

Psychological and sensory correlates of post-earthquake trauma: the roles of tinnitus and empathy

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Abstract

Background: This study aimed to examine the associations between post-earthquake trauma levels, self-reported tinnitus symptoms, and empathy levels in university students.

Methods: In this cross-sectional study, data were collected via an online survey from university students following the February 6, 2023 earthquake. Post-earthquake trauma levels were assessed using the Post-Earthquake Trauma Level Scale (PETLS), self-reported tinnitus symptoms were evaluated using the Skarzynski Tinnitus Scale (STS), and empathy levels were measured using the Toronto Empathy Questionnaire (TEQ). Correlation and multiple linear regression analyses were performed using SPSS.

Results: The mean age of participants was 20.90 ± 3.86 years, and the mean PETLS total score was 41.38 ± 13.30 . A low but statistically significant positive correlation was observed between trauma levels and tinnitus scores ($r = 0.220$, $p < 0.001$). A statistically significant but weak positive correlation was also observed between trauma and empathy scores ($r = 0.139$, $p = 0.029$). In the multiple regression analysis, age ($\beta = -0.206$), tinnitus ($\beta = 0.215$), and empathy ($\beta = 0.131$) were identified as significant predictors of trauma levels. The model explained 11% of the variance ($R^2 = 0.110$, Adjusted $R^2 = 0.099$, $p < 0.001$).

Conclusion: Post-earthquake trauma was significantly associated with self-reported tinnitus symptoms and empathy, highlighting the potential interplay between psychological distress, sensory symptoms, and empathic tendencies following a large-scale disaster. These findings broaden the perspective on post-disaster trauma responses beyond traditional psychological outcomes, although their interpretation should remain cautious given the cross-sectional design and modest explanatory power of the model.

Keywords: Earthquake, Trauma, Post-Traumatic Stress, Tinnitus, Empathy, University Students, Türkiye

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Background

Natural disasters exert profound effects not only on physical environments but also on individuals' psychological and physiological well-being. Among these events, earthquakes are considered particularly devastating due to their sudden onset, unpredictability, and high rates of mortality and injury [1]. A substantial body of research has demonstrated that exposure to earthquakes is associated with elevated rates of psychological disturbances, including anxiety, fear, sleep disorders, depression, and post-traumatic stress disorder (PTSD) [2, 3]. PTSD is a severe and potentially chronic psychiatric condition that may develop following exposure to life-threatening or highly distressing events [4]. The disorder is characterized by symptom clusters such as intrusive re-experiencing, avoidance, hyperarousal, and alterations in cognitive and emotional functioning [5]. Importantly, PTSD is increasingly recognized as a condition that extends beyond psychological symptoms, involving complex interactions with physiological and somatic systems. Previous studies have documented a range of physical and sensory-related manifestations associated with post-traumatic processes, including headaches, sleep disturbances, balance problems, and tinnitus [6]. Tinnitus, traditionally conceptualized as an auditory symptom, has been increasingly examined within stress- and trauma-related frameworks. Evidence suggests that tinnitus may not solely reflect peripheral auditory dysfunction but may also be influenced by central nervous system processes associated with stress and emotional regulation [7]. In trauma-exposed populations, tinnitus has been described as a potential somatic correlate of psychological

distress, with some authors proposing that tinnitus-related perceptual experiences may interact with trauma-related memory processes [8]. Although emerging research has begun to explore the association between PTSD and tinnitus, studies specifically addressing trauma following large-scale natural disasters remain limited [6,7,9]. This perspective is supported by studies suggesting that tinnitus emerging after traumatic events may reflect broader stress-related neurophysiological processes rather than isolated auditory dysfunction [10]. Beyond its intrapersonal consequences, PTSD has also been associated with disruptions in social cognitive functioning. Empathy, a multidimensional construct central to social interaction and emotional understanding, may be altered following traumatic experiences [11]. Previous research has indicated that individuals with PTSD may exhibit changes in empathic processing, including impairments in emotional empathy and perspective-taking [12, 13]. However, the direction and nature of the relationship between trauma-related symptoms and empathy remain complex and may vary depending on contextual and individual factors. Given the central role of empathy in social functioning, alterations in empathic capacity may contribute to interpersonal difficulties and impaired psychosocial adjustment [14]. Despite the growing literature on PTSD, tinnitus, and empathy, few studies have examined these variables within a unified framework, particularly in populations exposed to natural disasters. University students represent a psychologically vulnerable yet underexamined group in disaster research, as they may experience significant stress-related consequences while navigating critical developmental and academic demands. Recent studies conducted following the February 6, 2023 earthquakes in Türkiye have documented substantial trauma-related psychological responses among university students, including those with both direct and indirect earthquake exposure [15-17]. In addition, recent evidence has shown that post-traumatic stress responses in university students may be associated with a range of individual and earthquake-related factors, highlighting the heterogeneity of psychological outcomes following large-scale disasters [18]. Accordingly, the present study aimed to investigate the associations between post-earthquake trauma levels, self-reported tinnitus symptoms, and empathy levels in university students. By integrating psychological and sensory-related variables, this study seeks to contribute to a more comprehensive understanding of the multidimensional impact of disaster-related trauma. Furthermore, the findings may contribute to a broader understanding of post-disaster psychosocial responses and inform future multidisciplinary research and assessment approaches following large-scale disasters.

