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Original Article

# Evaluation of fear of falling, balance, and kinesiophobia in earthquake survivors: A comparative study between older and young adults

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***ABSTRACT***

**Objectives:** This study aims to evaluate fear of falling, balance, and kinesiophobia among survivors of the earthquake that occurred in Türkiye on February 6th, 2023 and to identify potential predictors of fear of falling and impaired balance.

**Patients and methods:** In this single-center, cross-sectional study, a total of 260 Kahramanmaraş earthquake survivors (105 males, 155 females; median age: 44.0 years; range, 18 to 91 years) between May 08, 2024 and July 08, 2024 were included. The sociodemographic data including age, sex, body mass index (BMI), marital status (single, married, widow), education status (years), monthly income (TL), smoking status (never smoked, smoking before the earthquake or started smoking after the earthquake), alcohol intake (never, regular use of alcohol before the earthquake, or started alcohol consumption after the earthquake) of the participants were recorded. Comorbidities were evaluated using the modified Charlson Comorbidity Index (CCI), anxiety and depression using the Hospital Anxiety and Depression Scale (HADS), post-traumatic stress disorder using the National Stressful Events Survey for PTSD-Short Scale (NSESSS-PTSD), sleep disorders using the Jenkins Sleep Evaluation Scale (JSS), fear of falling using the Falls Efficacy Scale (FES), functional balance using the Berg Balance Scale (BBS), and kinesiophobia using the Tampa Scale for Kinesiophobia (TSK).

**Results:** Of the survivors (n=260), 4.6% and 33.8% experienced loss of first-degree relatives and house damage, respectively. The FES and TSK scores were higher, while the BBS score was lower in older adults (n=56) compared to younger counterparts (n=204) ($p<0.001$). Multivariate linear regression analysis revealed that increased age affected the BBS ($\beta=-0.124$; 95% CI: −0.263 to −0.185; $p<0.001$) and FES scores ($\beta=0.404$; 95% CI: 0.255 - 0.451; $p<0.001$). The PTSD-SS score had a significant effect on the FES score ($\beta=0.915$; 95% CI: 0.734 - 1.110; $p<0.001$).

**Conclusion:** The Kahramanmaraş earthquake caused detrimental effects. Older people were more affected in terms of balance, fear of falling, and kinesiophobia. Increased age and post-traumatic stress are significantly associated with fear of falling following the earthquake. As a potential risk factor for fear of falling, post-traumatic stress should be managed properly in survivors of such disasters, particularly in those at older age.

***Keywords:*** Aged, aging, balance, earthquake, falls, kinesiophobia.

Natural disasters are extreme events that have detrimental effects on humans' well-being.[1] Disasters include, but not limited to, earthquakes, fires, and floods.[2] Natural disasters have received a great deal of attention from scholars, who have investigated their influence on affected populations.[3] Researchers have identified several impacts of disasters. These include the death of a large number of individuals, physical, social, and psychological disturbances, substantial economic and political consequences, damage to residential dwellings, and an overall disruption of social life in communities. Among these, the effects that impair health and lives of individuals are vital.[2]

On February 6th, 2023, earthquakes measuring 7.7 and 7.6 Mw. on the Richter scale struck Kahramanmaraş in Türkiye at 04:17 A.M. and 13:24 P.M., respectively. The earthquakes resulted in considerable damage and fatalities affecting

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10 provinces, including Kahramanmaraş, Hatay, Gaziantep, Osmaniye, Malatya, Adana, Diyarbakır, Şanlıurfa, Adıyaman, and Kilis.[4] Many individuals lost their lives and relatives, and their houses were destroyed or damaged. Many earthquake survivors had to leave their homes or stay in a safer place temporarily or permanently due to damage, precaution and/or fear. This negative picture also negatively affected the physical and mental health of the individuals.

In the literature, the effects of earthquakes on human health and quality of life have been investigated in various studies.[5-8] Post-traumatic stress disorder (PTSD) is one of the most frequently studied topics after an earthquake.[9] Trauma experienced during and after an earthquake can cause PTSD. The risk of depression is also increased in cases with PTSD. After trauma, levels of interleukin-1β and tumor necrosis factor-α increase, and increased inflammatory activity leads to PTSD.[10] However, information on the relationship between PTSD and falls or fear of falling is limited. Wang et al.[11] found that falls and fear of falling increased in the elderly population after the earthquake. On the other hand, Tevzadze and Shakarishvili[12] found that vestibular symptoms increased after the earthquake. Psychological stress could be associated with benign paroxysmal positional vertigo, and earthquakes might predispose to this situation. On the other hand, to the best of our knowledge, post-earthquake kinesiophobia has not been studied so far.

