

# Clinical Trial Protocol

## Iranian Registry of Clinical Trials

10 Jun 2026

### Effects of transcranial direct current stimulation and acetazolamide consumption on exercise and cognitive performance, and physiological and perceptual responses of mountaineers in simulated altitude

#### Protocol summary

##### Study aim

Determining the separate and combined effects of acetazolamide administration and transcranial direct current stimulation (tDCS) on athletic and cognitive performance, as well as physiological and perceptual responses, in mountaineers under simulated high-altitude conditions

##### Design

Within-subject (crossover), double-blind design: 1) Acetazolamide + M1 stimulation 2) Acetazolamide + DLPFC stimulation 3) Acetazolamide + sham stimulation 4) Placebo + M1 stimulation 5) Placebo + DLPFC stimulation 6) Placebo + sham stimulation

##### Settings and conduct

The laboratory of the Faculty of Physical Education and Sport Sciences. Both the participant and the researcher were blinded.

##### Participants/Inclusion and exclusion criteria

Inclusion criteria: male participants aged 18–44 years old; active mountaineers (history of ascents to altitudes above 4,000 m); regular aerobic training at least three sessions per week (including mountaineering and hiking); previous history of acute mountain sickness (AMS) during overnight stays at altitudes above 3,000 m; medical clearance certifying no contraindication for participation in the exercise training program. Exclusion criteria: overnight stay at altitudes above 2,700 m within two weeks prior to the start of the study; use of acetazolamide within two weeks prior to the start of the study; allergy to acetazolamide or sulfonamides; history of any cardiovascular, pulmonary, or metabolic disease; presence of any implanted medical devices or pacemakers.

##### Intervention groups

Normobaric Hypoxia; Acetazolamide; tDCS

##### Main outcome variables

Time to exhaustion; EMG amplitude; choice reaction

time; Continuous Performance Test; Stroop word-color test; perceived exertion; arterial oxygen saturation; pleasure, arousal; balance

#### General information

##### Reason for update

##### Acronym

##### IRCT registration information

IRCT registration number: **IRCT20250812066837N1**

Registration date: **2025-09-05, 1404/06/14**

Registration timing: **prospective**

Last update: **2025-09-05, 1404/06/14**

Update count: **0**

##### Registration date

2025-09-05, 1404/06/14

##### Registrant information

##### Name

Rezvan Kheirandish

##### Name of organization / entity

The University of razi

##### Country

Iran (Islamic Republic of)

##### Phone

+98 61 5272 7465

##### Email address

r.kheirandish@razi.ac.ir

##### Recruitment status

**Recruitment complete**

##### Funding source

##### Expected recruitment start date

2025-09-06, 1404/06/15

##### Expected recruitment end date

2025-11-21, 1404/08/30

##### Actual recruitment start date

empty

**Actual recruitment end date**  
empty

**Trial completion date**  
empty

**Scientific title**  
Effects of transcranial direct current stimulation and acetazolamide consumption on exercise and cognitive performance, and physiological and perceptual responses of mountaineers in simulated altitude

**Public title**  
Effects of tDCS Stimulation and Acetazolamide consumption on Exercise Performance

**Purpose**  
Supportive

**Inclusion/Exclusion criteria**  
**Inclusion criteria:**  
Men aged 18 to 44 years Active mountaineers (with a history of ascents to altitudes above 4,000 meters and regular mountaineering activities in the past year) Regular aerobic training at least three sessions per week (including mountaineering and hiking) History of acute mountain sickness (AMS) during previous overnight stays at altitudes above 3,000 meters Obtaining a medical certificate of fitness for participation in the exercise training program  
**Exclusion criteria:**  
Overnight stay at an altitude above 2,700 meters within two weeks prior to the start of the study Use of acetazolamide within two weeks prior to the start of the study Allergy to acetazolamide or sulfonamides Presence of any cardiovascular, pulmonary, or metabolic disease History of seizures, epilepsy, or other types of neurological disorders Presence of implanted medical devices or pacemakers

