Research Article / Araştırma Makalesi

Impact of Massive Trauma on Brain Structures: MRI Volumetric Analysis Post-February 6 Earthquake

Masif Travmanın Beyin Yapıları Üzerindeki Etkisi: 6 Şubat Depremi Sonrası MR Volümetrik Analizi

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Abstract

Background: This study aims to investigate the impact of the February 6 earthquake on brain structures, particularly mood centers, using MRI volumetric analysis.
Materials and Methods: In this retrospective study, 20 neurology clinic patients who were treated at a neurology clinic and underwent brain MRI both before and after the earthquake (2022–2023). MRI scans were analyzed within one year prior to and after the disaster. Patient data included age, gender, MRI indications and medical history. Inclusion criteria required participants to have experienced headaches but excluded those with neurodegenerative diseases, head trauma, or other structural brain pathologies. The volBrain method was used to assess total brain, white and grey matter, cerebrospinal fluid, limbic system (hippocampus, parahippocampal gyrus, amygdala, hypothalamus, cingulate gyrus, entorhinal cortex), prefrontal cortex, cerebellum, and thalamus via 3T MRI T1 sequences. All participants had experienced first-degree relative loss or home destruction.
Results: The study group comprised 65% women and 35% men, with a mean age of 42.15 ± 8.41 years. Significant volumetric changes were observed in several brain regions post-earthquake. White matter volume decreased significantly (p=0.011), while CSF volume increased (p=0.017), and total brain volume showed a significant reduction (p=0.025). The cerebellum exhibited significant volume reductions, including total volume (p=0.023), as well as the right (p=0.021) and left hemispheres (p=0.029). Similarly, the thalamus demonstrated significant reductions in total volume (p=0.008), right hemisphere (p=0.009), and left hemisphere (p=0.010). Conversely, the posterior cingulate gyrus (PCgG) showed significant volume increases in total (p=0.007), right (p=0.023), and left hemispheres (p=0.012).
Conclusions: The findings reveal significant volumetric changes in specific brain regions suggesting neurobiological effects of acute stressor trauma caused by the earthquake. These changes highlight the need for further studies to understand the mechanisms underlying these alterations and to develop interventions aimed at mitigating the long-term effects of such traumatic events.

Keywords: Limbic system, Mrı volumetric analysis, Earthquake, Disaster, Massive trauma, Neuroimaging

Öz

Amaç: Bu çalışma, 6 Şubat depremi sonrası beyin yapıları üzerindeki etkileri, özellikle duygu durumla ilişkili merkezleri Manyetik Rezonans Görüntüleme (MRG) volümetrik analizi kullanarak incelemeyi amaçlamaktadır.
Materyal ve Metod: Bu retrospektif çalışma, nöroloji kliniğinde takip edilen ve beyin MRG'i hem deprem öncesinde hem de sonrasında çekilmiş 20 hastayı (2022-2023) içermektedir. MRG taramaları, felaketten önceki ve sonraki bir yıl içinde analiz edilmiştir. Çalışmaya dahil edilen hastaların yaşı, cinsiyeti, MRG endikasyonları ve tıbbi öyküsü kaydedilmiştir. Dahil edilme kriterleri baş ağrısı öyküsü bulunan bireyleri kapsarken, nörodejeneratif hastalıkları, kafa travması veya diğer yapısal beyin patolojileri olan hastalar çalışmadan dışlanmıştır. Beyin hacminin volümetrik analizi için volBrain yöntemi kullanılmıştır. 3T MRG T1-ağırlıklı sekanslar ile toplam beyin hacmi, beyaz madde, gri madde, beyin omurilik sıvısı (BOS) ve limbik sistem (hipokampus, parahipokampal girus, amigdala, hipotalamus, singulat girus, entorinal korteks), prefrontal korteks, beyincik ve talamus gibi belirli beyin bölgeleri değerlendirilmiştir. Çalışmaya katılan tüm hastalar deprem nedeniyle birinci derece yakın kaybı yaşamış veya evleri yıkılmış bireylerden oluşmaktadır.
Bulgular: Çalışma grubunun %65'i kadın, %35'i erkek olup, yaş ortalaması 42,15 ± 8,41 yıldır. Deprem sonrası birçok beyin bölgesinde anlamlı volümetrik değişiklikler gözlemlenmiştir. Beyaz madde hacmi belirgin şekilde azalırken (p=0,011), BOS hacmi artmıştır (p=0,017). Toplam beyin hacminde anlamlı bir azalma saptanmıştır (p=0,025). Beyincik toplam hacmi (p=0,023) ile sağ (p=0,021) ve sol hemisferleri (p=0,029) anlamlı küçülme göstermiştir. Benzer şekilde, talamus toplam hacmi (p=0,008), sağ (p=0,009) ve sol hemisferleri (p=0,010) anlamlı olarak azalmıştır. Buna karşın, posterior singulat girus (PCgG) toplam (p=0,007), sağ (p=0,023) ve sol (p=0,012) hemisferlerinde belirgin hacim artışı göstermiştir.
Sonuç: Elde edilen bulgular, akut stres veya travmanın nörobiyolojik etkilerini yansıtan belirgin beyin hacmi değişikliklerine işaret etmektedir. Bu değişimler, deprem gibi travmatik olayların uzun vadeli etkilerini anlamak ve bu etkileri azaltmaya yönelik müdahaleler geliştirmek için ileri çalışmalara duyulan ihtiyacı ortaya koymaktadır.