Given the limited data in the literature, in the present study, we aimed to evaluate fear of falling, balance, and kinesiophobia among survivors of the earthquake that occurred in Türkiye on February 6$^{th}$, 2023 and to identify potential predictors of fear of falling and impaired balance.

## PATIENTS AND METHODS

This single-center, cross-sectional study was conducted at Çukurova University Faculty of Medicine, Department of Physical Medicine and Rehabilitation between May 08, 2024 and July 08, 2024. Those aged 18 and over who experienced the Kahramanmaraş earthquake on February 6$^{th}$, 2023 were included in the study. A written informed consent was obtained from each patient. The study protocol was approved by the Çukurova University Faculty of Medicine Ethics Committee (date: 05.05.2023, no: 133/21). The study was conducted in accordance with the principles of the Declaration of Helsinki. Exclusion criteria were as follows: the presence of any disease that may cause falls and balance impairment or kinesiophobia (e.g., hemiplegia, major organ dysfunction); using any medication that may cause balance disorder (e.g., psychotropic drugs); history of severe psychiatric disorder diagnosed before the earthquake; and history of balance disorder diagnosed before the earthquake (e.g., benign paroxysmal positional vertigo). Finally, a total of 260 earthquake survivors (105 males, 155 females; median age: 44.0 years; range, 18 to 91 years) were included in the study.

The sociodemographic data including age, sex, body mass index (BMI), marital status (single, married, widow), education status (years), monthly income (TL), smoking status (never smoked, smoking before the earthquake or started smoking after the earthquake), alcohol intake (never, regular use of alcohol before the earthquake, or started alcohol consumption after the earthquake) of the participants were recorded. The level of being affected by the earthquake was evaluated with various questions (presence of any earthquake-related injuries [Yes/No], loss of the first-degree relatives, house damage [Yes/No], damage to their houses [no damage, slightly damaged, moderately damaged, severely damaged, destroyed], days spent out of their own house, current residential [own house, house of a relative or friend, other], earthquake-related economic deterioration [Yes/No], disruption in access to hospital after the earthquake [Yes/No], disruption in access to medicine after the earthquake [Yes/No], number of non-prescription drug use after the earthquake, number of falls after the earthquake).

Presence of musculoskeletal pain [Yes/No], duration of pain, Numeric Rating Scale (NRS) for pain, painful area, and any aggravation of pain following the earthquake(s) were questioned. Comorbidities were evaluated using the modified Charlson Comorbidity Index (CCI).[13] The modified CCI is a 19-item composite score based on age and various comorbidities. The modified CCI total score is the sum of the weights, with higher scores indicating both a higher mortality risk and more severe comorbid diseases. Symptoms of anxiety and depression were assessed by the Hospital Anxiety and Depression Scale (HADS). The HADS is a self-assessment scale evaluating psychological discomfort in the setting of a hospital medical outpatient clinic. It is composed of two subscales: anxiety and depression. The total HADS score ranges from 0 to 42. Higher scores indicate more severe impairment.[14,15] Post-traumatic stress disorder was evaluated by the National Stressful Events Survey

for PTSD-Short Scale (NSESSS-PTSD). The total PTSD-Short Scale (PTSD-SS) score ranges from 0 to 36 where higher scores indicate more impairment.[16] Evren et al.[17] reported that a cut-off of 24 points was the most critical value for identifying an individual as having a PTSD with a sensitivity of 0.91 and a specificity of 0.77. Sleep disorders were evaluated by the Jenkins Sleep Evaluation Scale (JSS). The JSS is a four-item questionnaire that evaluates sleep disruptions for a variety of disorders. The scale assessed the number of days that the individual experienced sleeping issues in the previous month. The questions are answered on a 6-point Likert scale (0= not at all, 1= 1-3 days, 2= 4-7 days, 3= 8-14 days, 4= 15-21 days, 5= 22-31 days). The total score ranges from 0 to 20, with higher total scores reflecting a larger number of sleep issues. If the mean score is ≥2, this corresponds to at least one disturbed night per week.[18,19]

