

# BRAIN STIMULATION AS NOVEL TREATMENT FOR INSOMNIA

A systematic review by L. B. Krone, K. D. Fehér, T. Rivero and X. Omlin.  
Published in *Journal of Sleep Research* (2023)



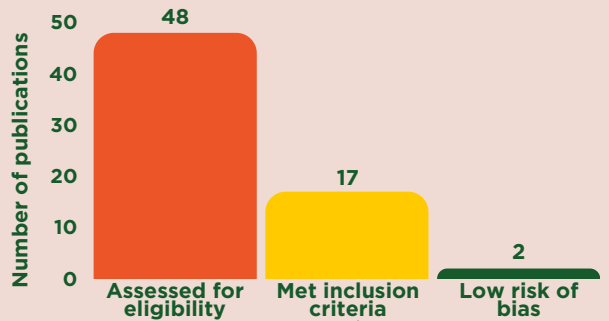
## WHAT IS BRAIN STIMULATION?

Brain stimulation directly or indirectly modulates brain activity in targeted brain regions or cranial nerves using electric, magnetic, sound, ultrasound or thermal manipulations.



## IS THERE RELIABLE DATA?

Of the 1556 screened records...



### Inclusion criteria:

1. Adults with clinical insomnia
2. Brain stimulation as intervention, incl. control group
3. Used validated sleep outcomes



## WHAT IS INSOMNIA?

Insomnia is a sleep disorder defined by trouble falling asleep, staying asleep, or waking up too early. It impairs daytime functioning and may have long-term health consequences.



## WHAT IS THE EVIDENCE FOR USING BRAIN STIMULATION IN INSOMNIA TREATMENTS?

### TRANSCRANIAL MAGNETIC STIMULATION

9 studies

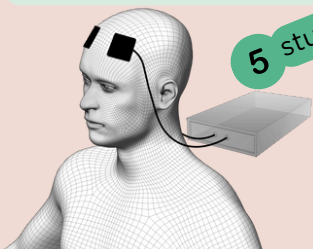
- **Stimulation frequency:** Low (1 Hz, inhibitory) or high (10 Hz, excitatory).
- **Target region:** Mostly left dorsolateral prefrontal cortex (dlPFC).
- **Results:** All report positive results or trends on insomnia symptoms.
- **To note:** All studies raise concerns or have a high risk of bias.



### TRANSCRANIAL ELECTRIC STIMULATION

5 studies

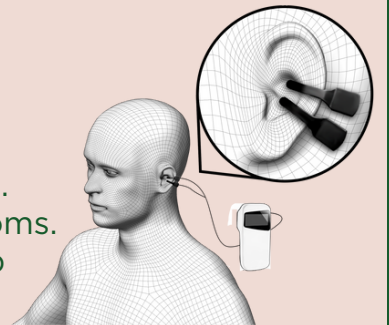
- **Stimulation type:** Transcranial direct or alternating current.
- **Target region:** Prefrontal and frontal cortical areas.
- **Results:** 4/5 report positive effects on insomnia symptoms.
- **To note:** All studies raise concerns or have a high risk of bias. One grossly exceeds recommended safety limits.



### TRANSCUTANEOUS AURICULAR VAGUS NERVE STIMULATION

2 studies

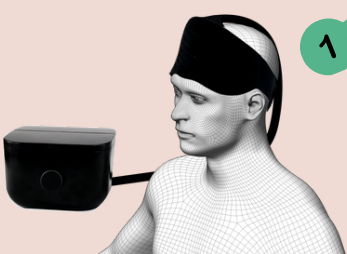
- **Stimulation type:** Electrical stimulation at 20 Hz or 4 Hz.
- **Target region:** Afferent auricular branch of the vagus nerve.
- **Results:** Studies report no main effects on insomnia symptoms.
- **To note:** One exploratory analysis suggests effects on sleep quality. One study raises concerns, one has low risk of bias.



### FOREHEAD COOLING

1 study

- **Stimulation condition:** Fluid-filled bladder at 14-16°C.
- **Target region:** Forehead over the frontal cortex.
- **Results:** Study finds no effects on primary endpoints.
- **To note:** Exploratory analysis suggests faster sleep onset. Excellent study design with double-blinding and credible device control, low risk of bias.



## WHAT ARE THE LIMITATIONS?

- >100 studies report positive effects of brain stimulation on insomnia symptoms.
- Only 17 studies meet inclusion criteria.
- 15/17 studies still raise concerns or have a high risk of bias.
- Evidence of strong pre-post effects with credible device control.

# BIAS

Sham brain stimulation elicits strong placebo effects



## ARE THERE ALTERNATIVES?

**Deep brain stimulation** - unsuitable due to invasiveness



**Vestibular nerve stimulation** - suitability subject to further methodological development

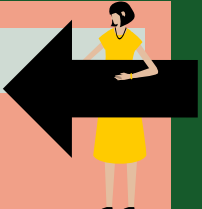


**Auditory stimulation** - awaiting results; promising as it modulates sleep oscillations and functions



## WHAT IS THE TAKE-HOME MESSAGE?

To date, no brain-stimulation protocol can claim relevant therapeutic benefit for insomnia.



## WHAT NEEDS TO BE DONE TO ADVANCE THE FIELD?

- Understand sleep-regulating brain circuitry to identify optimal stimulation targets.
- Use effective double-blinding and reliable sham conditions to prove superiority.
- Use predefined outcome measures, avoid overinterpretation of exploratory analyses.

