BMC Public Health

RESEARCH Open Access

The effect of earthquake exposure on PTSD symptoms is mediated by intrusive rumination and moderated by gender: a cross-sectional study on the 2023 Kahramanmaraş earthquake survivors

Şenel ÇITAK[1*] and İbrahim Dadandı[2]

Abstract

Background Evidence suggests that natural disasters, such as earthquakes, can lead to post-traumatic stress disorder (PTSD), with women being particularly vulnerable. However, there is a dearth of knowledge about the underlying mechanisms linking traumatic experiences to PTSD as well as gender differences in the operation of these mechanisms. This study examined the mediating effect of intrusive rumination and the moderating effect of gender on the relationship between earthquake exposure level and PTSD symptoms.

Methods This cross-sectional study was conducted 12 months after the devastating earthquake in Kahramanmaraş, Turkey. The sample included 632 adult survivors of the earthquake, including 374 females (59.2%) and 258 males (40.8%). Participants completed a set of questionnaires assessing their demographic information, level of earthquake exposure, intrusive rumination, and PTSD symptoms. Correlation analysis, mediation analysis, and conditional process analysis were employed to evaluate the research hypotheses.

Results Findings revealed significant associations between the level of earthquake exposure, intrusive rumination and PTSD symptoms. The level of earthquake exposure significantly predicted PTSD symptoms. Moreover, intrusive rumination partially mediated the relationship between earthquake exposure level and PTSD symptoms. Additionally, the mediating effect of intrusive rumination was more pronounced among females than males.

Conclusion This study revealed the significant mediating role of intrusive rumination in the development of post-earthquake PTSD symptoms. By uncovering gender differences in this mechanism, it also emphasized the importance of designing interventions that are sensitive to the varying needs of different demographic groups affected by the disaster in post-disaster mental health interventions.

Keywords Earthquake exposure, Post-traumatic stress disorder, Intrusive rumination, Gender, Kahramanmaraş earthquake

*Correspondence:
Şenel ÇITAK
senelcitak52@gmail.com

[1]Faculty of Education, Department of Educational Sciences, Ordu University, Ordu 52200, Turkey
[2]Faculty of Education, Department of Educational Sciences, Yozgat Bozok University, Yozgat 66900, Turkey

Introduction

Kahramanmaraş, located in southeastern Turkey, was struck by a 7.7 magnitude earthquake at 04:17 on February 6, 2023, followed by another significant tremor measuring 7.6 magnitude approximately nine hours later. These consecutive earthquakes led to great destruction in 11 provinces hosting 14 million people; more than 50,000 lives were lost, and over 107,000 individuals sustained various injuries, including fractures and crush injuries, serious brain and spinal cord trauma and limb loss [1, 2]. Such catastrophic natural disasters also pose a threat to the psychological well-being of affected populations, leading to serious mental health problems including major depressive disorder, anxiety disorders, suicide attempts, panic disorder, substance use disorder, and PTSD [3–5].

PTSD is a mental health condition that may develop following exposure to traumatic events and is characterized by specific symptoms such as re-experiencing the event through flashbacks and nightmares, avoiding reminders, and experiencing negative changes in mood and cognition, and heightened arousal [6, 7]. Compulsive flashes, indicative of PTSD, can be triggered by both internal and external stimuli, leading individuals to feel as though they are traveling back in time and relieving the initial distressing experience [8, 9]. PTSD significantly impairs both psychological and physical health, potentially leading to decreased psychosocial functionality, sleep disorders, increased emotional distress, and other psychological issues [10–12]. It may also adversely affect multiple biological systems, including brain circuits and neurochemistry [13], and increase the risk of cardiovascular disease [14]. This mental condition may also diminish work and social functioning, resulting in a reduced overall quality of life [15, 16]. Research has shown that PTSD is among the most prevalent problems faced by earthquake victims, with prevalence rates ranging from 4.10 to 67.07% [17]. This variability suggests that exposure to an earthquake does not necessarily result in PTSD, and that individuals' responses may significantly vary owing to their psychological and environmental resources.

Understanding the specific factors that link earthquake exposure to PTSD is crucial, because symptoms of PTSD may not manifest immediately after the trauma; rather, they often evolve over time and fluctuate in intensity [18]. While existing literature indicates a positive association between the level of earthquake exposure and PTSD symptoms [19, 20], the underlying psychological mechanisms that facilitate this connection remain largely unexplored. Moreover, although gender differences in PTSD following traumatic experiences are well-documented, the specific reasons for these differences are not yet fully understood [21]. To address these gaps, this study aims to explore the mediating role of intrusive rumination in the relationship between earthquake exposure and PTSD symptoms, based on the cognitive theory of stress and coping [22] and the cognitive model of PTSD [23]. Additionally, drawing from the mediation hypothesis [24], this research investigates whether gender moderates these associations. To the best of our knowledge, no previous studies have simultaneously explored these mechanisms among earthquake survivors. Understanding these dynamics is crucial for developing targeted psychological interventions that address the specific needs of various survivor groups. Therefore, this study may enhance the understanding of factors affecting the trajectory of PTSD after earthquakes, thereby aiding in the development of targeted interventions and enhancing the effectiveness of disaster response and recovery efforts.

Earthquake exposure and PTSD

Carlson and Dalenberg [25] developed a theoretical framework to explain how traumatic events are linked to subsequent psychological responses, arguing that more intense traumatic experiences are likely to result in more severe post-traumatic symptoms due to their increased potential to provoke overwhelming fear and helplessness. In this context, survivors who face multiple adversities during an earthquake, such as being trapped under debris or losing loved ones, may develop more severe PTSD symptoms. This is because they experience prolonged exposure to life-threatening conditions and intense emotions such as fear, terror, and helplessness, which are crucial factors in the development of the disorder. A substantial body of evidence indicates a positive correlation between the degree of earthquake exposure and the development and persistence of PTSD [19, 20, 26]. For example, a study on the Wenchuan earthquake demonstrated that exposure to more traumatic experiences during and after the earthquake increased survivors' perception of risk, resulting in more severe PTSD symptoms [27]. Additionally, research has shown that severe experiences, such as feeling unable to escape from the disaster, experiencing extreme panic or fear and being trapped for a longer time, pose a significant risk for PTSD [17, 28]. In this vein, the current study proposes the following hypothesis.

Hypothesis 1 There is a positive relationship between earthquake exposure level and PTSD symptoms.

The mediating role of intrusive rumination in the relationship between earthquake exposure and PTSD symptoms

Rumination, the cognitive act of repeatedly contemplating an event or information, may manifest in both

functional and dysfunctional forms [29]. Research suggests that earthquake survivors may exhibit two distinct styles of rumination: intrusive and deliberate, each of which influences the course and nature of the psychological impact from the earthquake. Deliberate rumination, characterized by purposeful reflection on the traumatic event, may foster post-traumatic growth. In contrast, intrusive rumination, which refers to a persistent negative focus on trauma-related memories or emotions, may promote the development of PTSD symptoms [30]. Moreover, studies have shown that negative forms of rumination, including intrusive rumination, may serve as mediators between earthquake exposure and PTSD [31, 32], although further research is needed to validate these relationships.

