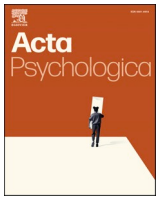
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Investigation of the factors affecting post-traumatic stress disorder in survivors of the 2023 Kahramanmaraş earthquakes

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ABSTRACT

Background: This study investigates the factors influencing post-traumatic stress disorder in the youth population seven months after the February 6, 2023, Kahramanmaraş earthquakes, which caused massive destruction in Türkiye and resulted in the loss of over 55,000 lives.
Objective: The effects of gender, damage levels of buildings, financial resources, participation in search and rescue operations, peritraumatic distress, perceived social support, and resilience are investigated for their impacts on post-traumatic stress disorder. The goal is to examine how these factors influence post-traumatic stress disorder not only on average but also across different levels of its distribution.
Method: A face-to-face survey was conducted between September and October 2023 with a randomly selected sample of 160 voluntary university students aged 18 and above who had directly experienced the earthquakes in the affected zone. The study employs quantile regression alongside classical regression and conventional statistical methods to examine the effects of various factors on post-traumatic stress disorder.
Results: The prevalence rates of PTSD are 65.6 % and 35 % based on the PTSD Checklist for DSM-5 (PCL-5), using cut-off scores of 33 and 47, respectively. Classical regression results indicate that female gender ($\beta = 7.98$, $p < 0.001$), moderate or higher building damage ($\beta = 5.6$, $p < 0.05$), moderate ($\beta = -6.3$, $p < 0.001$) and high ($\beta = -7.69$, $p < 0.01$) financial resources, peritraumatic distress ($\beta = 0.6$, $p < 0.001$), perceived social support ($\beta = -0.12$, $p < 0.05$), and resilience ($\beta = -0.66$, $p < 0.001$) have impacts on average PTSD scores. Quantile regression results reveal that all factors are effective at various quantiles of post-traumatic stress disorder. For instance, while minor damage ($\beta = 5.06$, $p < 0.05$) is found to be significant at the 10th percentile, participation in search and rescue operations ($\beta = 8.12$, $p < 0.01$) is significant at the 80th percentile.
Conclusions: The effects of gender, building damage levels, financial resources, peritraumatic distress, perceived social support, and resilience remain consistent, showing no substantial variation across the quantiles of post-traumatic stress disorder. However, in the upper tail of the PTSD distribution, participation in search and rescue operations emerges as a risk factor, exacerbating its severity.

1. Introduction

On February 6, 2023, there were two major earthquakes down in the south of Türkiye, happening very close to each other. First, at 4:17 AM, there was an earthquake with a magnitude of ML = 7.5 (Mw = 7.6) centered in Kahramanmaraş. About 9 h later, there was another earthquake, with a magnitude of ML = 7.4 (Mw = 7.7), about 100 km further south, centered in Gaziantep. Approximately >14 million individuals have personally experienced the earthquakes. These earthquakes, referred to as the Kahramanmaraş Earthquakes in the literature, shook up 11 cities in Türkiye, and >55,000 people lost their lives (Alpay & Aydın, 2024).

Earthquakes are one of the leading natural disasters that catch people at their most vulnerable moments with their devastating effects in a

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short time. Earthquakes with high damage affect all individuals living in that geography. Such disasters not only cause physical harm but can also have serious effects on emotional and psychological health. Tragic events such as building collapses, losses, injuries, and homelessness during earthquakes can create a deep sense of helplessness in individuals. The struggle to survive and people's efforts to rebuild their daily lives can cause the trauma experienced in this process to leave deep scars. These traumas can create permanent psychological effects in people. Numerous scientific studies have demonstrated that individuals who survive disasters may develop post-traumatic stress disorder (PTSD), which is the most common psychological trauma after an earthquake (Alipour & Ahmadi, 2020; Kerkez & Şanli, 2024). In the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), PTSD is described as a mental health problem that can develop following direct exposure to a traumatic event, witnessing such an event, or through repeated indirect contact with its details. It is characterized by a group of symptoms assessed into four clusters: (a) re-experiencing (e.g., recurrent memories, flashbacks, nightmares), (b) avoidance (e.g., efforts to avoid trauma-related thoughts or external reminders), (c) negative alterations in cognition and mood (e.g., distorted blame of self or others, persistent negative emotional states), and (d) hyperarousal (e.g., hypervigilance, exaggerated startle response) (Weathers et al., 2013). Studies on earthquake-induced PTSD mainly focus on socioeconomic, demographic, earthquake-related, and psychological factors. The factors such as gender, age, education level, social and economic conditions play a significant role in the manifestation and outcomes of PTSD among earthquake survivors. The studies demonstrate that females and the individuals with young and old ages are more vulnerable to developing PTSD following earthquakes (Carmassi & Dell'Osso, 2016; Nobakht et al., 2019; Wu et al., 2014; Zheng et al., 2012).

Key earthquake-related predictors of PTSD include distance from the earthquake centre, loss of life, being trapped under debris, injury, level of damage, property loss, and participation in search and rescue operations. Among these, the extent of building damage has been shown to significantly influence the development and severity of PTSD in affected individuals. Tang et al. (2017) indicate that the level of building damage serves as a constant reminder of the traumatic earthquake experience and continually reactivates PTSD symptoms in survivors. Moreover, studies have found a correlation between the severity of building damage and the prevalence of PTSD among earthquake survivors (Imani et al., 2022; Soqia et al., 2024). Participating in rescue work leads to greater exposure to the devastating effects of earthquakes. Previous studies indicate that participating in search and rescue operations is associated with more severe PTSD symptoms, parallel to studies conducted with rescue workers (Huang et al., 2013; Köse, 2023).