Anahtar Kelimeler: Deprem kaynaklı travma, MRG volümetrik analiz, Limbik sistem, Deprem, Nörogörüntüleme

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Introduction

Massive trauma lacks a universally accepted definition due to the diverse nature of traumatic events. However, it can be quantitatively characterized by the large-scale impact on individuals during catastrophic events such as earthquakes, wars, or major terrorist attacks (1). On February 6, 2023, two powerful earthquakes with magnitudes of 7.7 and 7.5 struck the Kahramanmaraş region of Turkey. These earthquakes caused extensive destruction, a significant loss of life, and numerous injuries, with Hatay experiencing the most severe devastation and casualties. The widespread trauma resulting from these events profoundly impacted the region.

Natural disasters like earthquakes are among the most severe and unpredictable stressors, significantly affecting individuals' mental and physical health (2, 3). Massive trauma has been shown to induce physiological changes in the brain, particularly in regions associated with memory, emotional regulation, and threat detection (4, 5). Acute stress from traumatic events has been linked to various neuropsychiatric outcomes, including post-traumatic stress disorder (PTSD), anxiety and depression (6, 7). Increasing evidence suggests that significant stressors can alter both brain structure and function, particularly in regions involved in mood regulation and cognitive processing, such as the limbic system, prefrontal cortex, cerebellum, and thalamus (8). These regions are known to be especially vulnerable to the effects of acute stress and trauma (8).

Recent advancements in neuroimaging, particularly magnetic resonance imaging (MRI) with volumetric analysis, have enabled researchers to quantify structural changes in these critical brain regions. These methods have provided valuable insights into the neural correlates of trauma (9-11). However, despite these advancements, the specific effects of large-scale disasters, such as earthquakes, on brain structures remain poorly understood.

The devastating February 6 earthquake, which caused significant loss of life and property, offers a unique opportunity to explore the neurological impacts of massive trauma. This study focuses on individuals who experienced severe stress, such as the loss of a first-degree relative or home destruction. Using MRI-based volumetric analysis, this study aims to evaluate structural alterations in the limbic system, prefrontal cortex, cerebellum, thalamus, and other related brain regions.

Materials and Methods

This cross-sectional study was conducted at a single center between 2022 and 2023. Ethical approval was obtained from the Mustafa Kemal University Local Ethics Committee (Approval No: 2024.07.09/10).

All procedures were performed in accordance with the principles outlined in the Declaration of Helsinki. The study retrospectively included 20 patients followed up in the neurology clinic who underwent brain MRI examinations both before and after the February 6, 2023 earthquake. The data were retrieved from the archives of the Department of Radiology.