The mediating role of intrusive rumination in the relationship between the level of earthquake exposure and PTSD symptoms can be discussed through the lens of cognitive theories of PTSD and stress. The cognitive theory of stress and coping [22] posits that individuals' appraisal of traumatic experiences plays a significant role in their cognitive coping mechanisms. The direct exposure to trauma or witnessing it firsthand may lead individuals to dwell more on distressing memories and emotions to cope with the event's impact [33]. Although intrusive rumination is a dysfunctional response during the post-traumatic period, it is considered an automatic attempt to understand and focus on the traumatic event [34]. A higher degree of exposure to traumatic experiences may amplify the perception of disaster severity, thereby intensifying the preoccupation with negative ruminative thoughts [27, 35]. Consequently, the multitude of traumatic experiences during and after the earthquake, such as being trapped under rubble, grieving the loss of loved ones, and facing challenges in accessing shelter and food, can significantly increase the tendency for intrusive rumination among survivors [31].

Rumination is widely recognized as a cognitive risk factor for both the onset and persistence of PTSD [36]. The cognitive model of PTSD [23] suggests that maladaptive processing of traumatic memories through intrusive rumination plays a crucial role in maintaining the disorder. Essentially, individuals may use repetitive thinking as a coping mechanism to alleviate the sense of threat created by the traumatic event, yet this approach often paradoxically intensifies the problem [37]. Specifically, while individuals engage in rumination to avoid intrusive memories related to trauma [38], the negative emotions arising during rumination can in turn trigger further intrusive memories [34]. This cycle may reinforce problematic appraisals of the trauma and lead to cues that evoke distressing memories, thus contributing to the persistence of PTSD [23]. Numerous studies have demonstrated that intrusive rumination plays a crucial role in the development of PTSD following both human-made and natural traumas, including earthquakes [36, 39, 40]. A longitudinal study showed that intrusive rumination after an earthquake significantly predicted subsequent rumination tendencies and severity of PTSD [30]. Therefore, intrusive rumination, particularly when focused on danger signs and the impact of trauma, may sustain threat perceptions and thereby mediate the relationship between earthquake exposure and PTSD symptoms.

Hypothesis 2 Intrusive rumination mediates the relationship between earthquake exposure level and PTSD symptoms.

The moderating role of gender in the relationships between earthquake exposure, intrusive rumination, and PTSD symptoms

Gender difference in PTSD is a well-documented phenomenon consistently demonstrated by empirical evidence in the relevant literature, yet its underlying etiology remains incompletely understood [24]. The existing literature indicates that women are two to three times more likely to develop the disorder than men [41], despite reporting fewer traumatic events [42]. A systematic review of long-term follow-up studies on PTSD symptoms following natural disasters demonstrated that gender, along with other factors such as disaster experience, significantly influences PTSD symptomatology [43]. Researchers also reported higher incidence rates and more severe symptoms of PTSD in women compared to men following natural disasters [19, 44]. Peritraumatic stress reactions significantly impact the development of PTSD. Research indicates that women experience more intense immediate reactions to traumatic events, including increased levels of initial traumatic stress, greater peritraumatic dissociation, and an increased perception of life threat [45]. Consequently, due to their more intense acute psychological responses, women may have heightened vulnerability to PTSD following an earthquake.

The mediation hypothesis [24] suggests that certain risk factors, such as depression, anxiety sensitivity, peritraumatic fear, and dissociation, are more severe among women, which may explain gender variations in PTSD. In this context, research indicates that there are gender differences in the pattern of rumination, with women reported to engage in higher levels of negative repetitive thoughts compared to men [46]. Consequently, women may be more susceptible to ruminating on negative emotions triggered by earthquakes, such as fear, guilt, helplessness, and grief. Moreover, women may be more likely to engage in an intrusive ruminative pattern concerning their symptoms when the initial symptoms of the disorder begin [47]. When this cognitive processing style,

Table 1 Demographic characteristics of the sample

Variable	Level	*n*	%
Gender	Female	374	59,2
	Male	258	40,8
Education level	Primary	26	4,1
	Secondary	90	14,2
	High School	278	44
	Undergraduate/Graduate	238	37,7
Marital status	Married	295	46,7
	Single	337	53,3
Household income	Under 500USD	174	27,5
	501–750 USD	183	29
	751–1000 USD	120	19
	1001–1250 USD	106	16,8
	1251 USD and above	49	7,8
Receiving psychological help	Yes	97	15,3
	No	535	84,7

marked by rumination, combines with more intense initial reactions to trauma, it may result in more severe PTSD symptoms following an earthquake.

Hypothesis 3 Gender moderates the relationships between earthquake exposure, intrusive rumination and PTSD symptoms.

Methods

Participants and procedure

This study was conducted between January and February 2024, one year after the Kahramanmaraş earthquake. In research, it is often challenging (sometimes even impossible) to establish random sampling where every potential subject has an equal chance of participating. In such circumstances, convenience sampling is a suitable method [48]. Due to the extraordinary circumstances and the considerable number of individuals impacted by the earthquake, data for this study were collected via face-to-face and online surveys using a convenience sampling technique. Specifically, face-to-face data were obtained from 278 participants who migrated from the earthquake area and university students from the affected regions who were studying at universities affiliated with the researchers. Additionally, an online survey link was shared across various social media platforms, resulting in 384 online responses. After data cleaning, from 662 questionnaires, 16 were excluded due to incomplete or inconsistent answers, and 14 were identified as outliers, leaving 632 valid responses for analysis.

Inclusion criteria were (a) volunteering, (b) being aged 18 years or older, and (c) presence in one of the cities affected by the earthquake at the time of the earthquake. After potential participants were briefed on the objectives of the study, they provided written or online consent. Moreover, all participants were assured of the anonymity of their responses and the confidentiality of the data. This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the ethics committee of the first researcher's university.

The final sample consisted of 632 adults (F = 374, 59.2%; M = 258, 40.8%). Table 1 displays the demographic information regarding the participants. The mean age for the entire sample was 29.47 (SD = 10.04, min.–max. = 18–63) years. The mean age was 28.66 (SD = 9.04, min.–max. = 18–57) years for female participants, while it was 30.64 (SD = 11.22, min.–max. = 18–63) years for males. Additionally, 337 participants (53.3%) were single, and 295 (46.7%) were married.

Variables

Earthquake exposure

Drawing from previous studies [19, 20, 27, 28], a binary questionnaire (yes = 1; no = 0) was developed to assess the severity of earthquake exposure. This survey included 12 items assessing the adverse effects of the earthquake and its impact on survivors' daily lives (Table 2). Individual

Table 2 Frequency of adverse experiences related to earthquake

Items	*N* (Yes)	%
Did you lose a family member or a close relative?	110	17.4%
Were you trapped under debris?	28	4.4%
Were you injured?	68	10.8%
Was a family member or a close relative trapped under debris?	151	23.9%
Was a family member or a close relative injured?	199	31.5%
Did you feel that your life or the lives of your loved ones were at risk during the earthquake?	582	92.1%
Did you witness dead bodies or body parts during the rescue and cleanup operations?	193	30.5%
Did you witness the death or serious injury of others?	313	49.5%
Did you need food and/or aid following the earthquake?	400	63.3%
Did you experience challenges in finding shelter after the earthquake?	412	65.2%
Was your home destroyed or significantly damaged?	209	33.1%
Apart from the damage to your home, did you suffer significant financial losses (e.g., destruction of your workplace, loss of usable household items)?	250	39.6%

item scores from participants' responses were summed to create a composite score, which ranged from 0 to 12, representing the level of earthquake exposure. Higher scores indicated greater exposure to earthquake-related traumatic experiences.