Among the psychological effects, peritraumatic distress is defined as the emotional and physiological distress that individuals undergo during and immediately following a traumatic incident. It has been recognized as a significant predictor of PTSD among individuals exposed to traumatic events such as earthquakes (Alpay & Aydın, 2024; Bunnell et al., 2018; Cénat & Derivois, 2014; Moss et al., 2017; Nishi et al., 2012). The Peritraumatic distress inventory (PDI) is a valuable instrument for assessing peritraumatic distress, offering insights into the immediate reactions of individuals to trauma (Thomas et al., 2012). Studies have shown that higher levels of PDI predict the onset and chronicity of PTSD symptoms (Hiar et al., 2016; Yoon et al., 2021). Additionally, PDI has been linked to the trajectory of PTSD symptoms over time, highlighting its role as an early risk factor for the development of PTSD (Boisclair Demarble et al., 2020).

As a psychological factor, resilience plays a crucial role in the context of PTSD among earthquake survivors. Defined as the ability to positively adapt to adversity, resilience has been identified as a significant protective factor against the development and persistence of PTSD symptoms following traumatic events. Kukihara et al. (2014) and Wu et al. (2015) emphasize the buffering effect of resilience on PTSD among earthquake survivors. Resilience has been found to mitigate the relation between exposure to trauma and mental health outcomes, with higher levels of resilience associated with lower levels of PTSD (Bibi et al., 2018; Civan Kahve et al., 2021; Jia et al., 2015; Lekka et al., 2022; Xia et al., 2014).

Along with aforementioned factors, perceived social support is also a critical factor in the context of PTSD among earthquake survivors. Numerous studies consistently demonstrate that higher levels of perceived social support are associated with lower levels of PTSD symptoms in individuals who have experienced earthquakes (Cénat & Derivois, 2014; Wang et al., 2009; Zhang et al., 2021). Support from friends, family, and communities has been linked to better psychological adjustment, coping mechanisms, and overall well-being following traumatic events.

Numerous studies in the literature have assessed the PTSD levels among individuals exposed to Kahramanmaraş Earthquakes. Bilge et al. (2024) and Alpay and Aydın (2024) studied on adult individuals experiencing the earthquake to identify the factors influencing PTSD. Furthermore, Uyar et al. (2023) and Satilmis et al. (2024) investigated the factors impacting the PTSD levels of healthcare workers in the earthquake-affected region. These studies mainly focus on the presence or absence of the effects on PTSD. However, the effects of factors can change or some interactions between factors can appear according to PTSD severity. The aim of present study is novel to address this gap in literature by investigating the changes of the effects over PTSD. Unlike many existing studies, this study adopts an integrative approach to examine PTSD levels in young people affected by Kahramanmaraş earthquakes, using both quantile regression and traditional linear regression methods to explore the impact of various factors. We define protective factors as being male, non-participation in search and rescue operations, non-damaged building, possessing sufficient financial resources, low peritraumatic distress, perceived social support, and resilience. We also determine risk factors as being female, participation in search and rescue operations, damaged building, lacking financial resources, high peritraumatic distress, low perceived social support, and low resilience. In this regard, research hypotheses have directions and they are summarized as follows:

H1. Protective factors have decreasing effects on PTSD.

H2. Risk factors have increasing effects on PTSD.

2. Methods

2.1. Participants and procedure

This study constitutes the first phase of a two-stage research project conducted at Yildiz Technical University, a public university located in Istanbul. The project employed different questionnaire forms and distinct samples across its phases. In this initial phase, a cross-sectional face-to-face survey was conducted between 12 September 2023 and 11 October 2023 to collect data from university students. The inclusion criteria required participants to be university students aged 18 years or older, to have directly experienced the 2023 Kahramanmaraş earthquakes, and to voluntarily consent to participate in the study. The exclusion criteria were not having directly experienced the earthquakes and not volunteering to participate. To recruit eligible participants, a random sample of university students whose registered residence addresses were located within the 11 provinces affected by the earthquakes was identified and contacted by phone. During the phone call, participants were informed about the purpose of the study and were invited to attend the face-to-face survey. It was emphasized that participation was voluntary, that confidentiality would be strictly maintained, that participants could withdraw from the study at any time without consequence, and that the collected data would be used solely for scientific purposes. The final sample consisted of students who attended the face-to-face sessions among those who had been scheduled. The ethics

committee approved this procedure (Date: May 3, 2023, Reference number: 20230502119).

2.2. Measures

2.2.1. Post-traumatic stress disorder

PTSD Checklist for DSM-5 (PCL-5) extended from previous PTSD Checklist (PCL) (Weathers et al., 2013) (Turkish Version: Boysan et al. (2017)). It consists of 20 items scored on a 5-point likert scale (0 = "Not at all" to 4 = "Extremely"). The total PTSD score is between 0 and 80 and higher scores indicate higher psychological disorder. It consists of four sub-clusters. These are the re-experiencing with items from 1 to 5 (B criteria), avoidance with items from 6 to 7 (C criteria), negative alterations with items 8 from 14 (D criteria), and hyper-arousal with items from 15 to 20 (E criteria). The overall scale has an internal consistency 0.94 for Turkish version of PTSD.

2.2.2. Peritraumatic Distress Inventory

Peritraumatic Distress Inventory was proposed as a measure of PTSD criterion A2 (Brunet et al., 2001) (Turkish Version: Ermağan Çağlar et al. (2022)). It consists of 13 items and is scored on a 5-point Likert scale (0 = "Not at all true" to 4 = "Extremely true"). The total PDI score ranges 0 and 52, and a higher PDI score is indicative of higher distressing feelings experienced during or shortly after a traumatic event. It consists of two sub-dimensions. These are negative emotions (items 1, 2, 3, 5, 6, 8, and 10) and perceived life threat and bodily arousal (items 4, 7, 9, 11, 12, and 13). The internal consistency is 0.88 for Turkish version of PDI.

2.2.3. Psychological resilience

The Brief Resilience Scale reduced from previous Resilience Scale (Smith et al., 2008) and proposed by Smith et al. (2010) (Turkish Version: Doğan (2015)). It consists of 6 items and is scored on a 5-point scale (from 1 = "Strongly disagree" to 5 = "Strongly agree"). In The Brief Resilience Scale, some items are reversed. These items are 2, 4, and 6. The total score of the scale ranges between 6 and 30. The higher total score indicates the higher psychological resilience. The internal consistency is 0.88 for Turkish version of The Brief Resilience.