Patients aged 18 to 60 years who experienced significant trauma, such as first-degree relative loss or home destruction due to the earthquake, were included in the study. Exclusion criteria included a history of stroke, psychiatric illnesses such as psychosis, schizophrenia, or major depression, brain tumors, epilepsy, head trauma with loss of consciousness during the earthquake, or limb loss resulting from the disaster. Patients' demographic data, including age, gender, the reason for MRI request, and known medical history, were recorded. Written and verbal informed consent was obtained from all participants, explaining the purpose of the study and the use of MRI examinations.

MRI Acquisition

Conventional brain MRI examinations were performed using a GE-3 Tesla Signa Architect MRI device located in the Department of Radiodiagnostics. Structural MRI data were acquired using the T1-weighted brain volume sequence. The imaging parameters were set as follows: a repetition time (TR) of 2220 ms, an echo time (TE) of 2.8 ms, a field of view (FOV) of 22.4 mm, a flipangle of 8°, 220 slices, and a voxel size of 1.0 × 1.0 × 1.4 mm.

Segmental volumetric analysis of the brain structures was carried out using the volBrain algorithm, an open-access platform for MRI-based brain analysis. The volBrain platform (http://volbrain.upv.es) is an AI-powered system that processes brain MRI images to provide volumetric data for various brain regions (12). The process includes loading T1-weighted images, quality control, removal of non-brain structures, correction and normalization, automated tissue classification, segmentation and parcellation of brain regions, volume calculation and reporting (13). In this study, T1-weighted images were converted from DICOM to NIfTI format using MRI cron software. Anonymized and compressed NIfTI (nii.gz) files, alongwith the participants' age and gender, were uploaded to the volBrain platform, which provided volumetric measurements and normal reference values for each tissue or structure.

The analysis encompassed total brain volume, cerebrospinal fluid (CSF) volume, and specific brain region volumes such as the hippocampus, parahippocampal gyrus, amygdala, hypothalamus, posterior cingulate gyrus, entorhinal cortex, prefrontal cortex, thalamus and cerebellum. These volumes were calculated for both the left and right hemispheres, where applicable (Figure 1).

Statistical Analysis

Data analysis was conducted using SPSS software (version 25). Descriptive statistics, including frequencies and percentages for categorical variables and means with Standard deviations for continuous variables, were used to summarize the data. The Wilcoxon Signed-Rank Test was employed to compare volumetric measurements obtained before and after the earthquake. A p-value of less than 0.05 was considered statistically significant.

