

2023 KAHRAMANMARAŞ DEPREMİNDEN SAĞ KALAN BİREYLERDE SOLUNUM FONKSİYONU, YAŞAM KALİTESİ VE RUH SAĞLIĞI

RESPIRATORY FUNCTION, QUALITY OF LIFE, AND MENTAL HEALTH IN THE SURVIVORS OF THE 2023 KAHRAMANMARAŞ EARTHQUAKE

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ÖZET

AMAÇ: Bu çalışma, 2023 Kahramanmaraş depremlerinin ardından ortaya çıkan çevresel koşullara maruz kalan bireylerde solunum fonksiyonu, yaşam kalitesi ve psikolojik iyilik hali üzerindeki etkileri değerlendirmeyi amaçlamıştır.

GEREÇ VE YÖNTEM: Çalışmaya toplam 100 birey katılmıştır: Deprem bölgesinde kalmaya devam eden ve "Deprem Mağduru Grubu" (DMG) olarak sınıflandırılan 50 kişi ile, depremden etkilenmeyen bölgelerden yaş ve cinsiyet açısından eşleştirilmiş 50 sağlıklı bireyden oluşan Kontrol Grubu (KG). Solunum fonksiyonu spirometri ile değerlendirilmiştir. Yaşam kalitesi ve psikolojik durum değerlendirmeleri ise Nottingham Sağlık Profili (NSP), Beck Depresyon Ölçeği (BDÖ), Pittsburgh Uyku Kalitesi İndeksi (PUKİ) ve Durumluk-Süreklilik Kaygı Envanteri (DSKE) kullanılarak yapılmıştır. Bronşiyal aşırı duyarlılığı değerlendirmek için Egzersiz Provakasyon Testi (EPT) uygulanmıştır.

BULGULAR: KG ile karşılaştırıldığında, DMG'de FVC ve FEV1/FVC değerleri anlamlı düzeyde daha düşük bulunmuştur ($p<0,05$). Ayrıca EPT sonrası FEV1 değişimi DMG'de anlamlı olarak daha yüksekti ($p<0,001$); bu durum artmış hava yolu duyarlılığına işaret etmektedir. DMG'deki bireylerin STAI, BDI ve PSQI skorları anlamlı şekilde daha yüksekti ($p<0,001$); bu da artmış psikolojik sıkıntı ve bozulmuş uyku kalitesi ile ilişkiliydi. NSP alt boyutları incelendiğinde, DMG'de ağrı, duygusal iyilik hali ve uyku alanlarında anlamlı olarak daha kötü skorlar elde edilmiştir ($p<0,05$). Deprem bölgesinde geçirilen gün sayısı ile EPT sonrası FEV1 değişimi arasında orta düzeyde pozitif bir korelasyon bulunmuştur ($r=0,374$, $p=0,007$).

SONUÇ: Deprem sonrası çevresel ve psikososyal koşullara maruz kalmak, solunum fonksiyonlarında azalmaya, depresyona ve anksiyete düzeylerinde artışa ve sağlıkla ilişkili yaşam kalitesinde düşüşe neden olmuştur. Bu bulgular, afetlerden etkilenen bireylerde hem solunum hem de ruh sağlığını hedef alan kapsamlı rehabilitasyon stratejilerine duyulan ihtiyacı ortaya koymaktadır. Gelecekte yapılacak çalışmalarda çevresel maruziyetin nesnel olarak değerlendirilmesi önem arz etmektedir.

ANAHTAR KELİMELER: Solunum fonksiyon testleri, Depremler, Yaşam kalitesi, Depresyon, Uyku kalitesi, Toz.

ABSTRACT

OBJECTIVE: This study aimed to evaluate the effects of the 2023 Kahramanmaraş earthquake on respiratory function, quality of life, and psychological well-being in individuals exposed to post-earthquake environmental conditions.

