respectively). However, no significant correlation resulted between gender and taking precautionary measures ($p>0.05$).

More than half of the participants replied not to have taken any preparedness and protective action against earthquakes (n351, 58.4%) and the reasons are explained in Table 4. An important portion of the participants claimed ignorance of the necessary measures to take (n121/351, 34.5%, Table 4). This unexpected claim may have several explanations: lack of access to information or lack of trust in official recommendations. Worth mentioning is also the fact that only half of the participants responding not to have undertaken preparedness and protective actions (n181/351, 51.6%) are likely and very likely to take similar measures in the near future (Table 4). The majority of this group had claimed high level of worry ≥3 (n123/181, 68%) in a previous question further supporting the interplay between worry and the adoption of protective actions. The Hazard Zone of residence did not influence the decision for undertaking protective actions according to our results; more than half of the participants living/studying in Zones II and III (n224/601) (Figure 2) have not taken any protective action in the last twelve months.

The results show that the most common ways of preparation that participants reported were those of low or no cost and easy to adopt, but still extremely vital. Only 32participants realized anti-seismic reinforcement of their houses but no correlation has been proven with the age of their residential building construction, or the seismic hazard zone they live in. The impact of personal psychology factors is evident (n134/236), followed by previous experience of a strong seismic event in Greece and worldwide (n105/236 and n84/236 respectively) (Table 4). 14 answers (2.3%) were excluded from the analysis of this question because they were considered contradictory and invalid (Table 4).

The concern about the current energy crisis (Ozili and Ozen 2022) is captured by participants' answers. Most of them stated a preference on energy upgrade (n323/601, 53.7%) instead of the anti-seismic reinforcement of their houses (n278/601, 46.3%).

Table 4. University Students' preparedness and protective actions and future intentions.

Did you take any preparedness protective action in your daily life in the last 12 months?		
Answers	**n (total 601)**	**%**
Yes (at least one action)	236	39.3
No	351	58.4
Other (controversial) answers.	14	2.3
If yes:		
What protective actions have you taken in the past year against earthquakes? (Multiple choice question, n236)		
Answers	**n (total 236)**	**%**
Fixing hanging objects	93	39.4
Preparation of an evacuation plan in case of emergency	134	56.8
Anti-seismic reinforcement of my house	32	13.6
Preparation of emergency supplies (e.g. water, flashlights etc)	104	44.1
What did it drive you to take preparedness protective actions? (Multiple choice question, for n236 answers)		
Answers	**n (total 236)**	**%**
Strong earthquake in Greece in the past	108	45.8
Awareness activities in my University	40	16.9
My studies' relevant object	34	14.4
My participation in a volunteer group	14	5.9
Personal psychological factors	134	56.8
Strong earthquake that occurred in another country	81	34.3
Predictions released for upcoming major earthquake	42	17.8
Preparation for another risk	66	28.0

If no:

Participants' justification for not taking preparedness protective actions against earthquakes in the past year (for n351 answers)		
Answers	**n (total 351)**	**%**
I feel safe at my house.	72	20.5
I didn't know what necessary measures to take.	121	34.5
I believe that the authorities will give instructions on necessary protective measures when necessary.	35	10
I do not think that I will experience an earthquake in my area.	57	16.2
I neglected it/ did not think about it.	22	6.3
No answer (Null).	33	9.4
Other answers.	11	2.8

How likely or unlikely do you consider taking protection and preparedness measures in the near future?		
Answers	**n (total 351)**	**%**
Very likely	35	10.0
Likely	146	41.6
Somewhat likely	131	37.3
Very unlikely	28	8.0
Neither likely nor unlikely	11	3.1

If you had to choose between an energy upgrade of your house and an anti-seismic reinforcement (at the same cost), what would you prefer?		
Answers	**n (total 601)**	**%**
House energy upgrade	323	53.7
House anti-seismic reinforcement	278	46.3

1.1

Communication preferences during seismic crisis

Among the objectives of the present work was to explore participants' level of trust towards competent authorities, the scientific community and the media in the case of an earthquake emergency. According to the results, 70.9% (n426) of the university students consider scientists trustworthy for communicating protection information after an earthquake (n426, 70.9%, Table?) followed by the emergency operators (n370, 61.6%, Table 5). Trust in competent authorities and public bodies at central, regional and local level tends to be lower. The results coincide with the results of Ipsos Global Trustworthiness Index 2022 (ISPS 2022) where a relatively high trust has been reported towards the scientific community by more than 18k survey participants from 28 countries all over the world.

Table 5. Participants' answers regarding seismic risk/ crisis information and communication preferences.