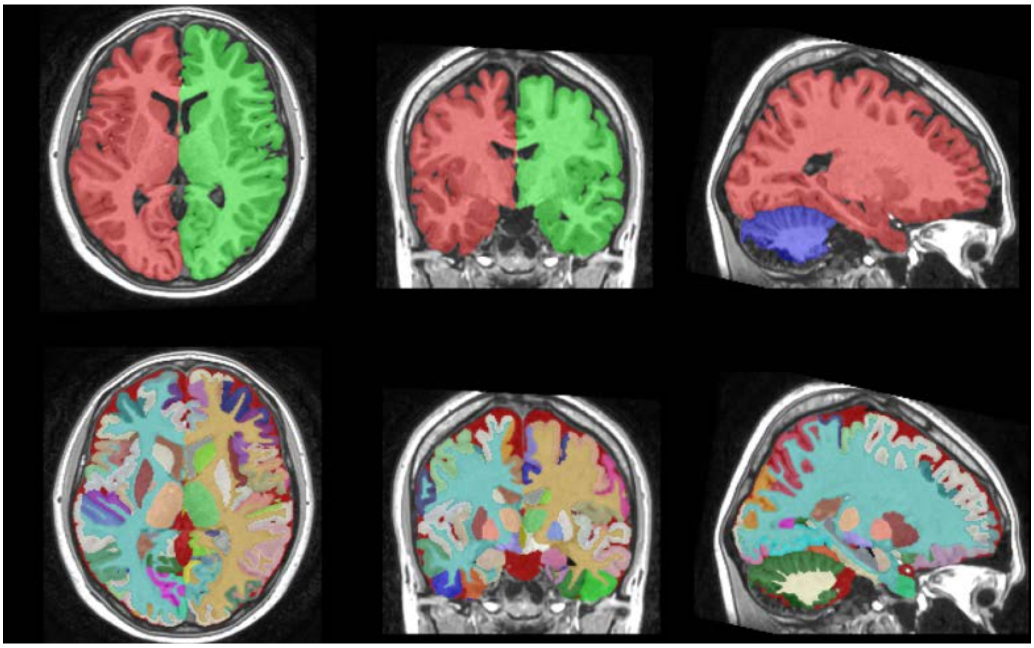

Figure 1. Structure segmentation and volumetric analysis of the brain using the volBrain pipeline.All the volumes are presented in absolute value (measured in cm3) and in relative value (measured in relation to the ICV).Segmentation images are located in the MNI space (neurological orientation).

Results

The study group consisted of 65% women and 35% men, with a mean age of 42.15 ± 8.41 years (range: 27–55 years). Volumetric measurements of various brain structures were obtained both before and after the earthquake. These measurements were statistically analyzed, including calculations of mean, Standard deviation, minimum and maximum values, and p-values. The findings provide critical insights into the potential impact of the earthquake on brain volumes. White matter volume (WM) showed a significant decrease after the earthquake (p=0.011). Similarly, cerebrospinal fluid (CSF) volume demonstrated a notable increase post-earthquake (p=0.017). Thalamic volumes, including total, right, and left thalamus, experienced significant reductions with p-values of 0.008, 0.009, and 0.010, respectively. Cerebellum volume, encompassing total, right, and left cerebellum, also decreased significantly, with p-values ranging from 0.021 to 0.029. The posterior cingulate gyrus (PCgG) exhibited a significant increase in total, right, and leftvolumes, with p-values of 0.007, 0.023, and 0.012, respectively (Table 1).

Table 1. Volumetric Analysis of Brain Regions with Statistically Significant Changes Before and After the February 6 Earthquake

Regions	Before Earthquake		Post Earthquake		P value
	Volume (cm^3)				
	Mean±SD	Min - Max	Mean±SD	Min - Max	
White Matter	491.2 ± 61.4	406.2 - 612.0	479.0 ± 52.9	403.3 - 582.5	0.011
Cerebrospinalfluid	168.5 ± 57.6	63.7 - 347.1	180.2 ± 60.4	129.1 - 386.4	0.017
Brain WMGM	1148.8 ± 93.3	993.5 - 1332.8	1136.3 ± 90.0	981.2 - 1296.2	0.025
Cerebellum total	121.7 ± 12.5	95.3 - 144.7	119.4 ± 13.5	87.0 - 145.4	0.023
Cerebellum right	60.9 ± 6.3	47.8 - 73.0	59.8 ± 6.9	43.4 - 73.9	0.021
Cerebellum left	60.7 ± 6.2	47.4 - 72.4	59.6 ± 6.7	43.6 - 71.5	0.029
Thalamus total	12.0 ± 1.2	10.1 - 14.4	11.9 ± 1.2	9.9 - 14.2	0.008
Thalamus right	6.0 ± 0.5	5.0 - 7.0	5.9 ± 0.6	4.9 - 7.0	0.009
Thalamus left	6.0 ± 0.6	5.0 - 7.3	6.0 ± 0.6	5.0 - 7.2	0.010
PCgG total	9.2 ± 0.7	7.9 - 10.2	9.5 ± 0.8	8.5 - 11.3	0.007
PCgG right	4.6 ± 0.4	3.7 - 5.3	4.8 ± 0.5	4.1 - 5.9	0.023
PCgG left	4.6 ± 0.3	3.7 - 5.2	4.7 ± 0.4	4.1 - 5.4	0.012

WMGM:White Matter and Gray Matter, PCgG: Posterior cingulate gyrus.

There were no statistically significant changes in grey matter volume (p = 0.940), indicating stability in grey matter over this period. The limbic system, including total, right, and left limbic volumes, did not exhibit statistically significant changes (p > 0.05). Similarly, the prefrontal cortex showed no significant alterations (p > 0.05). Other regions, such as the hippocampus, insular cortex, amygdala, basalforebrain, and entorhinal cortex, displayed no significant volumetric changes, reflecting stability in these areas following the earthquake (Table 2).