MATERIAL AND METHODS: A total of 100 individuals participated in this study: 50 individuals who remained in the earthquake zone and were categorized as the Earthquake Victim Group (EVG), and 50 age- and sex-matched healthy individuals from non-affected regions forming the Control Group (CG). Respiratory function was assessed using spirometry, while quality of life and psychological status were evaluated with the Nottingham Health Profile (NHP), Beck Depression Inventory (BDI), Pittsburgh Sleep Quality Index (PSQI), and the State-Trait Anxiety Inventory (STAI). Bronchial hyperresponsiveness was evaluated using the Exercise Provocation Test (EPT).

RESULTS: Compared to the CG, the EVG exhibited significantly lower FVC and FEV1/FVC values ($p<0,05$), and significantly greater change in FEV1 after EPT ($p<0,001$), indicating increased airway sensitivity. The EVG also demonstrated significantly higher STAI, BDI, and PSQI scores ($p<0,001$), reflecting greater psychological distress and poorer sleep quality. NHP subdomains revealed significantly worse scores in pain, emotional well-being, and sleep among EVG participants ($p<0,05$). A moderate positive correlation was observed between the number of days spent in the earthquake zone and FEV1 change after EPT ($r=0,374$, $p=0,007$).

CONCLUSIONS: Exposure to earthquake-related environmental and psychosocial conditions was associated with decreased respiratory function, elevated depression and anxiety levels, and reduced health-related quality of life. These findings underline the need for comprehensive rehabilitation strategies that address both respiratory and mental health in disaster-affected populations. Future studies with objective environmental exposure assessments are warranted.

KEYWORDS: Respiratory function tests, Earthquakes, Quality of life, Depression, Sleep quality, Dust.

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INTRODUCTION

The earthquakes of magnitude 7.7 Mw and 7.6 Mw, which took place occurred on 6 February 2023, centred in Kahramanmaraş, caused great destruction in 11 provinces. According to the latest official data, 14 million people, constituting 16% of Turkey's population, were affected by this earthquake and more than 48 thousand people died, and 100 thousand people were injured (1). One of the critical public health concerns following large-scale earthquakes is exposure to environmental dust released from damaged structures. This dust comprises a complex mixture of hazardous particles, including but not limited to asbestos, cement dust, silica, glass fibers, and various chemical residues (2). The inhalation of such particulate matter may have acute and chronic adverse effects on the respiratory system (3).

Among these, asbestos has been extensively studied for its well-documented health risks. Once celebrated for its insulating and durable properties, asbestos was later classified as a carcinogenic substance and ultimately banned in Türkiye in 2010 (3). Nonetheless, it remains a concern in older buildings, especially those constructed prior to regulation. Asbestos-containing materials may still be present in insulation systems, roofing materials, and fireproof coatings. Notably, several regions severely impacted by the 2023 earthquakes coincide with areas of high environmental asbestos density (4). When buildings collapse or are demolished, asbestos and other dust particles may become airborne, posing health risks to both rescuers and residents.

Inhalation is the most critical route of exposure for such airborne dust. Studies have linked exposure to asbestos and cement dust with impairments in respiratory function. For example, Neghab et al. and Hossein et al. reported significant reductions in spirometric parameters such as FVC, FEV1, and FEF25-75% among workers exposed to cement dust (5, 6). Likewise, Balbay et al. highlighted that post-earthquake pulmonary dysfunction may stem from bronchial inflammation triggered by inhaled particulates (7).

Beyond the direct respiratory consequences, earthquakes also introduce significant psychosocial and neurophysiological stressors

that may further compromise health. Post-earthquake dizziness and balance disturbances, as described by Vivek et al. and Cengiz et al., have been associated with vestibular dysfunction, neural disruption, and psychological trauma (8,9). Moreover, respiratory symptoms like dyspnea can negatively impact sleep quality and overall quality of life, compounding the long-term burden on survivors (10).

Although post-disaster mental health outcomes have been a focus of many studies following the Kahramanmaraş earthquakes (8,11,12), there remains a lack of research that directly examines the combined physiological and psychological impact of environmental dust exposure in earthquake survivors. This gap is especially important considering the prolonged presence of individuals in heavily dust-contaminated environments. Supporting this concern, recent field measurements conducted in Hatay one of the most severely affected provinces reported average respirable dust concentrations of 30.84 mg/m³ and peaks up to 97.81 mg/m³. In addition, SEM-EDX analyses confirmed the presence of asbestos-like fibrous structures and toxic elements in post-earthquake dust samples (13). These findings provide concrete environmental evidence that complements previous assumptions regarding dust exposure in the affected region.

