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The intervention effect of transcranial magnetic stimulation on the craving level of drug-dependent individuals: A three-level meta-analysis and systematic review

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ADMINISTRATIVE INFORMATION

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Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 7 June 2026 and was last updated on 7 June 2026.

INTRODUCTION

Review question / Objective To systematically evaluate whether transcranial magnetic stimulation (TMS) effectively reduces craving in individuals with substance dependence, and to determine whether its effects are moderated by the type of substance dependence and TMS intervention parameters.

Condition being studied Following the PICOS framework, we included randomized controlled trials examining the effects of TMS on craving in individuals with substance dependence. A systematic literature search was conducted in PubMed, Web of Science, EMBASE, The Cochrane Library, CNKI, CBM, Wanfang, and VIP from database inception to June 2026. Two researchers independently screened the studies.

METHODS

Participant or population Adults aged 18 and above, who have been assessed by DSM-III (R)/IV as being dependent on alcohol, nicotine, prescription drugs, and illegal drugs.

Intervention The experimental group employed transcranial magnetic stimulation as the intervention method.

Comparator The control group received conventional treatments (such as health education, no intervention, placebo, etc.).

Study designs to be included Randomized controlled trial.

Eligibility criteria 1.3 Inclusion Criteria
Study Type: Randomized controlled trial.

Inclusion Criteria: ① Adults aged 18 years and above, who are classified as alcohol, nicotine, prescription drug, and illegal drug addicts according to DSM-III (R)/IV; ② The experimental group uses transcranial magnetic stimulation as the intervention method, while the control group receives conventional treatments (such as health education, no intervention, placebo, etc.); ③

Craving degree.

1.4 Exclusion Criteria

① Participants have received mental treatment or have other serious diseases; ② Transcranial magnetic stimulation is combined with other intervention methods (such as drug treatment); ③

Animal studies, conference abstracts, reviews, and duplicated publications; ④ Missing data or unable to be transformed into the form of mean and standard deviation ($M \pm SD$); ⑤ Literature quality evaluation score is lower than 6 points.

Information sources Following the PICOS framework, we included randomized controlled trials examining the effects of TMS on craving in individuals with substance dependence. A systematic literature search was conducted in PubMed, Web of Science, EMBase, The Cochrane Library, CNKI, CBM, Wanfang, and VIP from database inception to June 2026.

Main outcome(s) Craving (VAS refers to visual analog scale; ACQ refers to Alcohol Craving Questionnaire; PACS refers to Penn Alcohol Craving Scale; MCQ-SF refers to Marijuana Craving Questionnaire Short Form; OCDS refers to The Obsessive Compulsive Drinking Scale; QSU refers to Questionnaire of Smoking Urges; AUQ refers to alcohol urge questionnaire; CCQ refers to Cocaine Craving Questionnaire; TCQ-SF refers to Tobacco Craving Questionnaire Short Form).

Quality assessment / Risk of bias analysis The quality score of the literature was assessed using the modified version of the PEDro scale [2]. The scale includes 10 criteria: intention-to-treat analysis, random allocation, allocation concealment, baseline similarity, subject blinding, outcome assessment blinding, withdrawal rate $\leq 15\%$, therapist blinding, and point measurement and difference values. 1 point is given for each criterion that is met, and 0 points are given for any non-compliance. The total score of the scale is 10 points. A score less than 4 indicates poor quality, 4-5 indicates moderate quality, 6-8 indicates good quality, and 9-10 indicates high quality. Only studies with a score of 6 or above were included.

Strategy of data synthesis Statistical analysis was conducted using R software (packages: metafor, Matrix, and tidyverse) [5-9]. Since multiple related effect sizes might be reported in the same study, the main analysis employed a three-level random-effects meta-analysis model, nesting the effect sizes within studies to separately estimate sampling error, intra-study heterogeneity, and inter-study heterogeneity [10, 11]; a traditional two-level random-effects model was also constructed as a supplementary analysis. The effect sizes were expressed as Hedges' g and their variances and 95% confidence intervals were calculated based on the post-test means, standard deviations, and sample sizes of the intervention group and control group. Generally, g values of 0.20, 0.50, and 0.80 are considered to represent small, medium, and large effect sizes, respectively.

Heterogeneity was evaluated through variance component decomposition, and the I^2 values at each level were calculated to quantify the proportion of variance from different sources.

Subgroup analysis To further explore the sources of heterogeneity, subgroup analyses were conducted under a three-level random effects framework for variables such as drug dependence type, intervention frequency, intervention period, stimulation frequency, stimulation intensity, stimulated brain region, and the number of single pulses.

Sensitivity analysis Sensitivity analysis assesses the impact of individual effect sizes or studies on the overall effect estimate by sequentially removing the effect sizes and re-fitting the model.

Country(ies) involved China.

Keywords transcranial magnetic stimulation; craving; drug-dependence; meta.

Contributions of each author

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