Fear of falling was examined by the Falls Efficacy Scale (FES). The questionnaire assesses confidence of an individual in conducting daily tasks (e.g., bathing or showering, reaching, walking, making meals, etc.) without falling. The FES is a 10-item scale with ratings ranging from 1 to 10; 10 implies that you have no trust in the activity, while 1 indicates that you are confident. Total scores of ≥ 70 indicate that the individual is afraid of falling.[20] The Berg Balance Scale (BBS) was used to assess functional balance. The scale is a 14-question test with a 4-point Likert scale for each issue. The individual is given a score ranging from 0 to 56. Total scores of 0-20 denote "high fall risk", 21-40 "medium fall risk," and ≥41 "low fall risk", respectively.[21] Kinesiophobia was assessed by the Tampa Scale for Kinesiophobia (TSK) in participants with a complaint of musculoskeletal pain. The 17-item scale evaluates fear of movement/reinjury and fear-avoidance. In this 4-point Likert questionnaire, total scores range from 17 to 68. The cut-off value of the scale was set as 37. Accordingly, patients with a TKS score of >37 were categorized as high-fear subjects.[22,23]

### Statistical analysis

Statistical analysis was performed using the SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean ± standard deviation (SD), median and interquartile range (IQR) or number and frequency, where applicable. Distribution of data was checked using the Kolmogorov-Smirnov test. Comparison of sociodemographic and clinical variables between older adults and younger participants was performed using the Pearson's chi-square test for normally distributed categorical data, the Fisher's exact test for non-normally distributed categorical data, the independent samples t-test for normally distributed continuous data, and the Mann-Whitney U test for non-normally distributed continuous data. The correlation of BBS, FES, and TSK scores with sociodemographic and clinical variables was analyzed using the Spearman's correlation analysis. Univariate linear regression analysis was performed to identify the factors affecting the participants' BBS and FES scores. Multiple linear regression was used to identify variables that were associated with impaired balance and fear of falling. The dependent variables were the BBS score and the FES score. The variables that were significant in the univariate linear regression modelling were included in the multivariate linear regression analysis. The independent variables were age, sex, CCI score, education status, monthly income, BMI, musculoskeletal pain (Yes/No), and PTSD-SS score. Values were given in beta (β) and 95% confidence interval (CI). A $p$ value of <0.05 was considered statistically significant.

## RESULTS

### Comparison of demographic variables between older and young adults

There were no sex differences between the study groups. However, years of education and monthly income were significantly lower in older adults when compared to young adults (p<0.001 and p=0.027, respectively). Given a sample size of 56 and 204 in older and young adult groups, respectively the study was sufficiently powered (>80%) to detect the effect size calculated based on FES score.

A total of 88 participants (33.8%) experienced earthquake-related damage to their houses (severe damage, n=5; moderate damage, n=10; and mild damage, n=73). Seventy participants (27.3%) reported earthquake-related economic deterioration. The median number of days spent out of their own houses after the earthquake was 14 (IQR: 29) with no significant difference between young and older adults (p=0.068). Regular intake of alcohol was more frequent in young adults (p=0.049), while smoking status did not differ between the groups. Of the younger group, six participants started alcohol consumption after the earthquake and one participant started smoking following the disaster. Loss of the first-degree relatives was more frequent in older adults (10.7% and 2.9%, respectively; p=0.014) (Table 1).