Methods

Study Design

This cross-sectional study employed correlation and multiple linear regression analyses to investigate the associations between post-earthquake trauma levels, self-reported tinnitus symptom severity, and empathic traits among university students following a large-scale natural disaster.

Participants and Sampling Procedure

The study was conducted after the earthquake that occurred on February 6, 2023. Participants were recruited from students

enrolled in departments within the Faculty of Health Sciences at KTO Karatay University, Türkiye. Participants represented different departments within the faculty.

Sample size

Sample size estimation was performed using G*Power 3.1.9.2. Based on previously reported Post-Earthquake Trauma Level Scale (PETLS) scores (mean = 49.59, SD = 5.406) [19], the anticipated effect size was calculated as $\eta^2 = 0.078$ (Cohen's $f \approx 0.29$). With a significance level of $\alpha = 0.05$ and statistical power of $1 - \beta = 0.90$, the minimum required sample size was determined to be 250 participants. A non-probability convenience sampling strategy was employed.

Inclusion and exclusion criteria

Participants were included if they were between 18 and 45 years of age, understood and spoke Turkish, resided in Türkiye during the February 6, 2023 earthquake, reported experiencing tinnitus symptoms at least once during the month preceding participation, and voluntarily agreed to participate. For the purposes of this study, tinnitus symptoms were operationally defined as the self-reported experience of tinnitus at least once during the month preceding participation. This criterion was based on self-report and did not require clinical or audiological confirmation. Participants were excluded if they had a previously diagnosed psychiatric or neurological disorder, had a diagnosis of chronic hearing loss, and provided incomplete or inconsistent responses.

Data Collection Procedure

Data were collected between March and June 2023 using an online survey platform (Google Forms). The survey link was distributed to students through WhatsApp groups and shared by faculty members. Participation was anonymous and voluntary. Prior to data collection, participants were informed about the study objectives, confidentiality principles, and their right to withdraw through the informed consent form. Electronic informed consent was obtained. The survey included the Personal Information Form, the PETLS, the STS, and the TEQ. The average completion time was approximately 20 minutes.

Study tools

Personal Information Form

A structured form developed by the researchers based on previous literature [6, 20] was used to collect sociodemographic and earthquake-related information, including the city where participants were located at the time of the February 6, 2023 earthquake and whether they had a relative affected by the earthquake.

Post-Earthquake Trauma Level Scale (PETLS)

The PETLS [21] is a 20-item, five-point Likert-type scale designed to assess trauma-related distress following an earthquake. Scores range from 20 to 100, with higher scores indicating greater trauma-related symptom severity. The Cronbach's alpha coefficient was 0.87 in the original study and 0.87 in the present sample.

Skarzynski Tinnitus Scale (STS)

The STS [22] is a 14-item self-report scale assessing psychological, functional, and coping-related aspects of tinnitus.

In the present study, STS scores were used to assess self-reported tinnitus symptom severity; no clinical or audiological confirmation of tinnitus was performed. The Turkish validity and reliability study was conducted by Baba et al. [23]. Scores were calculated according to standardized procedures. The Cronbach's alpha coefficient in the present study was 0.87.

Toronto Empathy Questionnaire (TEQ)

The TEQ [24] is a 13-item, single-factor measure assessing empathic tendencies. The Turkish adaptation was performed by Totan et al. [25]. Higher scores indicate greater empathy. The reliability analysis of the Turkish version reported a Cronbach's alpha of 0.79.

Statistical analysis

The data obtained from the study were analyzed using IBM SPSS Statistics (Version 25). Descriptive statistics were calculated and presented as mean $\pm$ standard deviation for continuous variables and frequency (n) and percentage (%) for categorical variables. The normality of the data distribution was assessed using skewness and kurtosis values. Based on the distribution characteristics of the variables, Pearson correlation analysis was performed to examine the relationships between post-earthquake trauma, tinnitus symptoms, and empathy levels. Multiple linear regression analysis was conducted to identify the variables predicting post-earthquake trauma levels. Age, TEQ total scores, and STS total scores were included in the regression model. Multicollinearity was evaluated using tolerance and variance inflation factor (VIF) values. A significance level of $p < 0.05$ was adopted for all statistical analyses.