2.2.4. The Multidimensional Scale of Perceived Social Support

The Multidimensional Scale of Perceived Social Support (MDPSS) was proposed by Zimet et al. (1988) (Turkish Version: Eker et al. (2001)). It consists of 12 items and is scored on a 6-point Likert scale (from 0 = "Strongly disagree" to 7 = "Strongly agree"). It consists of three sub-dimensions. These are family supports (items 3, 4, 8, and 11), friends supports (items 6, 7, 9, and 12) and significant other's supports (items 1, 2, 5, and 10). Total score of the scale ranges 0 and 84, and higher scores from the scale mean more social support is perceived. Cronbach alpha coefficients for Turkish version of the MDPSS scale are high with the values of 0.86, 0.91, 0.83, and 0.89 for psychiatry patients, surgery patients, normal community, and overall sample, respectively.

Reliability analyses of the scales were conducted on the sample. Cronbach alpha coefficients of the PTSD, PDI, MDPSS, and Resilience scales were obtained as 0.921, 0.829, 0.912, and 0.870, respectively, providing fairly high internal consistency of the scales (Taber, 2018) with the values within the acceptable range suggested over 0.70 (Nunnally & Bernstein, 1994). There was no item in the scales which increases reliability when it is removed from the corresponding scale. Total scores of the scale items were used in further analysis by the virtue of satisfactory composite reliability.

2.3. Statistical analysis

The youth population in the earthquake-affected 11 regions is N = 2,336,230 according to address based population registration system (TURKSTAT, 2023). The sample size required to represent this youth population was determined to be 96 using the formula $n = \left(Nz^2p(1-p)\right)/\left(Nd^2 + z^2p(1-p)\right)$ with the values $p = 0.5$ of PTSD prevalence, $d = 0.10$ of sensitivity, and $z = 1.96$ of 95 % confidence level. The significance level of $\alpha = 0.05$ was considered in hypothesis tests.

The data were analyzed by means of SAS/STAT 9.4 software (SAS Institute Inc., 2023) for descriptive statistics and correlations. Pearson correlation coefficients were calculated to assess the linear associations among PTSD, PDI, MDPSS, and resilience. Kolmogorov–Smirnov tests were conducted as a preliminary step to verify the normality assumptions for these variables. To control for the potential confounding effects of the factors of gender, damage level, financial resources, and participation in search and rescue operations, partial correlation analyses were subsequently conducted. These analyses allowed for the assessment of the unique associations among the primary psychological variables while statistically adjusting for the influence of the aforementioned factors.

Independent samples *t*-tests (for gender and search and rescue participation), and ANOVA (Analysis of Variance) tests with post-hoc comparisons (for damage level and financial resources) were used to compare average PTSD scores across groups.

Both classical and quantile regression analyses were applied to examine the effects of gender, financial resources, building damage level, participation in search and rescue operations, PDI, MDPSS, and resilience on PTSD. In these models, gender and participation in search and rescue participation were treated as dichotomous variables (reference: male and non-participant, respectively). Damage was categorized into three levels: moderate or higher, minor, and non-damage (reference category) indicating the damage status of the building where the earthquakes were experienced. Similarly, financial resources variable was classified into three levels: high, moderate, and low (reference category), expressing the financial resources of the participants. PDI, MDPSS, and resilience were included as quantitative predictors, as they represent the total scores of the respective scales.

Classical regression models describe the average response focusing on the conditional mean given the values of the predictor variables (Leiva et al., 2020). Quantile regression, proposed by Koenker and Bassett (1978), models the conditional quantiles of the response variable by extending median regression to ordinary quantiles using the regression context. There are several advantages of using quantile regression in this study. First, unlike logistic regression, quantile regression does not require a predefined threshold, as logistic regression results are sensitive to cut-off values. Second, quantile regression allows for the examination of how the effects of predictors vary across the entire conditional distribution of PTSD, not just at the mean, as in multiple linear regression. This is particularly useful when some predictors or their interactions are not significant at the mean but may exert meaningful effects at the lower or upper tails of the distribution (e.g., at very low or high levels of PTSD). Additionally, compared to classical regression, quantile regression is more flexible and robust to non-normality, heteroscedasticity, and the presence of outliers.

Classical linear regression model based on the ordinary least squares (OLS) was fitted by using the lm function of R 4.1.3 software (R Core Team, 2021). Classical linear regression model assumptions were checked for the validity of the inferences. The normality assumption of the error terms was checked using the Kolmogorov-Smirnov test. Regression diagnostics for multicollinearity, heteroscedasticity, and outliers were conducted using the car (Fox & Weisberg, 2019), skedastic (Farrar and University of the Western Cape, 2024), and olsrr (Hebbali, 2020) packages of R 4.1.3 software (R Core Team, 2021), respectively.

Since we have categorical predictors with unequal cardinalities, adjusted generalized variance inflation factor (GVIF) values proposed by Fox and Monette (1992) were investigated to determine if the multicollinearity problem was present for each predictor. In order to check the homogeneity assumption of error variances for the classical linear

regression model, Breusch and Pagan (1979) score test statistics were computed from the regression of standardized squared residuals on the fitted values of PTSD.

The potential outliers for which their externally and internally studentized residuals slightly exceed 2 were detected from residual analysis. In order to make valid inferences in the presence of potential outliers, robust regressions were fitted using the iteratively reweighted least squares (IRLS) estimation method based on M-estimation with Huber and bisquare weighting. Robust regressions based on IRLS were fitted by the rlm function of MASS package (Venables & Ripley, 2002) in R Studio (Posit team, 2023).

Quantile regression models were fitted to the data using the simplex algorithm. Quantile regression coefficients are defined as τ regression quantiles for any quantile $\tau \in (0, 1)$. Confidence intervals (CIs) for the regression quantiles were constructed based on the sparsity method. Quantile process plots were used to visualize how regression quantiles evolve across different τ quantiles of the PTSD distribution. Optimal number of regression quantiles for the predictors was determined by grid search on $\tau \in (0, 1)$. Quantile regression estimates and plots were provided by using the quantreg procedure in SAS/STAT 9.4 software (SAS Institute Inc., 2023).

