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Comparing different non-invasive brain stimulation interventions for attention deficit hyperactivity disorder: a meta-analysis of randomized controlled trials

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ADMINISTRATIVE INFORMATION

Support - Currently none.

Review Stage at time of this submission - Formal screening of search results against eligibility criteria.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202440034

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 07 April 2024 and was last updated on 09 July 2024.

INTRODUCTION

Review question / Objective PICOS criteria: (1) Patient: participants with a diagnosis of attention deficit hyperactivity disorder; (2) Intervention: any non-invasive brain stimulation; (3) Comparison: sham, active, or waitlist controls; (4) Outcome: changes in overall attention deficit hyperactivity disorder symptoms, attention symptoms, hyperactivity symptoms, dropout rates and serious adverse events; and (5) Study design: randomised controlled trials.

Condition being studied Attention deficit hyperactivity disorder is a neurodevelopmental disorder characterized by symptoms such as inattention, hyperactivity, and impulsivity, which may adversely affect an individual's learning, work, and social functioning. Non-invasive brain stimulation is a therapeutic approach aimed at modulating brain activity to improve specific neurological disorders or symptoms. These methods typically do not require surgery and involve external stimulation to influence brain activity. The development and application of brain stimulation techniques are continuously advancing, including research into their adjunctive treatment of mental health disorders. Current research focuses on evaluating the effectiveness and safety of non-invasive brain stimulation for treating attention deficit hyperactivity disorder. Researchers are exploring different forms of brain stimulation techniques, such as transcranial magnetic stimulation and transcranial direct current stimulation, to understand their efficacy in modulating brain function.

METHODS

Participant or population Participants with a diagnosis of attention deficit hyperactivity disorder.

Intervention Any non-invasive brain stimulation intervention.

Comparator Sham or active non-invasive brain stimulation (control).

Study designs to be included Randomized controlled trial.

Eligibility criteria Inclusion criteria were as follows: (1) human participant studies; (2) attention deficit hyperactivity disorder diagnosis confirmed by recognized standards such as the International Classification of Diseases, the Diagnostic and Statistical Manual of Mental Disorders, or diagnosis by a certified specialist; (3) participants undergoing various forms of non-invasive brain stimulation treatments ; (4) studies that provided both baseline and follow-up scores, or changes in scores for overall attention deficit hyperactivity disorder symptoms, inattentive symptoms, or hyperactive/impulsive symptoms as measured by scales; (5) study designs were parallel or crossover, using passive sham or active controls. Exclusion criteria included: (1) study types were non-randomized controlled trial studies, case reports, conference papers, or articles not peer-reviewed; (2) the study failed to report the specified outcomes of interest, such as only cognitive function tests and no attention deficit hyperactivity disorder symptom scales; (3) studies contained datasets that were duplicative of larger studies. For studies with overlapping datasets, we selected those with the largest sample size and most detailed data.

Information sources PubMed, Embase, and Cochrane CENTRAL, spanning from their respective inceptions up to July 1, 2024, without restricting by language.

Main outcome(s) Two outcomes of efficacy and feasibility. Efficacy was quantified through the assessment scores relating to overall attention deficit hyperactivity disorder symptoms, as well as specific subscales for attention-deficit and hyperactivity/impulsive symptoms. Feasibility was measured by the dropout rate.

Additional outcome(s) Secondary outcome of feasibility was serious adverse events.

Quality assessment / Risk of bias analysis Cochrane risk of bias tool version 2.

Strategy of data synthesis We conducted network meta-analysis to assess the pre-post changes for continuous variables and incidence rates for categorical variables. We estimated standardised mean differences with 95% confidence intervals for continuous variables and odds ratios and 95% confidence intervals for categorical variables. We applied a 0.5 zero-cell correction for studies with zero events in either treatment arm. Random-effects and frequentist models were generally used for pairwise meta-analyses and network meta-analysis. Heterogeneity among the included studies was evaluated using the tau value, the estimated standard deviation of the effects across the studies.

Subgroup analysis Covariates in randomized controlled trials, such as age, sex, co-treatment, and total non-invasive brain stimulation sessions, may influence treatment effects. Therefore, we conducted network meta-regression analyses to identify these potential moderators that influence the relative efficacy in overall attention deficit hyperactivity disorder symptoms. For the network meta-regression, we categorized these variables into binary groups to allow for better interpretation: age was defined as older than or equal to 18 years (adult) versus younger than 18 years (children and teenagers, reference); sex was categorized as predominantly female (≥50% female in the randomized controlled trial) versus predominantly male (<50% female in the randomized controlled trial, reference); co-treatment was defined as the presence versus absence of pharmacotherapy or psychotherapy (reference); and total non-invasive brain stimulation sessions were classified as more than or equal to 10 sessions versus fewer than 10 sessions (reference).

Sensitivity analysis No.

Language restriction No.

Country(ies) involved Taiwan.

Keywords ADHD, efficacy, non-invasive brain stimulation, safety.

Contributions of each author

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