**TABLE 1**
The comparison of sociodemographic and clinical variables between older and young adults

| | Total sample | | | | | Older adults | | | | | Young adults | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | Mean±SD | Median | IQR | n | % | Mean±SD | Median | IQR | n | % | Mean±SD | Median | IQR | *p* |
| Age (year) | | | | 44.0 | 26 | | | | 68.5 | 10 | | | | 40 | 20 | <0.001 |
| Sex | | | | | | | | | | | | | | | | 0.421 |
| Female | 155 | 59.6 | | | | 36 | 64.3 | | | | 119 | 58.3 | | | | |
| Male | 105 | 40.4 | | | | 20 | 35.7 | | | | 85 | 41.7 | | | | |
| BMI (kg/m$^2$) | | | 26.3±5.9 | | | | | 27.4±6.6 | | | | | 26±5.5 | | | 0.001 |
| Marital status | | | | | | | | | | | | | | | | |
| Single | 72 | 27.7 | | | | 2 | 3.6 | | | | 70 | 34.3 | | | | |
| Married | 171 | 65.8 | | | | 44 | 78.6 | | | | 127 | 62.3 | | | | |
| Widow | 17 | 6.5 | | | | 10 | 17.9 | | | | 7 | 3.4 | | | | |
| Education status (year) | | | | 12.5 | 7 | | | | 8 | 6 | | | | 15 | 4 | <0.001 |
| Monthly income (TL) | | | | 8,250 | 9,375 | | | | 7,500 | 3,500 | | | | 10,000 | 14,625 | 0.027 |
| Smoking status | | | | | | | | | | | | | | | | 0.341 |
| Never smoked | 158 | 60.8 | | 37 | 66.1 | | | | 121 | 59.3 | | | | | | |
| Already smoking | 96 | 36.9 | | 19 | 33.9 | | | | 77 | 37.7 | | | | | | |
| Started smoking after the earthquake | 6 | 2.3 | | 0 | 0 | | | | 6 | 2.9 | | | | | | |
| Alcohol intake | | | | | | | | | | | | | | | | 0.049 |
| Never | 173 | 66.8 | | | | 45 | 80.4 | | | | 128 | 63.1 | | | | |
| Regular use of alcohol before the earthquake | 85 | 32.8 | | | | 11 | 19.6 | | | | 74 | 36.5 | | | | |
| Started alcohol consumption after the earthquake | 1 | 0.4 | | | | 0 | 0 | | | | 1 | 0.5 | | | | |
| Earthquake-related injuries[a] | 2 | 0.8 | | | | 0 | 0 | | | | 2 | 1 | | | | >0.999 |
| Loss of 1$^{st}$ degree relatives[b] | 12 | 4.6 | | | | 6 | 10.7 | | | | 6 | 2.9 | | | | 0.014 |
| House damage | | | | | | | | | | | | | | | | 0.012 |
| No damage | 172 | 66.2 | | | | 35 | 62.5 | | | | 137 | 67.2 | | | | |
| Slightly damaged | 73 | 28.1 | | | | 14 | 25 | | | | 59 | 28.9 | | | | |
| Moderately damaged | 10 | 3.8 | | | | 3 | 5.4 | | | | 7 | 3.4 | | | | |
| Severely damaged | 5 | 1.9 | | | | 4 | 7.1 | | | | 1 | 0.5 | | | | |
| Days spent out of own house | | | | 14 | 29 | | | | 7 | 30 | | | | 15 | 27 | 0.068 |
| Current residential | | | | | | | | | | | | | | | | 0.267 |
| Own house before the earthquake | 224 | 86.2 | | | | 47 | 83.9 | | | | 177 | 86.8 | | | | |
| Own house moved after the earthquake | 17 | 6.5 | | | | 6 | 10.7 | | | | 11 | 5.4 | | | | |
| House of a relative or friend | 12 | 4.6 | | | | 3 | 5.4 | | | | 9 | 4.4 | | | | |
| Other | 7 | 2.7 | | | | 0 | 0 | | | | 7 | 3.4 | | | | |
| Earthquake-related economic deterioration | 71 | 27.3 | | | | 8 | 14.3 | | | | 63 | 30.9 | | | | 0.014 |
| Disruption in access to hospital after the earthquake | 33 | 12.7 | | | | 7 | 12.5 | | | | 26 | 12.7 | | | | 0.961 |
| Disruption in access to medicine after the earthquake | 17 | 6.6 | | | | 4 | 7.1 | | | | 13 | 6.4 | | | | 0.768 |