**Age**  
From **18 years** old to **44 years** old

**Gender**  
Male

**Phase**  
N/A

**Groups that have been masked**

- Participant
- Investigator

**Sample size**  
Target sample size: **12**

**Randomization (investigator's opinion)**  
Randomized

**Randomization description**  
To randomize the order in which participants are exposed to the four different conditions, the Latin square method will be used. First, using the website [www.random.org](http://www.random.org), each participant will be randomly assigned a number between 1 and 12 as an identification code. Then, the English letters A, B, C, D, E, and F will be assigned to the six intervention conditions, and a 6×6 Latin square will be created. After generating the Latin square, participants numbered 1 and 2 will follow the sequence of the first row, participants numbered 3 and 4

will follow the sequence of the second row, participants numbered 5 and 6 will follow the sequence of the third row, participants numbered 7 and 8 will follow the sequence of the fourth row, participants numbered 9 and 10 will follow the sequence of the fifth row, and participants numbered 11 and 12 will follow the sequence of the sixth row

**Blinding (investigator's opinion)**

Double blinded

**Blinding description**

The present study will be conducted in a double-blind manner. Neither the participants nor the principal investigator will be aware of the type of stimulation administered in each session, and this information will be accessible only to an individual outside the research team until the completion of the study. To conceal the stimulation order from the principal investigator, all procedures related to the random determination of the stimulation sequence for each participant will be carried out by the same individual outside the research team. Furthermore, to conceal the type of stimulation in each session from the participants, the tDCS device will be hidden from their view using a cover, and the principal investigator will not be present in the laboratory during electrode placement or at the end of the 20-minute session when the electrodes are removed.

**Placebo**

Used

**Assignment**

Crossover

**Other design features**

**Secondary Ids**

empty

**Ethics committees**

**1**

**Ethics committee**

**Name of ethics committee**

Ethics Committee of Biomedical Research, Razi University

**Street address**

No. 1, Razi University, University Street, Taq-Bostan, Kermanshah

**City**

Kermanshah

**Province**

Kermanshah

**Postal code**

6714414971

**Approval date**

2023-02-01, 1401/11/12

**Ethics committee reference number**

IR.RAZI.REC.1401.075

**Health conditions studied**

## 1

### **Description of health condition studied**

Healthy Mountaineers

### **ICD-10 code**

### **ICD-10 code description**

## **Primary outcomes**

## 1

### **Description**

Continuous Performance Test (CPT)

### **Timepoint**

During exercise

### **Method of measurement**

Computerized Continuous Performance Test (CPT)

## 2

### **Description**

EMG amplitude

### **Timepoint**

During exercise

### **Method of measurement**

16-channel wireless electromyography (EMG) device (Noraxon, Scottsdale, AZ 85260, Germany)

## 3

### **Description**

Choice reaction time

### **Timepoint**

After brain stimulation, after exercise

### **Method of measurement**

Choice Reaction Time Apparatus, Model (Indiana, Lafayette, 63035A, Panel Respon)

## 4

### **Description**

Time to exhaustion

### **Timepoint**

During exercise

### **Method of measurement**

Running on a treadmill until reaching 90% of maximum heart rate or a rating of 19 on the Borg Rating of Perceived Exertion scale

## 5

### **Description**

SpO<sub>2</sub>

### **Timepoint**

During brain stimulation, During fatiguing exercise

### **Method of measurement**

Pulse oximeter (Nonin, USA)

## 6

### **Description**

Stroop Color-Word

### **Timepoint**

After brain stimulation, after exercise

### **Method of measurement**

Computerized Stroop Test

## 7

### **Description**

Borg Rating of Perceived Exertion

### **Timepoint**

During fatiguing exercise

### **Method of measurement**

Borg Rating of Perceived Exertion (RPE) scale, 6-20

## 8

### **Description**

Sense of pleasure

### **Timepoint**

During fatiguing exercise

### **Method of measurement**

The Feeling Scale (FS; ranging from -5 to +5) was used, with responses recorded on a 5-point Likert-type scale.

## 9

### **Description**

Felt Arousal Scale

### **Timepoint**

During fatiguing exercise

### **Method of measurement**

The Felt Arousal Scale (FAS; ranging from +1 to +6) was used, and its mean scores were analyzed on a 6-point Likert-type scale.