3. Results

3.1. Outcomes of data collection

A random sample of 370 university students was called to participate in the survey. Of these, 31 (8.4 %) reported that they had not directly experienced the earthquake and were therefore excluded. Eighty-four students (22.7 %) declined to participate, and 75 (20.3 %) could not be reached. Of the remaining 180 students, the final study sample consisted of 160 individuals who voluntarily completed the survey. The demographic, socioeconomic, and earthquake-related characteristics of the respondents are presented in Table 1.

The mean age of the participants is 21.23 years, with a standard deviation of 2.05. Table 1 shows that 65 % of participants are male. The majority of the sample is aged between 20 and 24 (78.8 %), is single (91.9 %), is composed of undergraduate students (97.5 %), experienced the earthquakes in urban areas (90.6 %) of the 9 different provinces of the earthquake region, and lived in the earthquake zone (93.1 %) after the earthquakes. 49.4 % of the participants describe their financial situation as moderate in terms of having enough money to meet their needs. There are 3 (1.9 %) respondents who stayed under the rubble. There are 8 (5.0 %) participants who had a family member trapped under rubble. 24.4 % of the participants state that the buildings in which they were exposed to the earthquakes are not damaged while 42.5 %, 9.4 %, 18.1 %, and 5.6 % of them specify the damage levels as minor, moderate, heavy, and destruction, respectively. 33.8 % of the participants state that they participated in the search and rescue operations after the earthquakes.

The prevalence of PTSD in the sample is 65.6 % according to the PTSD Checklist for DSM-5 (PCL-5) score greater than or equal to 33, which is a cut-off between 31 and 33 indicating probable PTSD proposed by the National Center for PTSD (Weathers et al., 2013). Furthermore, the prevalence rates are 35 % and 33.8 % with respect to the thresholds of 47 and 48 which are the suggested cut-off scores based on the study conducted for the assessment of psychometric properties of Turkish version of the PCL-5 (Boysan et al., 2017) for PTSD diagnosis in clinical use and community samples, respectively.

To ensure comparability for further analysis, some categories of the characteristics presented in Table 1 were combined. Financial resource levels were classified into three groups: low, by merging "not at all" and "a little"; moderate, represented by "moderately"; and high, by combining "mostly" and "completely." Accordingly, 31 (19.4 %), 79 (49.4 %), and 50 (31.3 %) of the participants were categorized as having low, moderate, and high financial resources, respectively. Similarly, the three damage levels—moderate, heavy, and destruction—were combined into a single category labeled "moderate or higher", which included 53 (33.1 %) participants.

Table 1
Characteristics of the respondents in the sample (n = 160).

Characteristic	Label	n	%
Gender	Male	104	65.0
	Female	56	35.0
Age	18–19	25	15.6
	20–24	126	78.8
	25–28	9	5.6
Marital status	Single	147	91.9
	Flirt/fiancé/ married	13	8.1
Academic program	Undergraduate	156	97.5
	Graduate	4	2.5
Financial resources	Not at all	6	3.8
	A little	25	15.6
	Moderately	79	49.4
	Mostly	37	23.1
	Completely	13	8.1
Province where the earthquakes were experienced	Adana	40	25.0
	Adıyaman	7	4.4
	Diyarbakır	8	5.0
	Gaziantep	11	6.9
	Hatay	52	32.5
	Kahramanmaraş	16	10.0
	Malatya	15	9.4
	Osmaniye	6	3.8
	Şanlıurfa	5	3.1
Division of province where the earthquakes were experienced	Urban	145	90.6
	Rural	15	9.4
Living in the earthquake zone after the earthquakes	Yes	149	93.1
	No	11	6.9
Trapped under rubble	Yes	3	1.9
	No	157	98.1
Any family member trapped under rubble	Yes	8	5.0
	No	152	95.0
Damage level of building where the earthquakes were experienced	Non-damage	39	24.4
	Minor	68	42.5
	Moderate	15	9.4
	Heavy	29	18.1
	Destruction	9	5.6
Participation in search and rescue operations	Non-participation	106	66.3
	Participation	54	33.8
PTSD prevalence (threshold value of 33)	Non-PTSD	55	34.4
	PTSD	105	65.6
PTSD prevalence (threshold value of 47)	Non-PTSD	104	65.0
	PTSD	56	35.0
PTSD prevalence (threshold value of 48)	Non-PTSD	106	66.3
	PTSD	54	33.8
Total		160	100

3.2. Descriptives, correlations and group comparisons

Descriptive statistics and correlations are presented in Table 2. As the normality of PTSD ($D = 0.064$, $p > 0.05$), PDI ($D = 0.067$, $p > 0.05$), MDPSS ($D = 0.069$, $p > 0.05$), and resilience ($D = 0.056$, $p > 0.05$) were not rejected, Pearson correlation coefficients were used to examine the associations among PTSD, PDI, MDPSS, and resilience. The upper diagonal elements of Table 2 show conventional Pearson correlations, while the lower diagonal elements present the partial correlations controlling for gender, damage, financial resources, and participation in search and rescue operations. As reported in Table 2, both conventional and partial correlations indicate a significant positive relation between PTSD and PDI, while the relations between PTSD and MDPSS, and between PTSD and resilience are negative. No significant correlation was found between MDPSS and PDI. Accordingly, it can be concluded that PTSD is associated with the psychological variables PDI, MDPSS, and resilience.

According to the independent samples *t*-test, average PTSD of females (M = 49.43, SD = 12.34) was found to be higher than males (M =

Table 2
Descriptive statistics and correlations between PTSD, PDI, MDPSS, and resilience.