Table 2. Volumetric Analysis of Brain Regions with Statistically Non-Significant Changes Before and After the February 6 Earthquake

Regions	Before Earthquake		Post Earthquake		p
	Volume (cm³)				
	Mean±SD	Min - Max	Mean±SD	Min - Max	
Grey Matter	657.5 ± 46.0	586.3 - 790.2	657.303±45,94	45.94036	0.94
FRP total	61613.3 ± 25360.4	6613.0 - 91723.0	64931.85±22398,12	22398.128	0.60
FRP right	31796.1 ± 11164.2	3263.0 - 48327.0	32266.55±11407,19	11407.194	0.91
FRP left	34760.8 ± 8956.5	3871.0 - 44669.0	32776.00±11201,64	11201.645	0.27
GRe total	36673.1 ± 12228.3	4261.0 - 52371.0	31338.20±16723,90	16723.901	0.26
GRe right	15262.0 ± 9049.3	1497.0 - 25118.0	20517.05±2148,99	2148.997	0.20
GRe left	19075.3 ± 5175.2	2076.0 - 27253.0	20244.65±2996,82	2996.829	0.70
OpIFG total	50435.7 ± 24387.1	5404.0 - 75389.0	55048.65±18440,14	18440.146	0.37
OpIFG right	29498.6 ± 10061.7	1947.0 - 41441.0	31749.15±4677,17	4677.1764	0.91
OpIFG left	27544.9 ± 9835.1	2674.0 - 43056.0	30148.7±4802,75	4802.75	0.82
OrIFG total	22756.9 ± 8253.7	2984.0 - 34329.0	26010.90±6382,06	6382.063	0.62
TrIFG total	51899.7 ± 21607.9	5869.0 - 71697.0	55594.50±16139,81	16139.810	0.60
TrIFG right	27031.7 ± 10350.3	2363.0 - 39574.0	28040.10±8194,33	8194.333	0.57
TrIFG left	27424.5 ± 9115.8	3183.0 - 36351.0	26326.05±10751,003	10751.003	0.31
Amygdala total	1.9 ± 0.2	1.4 - 2.2	1.881±0,93	.193	0.42
Amygdala right	0.9 ± 0.1	0.7 - 1.2	.94±0,09	.096	0.54
Amygdala left	0.9 ± 0.1	0.7 - 1.1	.94±0,10	.100	0.17
Basal Forebrain total	0.8 ± 0.1	0.5 - 1.0	.77±0,09	.096	0.70
Basal Forebrain right	0.4 ± 0.1	0.3 - 0.6	.40±0,052	.058	0.40
Basal Forebrain left	0.4 ± 0.1	0.2 - 0.5	.37±0,05	.0530	0.71

FRP: Frontal Pole, GRe: Gyrus Rectus, OpIFG: Opercular Part of the Inferior Frontal Gyrus, TrIFG: Triangular Part of the Inferior Frontal Gyrus (These are parts of the prefrontal cortex)

Table 3. Volumetric Analysis of Brain Regions with Statistically Significant Changes Before and After the February 6 Earthquake According to Sex