Whom do you trust to give you protection guidelines after an emergency? (Multiple choice question)		
Answers	n	%
The Ministry for Climate Crisis and Civil Protection (Central Government)	314	52.2
The Regions of Greece or Municipalities (Regional and Local level)	152	25.3
Scientists	426	70.9
Private Engineers	90	15
Family and friends	35	5.8
The Media and Social Media	49	8.2
Emergency Operators (Police, Fire Service etc)	370	61.6
None of the above	31	5.2
Other answers	7	1.2
How do you choose to obtain information after an earthquake (about the size, epicenter, impact, first assessments, protection measures, instructions, etc. – Multiple choice question)		
Answers	**n**	**%**
TV	239	39.8
Radio	102	17
News Papers	20	3.3
Direct call to competent authority	49	8.2
News websites	407	67.7
Authorities' official webpages and social media	356	59.2
Seismologists' social media	240	39.9
Applications or/and warning messages in cell phones	237	39.4
Family and friends	64	10.6
Other answers	2	0.3
Do you have an application in your smartphone for a real time earthquake alert?		
Answers	**n**	**%**
Yes	65	10.8
No	242	40.3
I did not know that this kind of app exists	293	48.8
Have you recently seen, heard or read any information or campaign about earthquake protection?		
Answers	**n**	**%**
Yes	190	31.6
No	346	57.6
I don't remember	65	10.8

If yes, indicate source/ means (Multiple choice question)		
Answers *(n190, see answers to the previous question)*	**n**	**%**
TV	75	39.5
Social Media	60	31.6
The Internet	101	53.2
Information campaigns from Volunteering Teams	26	13.7
My workplace	23	12.1
The University	71	37.4
A printed material (a campaigns flyer or poster)	41	21.6
A person I know (relative, friend, colleague etc.)	17	8.9
The European Emergency Number	24	12.6
I don't remember	2	1.1
Other answers	2	1.1
No answer	2	1.1

The results indicate that, internet sources (webpages and social media) are the most popular means of receiving and sending information for youngsters. Preference in the traditional sources of information, such as TV, radio or printed newspapers has declined over many years. Indeed, social media isn't just about entertainment. It has been documented that their role in crisis communication and management as an information propagator is essential (Babatunde et al 2022). Media system dependency (MSD) theory states that "in an ambiguous situation, dependency on mass media increases because mass media outlets are likely to contain important and exclusive information that is not available from other sources" (Ball-Rokeach, 1998).

Despite the clear preference for internet and social media sources, only 10.8% (n65/601) of the participants have a real time earthquake alert application in their smartphone. In fact 48.8% (n293/601, Table?) did not know even the existence of such an application. The idea of this kind of application is that when an earthquake is detected, an alert message is sent to all the smartphones within the affected area. Such applications operate in many countries worldwide like USA, Japan and New Zealand (Strauss and Allen 2016, Cremen and Galasso 2020). This practice has been proven extremely useful not only to critical infrastructure operators such as train services (Dallo et al 2022) but also to the public offering a wide range of timely and reliable information (earthquake parameters, tsunami warning and safety tips, available shelters and assistance in the case of disaster) (Fokaefs and Sapountzaki 2021). In Greece, a similar application known as Seismicity-NOA application has been released by the Geodynamic Institute of the National Observatory of Athens in 2021.

Participants were asked what they would like to be informed about, before and in time of an earthquake emergency among a set of predefined options. Their answers are summarized in Figure 5. It was found that more than half of participants are mostly (absolutely) interested in being informed about the proper protective actions in time of earthquake emergency (59.9%, n360/601) as well as the ways to communicate and protect their family and friends (59.6%, n358/601), followed by precautionary measures (47.9%, n288/601).