Post traumatic stress disorder

PTSD symptoms were assessed using The National Stressful Events Survey for PTSD Short Scale (NSESSS-PTSD) [49]. This scale comprises 9 items that assess the dimensions of post-traumatic stress disorder in line with DSM-5 criteria. Participants rate each item on a five-point Likert-type scale that ranges from 0 ('not at all') to 4 ('all the time'). Total scores range from 0 to 36, with higher scores indicating more severe PTSD symptoms. The Turkish version of the PTSD-Short Scale has been found to be a valid and reliable ($\alpha=0.87$) measure for assessing PTSD symptoms within the Turkish population [50]. Cronbach's alpha was found to be 0.88 in the present study.

Intrusive rumination

Intrusive rumination was measured using the 10-item Intrusive Rumination subscale of the Event Related Rumination Inventory [29]. Items are rated on a four-point Likert scale ranging from 0 ("Never") to 3 ("Very often"). Consequently, the total scores can range from 0 to 30, with higher scores indicating a greater tendency for intrusive rumination. Adaptation studies have demonstrated that the Turkish version of the scale exhibits robust psychometric properties. It was reported that the Intrusive Rumination subscale accounted for 46% of the total variance, and its Cronbach's alpha coefficient was 0.94 [51]. In the present study, Cronbach's alpha was determined as 0.95.

Data analysis

The dataset was initially examined for incorrect entries, missing data, and outliers. A total of 16 entries, found to be invalid due to incomplete or inconsistent answers, and 14 outliers, identified using Mahalanobis distance, were removed from the dataset. Missing data analysis revealed a rate below 5% with a random distribution ($\chi^2=366.80$, df=390, $p>.05$). Therefore, missing data were imputed using the series mean method. Afterwards, normal distribution and multicollinearity were examined. Skewness and kurtosis values were found between −1.5 and +1.5, indicating a normal distribution [52]. Variance Inflation Factor (VIF) values were below 10 and Tolerance values were above 0.10 (ranging from 0.91 to 0.98), indicating the absence of multicollinearity [53].

Prior to the main analyses, the data were summarized using descriptive statistics. Pearson correlation coefficients were utilized to assess the associations among the study variables, and independent sample t-test was conducted to explore gender differences. A moderator analysis was conducted using Haye's PROCESS macro (Model 4) to investigate the mediating role of intrusive rumination in the relationship between the degree of earthquake exposure and PTSD symptoms. The moderating effect of gender on these relationships was investigated through Conditional Process Analysis (PROCESS macro, Model 8) [54]. The significance of the indirect effects was evaluated using the bootstrapping method with 5000 resamples and 95% confidence intervals. Effects were considered statistically significant if their confidence intervals did not include zero [55]. All data were analyzed using the SPSS 26.0 statistical software package.

Results

Frequency of adverse experiences related to earthquake

Table 2 presents the negative experiences of survivors during and after the earthquake, based on the results of the earthquake exposure survey. The majority of the sample, 92.1%, reported feeling that their lives or the lives of their relatives were in danger during the earthquake. Participants also noted a range of significant traumatic effects: 17.4% lost a family member or relative, 4.4% were trapped under debris, 10.8% were injured. In addition, 23.9% had a family member or relative trapped under rubble, and 31.5% reported having an injured family member or relative.

Concerning post-earthquake experiences, nearly half of the sample, 49.5%, reported witnessing the death or serious injury of others, while 30.5% reported seeing corpses and/or body parts during rescue and debris removal operations. Additionally, 33.1% indicated that their homes were either destroyed or severely damaged, 65.2% stated facing difficulty in finding shelter after the earthquake, 63.3% expressed a need for food and/or assistance, and 39.6% declared experiencing major financial losses beyond the damage to their homes.

Testing for common method bias

A Harman's single-factor test, encompassing all scale items, was conducted to control for the possibility of common method bias. Principal component analysis revealed 10 factors with eigenvalues>1. The first factor accounted for 25.46% of the total variance, which was below the recommended threshold of 40% [56]. In this regard, common method bias did not pose a serious problem in the current study.

Descriptive statistics and correlation analysis

Table 3 presents the means, standard deviations, skewness, and kurtosis values for each variable, along with Pearson correlations and gender differences among study variables. As expected, correlation analysis showed that

Table 3 Descriptive statistics, Pearson correlations and gender differences

	Mean	SD	Skewness	Kurtosis	EE	IR	PTSD	Gender Differences
EE	4.61	2.79	0.35	−0.66	1			-
IR	20.93	8.03	−0.72	−0.25	0.36***	1		F > M***
PTSD	22.65	7.98	−0.49	−0.31	0.34***	0.54***	1	F > M***

*** $p<.001$; EE: Earthquake exposure; IR: Intrusive rumination

Table 4 Resutls of mediation analysis

Criterion	Predictors	R^2	F	*B*	SE	%95 CI		t
						LL	UL	
PTSD	Constant	0.12	85.56	18.10	0.58	16.97	19.24	31.33***
	EE			0.98	0.11	0.78	1.19	9.19***
IR	Constant	0.13	97.84	16.07	0.57	14.94	17.20	27.98***
	EE			1.05	0.11	0.84	1.26	9.89***
PTSD	Constant	0.32	146.50	10.41	0.76	8.92	11.91	13.67***
	EE			0.48	0.10	0.28	0.68	4.74***
	IR			0.47	0.04	0.41	0.55	13.56***

*** $p<.001$

the degree of exposure to earthquake-related traumatic experiences was positively and significantly correlated with both event-related intrusive rumination ($r=.36$, $p<.001$, 95% CI [0.30, 0.43]) and PTSD symptoms ($r=.34$, $p<.001$, 95% CI [0.27, 0.41]). Additionally, there was a positive relationship between intrusive rumination and PTSD symptoms ($r=.54$, $p<.001$, 95% CI [0.45, 0.62]). Regarding gender differences, the results of independent t-test revealed that females reported higher levels of intrusive rumination and more severe PTSD symptoms compared to males ($t(630)_{IR} = 4{,}27$, $p<.001$, 95% CI [1.47, 3.99]; $t(630)_{PTSD} = 4{,}30$, $p<.001$, 95% CI [1.49, 4.01]).

Mediation analysis

As shown in Table 4, earthquake exposure significantly and positively predicted both PTSD symptoms and intrusive rumination ($B=0.98$, $p<.001$, 95% CI [0.78, 1.19] and $B=1.05$, $p<.001$, 95% CI= [0.84, 1.26], respectively). When intrusive rumination was incorporated as a mediator in the model, the path coefficient from earthquake exposure to PTSD symptoms slightly decreased, yet remained significant ($B=0.48$, $p<.001$, 95% CI [0.28, 0.68]). In addition, intrusive rumination positively and significantly predicted PTSD symptoms ($B=0.47$, $p<.001$, 95% CI [0.41, 0.55]). Furthermore, the bootstrapping analysis demonstrated that the indirect effect of earthquake exposure on PTSD symptoms through intrusive rumination was statistically significant (indirect effect=0.50, bootSE=0.07, 95% CI [0.37, 0.65]), accounting for 50.05% of the total effect. These results indicate a partial mediating role of intrusive rumination in the relationship between earthquake exposure and PTSD symptoms.