Results

The mean age of the participants was 20.90 ± 3.86 years. Among the students, 26% reported having a relative affected by the earthquake. Among these participants, 35.4% reported a first-degree relative, 21.5% a second-degree relative, 23.1% a third-degree relative, and 20.0% a friend or neighbor (Table 1).

Table 1: Distribution of Participants' Sociodemographic Characteristics (n = 250)

Variable	Categories	N(%)
Age	Mean $\pm$ SD	20.90 $\pm$ 3.86
Relative affected by earthquake	Yes	65 (26)
	No	185(74)
Relationship to affected person	First-degree	23(35.4)
	Second-degree	14(21.5)
	Third-degree	15(23.1)
	Friend, neighbor	13(20.0)

The mean total PETLS score was 41.38 ± 13.30 . The mean STS score was 58.46 ± 8.02 , while the mean TEQ score was 47.62 ± 5.20 (Table 2). Correlation analyses revealed a statistically significant, positive, and low-level association between PETLS total scores and STS total scores ($r = 0.220$, $p < 0.001$). A statistically significant but very weak positive correlation was also observed between PETLS total scores and TEQ total scores ($r = 0.139$, $p = 0.029$) (Table 3). All PETLS subscales demonstrated strong and statistically significant correlations with the PETLS total score ($p < 0.001$). STS total scores showed weak but statistically significant positive correlations with all PETLS

subscales ($r = 0.157$ – 0.198 , $p \leq 0.013$). TEQ total scores were significantly associated with the Affective subscale ($r = 0.144$, $p = 0.023$) and Cognitive Structure subscale ($r = 0.232$, $p < 0.001$), whereas associations with Behavioral Problems, Emotional Limitation, and Sleep Problems were not statistically significant ($p > 0.05$) (Table 3).

Table 2: Scores on the Post-Earthquake Trauma Level Scale, Skarzynski Tinnitus Scale, and Toronto Empathy Questionnaire

Variable	Mean $\pm$ SD	Min-Max
PETLS Total Score	41.38 $\pm$ 13.30	20-87
Behavioral Problems Subscale	6.33 $\pm$ 2.63	4-18
Emotional Limitation Subscale	9.72 $\pm$ 4.36	5-25
Affective Subscale	9.40 $\pm$ 3.32	4-20
Cognitive Structure Subscale	9.96 $\pm$ 3.81	4-20
Sleep Problems Subscale	5.96 $\pm$ 2.69	3-15
STS Total Score	58.46 $\pm$ 8.02	39.29-87.50
TEQ Total Score	47.62 $\pm$ 5.20	32-58

PETLS = Post-Earthquake Trauma Level Scale; STS = Skarzynski Tinnitus Scale; TEQ = Toronto Empathy Questionnaire.

Multiple linear regression analysis indicated that age ($B = -0.712$, $\beta = -0.206$, $p = 0.001$), TEQ total scores ($B = 0.335$, $\beta = 0.131$, $p = 0.030$), and STS total scores ($B = 0.356$, $\beta = 0.215$, $p < 0.001$) were significant predictors of post-earthquake trauma levels. The regression model was statistically significant ($F(3, 246) = 10.152$, $p < 0.001$) and explained 11% of the variance in PETLS scores ($R^2 = 0.110$; Adjusted $R^2 = 0.099$). Multicollinearity diagnostics indicated no violations (Tolerance = 0.998–0.999; VIF = 1.001–1.002) (Table 4).

Discussion

This study was conducted to examine the relationship between trauma levels observed in university students following an earthquake and their self-reported tinnitus symptoms and empathy levels. The primary objective was to provide a more comprehensive understanding of the psychological and sensory correlates of post-earthquake trauma by evaluating variables extending beyond traditional psychological outcomes. In particular, this study contributes to the literature by considering self-reported tinnitus symptoms as a potential sensory correlate of post-earthquake trauma. The mean PETLS, TEQ, and STS scores observed in the present study were broadly comparable to values reported in previous studies. These findings are consistent with previous studies conducted in similar populations. For instance, Aylaz et al. (2025) reported moderate levels of post-earthquake trauma among university students [26]. Aytaç et al. (2025) reported moderate post-earthquake trauma levels among nursing students affected by the February 6, 2023 earthquakes in Türkiye [15]. Similarly, empathy scores reported by Banu et al. (2025) were comparable to those obtained in the present study [27]. In addition, Sanfins et al. (2023) reported moderate-to-high tinnitus scores using the Skarzynski Tinnitus Scale [28]. Collectively, these findings indicate that trauma-related responses and associated sensory experiences may be present in young university populations following large-scale disasters. A statistically significant but low-level positive correlation was identified between self-reported tinnitus symptoms and post-earthquake trauma levels.