		PTSD	PDI	MDPSS	Resilience
Descriptives	Mean	39.731	30.169	58.269	18.819
	Std. deviation	16.692	10.078	17.122	5.624
	Minimum	2	0	12	6
	Maximum	73	52	84	30
Correlations	PTSD	1	0.578***	−0.229**	−0.533***
	PDI		1	−0.058	−0.461***
	MDPSS			1	0.184*
	Resilience				1
Partial correlations	PTSD	1			
	PDI	0.512***	1		
	MDPSS	−0.195*	−0.020	1	
	Resilience	−0.433***	−0.408***	0.180*	1

*** $p < 0.001$.
** $p < 0.01$.
* $p < 0.05$.

34.51, SD = 16.44; $p < 0.001$). No statistically significant difference in PTSD scores was found between students who participated (M = 41.85, SD = 16.39) and those who did not participate (M = 38.65, SD = 16.82; $p > 0.05$) in search and rescue operations. ANOVA results indicated significant differences in mean PTSD scores across levels of damage ($p < 0.05$) and financial resources ($p < 0.05$). Pairwise comparisons using independent samples *t*-tests showed that individuals who experienced moderate or high levels of damage (M = 45.09, SD = 16.09) reported significantly higher PTSD scores than those with no damage (M = 34.21, SD = 15.90; $p < 0.01$) and those with minor damage (M = 38.72, SD = 16.59; $p < 0.05$). In terms of financial resources, students with low financial resources (M = 48.71, SD = 14.23) reported significantly higher PTSD scores compared to those with moderate (M = 39.58, SD = 16.88; $p < 0.01$) and high levels (M = 34.40, SD = 15.70; $p < 0.001$) of financial resources.

3.3. Classical regression results

The results of the classical regression model are summarized in Table 3. The general model was found to be significant (F = 20.11, $p < 0.001$). The predictive power of the model is substantial (Cohen, 1988) according to multiple correlation coefficient R^2 (54.68 %) and adjusted R^2 (51.96 %) indicating that the model explains more than half of variation of PTSD. The normality assumption of the error terms was not rejected according to the Kolmogorov-Smirnov test (D = 0.031, $p > 0.05$). Since all the adjusted GVIFs in Table 3 are near 1, we can argue that there is no strong multicollinearity problem in the data. The null hypothesis of equality of error variances was not rejected according to the score statistics based on the fitted values (Chi-square = 0.764, d.f. = 1, $p > 0.05$). Eight potential outliers were detected from residual analysis. We checked these 8 records, no suspicious or unusual case was found. Because of the presence of potential outliers, robust regressions with Huber and bisquare weighting were also performed. There was no difference in terms of significance status of the regression coefficients given in Table 3.

As seen from Table 3, the effects of gender ($p < 0.001$), moderate or higher level of damage ($p < 0.05$), moderate financial resources ($p < 0.05$), high financial resources ($p < 0.01$), PDI ($p < 0.001$), MDPSS ($p < 0.05$), and resilience ($p < 0.01$) on average PTSD were found significant. There was no sufficient evidence for the effects of both minor damage ($p > 0.05$) and participation in search and rescue operations ($p > 0.05$) on average PTSD scores. When the other predictors in the model are held constant, average PTSD of female students is 7.979 points higher than male students; average PTSD of the students with moderate or higher damaged buildings is 5.617 points higher than the students with non-damaged buildings; average PTSD scores of the students having moderate and high financial resources are 6.322 and 7.688 points less respectively in comparison to the students with low level of financial resources; one point increase in PDI score increases PTSD 0.604 points on average while one point increases in MDPSS and resilience decrease PTSD 0.119 and 0.658 points on average, respectively. Hence, we can deduce that female gender, increase in the damage levels and PDI are the risk factors while increase in financial resources, MDPSS and resilience are the protective factors of PTSD.

Table 3
Multiple linear regression model results.

Coefficient	Estimate	Std. error	t-Value	p-Value	Collinearity diagnostics		
					GVIF	df	Adjusted GVIF
Intercept	39.535***	7.190	5.499	0.000			
Gender (reference: male)					1.344	1	1.159
Female	7.979***	2.223	3.590	0.000			
Damage (reference: non-damage)					1.123	2	1.029
Minor	1.785	2.399	0.744	0.458			
Moderate or higher	5.617*	2.554	2.199	0.029			
Financial resources (reference: low)					1.085	2	1.021
Moderate	−6.322*	2.483	−2.545	0.012			
High	−7.688**	2.718	−2.829	0.005			
Search and rescue (reference: non-participation)					1.226	1	1.107
Participation	4.197	2.141	1.960	0.052			
PDI	0.604***	0.107	5.666	0.000	1.372	1	1.171
MDPSS	−0.119*	0.056	−2.136	0.034	1.089	1	1.044
Resilience	−0.658**	0.203	−3.244	0.001	1.544	1	1.243

*** $p < 0.001$.
** $p < 0.01$.
* $p < 0.05$.

3.4. Quantile regression results

Table 4 summarizes the results from the fitted quantile regression models for the selected τ quantile levels across 0.05, 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80, 0.90, and 0.95. Fig. 1 depicts the quantile process plots for the predictors in which there are optimally determined 274 quantiles along the horizontal axes and the estimated τ regression quantiles with 95 % confidence intervals (CI) along the vertical axes.

As seen from Table 4, the regression quantiles of the intercepts, which are the predicted PTSD for each quantile when the categorical predictor variables are all in their reference levels and the numerical predictors PDI, MDPSS, and resilience are all zero, are found significant in general across quantiles with their estimates varying between 22.693 and 63.861.

The effects of female gender on PTSD are found to be significant at almost all selected τ quantile levels, as presented in Table 4. Fig. 1(a) indicates that, for the majority of τ regression quantiles, the 95 % confidence intervals do not include zero. The directions of the effects of female gender on PTSD are consistently positive. Furthermore, the effects of female gender on PTSD are significant and stable across nearly all regions of the PTSD distribution. Female gender appears to be a risk factor for both probable PTSD and PTSD diagnosis.