Moderated mediation analysis

The moderating role of gender in the relationship between earthquake exposure, intrusive rumination, and PTSD symptoms was analyzed through the PROCESS macro (model 8). All continuous variables were mean-centered prior to analysis to minimize multicollinearity. The interaction effect of earthquake exposure and gender did not significantly predict PTSD symptoms. However, a significant moderation effect was observed for intrusive rumination ($B=-0.59$, SE=0.21, 95% CI [-1.01, −0.17]). As shown in Table 5; Fig. 1, the direct effect of earthquake exposure on intrusive rumination was stronger for females than for males ($B_{Female}= 1.28$, SE=0.14, 95% CI [1.02, 1.55]; $B_{Male}= 0.69$, SE=0.16, 95% CI [0.38, 1.01]). Moreover, bootstrapping results indicated a significant moderated mediation effect (index of moderated mediation=−0.27, BootSE=0.09, 95% CI [-0.47, −0.09]). Specifically, the indirect effect of earthquake exposure on PTSD symptoms, mediated by intrusive rumination, was higher in females than in males ($B_{Female}= 0.59$, BootSE=0.08, 95%CI [0.44, 0.76]; $B_{Male}= 0.32$, SE=0.09, 95% CI [0.16, 0.50]). The moderated mediation model is visualized in Fig. 2.

Discussion

Empirical evidence suggests a significant relationship between earthquake exposure and the development of PTSD symptoms. However, there is a dearth of research on the psychological mechanisms driving this relation, particularly concerning the emergence of gender-specific differences. To the best of our knowledge, this study is the first to explore the combined effects of intrusive rumination and gender on the relationship between the degree of exposure to adverse earthquake-related experiences and

Table 5 Results of moderated mediation analysis

Predictors	On IR				On PTSD			
	B	SE	95% CI		B	SE	95% CI	
			LL	UL			LL	UL
IR	-	-	-	-	0.46***	0.04	0.38	0.53
EE	1.87***	0.32	1.25	2.50	0.84**	0.29	0.27	1.42
Gender	-2.48***	0.59	-3.65	-1.32	-1.36*	0.54	-2.43	−0.30
EE x Gender	−0.59**	0.21	-1.01	−0.17	−0.24	0.19	−0.62	0.13
Conditional effects of EE on IR at values of the moderator								
Female	1.28	0.14	1.02	1.55				
Male	0.69	0.16	0.38	1.01				
Conditional indirect effects of EE on PTSD at values of the moderator								
Female	0.59	0.08	0.44	0.76				
Male	0.32	0.09	0.16	0.50				

*** $p<.001$; ** $p<.01$; * $p<.05$; Gender (1 = Female, 2 = Male)

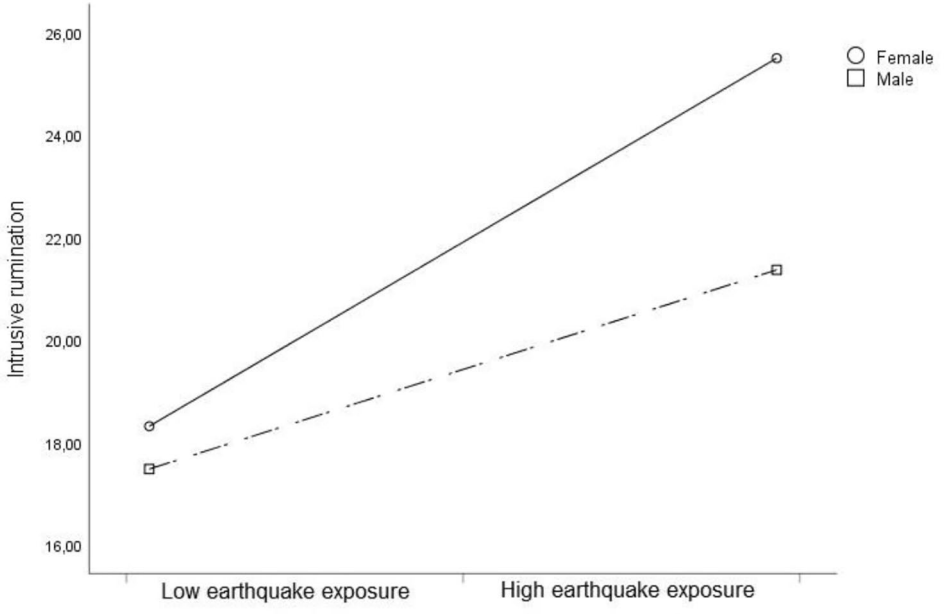

Fig. 1 Gender moderates the relationship between earthquake exposure and intrusive rumination

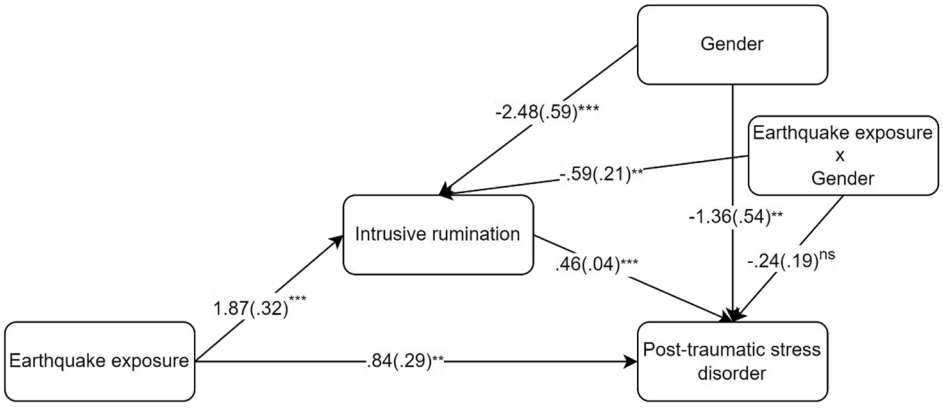

Fig. 2 Moderated mediation model

PTSD symptoms among survivors. The findings revealed a significant relationship between the level of exposure to the adverse effects of the earthquake and PTSD symptoms. The mediation analysis indicated that intrusive rumination partially mediated the relationship between traumatic experiences and PTSD symptoms. Moreover, the moderated mediation analysis demonstrated that this mediation effect was stronger in females compared to males. These results not only extend the existing literature on the subject, but also provide valuable insights for the development of targeted interventions aimed at addressing PTSD among earthquake survivors.

The findings demonstrated that survivors exposed to more traumatic experiences during the earthquake and its aftermath were more likely to develop PTSD, indicating a dose-response effect. Previous studies have shown that negative events such as being trapped under rubble, losing loved ones, house damage, and witnessing physical injury or death pose a serious risk for the development of PTSD following an earthquake [17, 57–59]. One possible explanation is that multiple traumatic experiences are likely to increase the severity and persistence of PTSD [60]. Experiencing a severe earthquake typically leads to intense fear, perceived threat, and feelings of helplessness among survivors, which can result in the onset of PTSD symptoms. Additional adverse experiences may further worsen outcomes by increasing the cumulative traumatic burden on survivors. For instance, being trapped under debris or witnessing the demise of loved ones can exacerbate the severity of PTSD symptoms due to heightened feelings of fear and helplessness they induce. Traumatic events are encoded within interconnected neural networks that can be activated by environmental and internal cues, leading to flashbacks characteristic of PTSD [61]. Stimuli with perceptual similarities to the original trauma cues can reactivate traumatic memories by triggering flashbacks [62]. Thus, sustained exposure to trauma-related stimuli, such as encountering demolished buildings or body parts during debris removal efforts over months, can perpetuate PTSD symptoms by perpetually reviving undesired memories.

The current study further revealed that the degree of earthquake exposure also indirectly influenced the severity of PTSD symptoms through intrusive rumination. In other words, a higher prevalence of adverse experiences during and after the earthquake may increase the tendency toward intrusive rumination, which in turn can lead to more severe PTSD symptoms. This finding is congruent with the disaster psychology literature, suggesting that intrusive rumination serves as a pivotal mediating mechanism in the relationship between degree of disaster exposure and PTSD [35, 39]. Additionally, it represents the first empirical evidence of such a mediating effect between earthquake experiences and PTSD.

