ISRCTN26393895 https://doi.org/10.1186/ISRCTN26393895

Effects of electronic cigarettes and traditional cigarettes on brain structures

Submission date
04/06/2026

Recruitment status
Not yet recruiting

Registration date
05/06/2026

Overall study status
Ongoing

Last Edited
05/06/2026

Condition category
Nervous System Diseases

[X] Prospectively registered
[_] Protocol
[_] Statistical analysis plan
[_] Results
[_] Individual participant data
[X] Record updated in last year

Plain English summary of protocol

Background and study aims
Smoking traditional cigarettes is known to affect the brain, but less is known about how electronic cigarettes, also called vaping, may change brain structure. This study aims to compare the brains of young adults aged 18 years to 30 years who use electronic cigarettes, those who smoke traditional cigarettes, and those who do not smoke at all. The researchers will look at differences in brain size, structure, and connections using brain scans.

Who can participate?
Healthy adults aged between 18 years and 30 years can take part. Participants must fall into one of three groups: people who have used only electronic cigarettes for at least 1 year, people who have smoked only traditional cigarettes for at least 1 year, or people who do not use any nicotine, tobacco, alcohol, or illicit drugs. Participants must not have serious medical, neurological, or psychiatric conditions and must be able to safely undergo an MRI scan.

What does the study involve?
Participants will first complete questionnaires about smoking habits and nicotine dependence. They will then have a brain scan using magnetic resonance imaging, also known as MRI. The scan does not use radiation, involves no injections, and is not painful. It takes about 30 minutes to 40 minutes. During the scan, participants lie still while detailed images of the brain are taken.

What are the possible benefits and risks of participating?
There are no direct health benefits for participants. However, the study may help researchers better understand how vaping and smoking affect the brain, which could benefit public health in the future. The risks are low. MRI scans are widely used and safe for most people, but some individuals cannot take part if they have certain metal implants or similar conditions.

Where is the study run from?
The study is run from Erciyes University, Faculty of Medicine in Kayseri, Türkiye.

When is the study starting and how long is it expected to run for?
The study is expected to begin recruitment on 01 July 2026 and continue until 01 October 2026. The overall study is expected to run until 01 July 2027.

Who is funding the study?
The study is funded by the Scientific Research Projects body at Erciyes University in Türkiye.

Who is the main contact?
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Study information

Scientific Title
Brain morphometry in electronic cigarette and traditional cigarette users: an MRI-based analysis

Acronym
EC-TC-BRAIN

Study objectives
The primary objective of this study is to investigate the morphometric changes occurring in the brains of young adult individuals as a result of exposure to electronic cigarettes (EC) and traditional cigarettes (TC). To achieve this purpose, structural and quantitative parameters—including brain volume, cortical thickness, white matter tracts (tractography), and olfactory-related tracts—will be compared among three distinct groups: exclusive electronic cigarette users, exclusive traditional cigarette users, and healthy non-smoking controls.

Ethics approval required
Ethics approval required

Ethics approval(s)
approved 24/12/2025, ERCIYES ÜNİVERSİTESİ SAĞLlK BiLiMLERi ARAŞTIRMA ETiK KURULU (Erciyes Üniversitesi Tıp Fakültesi Dekanlığı Melikgazi/KAYSERİ, Kayseri, 38038, Türkiye; +90 352207 66 66 - 23031; serifeserim@erciyes.edu.tr), ref: 2025/613

Primary study design
Observational

Secondary study design
Cohort study

Study type(s)

Health condition(s) or problem(s) studied
Neurotoxicity, brain morphometric and structural changes associated with electronic cigarette (vaping) and traditional cigarette use in young adults.

Interventions
Participant Selection and Grouping
Participants will be screened and classified into three distinct groups (n=25 per group, total N=75) based on specialized dependency scales and explicit inclusion/exclusion criteria: Electronic Cigarette (EC) group, Traditional Cigarette (TC) group, and a Healthy Control group. The classification and characterization will be performed using the Fagerström Test for Nicotine Dependence, the Penn State Electronic Cigarette Dependence Index, the E-Cigarette Dependence Scale, and the Sensory E-Cigarette Expectations Scale. Written informed consent will be obtained from all individuals prior to enrollment.

MRI Acquisition Protocol
All cranial imaging will be performed using a 3.0 Tesla superconducting MRI scanner (Ingenia, Philips) equipped with a 16-channel head coil. Participants will be scanned in the supine position without sedation and without the administration of contrast agents. The total scan duration will be approximately 30–40 minutes per participant, utilizing the following sequences:

T1-Weighted 3D Volumetric Data: Field of View (FOV) = 240 mm, slice thickness = 1 mm, spacing between slices = 0.5 mm, Number of Averages = 2, repetition time (TR) = 6.7 ms, and echo time (TE) = 3.0 ms.

Diffusion Tensor Imaging (DTI): Axial acquisition, TR = 3260 ms, TE = 85 ms, FOV = 240 mm, slice thickness = 2.5 mm, spacing between slices = 2.5 mm, Number of Averages = 2, b-value = 1000 s /mm², acquired along 32 non-collinear diffusion-sensitizing directions.