Table 3: Correlation of Empathy and Self-Reported Tinnitus Symptoms with Post-Earthquake Trauma

Variables	PETLS	BP	EL	AF	CS	SP	TEQ Total Score	STS Total Score
PETLS Total Score	1.000							
<i>Behavioral Problems (BP)</i>	r = 0.759** p < 0.001	1.000						
<i>Emotional Limitation (EL)</i>	r = 0.858** p < 0.001	r = 0.588** p < 0.001	1.000					
<i>Affective (AF)</i>	r = 0.769** p < 0.001	r = 0.463** p < 0.001	r = 0.581** p < 0.001	1.000				
<i>Cognitive Structure (CS)</i>	r = 0.825** p < 0.001	r = 0.492** p < 0.001	r = 0.614** p < 0.001	r = 0.570** p < 0.001	1.000			
<i>Sleep Problems (SP)</i>	r = 0.693** p < 0.001	r = 0.552** p < 0.001	r = 0.459** p < 0.001	r = 0.368** p < 0.001	r = 0.484** p < 0.001	1.000		
TEQ Total Score	r = 0.139* p = 0.029	r = -0.009 p = 0.892	r = 0.104 p = 0.102	r = 0.144* p = 0.023	r = 0.232** p < 0.001	r = 0.019 p = 0.766	1.000	
STS Total Score	r = 0.220** p < 0.001	r = 0.181** p = 0.004	r = 0.198** p = 0.002	r = 0.158* p = 0.012	r = 0.167** p = 0.008	r = 0.157* p = 0.013	r = -0.001 p = 0.987	1.000

*p < 0.05; **p < 0.01. BP = Behavioral Problems; EL = Emotional Limitation; AF = Affective; CS = Cognitive Structure; SP = Sleep Problems; PETLS = Post-Earthquake Trauma Level Scale; TEQ = Toronto Empathy Questionnaire; STS = Skarzynski Tinnitus Scale.

This finding aligns with previous research suggesting that tinnitus symptoms may function as stress-related or somatic indicators associated with psychological distress [29, 30]. Sudden and highly stressful events such as earthquakes have been proposed to influence autonomic and central nervous system processes that may be associated with tinnitus perception and severity. The present findings are consistent with studies demonstrating significant associations between stress, anxiety,

and tinnitus complaints [31]. Similarly, Prewitt et al. (2021) reported that individuals with greater tinnitus severity were more likely to exhibit elevated PTSD symptoms [32]. Terhaag et al. (2021) further identified increased tinnitus prevalence among individuals with post-traumatic stress disorder [33]. Taken together, these findings are consistent with a possible association between trauma-related psychological processes and sensory experiences.

Table 4: Multiple Regression Results Predicting Post-Earthquake Trauma Levels in University Students

Variables	B	β	t	p	95% CI for B	Tolerance	VIF
Age	-0.712	-0.206	-3.427	0.001	-1.121 to -0.303	0.998	1.002
TEQ Total Score	0.335	0.131	2.177	0.030	0.032 to 0.638	0.999	1.001
STS Total Score	0.356	0.215	3.573	<0.001	0.160 to 0.553	0.999	1.001

Model statistics: Dependent variable = PETLS total score; N = 250; R = 0.332; R² = 0.110; Adjusted R² = 0.099; F(3, 246) = 10.152; p < 0.001. β = standardized regression coefficient; CI = confidence interval; TEQ = Toronto Empathy Questionnaire; STS = Skarzynski Tinnitus Scale; VIF = Variance Inflation Factor.