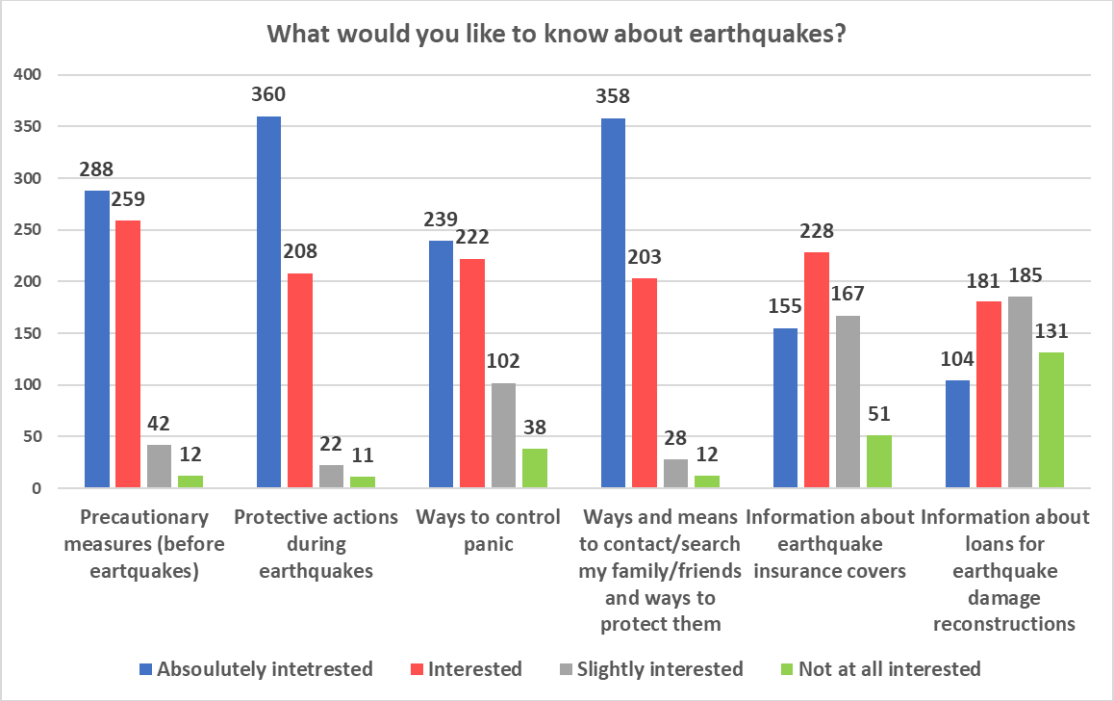


Figure 5. What participants would like to know about earthquakes.

Only a small portion of participants consider earthquake predictions announced on the Internet, Social Media and by the Government as completely trustworthy (Figure 6). However, earthquake predictions are not considered trustful by most participants. In fact, with respect to seismic prediction, the Government is acknowledged a barely trustful source exactly as the Internet, Social Media and TV. Mouth-to-mouth predictions are regarded as rumors (n428, 71.2%, Figure 6).

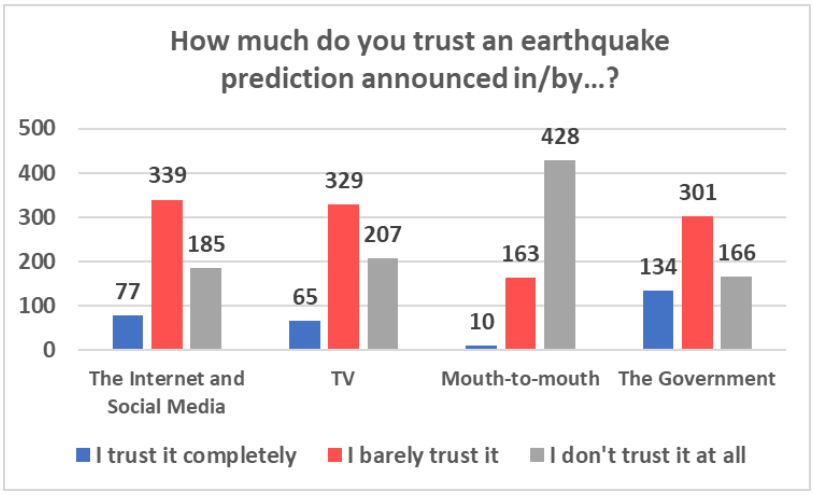


Figure 6. Participants' level of trust regarding earthquake prediction announced by different sources.

5. Discussion and conclusions

With the occasion of recent seismicity in Central Greece, e.g. the 2020-2021 seismic swarm activity in Thiva as well as the one during September 2023 in the Corinth Gulf scientists have pointed out -mainly through the media- the increased likelihood of a strong earthquake to strike Greece in the near future. Thus, questions are raised about the level of preparedness of individuals and organizations.

Focusing on young age population groups, in particular students from the Universities in Greece, the present study provides an overview of risk perception, in terms of knowledge about earthquakes and earthquake preparedness self-protection measures, previous experience and the level of worry on the basis of an online survey results. This research targeted also the protection behaviors and preparedness actions of youngsters, especially the drivers of these actions in connection with the components of seismic risk perception. The present study findings are considered a fundamental input for every earthquake disaster preparedness plan to build an earthquake resilient community.