Therefore, this study aims to investigate the effects of environmental dust exposure including asbestos and other particulate matter on respiratory function, health-related quality of life, and psychological well-being in individuals who remained in the earthquake zone following the 2023 Kahramanmaraş earthquakes.

MATERIAL AND METHOD

Participants

We calculated (G Power Version 3.1.9.4, Franz Faul, Universitat Kiel, Germany) power of 95% with 0.05 significance, a difference to be detected of 0.11 liters in forced vital capacity (FVC) values (14), generating a sample of 50 patients per group. Fifty individuals in the earthquake victim group (EVG) and 50 age-matched control group (CG) participated in this study.

The individuals included in the study were divided into two groups as the EVG consisting of individuals affected by the Kahramanmaraş earthquake on 6 February 2023 and the CG consisting of healthy individuals. The EVG included individuals who were over 18 years of age, who stayed in the earthquake zone after the Kahramanmaraş earthquake and who were exposed to debris-induced dust, and able to cooperate with the measurements and tests. Those with orthopaedic, neurological, vestibular, psychiatric, cardiac or pulmonary disorders that may prevent them from completing the tests, those who had acute infections in the last 15 days, those working in a job that may cause occupational lung diseases and pregnant women were excluded. The CG was composed of healthy, age- and sex-matched individuals residing in Kayseri, a city not affected by the earthquakes. Participants in this group had no history of chronic disease or occupational exposure to respiratory hazards, and were also required to cooperate with all measurements.

Setting

All measurements were conducted in April 2023, approximately 30–45 days after participants had left the earthquake zone. EVG participants were assessed in temporary clinical units established in the earthquake zone, while CG participants were evaluated at Kayseri Nuh Naci Yazgan University Health Sciences Faculty Laboratory. The EVG participants primarily consisted of individuals who had resided in Hatay and Kahramanmaraş, two of the most severely affected provinces during the 2023 earthquakes. Each participant's duration of dust exposure was documented through structured interviews.

Operator and Measurement Standardization

To minimize inter-rater variability, all spirometric and exercise testing procedures were performed by the same physiotherapist, who was trained and certified according to ATS/ERS guidelines. The operator was blinded to the group allocation to reduce performance bias. Although no formal inter-rater reliability study was conducted, all procedures followed a pre-defined protocol to ensure standardization.

Lung Function Test

To evaluate respiratory function, spirometry was performed using the Cosmed Pony FX Spirometer (Milan, Italy) in accordance with the American Thoracic Society/European Respiratory Society (ATS/ERS) guidelines. Measurements included forced expiratory volume in one second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, forced expiratory flow at 25–75% of FVC (FEF25–75%), and peak expiratory flow (PEF). The test was conducted in a seated position, and at least three technically acceptable trials were obtained. To ensure reliability, the two highest FEV1 values were required to differ by no more than 5%, and the best value was selected for analysis (15).

Nottingham Health Profile (NHP)

General quality of life was determined with the NHP. In our study, the form of the NHP that was adapted to the Turkish population and whose validity and reliability were performed was used (16). The scale evaluates various challenges individuals may face in daily life, categorized under seven subheadings: pain, emotional responses, sleep, social isolation, physical activity, and energy expenditure. Yes-no answers are given to the questions and the corresponding scores are summed. High scores indicate that quality of life is affected (16).

Exercise Provocation Test (EPT)

The EPT was conducted to assess airway sensitivity to exercise and determine the presence of bronchial hyperreactivity due to debris exposure in earthquake survivors. No pharmacological agents or chemical stimulants were administered during the test. Participants were instructed to wear comfortable clothing and sports shoes and to refrain from engaging in vigorous physical activity for at least four hours prior to testing. At the beginning of the test, baseline FEV1 was recorded. The exercise protocol commenced at a low speed, with the target of reaching 80–90% of the participant's age-predicted maximum heart rate (calculated as 220 minus age) within the first 2–3 minutes. The total test duration aimed to be 6–8 minutes, with participants maintaining the target heart rate for at

least four minutes before test termination. Following exercise cessation, FEV1 was measured at 1, 3, 5, 10, 15, 20, and 30 minutes post-exercise. Given the need for rapid post-exercise spirometric assessment, only a single measurement was obtained at each time point. The FEV1 value demonstrating the greatest decline from baseline was selected for analysis. A reduction of 12% or more in FEV1 was considered indicative of bronchial hyperreactivity (17).

