Effects of rTMS on Executive Functions in Preclinical Older Adults: Systematic Review and Meta-Analysis H.T. Pang, K.N.K. Fong, T.G. Melesse, R.Chung, J.J.Q. Zhang, H.C. Ju. *Gerontechnology* 25(s)

Purpose Dementia prevention requires early preclinical stages intervention. Among Cognitive Functions, Executive functions (EFs) are essential for daily independence and safety, and EF dysfunction in individuals with mild cognitive impairment (MCI) is associated with increased risk of dementia. Although repetitive transcranial magnetic stimulation (rTMS) shows potential for enhancing EF, prior reviews are limited by heterogeneous stimulation protocols, reliance on global EF outcomes, and minimal evaluation of hybrid approaches such as rTMS combined with cognitive training (rTMS+CT). Moreover, no review has clarified whether specific rTMS approaches yield distinct effects across EF subdomains. This systematic review and meta-analysis examined the effects of different rTMS protocols on cognitive flexibility (CF), inhibitory control (IC), and working memory (WM) in healthy and at-risk older adults, and identified protocol- and target-specific factors associated with the strongest EF outcomes. **Method** Randomized controlled and crossover trials involving adults ≥55 years receiving rTMS or rTMS+CT versus sham were included. Five databases were searched through 5 September 2025. Risk of bias was assessed using the PEDro scale. Random-effects models (Hedges' g) and subgroup analyses by stimulation protocol, target, and frequency were conducted. **Results and Discussion** Our database search initially identified 1,771 records. Seventeen studies, with 497 participants, met the inclusion criteria. Overall, rTMS/rTMS+CT yielded immediate improvements in CF (n = 10, g = 0.29, 95% CI [0.01, 0.56]) and WM (n = 11, g = 0.30, 95% CI [0.00, 0.60]), with no sustained follow-up effects. IC showed no significant improvement. High-frequency bilateral DLPFC stimulation demonstrated a significantly large effect on CF (g = 0.96), while high-frequency right DLPFC stimulation showed a marginal improvement in WM (g = 0.93). rTMS produces modest, short-term improvements in cognitive flexibility and working memory in healthy and preclinical older adults. The most responsive patterns were observed under high-frequency stimulation of the bilateral and right DLPFC, whereas protocol-based comparisons did not differ significantly. However, conclusions remain tentative due to small samples, heterogeneous protocols, and limited follow-up. Further high-quality trials are required to determine optimal stimulation parameters and clinical relevance. The review was registered in PROSPERO (CRD420251144444).

Keywords: repetitive transcranial magnetic stimulation, executive functions, aging, mild cognitive impairment (MCI)
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