**TABLE 1**
Continued

| | Total sample | | | | | Older adults | | | | | Young adults | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | Mean±SD | Median | IQR | n | % | Mean±SD | Median | IQR | n | % | Mean±SD | Median | IQR | *p* |
| Number of non-prescription drug use after the earthquake | | | | 0 | 1 | | | | 0 | 2 | | | | 0 | 1 | 0.136 |
| Presence of musculoskeletal pain | 139 | 53.5 | | | | 39 | 69.6 | | | | 100 | 49 | | | | 0.006 |
| Painful area | | | | | | | | | | | | | | | | <0.001 |
| Neck | 12 | 8.6 | | | | 0 | 0 | | | | 12 | 12 | | | | |
| Upper extremity | 4 | 2.9 | | | | 1 | 2.6 | | | | 3 | 3 | | | | |
| Back | 16 | 11.5 | | | | 0 | 0 | | | | 16 | 16 | | | | |
| Low back | 31 | 22.3 | | | | 5 | 12.8 | | | | 26 | 26 | | | | |
| Lower extremity | 13 | 9.4 | | | | 3 | 7.7 | | | | 10 | 10 | | | | |
| >1 painful areas | 44 | 31.7 | | | | 18 | 46.2 | | | | 26 | 26 | | | | |
| Widespread pain | 19 | 13.7 | | | | 12 | 30.8 | | | | 7 | 7 | | | | |
| Aggravation of pain after the earthquake | 92 | 66.2 | | | | 27 | 69.2 | | | | 65 | 65 | | | | 0.636 |
| Duration of pain (month) | | | | 30 | 52 | | | | 60 | 84 | | | | 14 | 42 | <0.001 |
| NRS (0-10) | 6 | 3 | | | | 6 | 2 | | | | 6 | 3 | | | | 0.292 |
| Fall history | 19 | 7.3 | | | | 11 | 19.6 | | | | 8 | 3.9 | | | | <0.001 |
| Number of falls after the earthquake | | | | 2 | 2 | | | | 2 | 2 | | | | 2 | 2 | 0.272 |
| Modified CCI score | | | | 0 | 2 | | | | 4 | 2 | | | | 0 | 1 | <0.001 |
| HADS-A (0-21) | | | | 8 | 5 | | | | 8 | 6 | | | | 8 | 5 | 0.230 |
| HADS-D (0-21) | | | | 8 | 6 | | | | 7 | 6 | | | | 8 | 6 | 0.729 |
| HADS total (0-42) | | | | 15 | 11 | | | | 16 | 10 | | | | 15 | 11 | 0.382 |
| PTSD-SS | | | | 13 | 13 | | | | 16 | 20 | | | | 13 | 11 | 0.144 |
| JSS (0-20) | | | | 8 | 9 | | | | 8 | 9 | | | | 8 | 8 | 0.834 |
| FES | | | | 14 | 18 | | | | 30 | 30 | | | | 12 | 2 | <0.001 |
| BBS (0-56) | | | | 56 | 3 | | | | 46.5 | 17 | | | | 56 | 1 | <0.001 |
| TSK (17-68) | | | 41.3±7.6 | | | | | 45.9±6.2 | | | | | 39.6±7.3 | | | <0.001 |

SD: Standard deviation; IQR: Interquartile range; BMI: Body mass index; TL: Turkish Lira; NRS: Numeric rating scale; CCI: Charlson Comorbidity Index; HADS-A: Hospital Anxiety and Depression Scale-Anxiety; HADS-D: Hospital Anxiety and Depression Scale-Depression; PTSD-SS: Post-traumatic stress disorder-Short Scale; JSS: Jenkins Sleep Evaluation Scale; FES: Falls Efficacy Scale; BBS: Berg Balance Scale; TSK: Tampa Scale for Kinesiophobia; a Represents at least one injury related to the earthquake; b Represents at least one first degree relatives lost.