Beck Depression Inventory (BDI)

Participants' depression levels were measured using the Turkish-adapted Beck Depression Inventory (BDI), a validated 21-item self-report scale. Each item is scored from 0 to 3, with higher total scores indicating greater depression severity. Standardized cut-off values classify scores as normal (1-10), mild (11-16), borderline (17-20), moderate (21-30), severe (31-40), and extreme depression (41-63). The Turkish version of the BDI is widely used in clinical and research settings for assessing depressive symptoms (18).

Pittsburgh Sleep Quality Index (PSQI)

Sleep quality was assessed using the PSQI, a widely validated self-report instrument designed to measure sleep quality and disturbances over a one-month period. The Turkish adaptation and validation of the PSQI were conducted by Ağargün et al. (19). The scale comprises 24 items, 19 of which are completed by the individual and 5 by a bed partner. However, only the 19 self-reported items are included in the evaluation, while the bed partner's responses are excluded. These 19 items assess seven subcomponents: subjective sleep quality, sleep duration, sleep latency, sleep disturbances, habitual sleep efficiency, daytime dysfunction, and use of sleep medication. The PSQI provides a comprehensive assessment of sleep patterns and has been widely utilized in both clinical and research settings to evaluate sleep-related issues.

The State-Trait Anxiety Inventory (STAI)

Individuals' anxiety levels were assessed using the STAI, a validated scale by Öner and Lecompte (1985). It consists of two subscales, state and trait anxiety, with total scores ranging from 20 to 80. The Likert-type scale has four response options, from "not at all" to "completely," where higher scores indicate greater anxiety levels (20).

Study Design

A total of 100 individuals, 50 in the study group and 50 in the control group, were included in the study as a result of the power analysis. Individuals who were extracted from under the rubble and exposed to dust from debris in the earthquake zone were evaluated at least 30 days after exposure. The data obtained were compared with the control group. At the same time, the duration of exposure was determined by questioning the day and time of exposure to dust and its relation with possible symptoms, if any, was analysed.

Ethical Committee

The study was conducted in accordance with the Declaration of Helsinki, and was approved by the Nuh Naci Yazgan University Clinical Research Ethics Committee (protocol code 2023/003-008, approval date: 30 March 2023).

Statistical Analysis

Statistical analyses and visualizations were performed using SPSS Statistics 27.0 (IBM, Armonk, NY) and GraphPad Prism 9.0.0 (GraphPad Software, San Diego, CA). Data were presented as mean \pm standard deviation, median (min-max), frequencies, and percentages. The Kolmogorov-Smirnov test assessed normality. Student's t-test compared EVG and CG groups, while Chi-square tests (Pearson's and Yates-corrected) analyzed categorical variables. Spearman's correlation evaluated relationships between numerical variables due to non-normal distribution. A p-value < 0.05 was considered statistically significant.

RESULTS

Participant characteristics

Participant characteristics are presented in **Table 1**. No significant differences were found between the study and control groups in terms of age, gender, body weight, height, BMI, or smoking history ($p > 0.05$ for all variables). The mean age was 32.24 ± 8.64 years in the EVG and 31.52 ± 7.02 years in the CG ($p = 0.649$). Smoking history also demonstrated no significant differences ($p = 0.943$). Among participants in EVG, the mean duration of stay in the earthquake zone was 15.74 ± 5.14 days.