Sex	Regions	Before Earthquake		Post Earthquake		p
		Volume (cm³)				
		Mean±SD	Min - Max	Mean±SD	Min - Max	
Women=13	**GRe right**	13602.5±9599.1	1497.0-25118.0	20410.3±2381.1	14081.0-23316.0	**0.028**
	CO left thickness mm	27910.1±2381.1	200043.0-47150	23789.3±6978.6		**0.028**
	CerebroSpinal Fluid (CSF)	152.0±42.6	63.7-253.4	165.5±41.4	129.2-256.1	**0.019**
	Cerebellum right volume	58.5±5.6	47.8	57.2±6.2	67.7	**0.046**
	Amygdala total volume	1.7±0.2	1.43-1.99	1.8±0.2	1.61-2.19	**0.034**
	Amygdala right volume	0.8±0.1	0.73-0.99	0.9±0.1	0.81-1.08	**0.027**
	Amygdala left volume	0.8±0.8	0.70-1.00	0.9±0.8	0.80-1.11	**0.036**
	Basal Forebrain total volume	0.7±0.1	0.5-0.8	0.8±0.1	0.6-0.9	**0.049**
	Hippocampus left volume	3.7±0.4	3.21-4.29	3.8±0.3	3.2-4.4	**0.022**
	Thalamus total volume	12.0±1.2	10.12-13.91	11.8±1.1	13.8-9.9	**0.030**
	PCgG total volume	5.4±0.5	4.2-6.6	5.5±0.5	4.7-6.6	**0.016**
Men=7	**Amygdala right volume**	1.1±0.1	0.8-1.2	1.0±0.1	0.8-1.2	**0.027**
	Basal Forebrain total volume	0.9±0.1	0.7-1.0	0.8±0.1	0.8-0.9	**0.027**
	FRP left volume cm3	37688.0±5306.1	31183.0-43396.0	31905.8±13462.5	32860.0-43325.0	**0.018**
	OpIFG total	35229.5±29355.0	5404.0-73271.0	58137.1±190635.9	42156.0-72175.0	**0.043**
	Caudate total volume	7.4±0.9	6.0-9.1	7.2±0.8	6.1-8.6	**0.028**
	Caudate right volume	3.7±0.5	2.4-.6	3.6±0.4	2.9-4.3	**0.028**
	Thalamus right volume	6.1±0.6	5.6-7.1	6.0±0.6	5.4-7.1	**0.043**
	Limbic right volume	20.5±1.4	19.2-23.4	20.1±1.4	19.1-23.0	**0.028**
	Insular right volume	14.2±1.1	12.6-15.7	13.8±0.9	12.6-13.7	**0.018**

FRP: Frontal Pole, GRe: Gyrus Rectus, OpIFG: Opercular Part of the Inferior Frontal Gyrus

Discussion

This study provides critical insights into the volumetric changes observed in various brain regions following the February 6 earthquake. The findings reflect both the brain's vulnerability to acute stress and its adaptive capacity.

In our study, white matter volume showed a significant decrease after the earthquake, suggesting that this region is particularly vulnerable to acute stress. White matter plays a crucial role in facilitating communication between brain regions, and its disruption may impair cognitive and motor functions. Abraham et al. emphasized consistent reductions in white matter integrity in individuals experiencing stress and depression, attributing these changes to neuroinflammation and stress-induced demyelination (14). Similarly, Meng et al. Reported long-term white matter microstructural alterations in survivors of traumatic events, highlighting the susceptibility of white matter to acute and chronic stress (15).

In contrast to white matter, our study found no significant changes in grey matter volume, indicating structural resilience to acute stress. McEwen et al. proposed that grey matter exhibits greater resistance to short-term stress due to its robust synaptic and neuronal architecture, which helps maintain functionality under environmental challenges (16). However, longitudinal studies are needed to explore whether chronic stressors might induce observable changes in grey matter structure.

Our findings revealed a significant increase in cerebrospinal fluid volume post-earthquake, likely reflecting compensatory mechanisms. Romeo et al. described CSF as a reservoir for brain-derived proteins and cellular by-products, which can provide insights into brain injury or stress (17). Hladky et al. emphasized that increases in CSF volume may result from reductions in other brain regions, such as white matter, to maintain intracranial pressure equilibrium(18). This dynamic fluid redistribution underscores the brain's capacity to adapt to acute stress while preserving structural balance.

The thalamus exhibited significant volume reductions, highlighting its vulnerability to stress-induced damage in our study. As a key relay center for sensory and motor signals, the thalamus is integral to emotional regulation and cognitive functions. Batail et al. linked thalamic atrophy to emotional dysregulation in patients with depressive disorders, further demonstrating the susceptibility of this region to stress (19). Similarly, Hong et al. identified heterogeneous alterations in thalamic subfields among individuals experiencing chronic stress, which may explain its significant reduction in our study (20).

Our study showed significant reductions in total cerebellar volume, including both hemispheres. The cerebellum, traditionally associated with motor coordination, also plays a critical role in emotional regulation. Lange et al. identified cerebellar lobule VI as essential for processing fear-related stimuli and memory consolidation (21). The reductions observed in our study may contribute to both motor and emotional impairments, reflecting the cerebellum's involvement in stress responses (22).