When examining the effects of damage levels at the selected quantiles in Table 4, the positive impacts of minor damage compared to non-damage are found significant at the 10th percentile while the positive impacts of moderate or higher damage levels are found significant at 10th, 20th, 30th, 40th, 50th, and 60th percentiles. When considering Fig. 1(b) and (c) together, the effects of minor damage and moderate or higher damage become insignificant after the 35th and 65th percentiles, respectively. The effects of higher levels of damage with their larger coefficients in a wider range, appear to be more dominant than minor damage. The effects of damage levels across the quantiles are clearly demonstrated for probable PTSD.

As seen in Table 4 and Fig. 1(d) and (e), having moderate or high financial resources, compared to low financial resources, generally reduces PTSD, even at some extreme quantiles. When Fig. 1(d) and (e) are examined together, it is observed that having moderate financial resources decreases PTSD in a similar manner to having high financial resources, but with smaller coefficients. Having low financial resources is identified as a risk factor for both probable PTSD and PTSD diagnosis.

The effects of participation in search and rescue operations are found to be significant at the 80th, 90th, and 95th percentiles, as shown in Table 4. The effects across the entire process are presented in Fig. 1(f). Although the amplifying effects of participation in search and rescue operations on PTSD gradually increase after the 60th percentile, they become statistically significant in the upper tail of the PTSD distribution, specifically after the 73rd percentile. As seen in Fig. 1(f), participation in search and rescue operations is identified as a risk factor for PTSD diagnosis.

The enhancing effects of PDI on PTSD are significant across the entire set of selected quantiles in Table 4. As seen in Fig. 1(g), the magnitudes of these effects remain largely constant across the PTSD distribution, with only negligible fluctuations. As the PDI score increases, the risk for both probable PTSD and PTSD diagnosis increases.

As seen in Table 4, the diminishing effects of MDPSS on PTSD are significant at the 10th, 30th, and 95th percentiles. Significant effects are also observed in the upper tail of the PTSD distribution, particularly beyond the 90th percentile. As expected, the direction of these effects is negative, and their magnitudes appear relatively consistent along the horizontal axis of Fig. 1(h).

As shown in Fig. 1(i), the mitigating effects of resilience on PTSD are generally significant and remain almost constant across the range. Although these effects appear negligible at both the extreme lower and upper tails of the PTSD distribution in Table 4, Fig. 1(i) reveals that the effects are significant after the 13th percentile across the range, even within the upper 10 % of the distribution. As the resilience score increases, the risk of PTSD decreases.

4. Discussion

Major disasters such as devastating earthquakes not only cause physical and economic damage in society, but also cause many psychological disorders including PTSD, which is often accompanies by other psychological disorders such as depression and anxiety. In this study, we investigated the factors affecting PTSD considering risk factors such as gender, building damage level, financial resources, participation in search and rescue operations, and PDI, as well as protective factors such as perceived social support and resilience, seven months after the February 6, 2023 Kahramanmaraş Earthquakes. The sample consisted of 160 university students who directly experienced the earthquakes and were examined using quantile regression, multiple linear regression, and conventional statistical methods.

In present study, the prevalence rates of PTSD according to the proposed threshold values of 33, 47 and 48 of PCL-5 are found to be quite high with the values of 65.6 %, 35 % and 33.8 %, respectively, and it emerges to be a vital issue in terms of public health. Although the threshold values considered in the studies are different, the prevalence rates we found in our sample appear to be consistent with these studies which are related to 2023 Kahramanmaraş earthquakes by using PCL-5. When the literature is reviewed, Bilge et al. (2024), in their study on earthquake victims living in containers 50 days after the 2023 Kahramanmaraş earthquakes, reported a PTSD prevalence rate of 69 % based on the PCL-5 threshold of 33. Satilmis et al. (2024) conducted a study on doctors and nurses who worked in the earthquake zone two months after the 2023 Kahramanmaraş earthquakes. They reported a PTSD prevalence of 37.9 % based on the PCL-5 threshold of 47. İlhan et al. (2023) found the probable PTSD prevalence to be 51.4 % based on the threshold value of 47 of PCL-5 three months after the 2023 Kahramanmaraş earthquakes on 388 survivors aged over 18 who applied to the emergency department for any reason.

According to our classical regression results, gender, financial resources, moderate or severe building damage, PDI, perceived social support, and resilience are effective factors on average PTSD, while the minor building damage and participating in search and rescue operations are not significant predictors of average PTSD. Our findings regarding the predictors of PTSD are largely consistent with recent literature. The effect of female gender as a risk factor aligns with numerous studies and a recent meta-analysis (Gökkaya et al., 2025; Gül & Aktürk, 2025; Kaya et al., 2025; Nolting et al., 2025; Tatu & Varlık, 2025), although Yılmaz and Bahadır (2025) reported a higher risk for males. Similarly, the role of financial hardship as a significant predictor is supported by several studies identifying low income as a risk factor among earthquake survivors (Kaya et al., 2025; Taskin et al., 2025; Yılmaz et al., 2025; Yılmaz & Bahadır, 2025). The impact of building damage level on PTSD is also well documented, with higher levels of structural damage associated with increased PTSD severity (Gül & Aktürk, 2025; Taskin et al., 2025; Yılmaz et al., 2025). Our results also confirm the role of peritraumatic distress (PDI) in predicting PTSD, in line with findings by Yilmaz and Erdem (2025) and Yılmaz and Bahadır (2025). Moreover, the protective role of social support has been widely reported in recent studies (Gökkaya et al., 2025;Kaya et al., 2025; Tatu & Varlık, 2025; Yıldırım et al., 2025). Lastly, the significant effect of resilience on PTSD symptoms is consistent with a growing body of evidence highlighting its buffering role in post-disaster mental health outcomes (Kaya et al., 2025; Tatu & Varlık, 2025; Yıldırım et al., 2025).

In a broader context beyond the 2023 Kahramanmaraş earthquakes, our findings are also align with results of Nobakht et al. (2019) who investigated PTSD following the 2017 Iran-Iraq earthquake. They reported PTSD prevalence rate of 77.7 % in one of the most severely affected area —and identified gender and peritraumatic dissociation/distress as significant predictors. Although gender differences in PTSD are widely observed across various contexts, the consistency of findings

Table 4
Parameter estimates (standard errors) at selected quantile levels.