## 10

### **Description**

Heart rate

### **Timepoint**

During fatiguing exercise

### **Method of measurement**

Polar heart rate monitor

## 11

### **Description**

Y-Balance

### **Timepoint**

After brain stimulation, after exercise

### **Method of measurement**

The maximum reach of the stance and non-stance leg was measured in three specified directions: (1) anterior, (2) posteromedial, and (3) posterolateral.

## **Secondary outcomes**

empty

## **Intervention groups**

## 1

### **Description**

Intervention 1 : Acetazolamide + stimulation of M1  
Before each exercise session, participants must take seven 125 mg capsules of acetazolamide. Administration will begin three days before the start of the test (one capsule in the morning and one capsule in the evening), and on the morning of the test day, the capsule will be taken. Acetazolamide will be obtained from Mehr Darou Company, establishment license No. 91988/665. Acetazolamide and placebo will be prepared in identical capsules. To precisely stimulate the M1 and DLPFC areas, the international 10-20 EEG brain mapping system and a dedicated EEG cap will be used. According to the type of stimulation, the target areas for electrode placement will be marked using the EEG cap, and then the electrodes will be placed on the marked areas. For stimulation of the right M1, the anodal electrode will be placed over FC2, and the cathodal electrode will be placed on the left shoulder. For stimulation of the left DLPFC, the anodal electrode will be placed over F3, and the cathodal electrode will be placed over AF8. In the sham stimulation condition, the electrode placement will be similar to that of the DLPFC condition.

**Category**  
Other

## 2

### **Description**

Intervention 2: Acetazolamide + stimulation of the DLPFC  
Before each exercise session, participants must take seven 125 mg capsules of acetazolamide. Administration will begin three days before the start of the test (one capsule in the morning and one capsule in the evening), and on the morning of the test day, the capsule will be taken. Acetazolamide will be obtained from Mehr Darou Company, establishment license No. 91988/665. Acetazolamide and placebo will be prepared in identical capsules. To precisely stimulate the DLPFC area, the international 10-20 EEG brain mapping system and a dedicated EEG cap will be used. According to the type of stimulation, the target areas for electrode placement will be marked using the EEG cap, and then the electrodes will be placed on the marked areas. For stimulation of the left DLPFC, the anodal electrode will be placed over F3, and the cathodal electrode will be placed over AF8.

**Category**  
Other

## 3

### **Description**

Intervention 3: Acetazolamide + sham stimulation  
Before each exercise session, participants must take seven 125 mg capsules of acetazolamide. Administration will begin three days before the start of the test (one capsule in the morning and one capsule in the evening), and on the morning of the test day, the capsule will be taken. Acetazolamide will be obtained from Mehr Darou Company, establishment license No. 91988/665. Acetazolamide and placebo will be prepared in identical capsules. In the sham stimulation condition, electrode placement will be identical to that of the DLPFC stimulation condition. In sham stimulation, the current is

ramped up for a few seconds and then decreased, producing sensations of itching and tingling similar to those experienced during active stimulation. In active stimulation, these sensations fluctuate as the participant adapts to the current, whereas in sham stimulation, the sensations disappear because the current is gradually stopped.

**Category**  
Other

## 4

### **Description**

Intervention 4: Placebo + stimulation of M1  
Before each exercise session, participants must take seven 125 mg capsules of placebo. Administration will begin three days before the start of the test (one capsule in the morning and one capsule in the evening), and on the morning of the test day, the capsule will be taken. The placebo will follow the same dosing protocol. The placebo will consist of lactose powder (seven 125 mg capsules). Both acetazolamide and placebo will be prepared in identical capsules. To precisely stimulate the M1 area, the international 10-20 EEG brain mapping system and a dedicated EEG cap will be used. According to the type of stimulation, the target areas for electrode placement will be marked using the EEG cap, and then the electrodes will be placed on the marked areas. For stimulation of the right M1, the anodal electrode will be placed over FC2, and the cathodal electrode will be placed on the left shoulder.