The first axis of the mediation mechanism indicates that survivors exposed to more traumatic experiences related to the earthquake were more prone to engaging in intrusive ruminative thoughts about the event. This finding can be explained in line with the cognitive theory of stress and coping [22], which posits that individuals may give maladaptive reactions when they perceive an inability to cope with the stress load. In other words, the intense feelings of fear and helplessness, along with exposure to additional adversities (e.g., being trapped under rubble or losing loved ones) may increase the traumatic stress burden on survivors. This increased traumatic load may also intensify the inclination toward repetitive thinking about events [63], as rumination may attenuate the severity of such emotional memories [64], despite worsening long-term outcomes. The perception that the earthquake was a major traumatic experience and significantly affected one's life may foster the development of intrusive rumination [32]. Survivors may engage more in intrusive rumination to cope with challenges such as finding safe shelter or mourning the death of a loved one. Moreover, this repetitive thought pattern that develops after the earthquake may become chronic over time and continue to negatively influence individuals as a persistent cognitive strategy [30].

Consistent with previous studies [30, 31, 65], the second axis of the current study's mediating mechanism underscores the contribution of intrusive rumination to the development of PTSD following the earthquake. This finding also aligns with the broader literature in trauma and natural disaster psychology [35, 36], which suggests intrusive rumination as a transdiagnostic process that influences the development of post-traumatic PTSD. Sleep disturbances, hyperarousal, startle, emotional strain, focusing on negative thoughts and nightmares after traumatic experiences such as earthquakes may be signs of PTSD [66, 67]. These markers also reflect the nature of ruminative thoughts [29, 36]; hence intrusive rumination may exacerbate PTSD symptoms by increasing emotional responses to trauma reminders [68]. Intrusive rumination not only extends exposure to distressing thoughts and memories related to the trauma, but also it can hinder the natural healing process by reinforcing negative beliefs and emotions related to the traumatic event [23]. Moreover, it may contribute to the prolongation and persistence of PTSD symptoms by impairing survivors' capacity to cognitive and emotional processing of traumatic events [69]. Therefore, intrusive rumination following an earthquake may not only facilitate the development of PTSD but also exacerbate its symptoms by perpetuating negative cognitive patterns and emotional responses, thereby significantly increasing the psychological impact of earthquake exposure.

The findings demonstrated that females were more prone to both intrusive rumination and the development of PTSD following an earthquake compared to males, which is consistent with existing literature identifying the female gender as a risk factor for rumination [46] and PTSD [21]. Since women encounter chronic tensions and acute traumas more frequently than men, they may develop low mastery expectations and a belief that emotions are less controllable [70]. They may also more inclined towards emotion-focused, defensive and palliative coping mechanisms [41], which may contribute to intrusive rumination. Studies have suggested that the gender difference in PTSD may be related to biological factors including hormonal, genetic and epigenetic factors [71]. In this regard, some authors have argued that biological factors, such as women's greater sensitivity to stress hormones and threats, may play a role in the observed gender disparity in PTSD symptoms following an earthquake [17]. However, the results of the current study showed that the direct effect of earthquake-related traumatic experiences on PTSD did not differ across genders. Instead, the observed difference derived from the mediating effect of intrusive rumination between earthquake experiences and PTSD, which was stronger among women compared to men. This suggests that more severe PTSD symptoms among women may be linked to a predisposition to risk factors such as intrusive rumination rather than a direct impact of the event, supporting the mediation hypothesis [24]. Likewise, Response Styles Theory [72] claims that gender differences in depression may be attributable to women's tendency to ruminate in response to a negative mood. This mechanism, which is maladaptive in the context of depressive symptoms, may similarly contribute to the development of PTSD [36]. When combined with the intense negative emotions and other challenges resulting from the earthquake, such a predisposition may increase women's risk of developing PTSD after the earthquake. Moreover, as early symptoms of the disorder manifest, women may experience increased intrusive rumination, especially regarding their symptoms, which may further exacerbate symptom severity, as proposed by response styles theory.

It is important to note that other possible explanations could account for the relationships observed in this study. For instance, the literature indicates that several pre- and post-earthquake factors, such as a prior history of violent trauma, low social support, income reduction, unemployment, and displacement after the earthquake, can significantly contribute to the development of PTSD following an earthquake [73–76]. Therefore, these earthquake-related factors might also explain the relationship between earthquake exposure and PTSD, as well as the gender differences in this relationship. For example, women might be more vulnerable to the adverse effects of these factors due to existing socio-economic disparities and differences in social support systems. Consequently, the gender differences in PTSD observed in this study may also be associated with these additional stressors rather than with earthquake exposure alone.

Limitations, implications and future directions

When interpreting the findings, it is essential to consider the limitations of the present study, like all scientific endeavors. First, the sample included individuals from the general population, which may not reflect possible differences in certain groups such as children, adolescents, or the elderly. Future research may investigate whether the relationships identified in the current study persist across these different demographic groups. Second, the data were obtained from a nonclinical sample, which constraints the generalizability of the findings to clinical populations. Third, the cross-sectional design of the study does not allow for definitive causal relationships between variables. Additionally, the correlational findings allow for the possibility of reverse causal associations between variables. For example, it is possible that higher levels of PTSD might lead to increased rumination rather than rumination leading to higher PTSD. Longitudinal studies may offer a deeper understanding of the direction of relationships among traumatic experiences, intrusive rumination, and PTSD symptoms. Fourth, this study focused on the mediating role of intrusive rumination and the moderating role of gender in the relationship between earthquake exposure and PTSD symptoms. Several other factors related to earthquakes, such as unemployment, displacement, and low social support, might also contribute to this relationship. Future research may incorporate these potential variables to provide a more comprehensive understanding of the mechanisms underlying PTSD development. Fifth, the use of self-report scales for data collection may introduce potential sources of error, such as social desirability bias. Additionally, the use of mixed methods for data collection, involving both online and face-to-face surveys, may introduce some variability due to potential differences in how respondents interact with these different formats. Future studies may employ diverse assessment methods, such as clinical interviews, alongside a mixed-methods approach that includes both qualitative and quantitative data collection techniques, to validate self-reported data and reduce potential biases. Lastly, PTSD symptoms were assessed merely through responses to the scale, which hinders distinguishing between PTSD due to earthquake experiences or other traumatic events. Further studies may adopt a more comprehensive approach, specifically to distinguish between earthquake-induced PTSD symptoms and those resulting from other traumatic experiences.

Despite its limitations, this study holds significant implications for both theoretical understanding and practical application. Theoretically, it provides empirical evidence within the earthquake context for the mediating effect of intrusive rumination on the development of post-traumatic PTSD symptoms, thus enriching the development of cognitive theories [23] that emphasize the role of cognitive processes in the etiology of PTSD. Besides, the study suggests that the relationship between intrusive rumination, traumatic experience, and PTSD symptoms is stronger among females. This finding may contribute to the understanding of gender differences in the development of PTSD by providing empirical support for the mediation hypothesis [24]. Furthermore, it encourages further research to examine gender differences in the mediating effect of other possible vulnerability factors such as social support [77], resilience [78] and depression [79]. In the context of psychosocial support and mental health improvement during natural disasters, this study provides notable findings for individuals affected by an earthquake disaster. The results highlight the need to develop intervention strategies that prioritize high-risk groups, such as those whose homes were severely damaged, injured, trapped under rubble, or those who lost their loved ones. Additionally, this study demonstrates the significance of psychological interventions aiming at reducing intrusive rumination as a key target factor. Such interventions may support the recovery process by facilitating survivors' transition away from the adverse impacts of the disaster. The findings reveal that vulnerability factors such as intrusive rumination pose a greater risk for developing PTSD, particularly among women. This underscores the need to consider the gender factor more carefully in post-traumatic interventions and emphasizes the importance of devising tailored intervention protocols in clinical practice that account for gender differences and the special needs of women.