Coefficient	Quantile level (τ)										
	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	0.95
	Estimate (standard error)										
Intercept	7.855	13.734	22.693*	29.482**	38.112***	39.556***	42.128***	49.534***	60.008***	63.861***	58.421***
	(8.233)	(9.368)	(10.918)	(9.982)	(8.258)	(7.996)	(7.829)	(9.816)	(7.674)	(8.789)	(7.699)
Gender (reference: male)											
Female	12.590**	11.019***	9.882***	7.041*	8.806***	6.935**	6.606**	7.656**	7.176**	3.174	2.996
	(3.520)	(2.861)	(2.923)	(3.164)	(2.451)	(2.335)	(2.311)	(2.850)	(2.295)	(1.766)	(2.647)
Damage (reference: non-damage)											
Minor	4.663	5.060*	3.600	5.823	3.252	1.641	1.741	1.559	−0.532	−1.825	4.136
	(3.066)	(2.410)	(2.498)	(3.087)	(2.935)	(3.312)	(3.559)	(3.414)	(3.574)	(1.960)	(5.362)
Moderate or higher	3.382	5.650*	9.949*	12.143**	9.574**	7.623*	7.109*	4.477	1.919	0.666	5.755
	(1.864)	(2.449)	(4.538)	(3.827)	(2.971)	(3.117)	(3.272)	(3.288)	(3.538)	(2.727)	(5.543)
Financial resources (reference: low)											
Moderate	−6.010*	−7.111*	−6.760*	−5.243	−7.410**	−5.470*	−5.940*	−5.356	−6.515*	−3.191	−11.353*
	(2.309)	(3.478)	(3.098)	(3.429)	(2.629)	(2.367)	(2.583)	(3.135)	(3.194)	(4.774)	(4.882)
High	−6.417***	−6.279*	−6.690*	−5.733	−9.294**	−7.466*	−5.664	−6.228*	−9.024**	−10.276	−12.046**
	(1.590)	(3.123)	(3.363)	(3.443)	(2.971)	(2.899)	(3.113)	(3.147)	(2.683)	(5.297)	(3.927)
Search and rescue (reference: non-participation)											
Participation	1.633	1.624	4.802	0.946	1.570	1.607	4.359	5.571	8.115**	8.500*	11.068***
	(2.451)	(2.146)	(3.052)	(2.752)	(2.372)	(2.584)	(3.074)	(3.037)	(2.973)	(4.038)	(2.065)
PDI	0.583***	0.727***	0.681***	0.732***	0.585***	0.639***	0.615***	0.541***	0.448***	0.468***	0.599***
	(0.136)	(0.132)	(0.155)	(0.145)	(0.115)	(0.108)	(0.119)	(0.134)	(0.108)	(0.129)	(0.124)
MDPSS	−0.076	−0.100*	−0.111	−0.149*	−0.106	−0.110	−0.100	−0.107	−0.082	−0.043	−0.164*
	(0.093)	(0.042)	(0.082)	(0.071)	(0.060)	(0.058)	(0.054)	(0.072)	(0.064)	(0.065)	(0.080)
Resilience	−0.124	−0.395	−0.573	−0.715**	−0.732**	−0.742***	−0.797***	−0.886***	−1.010***	−1.066***	−0.327
	(0.420)	(0.295)	(0.299)	(0.267)	(0.226)	(0.209)	(0.230)	(0.251)	(0.168)	(0.239)	(0.292)