Image Processing and Volumetric Analysis
Raw MRI data in DICOM format will be converted using Radiant DICOM Viewer and MRIcroGL software into NIfTI format (.nii.gz). For brain volumetry, NIfTI files will be uploaded to the vol2brain (volBrain) cloud-based, artificial intelligence-driven automated pipeline. This pipeline will automatically segment and calculate the volumes of 135 distinct brain regions, alongside macrostructural estimations of hippocampal subfields, brain structures age, cerebellar compartments, and cortical thickness metrics.

White Matter Tractography Analysis
Diffusion data processing and fiber tracking will be executed via DSI Studio software. Prior to reconstruction, tractography parameters will be uniformly configured as follows: Quantitative Anisotropy (QA) threshold = 0.20, Angular Threshold = 70 degrees, Smoothing = 0.50, minimum fiber length = 10 mm, maximum fiber length = 1000 mm, and a termination criterion of 100,000 tracts. Target white matter tracts will be tracked bilaterally. Quantitative microstructural metrics including total fiber count, mean fiber length (mm), fiber ratio (percentage of tract-specific fibers relative to whole-brain fibers), Fractional Anisotropy (FA), Mean Diffusivity (MD), Axial Diffusivity (AD), and Radial Diffusivity (RD) will be exported for statistical comparison.

Statistical Analysis
Statistical evaluations will be conducted using SPSS 25.0 and GraphPad Prism 10 softwares. Data normality will be verified using the Shapiro-Wilks test. Continuous variables showing normal distribution will be compared between two groups using the Student's t-test, while non-normally distributed data will be assessed using the Mann-Whitney U test. For multi-group comparisons (three groups), One-Way ANOVA or the Kruskal-Wallis H test will be implemented depending on the distribution properties. Relationships between behavioral scale metrics and morphometric imaging indices will be assessed via Pearson correlation analysis. Statistical significance will be set at $p < 0.05$.

Intervention Type
Other

Primary outcome(s)
1. Brain structural morphometry parameters (volumetry and cortical thickness) measured using Structural 3D T1-weighted Magnetic Resonance Imaging (MRI) data segmented via the automated, cloud-based vol2brain pipeline to calculate regional brain volumes (in cubic millimeters) of 135 brain regions and macrostructural cortical thickness metrics (in millimeters). at Baseline (single assessment during the 1-year study period)

2. White matter microstructural integrity and tractography metrics measured using Diffusion Tensor Imaging (DTI) processed via DSI Studio software to quantitatively analyze targeted white matter and olfactory-related tracts, exporting values for Fractional Anisotropy (FA), Mean Diffusivity (MD), Axial Diffusivity (AD), Radial Diffusivity (RD), total fiber count, and mean fiber length. at Baseline (single assessment during the 1-year study period)

Key secondary outcome(s))
1. Nicotine and electronic cigarette dependence severity measured using Total scores obtained from behavioral questionnaires and dependency scales, including the Fagerström Test for

Nicotine Dependence, Penn State Electronic Cigarette Dependence Index, E-Cigarette Dependence Scale, and Sensory E-Cigarette Expectations Scale. at Baseline (administered once at the time of participant enrollment)

Completion date
01/07/2027

Eligibility

Key inclusion criteria
1. Aged between 18 years and 30 years (both sexes included)
2. No known history of central nervous system disease
3. No known chronic systemic diseases (e.g., hypertension, diabetes, metabolic syndrome)
4. No contraindications for MRI scanning (e.g., metallic implants, cardiac pacemakers, neurostimulators, or severe claustrophobia)
5. Capable of giving written informed consent
6. Good MRI image quality without severe motion artifacts
7. Group-specific criteria:
7.1. Minimum 1 year of continuous exclusive use for the EC or TC groups
7.2. Absolute non-use of any nicotine or tobacco products, alcohol, or illicit substances for the healthy control group

Healthy volunteers allowed
Yes

Age group
Adult

Lower age limit
18 years

Upper age limit
30 years

Sex
All

Total final enrolment
75

Key exclusion criteria
1. History of serious neurological disease (e.g., epilepsy, cerebrovascular events)
2. Severe or unstable psychiatric disorders (e.g., major depressive disorder, schizophrenia, bipolar disorder)
3. Diagnoses affecting brain structure or development, such as ADHD
4. Alcohol or illicit substance use disorder, or active use within the past year
5. Dependence on substances other than nicotine
6. Extremely high or low body mass index (BMI) that could independently influence brain volume
7. Metabolic or chronic inflammatory diseases (e.g., uncontrolled diabetes)
8. Regular use of medications affecting central nervous system activity or structure (e.g.,

psychotropics, chronic steroids)
9. Pregnancy or lactation
10. Dual users (simultaneous users of both electronic and traditional cigarettes)

Date of first enrolment
01/07/2026

Date of final enrolment
01/10/2026

Locations

Countries of recruitment
Türkiye

Sponsor information

Organisation
Erciyes University

ROR
https://ror.org/047g8vk19

Funder(s)

Funder type

Funder Name
Bilimsel Araştırma Projeleri, Erciyes Üniversitesi

Alternative Name(s)
Scientific Research Council, Erciyes University, Scientific Research Projects, Erciyes, Directorate of Scientific Research Projects, Erciyes University, BAP Erciyes University, Erciyes Üniversitesi Bilimsel Araştırma Projeleri, BAP, ERU, ERU - BAP

Funding Body Type
Government organisation

Funding Body Subtype
Universities (academic only)

Location
Türkiye

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Not expected to be made available