Participants seem to share high knowledge on preparedness and response actions, but this does not result necessarily into taking preparedness protective actions against earthquakes. More in particular, most of them know exactly what actions to take/avoid in indoor and outdoor spaces in the case of an earthquake event; they even know what actions carry uncertainty, like for instance waiting for the 112 emergency message instructions or staying still in their position until the shaking stops. However, the survey revealed that only a small portion of participants have undertaken preparedness protective actions and these involve basically low cost and easy to adopt measures. Personal psychology factors and previous experience with a strong seismic event are found to be the main drivers of preparedness actions. This calls for an effective communication strategy to encourage university students to develop a culture on disaster preparedness in proportion to the proneness of the country to earthquakes. After all, according to the Social Learning Theory, in the absence of personal experience, other people' s behavior, both preparing for and responding effectively to disasters, may function as a prototype to trigger similar ways of action by those people who lack personal disaster experience. Furthermore, the campaigns for raising awareness on emergency disaster preparedness may include and communicate cases of personal experience with disasters.

The increasing frequency of Climate Change (CC) related hazards and disasters (like forest fires and probably pandemics and health risks) seem to gradually overshadow the concern / worry of youngsters for the rest, including earthquakes. This is a major issue that should be taken into account by future communication strategies for seismic crises and disasters. There are differences between men and women regarding the level of seismic risk perception. It seems that women worry more about seismic risk, but this does not translate necessarily into practical protective actions (compared to the respective initiatives by men). Regarding the demand for seismic information most participants seem to be interested for information that mainly involves the response phase, in particular self-protection actions and ways/means to contact family and friends during earthquakes. This evidences a lack of a seismic disaster prevention culture among the university students, a finding that is further supported by only a small portion of the students reporting anti-seismic reinforcement of their house in the recent past. It is also supported by the low interest of the respondents in earthquake insurance. Lack of a prevention culture is partly justified by the

young age of the survey participants but it reflects also a similar trend in the wider Greek society as reported by other studies. Thereupon, the communication strategy on seismic risk/crisis information should focus by priority on promoting a prevention culture in parallel with the diffusion of knowledge on alternative and complementary preparedness actions that enhances response capacities.

Scientists and emergency managers are among participants' most trusted groups to guide the public in the case of a seismic crisis. This is in accordance with the results of the Ipsos Global Trustworthiness Ranking, 2022, according to which, scientists are the second most trustworthy group of advisors after doctors in 28 countries around the world. It remains to be confirmed whether this preference for scientists is valid for all youngsters and the wider society (not only university students). Should this be the case communication strategies should involve a wide range of scientists and ensure public's access to the best scientific evidence and expertise, taking care not to confuse the public with scientific controversies.

Regarding the best means/channels of communication, the survey reveals participants' significant preference on internet sources for receiving and sending information related to earthquakes and earthquake disasters. After all, communicating risk/crisis information using modern means, like social media is a de facto reality. These means are becoming always more popular for early warnings, emergency public alerts and guidelines. However, there is a necessity for quality and reliability control of the information posted on social media; announcements containing unverified information or fake news may spread fear and panic and cause unnecessary activation of emergency responses like evacuations.

An important number of participants claimed not knowing whether waiting for instructions by the European Emergency Number 112 (via SMS) is an appropriate response. This alert method was set in operation in Greece by the Greek Civil Protection in August 2019, in view of high risk originating from forest fires. It seems that university students would not necessarily opt to wait and consequently follow the instructions given by the European Emergency Number, indicating that while scientists and emergency managers enjoy wide public acceptance, trust to the Governmental authorities issuing instructions is still an open issue.

Moreover it has been obvious by the survey's results that most participants are skeptical to earthquake predictions regardless of the issuing source; it should be noted though that participants who do express trust in these announcements accredit the Government as a credible and reliable source (n134, Figure 6) compared to the Internet, Social Media (n77, Figure 6) and TV (n65, Figure 6). It seems that when Government announcements are based on consultancy from scientific agencies the latter lend credibility and trust to the Governmental authorities. Untrue information (rumors) are rejected by the overwhelming majority of the university students; after all it has been documented that education significantly contributes to combating of rumors (Afassinou 2014; Lai et al., 2020).

University students are highly skilled members of the broader youngsters' community, and they should enjoy a leading role in crisis communication strategies. They should be considered a comparatively reliable "transmitter" of risk/crisis information because of their continuously advancing skills for information seeking, abstract reasoning and anticipation. The current survey documented that (a) they are knowledgeable of the seismic disaster's causal origins and the proper responses during a seismic event in both indoor and outdoor spaces; (b) they can take advantage of the modern and technologically advanced means of communication like the social media, the internet and the mobile phone applications for emergency messages while remaining cautious for

unverified rumors and fake news; (c) they can filter information and separate the scientific from the non-scientific content of it; (d) they can understand uncertainty as a fundamental component of disaster risk. It becomes obvious that further research is needed on how university students could become the principal agents of more intense and reliable seismic information campaigns and hence a key-component of future seismic crisis communication strategies.

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