**TABLE 2**
The correlation of fear of falling, balance and kinesiophobia scores with study variables

| | Falls Efficacy Scale | | Berg Balance Scale | | Tampa Scale for Kinesiophobia | |
|---|---|---|---|---|---|---|
| | ρ | *p* | ρ | *p* | ρ | *p* |
| Age (year) | 0.336 | <0.001 | −0.585 | <0.001 | 0.276 | 0.001 |
| Body mass index (kg/m$^2$) | 0.132 | 0.039 | −0.274 | <0.001 | 0.141 | 0,107 |
| Education status (years) | −0.272 | <0.001 | 0.358 | <0.001 | −0.212 | 0.014 |
| Monthly income (TL) | −0.162 | 0.014 | 0.138 | 0.038 | −0.106 | 0.233 |
| Days spent out of own house | −0.065 | 0.304 | 0.161 | 0.010 | 0.011 | 0.896 |
| Duration of pain | 0.255 | 0.002 | −0.357 | <0.001 | 0.134 | 0.116 |
| Numeric rating scale | 0.316 | <0.001 | −0.217 | 0.011 | 0.436 | <0.001 |
| Modified CCI score | 0.295 | <0.001 | −0.623 | <0.001 | 0.255 | 0.002 |
| HADS-A | 0.450 | <0.001 | −0.103 | 0.097 | 0.493 | <0.001 |
| HADS-D | 0.335 | 0.001 | −0.083 | 0.185 | 0.237 | 0.005 |
| HADS total | 0.440 | 0.001 | −0.107 | 0.085 | 0.403 | <0.001 |
| PTSD-SS | 0.504 | 0.001 | −0.168 | 0.007 | 0.508 | <0.001 |
| Jenkins sleep evaluation scale | 0.221 | 0.001 | −0.080 | 0.198 | 0.263 | 0.002 |
| Falls Efficacy Scale | 1 | - | −0.428 | <0.001 | 0.474 | <0.001 |
| Berg Balance Scale | −0.428 | <0.001 | 1 | - | −0.442 | <0.001 |
| Tampa Scale for Kinesiophobia | 0.474 | <0.001 | −0.442 | <0.001 | 1 | - |

FES: Falls Efficacy Scale; BBS: Berg Balance Scale; TSK: Tampa Scale for Kinesiophobia; TL: Turkish Lira; CCI: Charlson Comorbidity Index; HADS-A: Hospital anxiety and depression scale-anxiety; HADS-D: Hospital anxiety and depression scale-depression; PTSD-SS: Post-traumatic stress disorder-short scale.

### Comparison of clinical variables between older and young adults

Of the study population, 139 (53.5%) reported musculoskeletal pain with a significantly higher frequency in older adults (69.6% *vs.* 49%, p=0.006). Ninety-two (66.2%) of those with musculoskeletal pain experienced symptom aggravation after the earthquake. The NRS for pain did not significantly differ between the groups (p=0.292). Two patients from each group reported falls during the post-earthquake period. The HADS-anxiety, -depression and -total scores, as well as PTSD-SS and JSS scores were similar between the groups. However, the FES and TSK scores were higher, whereas the BBS sore was lower in older adults compared to their younger counterparts (p<0.001 for all) (Table 1).

### Correlation of falls efficacy, balance and kinesiophobia with sociodemographic and clinical variables

The FES score was significantly correlated with age, NRS-pain, HADS-anxiety, HADS-depression, HADS-total scores, and PTSD-SS score (Spearman's rho [ρ]=0.336, ρ=0.316, ρ=0.450, ρ=0.335, ρ=0.440, and ρ=0.504, respectively). The BBS score showed a negative correlation with age, duration of pain and modified CCI score (ρ=−0.585, ρ=−0.357, and ρ=−0.623, respectively). The TSK score was significantly correlated with NRS-pain, HADS-anxiety, HADS-total and PTSD-SS scores (ρ=0.436, ρ=0.493, ρ=0.403, and ρ=0.508, respectively). Moreover, all three parameters (FES, BBS and TSK) showed a correlation with each other (Table 2).

### Regression analysis results

Age, sex, comorbid disease status, education status, income level, BMI, musculoskeletal pain, and PTSD variables were included in the univariate linear regression model to identify the factors affecting the BBS scores of the participants. A significant correlation was found between the BBS score and age, education status, monthly income, BMI, CCI, and PTSD scores. The variables found to be significant in the univariate linear regression modelling were included in the multivariate linear regression modelling. None of the variables, except for age, affected the BBS score (β= −0.124; 95% CI: −0.263 to −0.185; p<0.001) (Table 3).

**TABLE 3**
Factors affecting the Berg Balance Scale score

| | Univariate+ | | | Multivariate++ | | |
|---|---|---|---|---|---|---|
| | *p* | β | 95% CI Lower-Upper | *p* | β | 95% CI Lower-Upper |
| Age | <0.001 | −0.224 | −0.263 - −0.185 | <0.001 | -0.124 | −0.193 - −0.056 |
| Sex | 0.366 | 0.767 | −0.902 - 2.437 | | | |
| CCI score | <0.001 | −0.611 | −7.584 - −4.628 | 0.453 | -0.808 | −2.928 - 1.312 |
| Education level | <0.001 | 0.626 | 0.451 - 0.801 | 0.110 | 0.156 | −0.036 - 0.347 |
| Annual income | 0.003 | 0.101 | 0.058 - 0.705 | 0.186 | 0.106 | 0.051 - 0.801 |
| Body mass index | <0.001 | −0.349 | −0.513 - −0.186 | 0.179 | -0.100 | −0.245 - 0.046 |
| Pain | 0.051 | −0.750 | −1.504 - 0.004 | | | |
| PTSD-SS | 0.003 | −0.142 | −0.236 - −0.480 | 0.891 | 0.007 | −0.092 - 0.105 |