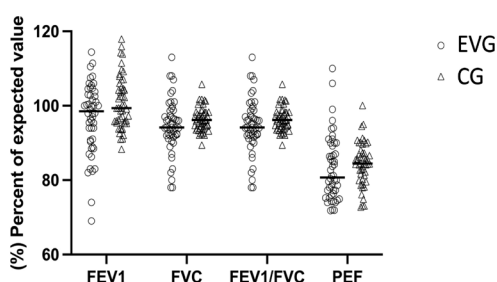
Table 1: Physical and demographic characteristics in study and control groups

Parameter	EVG (n=50)	CG (n=50)	p-value
	X±SD	X±SD	
Age (years)	32.24±8.64	31.52±7.02	0.649
Gender (male/female)	37/13	41/9	0.470*
Weight (kg)	70.56±9.79	74.52±6.62	0.051
Height (cm)	173.36±8.23	175.30±6.76	0.201
BMI (kg/m ²)	23.42±2.97	23.95±1.96	0.303
Smoking (pack-years)	6.85±8.37	6.96±6.57	0.943

Student t-test. *Chi-square test (Fisher's exact test). BMI: Body Mass Index, EVG: Earthquake Victim Group, CG: Control Group.

Lung function test

The lung function test results of the groups are presented in Figure 1. FVC and FEV1/FVC values were significantly decreased in the EVG compared to the CG ($p = 0.034$ and $p = 0.007$, respectively, **Figure 1**). The average FVC in EVG was $97.20 \pm 10.02\%$, compared to $100.92 \pm 6.98\%$ in the CG. Similarly, the FEV1/FVC in EVG was $79.83 \pm 5.79\%$, while it was $82.22 \pm 2.04\%$ in the CG. In contrast, FEV1 and PEF values showed no significant group differences ($p = 0.130$ and $p = 0.137$, respectively). The average FEV1 was $94.61 \pm 7.25\%$ in the EVG and $96.42 \pm 3.15\%$ in the CG, while PEF was $82.69 \pm 9.38\%$ in the EVG and $84.51 \pm 5.68\%$ in the CG.

**Figure 1:** Comparison of lung function parameters between group

Comparison of measured parameters between groups

The change in FEV1 after EPT was significantly greater in the EVG ($6.66 \pm 3.64\%$) than in the CG ($2.54 \pm 2.08\%$) ($p < 0.001$), indicating increased airway sensitivity in the EVG (**Table 2**). Similarly, PSQI scores were markedly elevated in the EVG (12.78 ± 2.83) compared to the CG (5.66 ± 2.20) ($p < 0.001$), indicating poorer sleep quality. Anxiety and depression levels were also significantly higher in the EVG as shown by STAI (54.30 ± 10.30 vs. 30.96 ± 10.07) and BDI scores (31.76 ± 9.73 vs. 10.92 ± 7.99) ($p < 0.001$ for both). Analysis of the Nottingham

Health Profile (NHP) sub-scores revealed that pain scores were significantly higher in the EVG (28.66 ± 34.18) than in the CG (1.83 ± 5.01) ($p < 0.001$). Emotional distress scores were also increased in the EVG (21.31 ± 25.45) compared to the CG (7.40 ± 5.83) ($p < 0.001$). Sleep disturbance scores were worse in the EVG (23.20 ± 24.77) than in the CG (2.47 ± 7.79) ($p < 0.001$). In addition, physical activity scores were elevated in the EVG (17.27 ± 14.18) compared to the CG (10.90 ± 10.08) ($p = 0.011$). No significant difference was found in the social isolation domain ($p = 0.126$). However, energy levels were significantly lower in the EVG (32.59 ± 37.15) compared to the CG (43.12 ± 14.09) ($p < 0.001$).

Table 2: Comparison of measured parameters between groups

Parameter	EVG (n=50)	CG (n=50)	p-value
	X±SD	X±SD	
FEV1 change after the EPT	6.66±3.64	2.54±2.08	<0.001*
PSQI	12.78±2.83	5.66±2.20	<0.001*
STAI	54.30±10.30	30.96±10.07	<0.001*
BDI	31.76±9.73	10.92±7.99	<0.001*
Nottingham Health Profile (NHP) sub-scores			
NHP-pain	28.66±34.18	1.83±5.01	<0.001*
NHP-emotional	21.31±25.45	7.40±5.83	<0.001*
NHP-sleep	23.20±24.77	2.47±7.79	<0.001*
NHP-social	12.37±19.47	7.82±7.45	0.126
NHP-physical	17.27±14.18	10.90±10.08	0.011*
NHP-energy	32.59±37.15	43.12±14.09	<0.001*

*The bold values represent statistically significant $p < 0.05$ values. Student t-test. FEV1: Forced expiratory volume in one second, EPT: Exercise Provocation Test, PSQI: Pittsburgh Sleep Quality Index, STAI: The State-Trait Anxiety Inventory, BDI: Beck Depression Inventory, EVG: Earthquake Victim Group, CG: Control Group.