**Category**  
Other

## 5

### **Description**

Intervention 5: Placebo + stimulation of DLPFC  
Before each exercise session, participants must take seven 125 mg capsules of placebo. Administration will begin three days before the start of the test (one capsule in the morning and one capsule in the evening), and on the morning of the test day, the capsule will be taken. The placebo will follow the same dosing protocol. The placebo will consist of lactose powder (seven 125 mg capsules). Both acetazolamide and placebo will be prepared in identical capsules. To precisely stimulate the DLPFC area, the international 10-20 EEG brain mapping system and a dedicated EEG cap will be used. According to the type of stimulation, the target areas for electrode placement will be marked using the EEG cap, and then the electrodes will be placed on the marked areas. For stimulation of the left DLPFC, the anodal electrode will be placed over F3, and the cathodal electrode will be placed over AF8.

**Category**  
Other

## 6

### **Description**

Control group: Placebo + stimulation of sham stimulation  
Before each exercise session, participants must take

seven 125 mg capsules of placebo. Administration will begin three days before the start of the test (one capsule in the morning and one capsule in the evening), and on the morning of the test day, the capsule will be taken. The placebo will follow the same dosing protocol. The placebo will consist of lactose powder (seven 125 mg capsules). Both acetazolamide and placebo will be prepared in identical capsules. In the sham stimulation condition, electrode placement will be identical to that of the DLPCF stimulation condition. In sham stimulation, the current is ramped up for a few seconds and then decreased, producing sensations of itching and tingling similar to those experienced during active stimulation. In active stimulation, these sensations fluctuate as the participant adapts to the current, whereas in sham stimulation, the sensations disappear because the current is gradually stopped.

**Category**

Other

**Recruitment centers****1****Recruitment center****Name of recruitment center**

Razi University, Kermanshah

**Full name of responsible person**

Vahid Tadibi

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No. 1, Razi University, University Street, Taq-Bostan, Kermanshah

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info@razi.ac.ir

**Sponsors / Funding sources****1****Sponsor****Name of organization / entity**

Vice-Chancellor for Research, Razi University

**Full name of responsible person**

vahid tadibi

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**Grant name****Grant code / Reference number****Is the source of funding the same sponsor organization/entity?**

No

**Title of funding source**

Vice-Chancellor for Research, Razi University

**Proportion provided by this source**

100

**Public or private sector**

Public

**Domestic or foreign origin**

Domestic

**Category of foreign source of funding**

*empty*

**Country of origin****Type of organization providing the funding**

Academic

**Person responsible for general inquiries****Contact****Name of organization / entity**

The Razi University of Kermanshah

**Full name of responsible person**

Rezvan Kheirandish

**Position**

Graduate in Physical Education

**Latest degree**

Master

**Other areas of specialty/work**

Exercise Physiology

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**Person responsible for scientific inquiries****Contact****Name of organization / entity**

The Razi University of Kermanshah

**Full name of responsible person**

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## Person responsible for updating data

### Contact

**Name of organization / entity**

The Razi University of Kermanshah

**Full name of responsible person**

Rezvan Kheirandish

**Position**

Graduate in Physical Education

**Latest degree**

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**Other areas of specialty/work**

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## Sharing plan

### Deidentified Individual Participant Data Set (IPD)

Undecided - It is not yet known if there will be a plan to make this available

**Study Protocol**

Yes - There is a plan to make this available

**Statistical Analysis Plan**

Yes - There is a plan to make this available

**Informed Consent Form**

Yes - There is a plan to make this available

**Clinical Study Report**

Undecided - It is not yet known if there will be a plan to make this available

**Analytic Code**

Undecided - It is not yet known if there will be a plan to make this available

**Data Dictionary**

Undecided - It is not yet known if there will be a plan to make this available

**Title and more details about the data/document**

Title: Psychological and Physiological Study Data Details:  
Includes questionnaire scores, exercise performance,  
and physiological indices of participants.

**When the data will become available and for how long**

The data will be available to qualified researchers after completion of the study and

**To whom data/document is available**

Access will be granted to qualified researchers and individuals with ethical approval

**Under which criteria data/document could be used**

The data will be used solely for research and scientific purposes, and access is conditional on compliance with ethical regulations and maintaining participant confidentiality.

**From where data/document is obtainable**

To access the data, researchers may contact the corresponding author of the study.

**What processes are involved for a request to access data/document**

Requests for data must be sent to the corresponding author. After reviewing ethical compliance and researcher qualifications, the data will be provided in a de-identified format.

**Comments**

All data will be stored and shared in accordance with data protection regulations and research ethics principles.