+: Linear regression; ++: Multivariate linear regression; CI: Confidence interval; CCI: Charlson Comorbidity Index; PTSD-SS: Post-traumatic stress disorder-Short Scale; $R^2$: 0.305, Adjusted $R^2$: 0.231, Durbin Watson: 2.450.

**TABLE 4**
Factors affecting the Falls Efficacy Scale score

| | Univariate+ | | | Multivariate++ | | |
|---|---|---|---|---|---|---|
| | *p* | β | 95% CI Lower-Upper | *p* | β | 95% CI Lower-Upper |
| Age | <0.001 | 0.353 | 0.255 - 0.451 | <0.001 | 0.404 | 0.184 - 0.624 |
| Sex | 0.017 | -4.525 | −8.231 - −0.819 | 0.835 | 0.583 | −4.945 - 6.111 |
| CCI score | <0.001 | 7.811 | 4.224 - 11.398 | 0.287 | -3.770 | −10.755 - 3.214 |
| Education level | <0.001 | -1.013 | −1.421 - −0.605 | 0.150 | -0.463 | −1.097 - 0.170 |
| Annual income | 0.020 | 0.104 | 0.079 - 0.211 | 0.797 | 0.119 | 0.081 - 0.307 |
| Body mass index | 0.028 | 0.417 | 0.046 - 0.788 | 0.507 | -0.157 | −0.624 - 0.310 |
| Pain | <0.001 | 2.858 | 1.334 - 4.383 | 0.940 | -0.064 | −1.735 - 1.607 |
| PTSD-SS | <0.001 | 0.917 | 0.734 - 1.1100 | <0.001 | 0.915 | 0.583 - 1.248 |

+: Linear regression; ++: Multivariate linear regression; CI: Confidence interval; CCI: Charlson Comorbidity Index; PTSD-SS: Post-traumatic stress disorder-Short Scale; $R^2$: 0.543, Adjusted $R^2$: 0.460, Durbin Watson: 2.112.

Age, sex, comorbidity status, education status, income level, BMI, musculoskeletal pain, and PTSD-SS were included in the univariate linear regression modelling to identify the factors affecting the FES score of the participants. According to the established model, a significant correlation was found between the FES score and age, sex, CSI score, education status, annual income, BMI, musculoskeletal pain, and PTSD-SS score. The variables that were significant in the univariate linear regression modelling were included in the multivariate linear regression modelling. Age and the PTSD-SS score had a significant effect on the FES score (β= 0.404; 95% CI: 0.255 - 0.451; p<0.001 and β= 0.915; 95% CI: 0.734 - 1.110; p<0.001, respectively) (Table 3).

## DISCUSSION

In this cross-sectional study, we studied a sample of earthquake survivors to evaluate fear of falling, balance, and kinesiophobia during the post-earthquake period. One of three participants experienced earthquake-related damage to their houses and 4.6% of the study sample lost first-degree relatives. Following the earthquake, the median day spent out of their own houses was 14. More than half of the participants reported pain in at least one site of the musculoskeletal system. Two of the three participants with pain experienced symptom deterioration following the earthquake. Comparative analyses between older and young adults revealed that fear of falling and kinesiophobia scores were higher;

balance scores were lower in the elderly. Regression analyses showed that fear of falling was significantly associated with increased age and post-traumatic stress, while impaired balance was related to age.