In our study, no significant changes were observed in the volumes of the limbic system. Despite its critical role in emotion and memory, Pitman et al. suggested that the limbic system may exhibit structural alterations only in response to prolonged or chronic stress (23). This stability in acute stress scenarios aligns with our findings.

In our study, the posterior cingulate gyrus demonstrated significant volume increases. This region, a central hub in the default mode network, is associated with self-referential thought, memory, and emotional regulation. Zhang et al. reported increased white matter integrity in the posterior cingulate gyrus during post-traumatic stres disorder recovery, attributing this to neuroplasticity (24). Leech et al. emphasized the importance of this region in maintaining cognitive and emotional equilibrium, particularly during adaptation to stress (25, 26).

In volume analysis according to the sex showed some differences. Forexample women exhibit a significant increase in amygdala volumes, while men show a stabilization or slight reduction. This suggests women may have a heightened emotional response to trauma.

Divergent changes in basal forebrain between sexes suggest potential sex-specific adaptations in attention and arousal mechanisms post-trauma. The observed reduction in cortical thickness in women but not men suggests possible structural vulnerability in female participants.

In our study, no significant alterations were observed in the prefrontal cortex volumes (PFC). The PFC is pivotal for higher-order cognitive functions and emotional regulation. Anderson et al. highlighted its role in "top-down" regulation of limbic structures such as the amygdala and hippocampus, which may explain its stability in acute stress scenarios (26).

The structural changes identified in our study can be attributed to three primary mechanisms: stress-induced neurobiological effects, neuroplasticity, and fluid redistribution. Elevated glucocorticoid levels, a hallmark of acute stres responses, are known to cause neuro inflammation, disrupt neurotransmitter systems, and result in structural damage to stress-sensitive brain regions (27, 28). Sorrells et al. linked such glucocorticoid-induced inflammation to demyelination and decreased neural connectivity, particularly affecting white matter and the thalamus (29). The observed increase in posterior cingulate gyrus volume likely reflects neuroplastic adaptations to acute stress. Hermans et al. underscored that stres responses can promote structural and functional brain changes, facilitating recovery and enhancing resilience in the aftermath of trauma (30). Additionally, fluid redistribution mechanisms were evident in the significant increase in CSF volume. Hinson et al. demonstrated that brain injuries often result in blood-brain barrier dysfunction, leading to shifts in CSF volume as a compensatory response to maintain intracranial equilibrium (31). These dynamic interactions highlight the brain's ability to adapt and respond to acute stress through a combination of biological, structural, and fluid-related mechanisms.

This study has limitations, including its retrospective design, small sample size, and lack of validated PTSD assessment scales. Future studies with larger cohorts and prospective designs are needed to validate these findings.

Future research should focus on longitudinal studies to evaluate the long-term persistence or reversibility of these changes and their implications for cognitive and emotional functions. Understanding the relationship between structural alterations and behavioral outcomes, as well as exploring hormonal and inflammatory mediators, will provide deeper insights into the neurobiological effects of natural disasters. Early diagnosis and targeted interventions are crucial to mitigate neurological damage and support recovery, ultimately enhancing the quality of life for individuals affected by such catastrophic events.

In conclusion, this study highlights the profound impact of acute stress caused by the February 6 earthquake on brain structure, revealing both vulnerabilities and adaptive mechanisms in various brain regions. Significant reductions in white matter, thalamus and cerebellum volumes indicate the brain's susceptibility to stress-related damage, while increases in CSF and posterior cingulate gyrus volumes reflect compensatory and neuroplastic responses. These findings underscore the brain's dynamic interplay between vulnerability and resilience in the face of acute trauma.

Ethical Approval: *Ethical approval was obtained from the Mustafa Kemal University Local Ethics Committee (Approval No: 2024.07.09/10), accordance with the principles stated in the Declaration of Helsinki.*

Author Contributions:
Concept: D.Y:D., H.B:
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Writing manuscript: D.Y.D., F.Ö.
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