Conclusion

In conclusion, this study reveals that intrusive rumination may be a significant mediating mechanism linking the traumatic experience caused by a natural disaster and subsequent PTSD symptoms. It also enriches the existing literature by revealing gender differences in this mechanism and emphasizes the necessity of gender-specific evaluations in post-traumatic interventions. The results highlight the significance of interventions that take into account the different needs of various groups affected by such events in providing more effective mental health support.

Acknowledgements
Thank you to all participants for your research contributions.

Author contributions
ŞÇ and İD conceptualized and designed the study. ŞÇ obtained ethical approval and collected the data. İD conducted data analyses, methodology, and validation. ŞÇ and İD wrote and edited the draft. ŞÇ and İD conducted the research. ŞÇ reviewed the manuscript. All authors read and approved the final manuscript.

Funding
This research received no external funding.

Data availability
The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was conducted in line with the principles of the Declaration of Helsinki and approved by the ethics committee of Ordu University. (Decision dated 28.12.03.2023 and numbered 2023/164). All participants provided a written/online consent form indicating their willingness to take part in the study.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Thanks
Thank you to all participants for your research contributions.

Received: 26 April 2024 / Accepted: 8 August 2024
Published online: 23 August 2024

References

1. Kılınçarslan A, Caparlar CÖ, Çakırca M, Sipahioğlu FÖ, Atar F, Ölmez S, Yılmaz N, Karaşahin M, Özkan D. Anesthetic approach to trauma patients in the city hospital after the 2023 Maraş earthquake. Turkish J Trauma Emerg Surg. 2024;30(3):167–73. https://doi.org/10.14744/tjtes.2024.92346.
2. Şenol AF. Kahramanmaraş depremleri (6 Şubat 2023) donrası Hatay ilindeki yapıların hasar durumlarının değerlendirilmesi. In: International Conference on Engineering, Natural and Social Sciences, 2023; (Vol. 1) pp.75–80.
3. Gerstner RM, Lara-Lara F, Vasconez E, Viscor G, Jarrin JD, Ortiz-Prado E. Earthquake-related stressors associated with suicidality, depression, anxiety and post-traumatic stress in adolescents from Muisne after the earthquake 2016 in Ecuador. BMC Psychiatry. 2020;20(1):1–9. https://doi.org/10.1186/s12888-020-02759-x.
4. Goldmann E, Galea S. Mental health consequences of disasters. Annu Rev Public Health. 2014;35:169–83. https://doi.org/10.1146/annurev-publhealth-032013-182435.
5. Saeed SA, Gargano SP. Natural disasters and mental health. Int Rev Psychiatry. 2022;34(1):16–25. https://doi.org/10.1080/09540261.2022.2037524.
6. American Psychiatric Association (APA) In: DSM-5-TR online assessment measures. 2013. https://www.psychiatry.org/psychiatrists/practice/dsm/educational-resources/assessment-measures#section_9 Accessed 15 Mar. 2024.
7. Wang M, Liu J, Sun Q, Zhu W. Mechanisms of the formation and involuntary repetition of trauma-related flashback: a review of major theories of PTSD. Int J Mental Health Promotion. 2019;21(3):81–97. https://doi.org/10.32604/IJMHP.2019.011010.
8. Birrer E, Michael T, Munsch S. Intrusive images in PTSD and in traumatised and non-traumatised depressed patients: a cross-sectional clinical study. Behav Res Ther. 2007;45(9):2053–65. https://doi.org/10.1016/j.brat.2007.03.005.
9. Brewin CR. Episodic memory, perceptual memory, and their interaction: foundations for a theory of posttraumatic stress disorder. Psychol Bull. 2014;140(1):69–97. https://doi.org/10.1037/a0033722.