Balance disorders, fear of falling, kinesiophobia, and falls are problems that affect the quality of life and cause various morbidities, particularly in the elderly population. The current study confirmed that older adults were more prone to experiencing balance problems, fear of falling and kinesiophobia following the earthquake compared to their younger counterparts. In this regard, particular attention should be paid to individuals aged 65 years and older in terms of protecting against balance issues and phobias related to movement and falling. Post-earthquake factors such as mood disorders and sleep problems may pave the way for these problems. Identifying these factors and performing a timely intervention seem to be valuable in terms of preventing balance disorders and falls. In the present study, post-traumatic stress appeared as a factor significantly affecting fear of falling. In the study by Tevzadze and Shakarishvili,[12] 60 patients with vestibular complaints in the first weeks following a strong earthquake were analyzed. Of the patients, benign paroxysmal positional vertigo was found in 47 and secondary vertigo was found in 11 individuals. Vertigo findings were associated with anxiety and obsessive-compulsive disorder.[12]

Fear of falling is an important factor for consequent falls. Fear of falling is regarded as a substantial predictor of the likelihood of falls in community-dwelling older adults.[24] The more individuals are afraid of falling, the more they experience falls. The ensuing restriction of activities as a result of this fear is one of the main effects, which can further increase the risk of falling by resulting in inactivity, deconditioning, and loss of confidence.[25,26] In this regard, identification of a potential fear about falling is essential. The FES is an easily administered questionnaire evaluating this parameter in the elderly population. Those with a fear of falling should be managed properly by addressing potential underlying conditions. In this study, fear of falling was found to be significantly associated with post-traumatic stress following the earthquake. Appropriate measures to protect against or overcome PTSD would be of certain benefit in preventing from fear of falling and related falls. In terms of the treatment of PTSD, behavioral techniques with/without pharmacological management can be used. Trauma-focused therapies such as prolonged exposure therapy, cognitive processing therapy, eye movement, desensitization, and restructuring are recommended for the management of PTSD.[27] Custom-tailored specific exercises may be useful to increase balance in those who have high risk of falling. Exercises mainly involving balance and functional training can reduce the risk of falls.[28] Pourhosseini et al.[2] identified 11 topics that had an impact on disaster healthcare management. These topics included managing human resources, managing resources, transferring victims' management, monitoring environmental hygiene, managing nutrition, controlling mental health, coordinating between agencies, training, managing technology, information, communication, and budgets. The current study supported the importance of mental health control among earthquake survivors. Natural disasters can result in numerous mental health issues such as anxiety, insomnia, damaged interpersonal connections, and depression.[3] Post-traumatic stress disorder is also frequent following disasters such as earthquakes.[29] Post-traumatic stress disorder may aggravate or lead to other problems and impair quality of life.[30,31] The current study, with a musculoskeletal point of view, highlighted a different facet of PTSD. Post-traumatic stress was found to be significantly associated with fear of falling in earthquake survivors. In a study by Wang et al.,[11] financial hardship was associated with fear of falling and falls, particularly recurrent falls. Relocation was inversely associated with fear of falling and social cohesion was protectively linked to fear of falling and falls. The relationships between disaster damage and fear of falling/falls were partially mediated by instrumental activities of daily living.

Combatting against PTSD is essential following any disaster, particularly for individuals with certain health issues such as fractures. Fifty months after the 2008 Sichuan earthquake, a retrospective cohort study by Ni et al.[32] assessed the impact of a rehabilitation intervention on fracture sufferers' physical dysfunction and PTSD. The results revealed that the rehabilitation strategy dramatically reduced physical dysfunction and PTSD. Continuing an exercise program following a disaster can also improve lower limb muscle strength and balance in older adults.[7] It is of value to set strategies to prevent mental health issues,[33] particularly for older earthquake survivors at high risk for psychological distress and poor health-related quality of life.[34]

Nonetheless, there are some limitations to the current study. First, the difference between older and young adults in terms of fear of falling, balance and kinesiophobia may be related to the diversities in coping. However, the study did not include a questionnaire evaluating coping after the earthquake. Second, the sample mainly included participants from Adana, which is not the main center of the earthquakes. Therefore, it is not possible to generalize the results of the study to the whole population experienced the earthquake.

In conclusion, one out of every three participants had earthquake-related home damage, and 4.6% of the study sample experienced the loss of first-degree relatives. Two/third of the participants with musculoskeletal pain reported worsening of their symptoms after the earthquake. Kinesiophobia, fear of falling, and impaired balance were more evident in the older adults. Based on the findings of this study, post-traumatic stress is substantially correlated with the fear of falling. Overall, aged individuals are at a higher risk of developing phobias of movement and falls. As a potential risk factor for increased fear of falling, PTSD should be properly managed in survivors of such disasters.

**Data Sharing Statement:** The data that support the findings of this study are available from the corresponding author upon reasonable request.

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