Relationship between the number of days spent in the earthquake zone and the measured parameters

As shown in **Table 3**, there was no significant correlation between the number of days spent in the earthquake zone and FVC ($r = 0.059$, $p = 0.682$), FEV1 ($r = -0.173$, $p = 0.228$), or FEV1/FVC ($r = -0.195$, $p = 0.175$). Although a positive trend was observed for PEF ($r = 0.187$, $p = 0.194$), it did not reach statistical significance. A moderate positive correlation was found between the number of days spent in the earthquake zone and the decline in FEV1 following the exercise provocation test ($r = 0.374$, $p = 0.007$). There were no significant correlations between the duration of exposure and STAI ($r = 0.049$, $p = 0.734$) or BDI ($r = 0.155$, $p = 0.283$) scores. PSQI also showed a non-significant positive trend ($r = 0.216$, $p = 0.132$). Regarding the Nottingham Health Profile (NHP) subdomains, near-significant correlations were identified for pain ($r = 0.263$, $p = 0.065$) and emotional status ($r = 0.246$, $p = 0.085$). No statistically significant correlation was observed for the other NHP domains (all $p > 0.05$).

Table 3: Relationship between the number of days spent in the earthquake zone and the measured parameters in earthquake victim group

Parameter	Number of days in the earthquake zone	
	r	p-value
FVC	0.059	0.682
FEV ₁	-0.173	0.228
FEV ₁ /FVC	-0.195	0.175
PEF	0.187	0.194
FEV ₁ change after the EPT	0.374	0.007*
STAI	0.049	0.734
BDI	0.155	0.283
PSQI	0.216	0.132
NHP-pain	0.263	0.065
NHP-emotional	0.246	0.085
NHP-sleep	0.173	0.231
NHP-social	-0.060	0.680
NHP-physical	-0.119	0.409
NHP-energy	0.116	0.422

*The bold values represent statistically significant $p < 0.05$ values, Spearman correlation analysis. Student t-test. FVC: Forced vital capacity, FEV₁: Forced expiratory volume in one second, PEF: Peak expiratory flow, EPT: Exercise Provocation Test, STAI: The State-Trait Anxiety Inventory, BDI: Beck Depression Inventory, PSQI: Pittsburgh Sleep Quality Index, NHP: Nottingham Health Profile, EVG: Earthquake Victim Group, CG: Control Group.

DISCUSSION

This study examined the effects of the number of days spent in the earthquake zone on respiratory function, psychological status, sleep quality, and health-related quality of life (HRQoL). The findings revealed significant impacts, particularly in FEV₁ changes after EPT and psychological metrics, highlighting the health challenges faced by earthquake victims.

Studies investigating the adverse effects of debris-related dust on respiratory function are limited. Balbay et al. observed respiratory dysfunction due to significant bronchial inflammation in individuals affected by the 2023 Kahramanmaraş earthquakes (7). Similarly, Mohammad et al. (21) reported a marked increase in respiratory-related hospital visits in the aftermath of the earthquake, attributing this to airborne particulate matter and debris-derived pollutants. However, respiratory function test was not applied in these studies. These findings reinforce the role of environmental exposure in exacerbating respiratory function. Another study conducted by Neghab et al. in employees of a cement industry in Shiraz, Iran, respiratory function test parameters (VC, FVC, FEV₁, PEF and FEF_{25-75%}) of those exposed to cement dust were significantly decreased compared to those not exposed (6). In our study, the EVG demonstrated significantly lower FVC and FEV₁/FVC values compared to the CG, indicating impaired respiratory function. These findings align with the established adverse effects of chronic stress and trauma on airway responsiveness. Furthermore, the significant increase in FEV₁ changes following EPT in the EVG ($p < 0.001$) suggests a heightened

risk of exercise-induced bronchospasm among individuals residing in the earthquake zone.