*** $p < 0.001$.
** $p < 0.01$.
* $p < 0.05$.

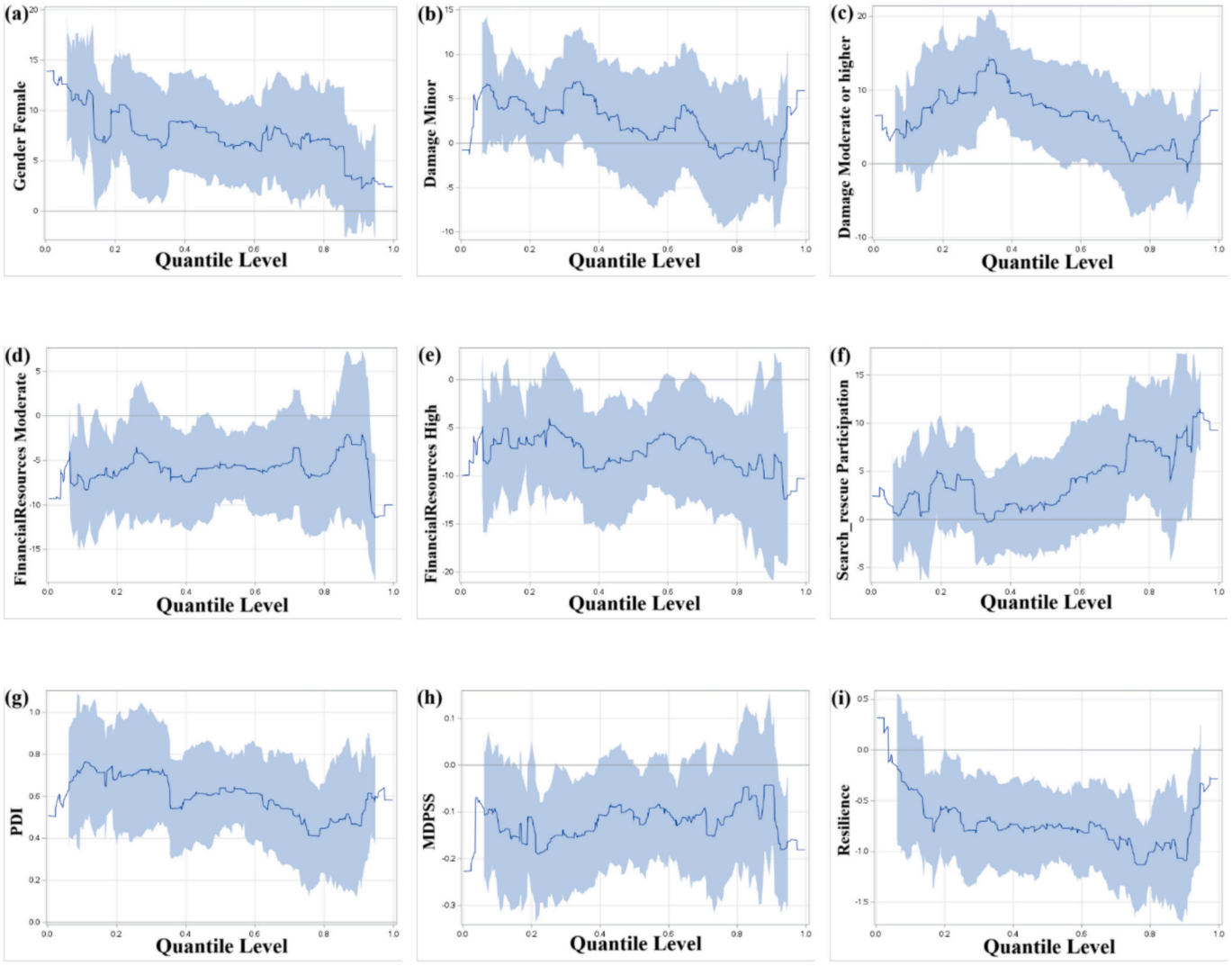


Fig. 1. The quantile process plots with 95 % CIs.

regarding other psychosocial risk factors may partly reflect similarities in disaster impact, post-earthquake living conditions, and broader sociocultural dynamics shared by Iran and Türkiye. This comparison supports the relevance of such risk factors across culturally comparable settings following major seismic disasters.

In this study, by utilizing the advantages of quantile regression, it is revealed that all the predictors affect PTSD at various quantiles of the PTSD distribution. Gender, financial resources, PDI, perceived social support, and resilience are generally effective in predicting probable PTSD and PTSD diagnosis. Findings indicate that damage levels of buildings are more effective for probable PTSD, while participating in search and rescue operations is effective in the upper tail of the PTSD distribution, that is, at high PTSD levels indicating PTSD diagnosis. Our quantile regression results also show that the directions of the effects are consistent not changing across the quantiles of the PTSD distribution. It is clear that protective factors decrease PTSD while risk factor increase PTSD.

These findings have both theoretical and practical implications. Theoretically, the results support existing psychological models emphasizing the role of individual vulnerability and protective resources in trauma outcomes. The consistent effects across PTSD severity levels also suggest that interventions should be tailored not only to those with clinical-level PTSD, but also to individuals with moderate symptoms, as they are influenced by the same risk and protective factors. Practically, our findings highlight the importance of providing targeted support to vulnerable groups, especially females, financially disadvantaged individuals, and those who experienced severe damage or distress. Moreover, the finding that participation in search and rescue activities is more effective at higher PTSD levels suggests that mental health interventions should also consider the specific psychological risks faced by individuals who were actively involved in search and rescue operations. Enhancing access to social support systems and resilience-building programs could help mitigate the long-term psychological impact of the earthquakes.

In summary, this study contributes to a better understanding of PTSD risk in post-earthquake settings. It highlights not only who is most at risk, but also how different levels of distress are shaped by social and psychological factors. These insights can guide both theory-building and the development of more effective mental health interventions in disaster contexts.

5. Limitations

There are several limitations to this study. First, it focuses on a youth population, specifically university students who directly experienced the 2023 Kahramanmaraş earthquakes. Therefore, the findings cannot be generalized to other demographic groups, such as older adults or children. Second, as this study examines only survivors of the 2023

Kahramanmaraş earthquakes, the results cannot be extrapolated to individuals who did not directly experience the disaster. Third, due to the cross-sectional nature of the study, causality cannot be inferred. Future research should include longitudinal studies to track changes over time and community-based studies to assess PTSD levels in the broader population.

6. Conclusion

In conclusion, gender, damage levels of building, financial resources, participating in search and rescue operations, PDI, MDPSS, and resilience are effective factors on potential PTSD.

PTSD severity among earthquake victims is higher for females. The risk of PTSD increases as the severity of building damage increases. Having poor financial resources causes a higher risk of PTSD. Participation in search and rescue operations increases the severity of PTSD at higher quantiles. Therefore, at the high levels of PTSD, participation in search and rescue operations is a risk factor, and non-participation in search and rescue operations is a protective factor. While PDI boosts the severity of PTSD, social support and resilience are among the protective factors against PTSD. The effects of the factors except damage levels and participating in search and rescue operations are more decisive and stable so that their effects do not change with respect to PTSD levels. The findings emphasize the need for targeted mental health interventions for high-risk groups, including females, individuals whose buildings were severely damaged, financially disadvantaged individuals, and search and rescue participants.

CRediT authorship contribution statement

Gülhayat Gölbaşı Şimşek: Writing – review & editing, Validation, Software, Investigation, Visualization, Methodology, Data curation, Supervision, Formal analysis, Conceptualization. **Fatma Noyan Tekeli:** Writing – review & editing, Project administration, Investigation, Formal analysis, Validation, Methodology, Supervision, Funding acquisition, Data curation. **Coşkun Parim:** Writing – original draft, Investigation, Software, Data curation, Resources, Formal analysis. **Batuhan Özkan:** Writing – original draft, Resources, Formal analysis, Software, Investigation, Data curation. **Egemen Ozkan:** Investigation, Writing – original draft, Resources, Data curation, Software, Formal analysis. **Tugay Karadag:** Writing – original draft, Resources, Data curation, Software, Formal analysis, Validation, Investigation. **Seydi Ahmet Satıcı:** Supervision, Validation, Conceptualization, Writing – review & editing, Methodology.

Consent to participate

Informed consent was obtained from all participants included in the study.

Ethics approval

Ethical approval was obtained from the Yıldız Technical University Social Sciences Ethics Committee (Date: May 3, 2023/Reference number: 20230502119).

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The data collected in this study are available on request from the corresponding author.

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