10. Kratovic L, Smith LJ, Vujanovic AA. PTSD symptoms, suicidal ideation, and suicide risk in university students: the role of distress tolerance. J Aggress Maltreatment Trauma. 2021;30(1):82–100.
11. Lu MY, Ahorsu DK, Kukreti S, Strong C, Lin YH, Kuo YJ, et al. The prevalence of post-traumatic stress disorder symptoms, sleep problems, and psychological distress among COVID-19 frontline healthcare workers in Taiwan. Front Psychiatry. 2021;12:705657. https://doi.org/10.3389/fpsyt.2021.705657.
12. Shea MT, Vujanovic AA, Mansfield AK, Sevin E, Liu F. Posttraumatic stress disorder symptoms and functional impairment among OEF and OIF National Guard and Reserve veterans. J Trauma Stress: Official Publication Int Soc Trauma Stress Stud. 2010;23(1):100–7. https://doi.org/10.1002/jts.20497.
13. Pitman RK, Rasmusson AM, Koenen KC, Shin LM, Orr SP, Gilbertson MW, et al. Biological studies of post-traumatic stress disorder. Nat Reviews Neuroscience. 2012;13(11):769–87. https://doi.org/10.1038/nrn3339.
14. O'Donnell CJ, Longacre LS, Cohen BE, Fayad ZA, Gillespie CF, Liberzon I, Et. Posttraumatic stress disorder and cardiovascular disease: state of the science, knowledge gaps, and research opportunities. JAMA Cardiol. 2021;6(10):1207–16. https://doi.org/10.1001/jamacardio.2021.2530.
15. Ozdemir O, Boysan M, Ozdemir PG, Yilmaz E. Relationships between posttraumatic stress disorder (PTSD), dissociation, quality of life, hopelessness, and suicidal ideation among earthquake survivors. Psychiatry Res. 2015;228(3):598–605. https://doi.org/10.1016/j.psychres.2015.05.045.
16. Vogt D, Smith BN, Fox AB, Amoroso T, Taverna E, Schnurr PP. Soc Psychiatry Psychiatr Epidemiol. 2017;52:341–52. https://doi.org/10.1007/s00127-016-1321-5. Consequences of PTSD for the work and family quality of life of female and male US Afghanistan and Iraq War veterans.
17. Tang B, Deng Q, Glik D, Dong J, Zhang L. A meta-analysis of risk factors for post-traumatic stress disorder (PTSD) in adults and children after earthquakes. Int J Environ Res Public Health. 2017;14(12):1537. https://doi.org/10.3390/ijerph14121537.
18. Shalev A, Liberzon I, Marmar C. Post-traumatic stress disorder. N Engl J Med. 2017;376(25):2459–69. https://doi.org/10.1056/NEJMra1612499.
19. Jin Y, Xu J, Liu H, Liu D. Posttraumatic stress disorder and posttraumatic growth among adult survivors of Wenchuan earthquake after 1 year: prevalence and correlates. Arch Psychiatr Nurs. 2014;28(1):67–73. https://doi.org/10.1016/j.apnu.2013.10.010.
20. Wang S, Shi X, Chen X, Zhu Y, Chen H, Fan F. Earthquake exposure and PTSD symptoms among disaster-exposed adolescents: a moderated mediation model of sleep problems and resilience. Front Psychiatry. 2021;12:577328. https://doi.org/10.3389/fpsyt.2021.577328.
21. Olff M, Langeland W, Draijer N, Gersons BP. Gender differences in posttraumatic stress disorder. Psychol Bull. 2007;133(2):183–204. https://doi.org/10.1037/0033-2909.133.2.183.
22. Lazarus RS, Folkman S. Stress, appraisal, and coping. New York; 1984.
23. Ehlers A, Clark DM. A cognitive model of posttraumatic stress disorder. Behav Res Ther. 2000;38(4):319–45. https://doi.org/10.1016/S0005-7967(99)00123-0.
24. Christiansen DM, Elklit A. Sex differences in PTSD. In: Lazinica A, Ovuga E, editors. Posttraumatic stress disorder in a global context. Rijeka, Croatia: InTech–Open Access Book; 2012. pp. 113–42.
25. Carlson EB, Dalenberg CJ, Trauma. Violence Abuse. 2000;1(1):4–28. https://doi.org/10.1177/1524838000001001.
26. Li Y, Lv Q, Li B, Lou D, Sun X, Xu J. The role of trauma experiences, personality traits, and genotype in maintaining posttraumatic stress disorder symptoms among child survivors of the Wenchuan earthquake. BMC Psychiatry. 2020;439(2020):1–11. https://doi.org/10.1186/s12888-020-02844-1.
27. Xu J, Dai J, Rao R, Xie H. The association between exposure and psychological health in earthquake survivors from the Longmen Shan Fault area: the mediating effect of risk perception. BMC Public Health. 2016;16:1–14. https://doi.org/10.1186/s12889-016-2999-8.
28. Chen X, Xu J, Li B, Li N, Guo W, Ran MS. The role of personality and subjective exposure experiences in posttraumatic stress disorder and depression symptoms among children following Wenchuan earthquake. Sci Rep. 2017;7(1):17223. https://doi.org/10.1038/s41598-017-17440-9.
29. Cann A, Calhoun LG, Tedeschi RG, Triplett KN, Vishnevsky T, Lindstrom CM, Anxiety. Stress Coping. 2011;24(2):137–56. https://doi.org/10.1080/10615806.2010.529901.
30. Zhou X, Wu X. The relationship between rumination, posttraumatic stress disorder, and posttraumatic growth among Chinese adolescents after earthquake: a longitudinal study. J Affect Disord. 2016;193:242–8. https://doi.org/10.1016/j.jad.2015.12.076.
31. García FE, Cova F, Rincón P, Vázquez C. Trauma or growth after a natural disaster? The mediating role of rumination processes. Eur J Psychotraumatology. 2015;6(1):26557. https://doi.org/10.3402/ejpt.v6.26557.
32. Leal-Soto F, Carmona-Halty M, Ferrer-Urbina R. Rumination in posttraumatic stress and growth after a natural disaster: a model from northern Chile 2014 earthquakes. Eur J Psychotraumatology. 2016;7(1):31638. https://doi.org/10.3402/ejpt.v7.31638.
33. Wozniak JD, Caudle HE, Harding K, Vieselmeyer J, Mezulis AH. The effect of trauma proximity and ruminative response styles on posttraumatic stress and posttraumatic growth following a university shooting. Psychol Trauma: Theory Res Pract Policy. 2020;12(3):227. https://doi.org/10.1037/tra0000505.
34. Halligan MT, Clark SL, Ehlers DM. Rumination in posttraumatic stress disorder. Depress Anxiety. 2007;24(5):307–17. https://doi.org/10.1002/da.20228.
35. Quan L, Zhen R, Yao B, Zhou X, Yu D. The role of perceived severity of disaster, rumination, and trait resilience in the relationship between rainstorm-related experiences and PTSD amongst Chinese adolescents following rainstorm disasters. Arch Psychiatr Nurs. 2017;31(5):507–15. https://doi.org/10.1016/j.apnu.2017.06.003.
36. Moulds ML, Bisby MA, Wild J, Bryant RA. Rumination in posttraumatic stress disorder: a systematic review. Clin Psychol Rev. 2020;82:101910. https://doi.org/10.1016/j.cpr.2020.101910.
37. Elwood LS, Hahn KS, Olatunji BO, Williams NL. Cognitive vulnerabilities to the development of PTSD: a review of four vulnerabilities and the proposal of an integrative vulnerability model. Clin Psychol Rev. 2009;29:87–100. https://doi.org/10.1016/j.cpr.2008.10.002.
38. Ehlers A, Steil R. Maintenance of intrusive memories in posttraumatic stress disorder: a cognitive approach. Behav Cogn Psychother. 1995;23:217–49. https://doi.org/10.1017/S135246580001585X.
39. Zhen R, Quan L, Yao B, Zhou X. Understanding the relationship between rainstorm-related experiences and PTSD among Chinese adolescents after rainstorm disaster: the roles of rumination and social support. Front Psychol. 2016;7:1407. https://doi.org/10.3389/fpsyg.2016.01407.
40. Zhou X, Wu X, Fu F, An Y. Core belief challenge and rumination as predictors of PTSD and PTG among adolescent survivors of the Wenchuan earthquake. Psychol Trauma: Theory Res Pract Policy. 2015;7(4):391–7. https://doi.org/10.1037/tra0000031.
41. Olff M. Sex and gender differences in post-traumatic stress disorder: an update. Eur J Psychotraumatology. 2017;8(sup4):1351204. https://doi.org/10.1080/20008198.2017.1351204.
42. Tolin DF, Foa EB. Sex differences in trauma and posttraumatic stress disorder: a quantitative review of 25 years of research. Psychol Bull. 2008;132(6):959–92. https://doi.org/10.1037/0033-2909.132.6.9592008.
43. Terasaka A, Tachibana Y, Okuyama M, Igarashi T. Post-traumatic stress disorder in children following natural disasters: a systematic review of the long-term follow-up studies. Int J Child Youth Family Stud. 2015;6(1):111–33. https://doi.org/10.18357/ijcyfs.61201513481.
44. Steinglass P, Gerrity E. Natural disasters and post-traumatic stress disorder short-term versus long-term recovery in two disaster-affected communities 1. J Appl Soc Psychol. 1990;20(21):1746–65. https://doi.org/10.1111/j.1559-1816.1990.tb01509.x.
45. Irish LA, Fischer B, Fallon W, Spoonster E, Sledjeski EM, Delahanty DL. Gender differences in PTSD symptoms: an exploration of peritraumatic mechanisms. J Anxiety Disord. 2011;25(2):209–16. https://doi.org/10.1016/j.janxdis.2010.09.004.
46. Johnson DP, Whisman MA. Gender differences in rumination: a meta-analysis. Personality İndividual Differences. 2013;55(4):367–74. https://doi.org/10.1016/j.paid.2013.03.019.
47. Nolen-Hoeksema S. Responses to depression and their effects on the duration of depressive episodes. J Abnorm Psychol. 1991;100(4):569–82. https://doi.org/10.1037/0021-843X.100.4.569.
48. Fraenkel JR, Wallen NE, Hyun HH. How to design and evaluate research in education. 8th ed. McGraw-Hill; 2012.
49. LeBeau R, Mischel E, Resnick H, Kilpatrick D, Friedman M, Craske M. Dimensional assessment of posttraumatic stress disorder in DSM-5. Psychiatry Res. 2014;218(1–2):143–7. https://doi.org/10.1016/j.psychres.2014.03.032.
50. Evren C, Dalbudak E, Aydemir O, Koroglu E, Evren B, Ozen S, Coskun KS. Psychometric properties of the Turkish PTSD-Short scale in a sample of undergraduate students. Bull Clin Psychopharmacol. 2016;26(3):294–302. https://doi.org/10.5455/bcp.20151205113132.
51. Haselden M. Üniversite öğrencilerinde travma sonrası büyümeyi yordayan çeşitli değişkenlerin Türk ve Amerikan kültürlerinde incelenmesi: Bir model önerisi (Publication No. 365042);[Doctoral dissertation, Hacettepe University]:

YÖK National Thesis Center. 2014. https://tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp Accessed 05 Oct. 2023.
52. Tabachnick BG, Fidell LS. Using multvariate statistics (5th Edition). Newyork:Allyn & Bacon;2007.
53. Kline RB. Principles and practice of structural equation modeling. 3rd ed. London: The Guilford Press; 2011.
54. Hayes AF, Rockwood NJ. Conditional process analysis: concepts, computation, and advances in the modeling of the contingencies of mechanisms. Am Behav Sci. 2020;64(1):19–54. https://doi.org/10.1177/0002764219859633.
55. Hayes AF. Beyond Baron and Kenny: statistical mediation analysis in the new millennium. Communication Monogr. 2009;76(4):408–20. https://doi.org/10.1080/03637750903310360.
56. Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J Appl Psychol. 2003;88(5):879–903. https://doi.org/10.1037/0021-9010.88.5.879.
57. Dai W, Chen L, Lai Z, Li Y, Wang J, Liu A. The incidence of post-traumatic stress disorder among survivors after earthquakes: a systematic review and meta-analysis. BMC Psychiatry. 2016;16(188):1–11. https://doi.org/10.1186/s12888-016-0891-9.
58. Fong KN, Law YM, Luo L, Zhao ZE, Chen H, Ganesan B, et al. Post-traumatic stress disorder (PTSD) after an earthquake experience: a cross-sectional survey of Wenchuan earthquake victims with physical disabilities 10 years later. Int J Disaster Risk Reduct. 2022;80103225:1–12. https://doi.org/10.1016/j.ijdrr.2022.103225.
59. Lai TJ, Chang CM, Connor KM, Lee LC, Davidson JR. Full and partial PTSD among earthquake survivors in rural Taiwan. J Psychiatr Res. 2004;38(3):313–22. https://doi.org/10.1016/j.jpsychires.2003.08.005.
60. Kube T, Elssner AC, Herzog P. The relationship between multiple traumatic events and the severity of posttraumatic stress disorder symptoms–evidence for a cognitive link. Eur J Psychotraumatology. 2023;14(1):2165025. https://doi.org/10.1080/20008066.2023.2165025.
61. Iffland B, Neuner F. Trauma and memory. Stress: concepts, cognition, emotion, and behavior. London: Academic; 2016. pp. 161–7.
62. Ehlers A, Hackmann A, Michael T. Intrusive re-experiencing in post-traumatic stress disorder: Phenomenology, theory, and therapy. Memory. 2004;12(4):403–15. https://doi.org/10.1080/09658210444000025.
63. Im S, Follette VM. Rumination and mindfulness related to multiple types of trauma exposure. Translational Issues Psychol Sci. 2016;2(4):395–407. https://doi.org/10.1037/tps0000090.
64. Teasdale JD. Emotional processing, three modes of mind and the prevention of relapse in depression. Behav Res Ther. 1999;37(1):53–77. https://doi.org/10.1016/s0005-7967(99)00050-9.
65. Wu X, Zhou X, Wu Y, An Y. The role of rumination in posttraumatic stress disorder and posttraumatic growth among adolescents after the Wenchuan earthquake. Front Psychol. 2015;6:148041. https://doi.org/10.3389/fpsyg.2015.01335.
66. Doran JM, O'Shea M, Harpaz-Rotem I. In their own words: veteran experiences with evidence-based treatments for PTSD in the Veterans Health Administration. Psychiatr Q. 2021;92:961–920. https://doi.org/10.1007/s11126-020-09861-z.
67. Ehlers A, Hackmann A, Steil R, Clohessy S, Wenninger K, Winter H. The nature of intrusive memories after trauma: the warning signal hypothesis. Behav Res Ther. 2002;40(9):995–1002. https://doi.org/10.1016/S0005-7967(01)00077-8.
68. Wisco BE, Vrshek-Schallhorn S, May CL, Campbell AA, Nomamiukor FO, Pugach CP. Effects of trauma-focused rumination among trauma-exposed individuals with and without posttraumatic stress disorder: an experiment. J Trauma Stress. 2023;36(2):285–98. https://doi.org/10.1002/jts.22905.
69. Buchholz KR, Bruce SE, Koucky EM, Artime TM, Wojtalik JA, Brown WJ, Sheline YI. Neural correlates of trait rumination during an emotion interference task in women with PTSD. J Trauma Stress. 2016;29(4):317–24. https://doi.org/10.1002/jts.22112.
70. Nolen-Hoeksema S, Jackson B. Mediators of the gender difference in rumination. Psychol Women Q. 2001;25(1):37–47. https://doi.org/10.1111/1471-6402.00005.
71. Christiansen DM, Berke ET. Gender-and sex-based contributors to sex differences in PTSD. Curr Psychiatry Rep. 2020;22(19):1–9. https://doi.org/10.1007/s11920-020-1140-y.
72. Nolen-Hoeksema S. Sex differences in unipolar depression: evidence and theory. Psychol Bull. 1987;101(2):259282. https://doi.org/10.1037/0033-2909.101.2.259.
73. Ali M, Farooq N, Bhatti MA, Kuroiwa C. Assessment of prevalence and determinants of posttraumatic stress disorder in survivors of earthquake in Pakistan using Davidson Trauma Scale. J Affect Disord. 2012;136(3):238–43. https://doi.org/10.1016/j.jad.2011.12.023.
74. Cerdá M, Paczkowski M, Galea S, Nemethy K, Péan C. Desvarieux M. psychopathology in the aftermath of the h aiti earthquake: a population-based study of posttraumatic stress disorder and major depression. Depress Anxiety. 2013;30(5):413–24.
75. Cheng Y, Wang F, Wen J, Shi Y. Risk factors of post-traumatic stress disorder (PTSD) after Wenchuan earthquake: a case control study. 2014;9(5): e96644. https://doi.org/10.1371/journal.pone.0096644
76. Salcioglu E, Basoglu M, Livanou M. Psychosocial determinants of relocation in survivors of the 1999 earthquake in Turkey. The Journal of Nervous and Mental Disease, 2008;196(1), 55–61. https://doi.org/101097/NMD.0b013e31815fa52e.
77. Yazawa A, Aida J, Kondo K, Kawachi I. Gender differences in risk of posttraumatic stress symptoms after disaster among older people: Differential exposure or differential vulnerability? J Affect Disord. 2022;297:447–54. https://doi.org/10.1016/j.jad.2021.10.094.
78. Kim SY, Kim SI, Lim WJ. Association between change in sleep duration and posttraumatic stress symptoms in natural disaster victims: the mediating role of resilience. Sleep Med. 2021;82:110–6. https://doi.org/10.1016/j.sleep.2021.03.042.
79. Wang Y, Xu J, Lu Y. Associations among trauma exposure, post-traumatic stress disorder, and depression symptoms in adolescent survivors of the 2013 Lushan earthquake. J Affect Disord. 2020;264:407–13. https://doi.org/10.1016/j.jad.2019.11.067.

Publisher's Note