The psychological impacts of disasters, particularly on sleep quality and anxiety levels, are profound. Güçsav et al. (22) identified a deterioration in asthma control among adults affected by the earthquakes, linking it to heightened stress and psychological distress. Ahmed et al. (23) further emphasized that debris pollution not only exacerbates physical health issues but also contributes to environmental stress, amplifying its effects on overall well-being and mental health. The EVG displayed significantly higher STAI and BDI scores, indicating elevated anxiety and depression levels in this group (both $p < 0.001$). Furthermore, the significantly higher PSQI scores in the EVG ($p < 0.001$) demonstrate the profound impact of traumatic events, such as earthquakes, on sleep quality. These findings are consistent with literature reporting the prevalence of sleep disturbances in post-disaster populations (12, 24). A study emphasized that sleep problems are among the most prevalent health concerns of disaster survivors, with short sleep duration, poor sleep quality, and insomnia symptoms being commonly reported. The study emphasized that disaster-related experiences and damages are linked to persistent sleep problems among older survivors (24). Furthermore, research has demonstrated that earthquake survivors experience various types of sleep problems, with prevalence rates ranging from 10.7% to 83.2%. The duration and quality of sleep tend to decrease after earthquakes, while insufficient sleep and insomnia problems increase significantly (12). Consistent with this, our study found elevated PSQI scores in the EVG, indicating poor sleep quality.

Post-disaster reductions in quality of life, particularly in the domains of physical health, emotional well-being, and sleep, are well-documented. Mavroulis et al. (25) emphasized that debris-derived dust adversely impacts not only respiratory health but also the general well-being of affected individuals. These observations align with our findings of deteriorations in NHP subscale scores, particularly in pain, emotional well-being, and sleep dimensions. Furthermore, Bayram et al. emphasized the multidimen-

sional health impacts of large-scale earthquakes, highlighting the need for comprehensive assessments of both physical and psychological health (21). Capar et al. (26) reported that exposure to earthquakes significantly impaired individuals' quality of life, encompassing psychological, physical, and environmental dimensions. Another study examined the HRQoL and academic achievement of Turkish university students six years after the Marmara earthquakes. A total of 407 participants were assessed. Findings indicate that earthquake survivors scored significantly lower in the psychological and environmental domains of HRQoL as well as in academic achievement compared to their non-exposed peers. Key risk factors adversely impacting survivors' HRQoL include gender, age during the earthquake, and ongoing financial challenges resulting from the disaster (27). In present study, NHP subdomains revealed significantly poorer outcomes in pain, emotional well-being, and sleep scores in the EVG. High scores in the pain and emotional well-being subdomains suggest that earthquake survivors face greater physical and emotional challenges. Lower energy subdomain scores in the EVG further indicate reduced overall vitality in this group. These results underscore the substantial physical and emotional health burdens associated with post-earthquake living conditions.

Furthermore, qualitative evidence supports our findings regarding the vulnerability of respiratory and chronic disease patients in post-earthquake conditions. In a study conducted by Dogan et al. (28), individuals with chronic conditions reported exacerbation of symptoms such as increased cough and mucus retention due to overcrowded, poorly ventilated temporary shelters following the 2023 Kahramanmaraş earthquakes. These environmental hardships were identified as critical barriers to effective disease management in the acute post-disaster phase. The study also revealed that lack of access to medications, fear of asking for essential medical equipment, and shifting survival priorities negatively affected the management of existing health conditions. These findings complement our data by providing contextual insight into how post-disaster

environments may further compromise respiratory health and psychological well-being.