Multiple regression analysis revealed that age, empathy levels, and tinnitus symptoms were significant predictors of post-earthquake trauma levels, explaining approximately 11% of the variance. A negative association between age and trauma levels indicated that younger participants reported higher trauma scores. This finding is consistent with İlhan et al. (2023), who identified younger age as a factor associated with probable PTSD among survivors of the 2023 Türkiye earthquake [34]. Similarly, O'Connor et al. (2023) reported an association between age and PTSD symptom severity [35]. Although the age range in the present study was relatively narrow, the observed association suggests that even minor age differences within university populations may hold relevance in trauma research. A weak but statistically significant positive association was observed between empathy and post-earthquake trauma levels in the bivariate analysis, and empathy also remained a significant predictor in the multivariate regression model. Although the magnitude of the association was small, this finding suggests that empathy may account for a modest but independent proportion of variability in trauma levels. One possible explanation is that

individuals with heightened empathic tendencies may demonstrate increased emotional sensitivity to distressing stimuli, which may be associated with greater trauma-related symptom reporting. Previous research supports this interpretation. Decety and Lamm (2006) suggested that heightened empathic sensitivity may increase vulnerability to emotional distress, while Singer and Klimecki (2014) highlighted the potential link between empathy-related neural processes and stress reactivity [36, 37]. Empirical findings have similarly indicated greater PTSD symptom severity among individuals with higher empathy levels [38, 39]. More recent evidence further suggests that individuals with heightened empathic tendencies may exhibit intensified stress responses following traumatic experiences [40]. While empathy is traditionally conceptualized as a protective social-cognitive resource, the present findings underscore its complex and context-dependent role, suggesting that under conditions of large-scale traumatic stress, heightened empathic sensitivity may also be associated with greater vulnerability to trauma-related distress in some contexts.

Importantly, although the regression model was statistically significant, the proportion of explained variance was modest ($R^2 = 0.110$), which should be considered when interpreting the clinical relevance of these findings. This modest explanatory power indicates that post-earthquake trauma is likely influenced by a broader range of psychological, environmental, and biological factors not captured in the present study. Given the cross-sectional design and the self-reported assessment of tinnitus symptoms, the present findings should be interpreted as associations rather than as evidence supporting clinical prediction or screening. Nevertheless, the observed relationships suggest that the interplay between psychological distress and sensory complaints warrants further investigation in post-disaster populations. Future studies incorporating clinically confirmed audiological measures and additional psychosocial and environmental variables may provide a more comprehensive understanding of trauma-related outcomes. Several limitations should be considered. First, the cross-sectional design limits causal interpretation of the observed relationships. Second, the study relied on self-report measures, and tinnitus symptoms were not confirmed through clinical assessment. Participants were included based on the presence of self-reported tinnitus symptoms; therefore, the findings primarily reflect variability in self-reported tinnitus symptom severity rather than tinnitus prevalence. Third, the sample consisted solely of university students, which may limit the generalizability of the findings. Fourth, gender was not included as a covariate in the regression model; therefore, potential residual confounding related to gender cannot be excluded and should be considered when interpreting the findings. Fifth, specific types and severity of earthquake-related exposure, such as personal or family losses, displacement, or property loss, were not examined as separate predictors in the statistical analyses. These individual differences in earthquake exposure may have influenced post-traumatic psychological responses. Finally, although the regression model was statistically significant, the explained variance was modest, suggesting that additional unmeasured factors may contribute to post-earthquake trauma levels.

Conclusion

This study identified statistically significant associations between post-earthquake trauma levels, self-reported tinnitus symptoms, and empathy levels in university students. The findings suggest that post-earthquake trauma may be associated with both sensory symptoms and individual differences in empathic tendencies. However, given the cross-sectional design, self-reported assessment of tinnitus symptoms, and modest explanatory power of the regression model, the findings should be interpreted cautiously and do not support causal or clinical predictive conclusions. Future longitudinal studies incorporating clinical audiological assessment and more detailed measures of earthquake exposure are warranted to clarify these relationships.

Abbreviation

AF: Affective; BP: Behavioral Problems; CI: Confidence Interval; CS: Cognitive Structure; EL: Emotional Limitation; PETLS: Post-Earthquake Trauma Level Scale; PTSD: Post-Traumatic Stress Disorder; SP: Sleep Problems; SPSS: Statistical Package for the Social Sciences; STS: Skarzynski Tinnitus Scale; TEQ: Toronto Empathy Questionnaire; VIF: Variance Inflation Factor.

Declaration

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request by emailing fzehragumuss@gmail.com.

Authors' contributions

Fatma Zehra Gümüş Selek (FZGS), Büşra Demirdağ (BD), and Ayşenur Demir Küçükköseler (A.K) designed the study. FZGS and ADK collected the data. FZGS and BD performed the statistical analyses. All authors contributed to the interpretation of the data, critically revised the manuscript, and approved the final version. All authors read and approved the final manuscript.

Ethics approval and consent to participate

We conducted the research in accordance with the Declaration of Helsinki. Ethical approval for this study was obtained from the KTO Karatay University Non-Interventional Clinical Research Ethics Committee (Approval No: 2023/028). All participants provided informed consent prior to participation.

Consent for publication

Not applicable

Competing interest

The authors declare that they have no competing interests.

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