Although our study did not include direct environmental dust analysis, recent measurements conducted in Hatay one of the earthquake-affected provinces confirmed high levels of respirable dust following the 2023 Kahramanmaraş earthquakes. Oral et al. reported average respirable dust concentrations of 30.84 mg/m^3 and peak levels up to 97.81 mg/m^3 during a five-day monitoring period. Elemental analyses via SEM-EDX revealed the presence of asbestos-related fibrous structures and various toxic elements (13). These findings validate the environmental hazard assumptions underlying our research and support the plausibility of dust-related respiratory impairments. Although no significant correlations were observed between the number of days spent in the earthquake zone and most respiratory function and psychological parameters, a positive correlation was found between FEV1 changes after EPT ($r = 0.374$, $p = 0.007$) and the duration of exposure. This suggests that prolonged exposure to earthquake-related conditions may exacerbate airway hyperreactivity. Near-significant correlations in NHP pain ($p = 0.065$) and emotional well-being ($p = 0.085$) subdomains further support the potential influence of prolonged disaster-related stress on health outcomes. The lack of significant correlations between the number of days spent in the earthquake zone and most measured parameters could stem from several factors. Individual differences in resilience and coping mechanisms may have mitigated the impact of exposure on health outcomes. Additionally, the absence of direct measurements of dust intensity, such as PM_{2.5} or asbestos levels, may have limited the ability to assess true exposure effects. Protective behaviors, like mask usage, and varying physical activity levels in the zone could also have influenced results. Lastly, the exposure duration might not have been sufficient to induce cumulative health effects detectable within the study's timeframe. Future research with more precise exposure assessments and long-term follow-up is essential to clarify these relationships.

Although the assessments in this study were conducted approximately 30–45 days after participants had left the earthquake zone following an average dust exposure period of 15.74 days, prior research has shown that inflammatory responses in the lungs, as well as psychological consequences such as anxiety, sleep disturbances, and stress-related symptoms, may persist for weeks or even months following environmental disasters (29,30). Therefore, while some acute effects of dust exposure might have diminished by the time of evaluation, the persistence of significant impairments across multiple parameters suggests that the observed findings still reflect meaningful post-exposure health consequences. Despite this temporal limitation, the study remains valuable as one of the first to quantitatively examine both respiratory and psychosocial outcomes in survivors of the 2023 Kahramanmaraş earthquakes.

This study provides critical insights into the physical and psychological health of earthquake survivors. The findings highlight the importance of holistic interventions addressing respiratory health, sleep disturbances, and psychosocial support in post-disaster populations. Particular attention should be given to exercise-induced respiratory changes and stress-related issues, as these can significantly impact long-term health. Health policies and rehabilitation strategies in disaster settings should prioritize these aspects for better outcomes.

This study has several limitations that should be considered when interpreting the findings. First, although direct environmental assessments such as on-site air quality monitoring or asbestos sampling were not conducted within this study, recent independent field measurements from the same region confirmed elevated respirable dust concentrations and the presence of asbestos-like fibers. These external data support the plausibility of the environmental exposure discussed here but do not substitute for individual-level exposure quantification.

Additionally, the study did not control for confounding factors such as use of protective masks, personal sensitivity to environmental irritants, or differences in physical activity levels during exposure. These variables may have influenced individual outcomes.

Finally, while the sample size was statistically adequate for detecting group differences, it may not fully represent the diverse experiences of all earthquake survivors. Nevertheless, this study offers considerable value by being among the first to investigate the combined respiratory and psychological effects of environmental dust exposure in the context of a major natural disaster.

In conclusion, this study underscores the need for comprehensive health strategies to mitigate the physical and psychological impacts of living in disaster-prone areas, thereby improving the overall well-being of affected populations. These observations underscore the necessity for further investigation into the long-term impact of chronic stress and environmental exposures on respiratory health. These findings demonstrate the need for more comprehensive studies on post-debris dust exposure and psychological impacts, as well as the importance of debris management and environmental protection strategies. Such strategies could play a critical role in mitigating health effects and improving the overall quality of life for affected individuals. Future research should involve larger and more diverse cohorts, with a focus on variables such as stress, air pollution, and social support. Longitudinal studies are also needed to better understand the long-term health effects of traumatic events like earthquakes. Importantly, this study fills a critical gap in the literature by being one of the first to present quantitative evidence of respiratory and psychological outcomes associated with post-earthquake dust exposure, underscoring its scientific and public health relevance.

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