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REVIEW

"Repetitive Transcranial Magnetic Stimulation for Auditory Hallucinations in Schizophrenia": Scoping Review

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Background: Auditory verbal hallucinations (AVH) are among the most disabling symptoms of schizophrenia, often resistant to pharmacological treatment. Repetitive transcranial magnetic stimulation (rTMS) has emerged as a potential non-pharmacological intervention; however, existing evidence is fragmented across heterogeneous study designs.

Objective: This scoping review aimed to map the available evidence on the use of rTMS for AVH in patients with schizophrenia, focusing on stimulation parameters, clinical outcomes, neuroimaging findings, and gaps in current research.

Methods: A scoping review was conducted following the Joanna Briggs Institute (JBI) methodology and reported in accordance with PRISMA-ScR guidelines. Literature searches were performed in PubMed, Scopus, EBSCO, and ScienceDirect for studies published between 2015 and 2025. Eligible studies included randomized controlled trials (RCTs), observational studies, and exploratory trials investigating rTMS in schizophrenia patients with AVH. Data were extracted and synthesized descriptively.

Results: Eight studies met the inclusion criteria. Most were conducted in China, with additional contributions from France, India, and the Netherlands. Low-frequency rTMS (1 Hz) targeting the temporoparietal junction (TPJ) was the most frequently applied protocol, while high-frequency stimulation (10 Hz) over the dorsolateral prefrontal cortex (DLPFC) and cerebellar theta burst stimulation were less common. Several RCTs demonstrated significant reductions in AVH severity, whereas others highlighted placebo effects. Neuroimaging studies reported rTMS-induced modulation of brain connectivity, particularly within the default mode, language, and auditory networks. Across studies, small sample sizes, heterogeneous protocols, and limited follow-up restricted generalizability.

Conclusion: rTMS shows promise as a non-pharmacological intervention for AVH in schizophrenia, particularly with low-frequency stimulation over the TPJ. However, evidence remains heterogeneous, and future multicenter trials with standardized protocols and long-term outcomes are warranted to establish clinical effectiveness.

Keywords: schizophrenia, auditory verbal hallucinations, repetitive transcranial magnetic stimulation, neurostimulation

Introduction

Auditory hallucinations are a primary symptom of psychotic disorders, including schizophrenia. This phenomenon is characterized by the perception of sounds or speech in the absence of external sensory stimuli. These experiences may manifest as remarks, commands, or dialogues that are often distressing or threatening. Auditory hallucinations substantially impair quality of life, leading to reduced social functioning, increased psychological distress, and a higher risk of relapse.[1] The management of psychotic disorders primarily relies on pharmacological treatment with antipsychotic medications. However, a considerable proportion of patients do not achieve adequate symptom control. Approximately 25–30% of individuals with schizophrenia continue to experience persistent auditory hallucinations despite prolonged antipsychotic treatment.[2,3] This condition is commonly referred to as treatment-resistant auditory hallucinations and represents a significant challenge in psychiatric care. The limitations of pharmacological approaches have prompted the exploration of alternative interventions, including repetitive transcranial magnetic stimulation (rTMS).

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Repetitive transcranial magnetic stimulation (rTMS) is a non-invasive neuromodulatory technique that modulates cortical excitability through the application of repetitive magnetic pulses to targeted brain regions. By inducing neuroplastic changes via long-term potentiation and depression mechanisms, rTMS has been increasingly investigated for various neuropsychiatric conditions, including schizophrenia. In patients with schizophrenia, rTMS is thought to influence aberrant neural circuits associated with auditory verbal hallucinations, particularly within the temporoparietal cortex. These neuromodulatory effects provide a neurobiological rationale for exploring rTMS as a therapeutic intervention in this population.

In schizophrenia, rTMS is hypothesized to modulate dysfunctional neural circuits associated with auditory verbal hallucinations, particularly within the left temporoparietal cortex, a region implicated in language processing and internal speech perception[4] These neuromodulatory effects provide a neurobiological rationale for the use of rTMS as a potential adjunctive treatment for patients who do not respond adequately to conventional therapies.

The growing body of research on rTMS, alongside advances in stimulation technology and an improved understanding of the neurobiology of hallucinations, underscores the need for further investigation into its therapeutic potential. rTMS offers a non-invasive and relatively safe intervention with fewer systemic adverse effects compared to psychotropic medications, while allowing precise anatomical targeting of implicated brain regions.

Despite numerous clinical trials and systematic reviews examining the efficacy of rTMS for auditory hallucinations, the current evidence remains heterogeneous. Variability in study design, stimulation parameters (including frequency, target region, and treatment duration), and sample sizes limits the generalizability of findings. Additionally, placebo effects reported in some studies complicate interpretation of treatment outcomes. Therefore, a comprehensive mapping of the existing evidence is required to clarify the extent and characteristics of rTMS research in individuals with schizophrenia experiencing auditory verbal hallucinations. A scoping review methodology was selected to systematically identify available evidence, summarize research trends, and highlight knowledge gaps to inform future research. This review aims to synthesize current evidence regarding rTMS for auditory verbal hallucinations in schizophrenia, with particular attention to stimulation protocols, clinical outcomes, eurobiological findings, and remaining research limitations.

Methods

Study Design

This study employed a scoping review methodology in accordance with the Joanna Briggs Institute (JBI) guidelines and was reported following the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews). The scoping review approach was selected to comprehensively map existing evidence regarding the use of repetitive transcranial magnetic stimulation (rTMS) for auditory verbal hallucinations (AVH) in individuals with schizophrenia and to identify existing knowledge gaps.

Research Question

The research question was formulated using the PCC framework (Population, Concept, Context). The population comprised individuals diagnosed with schizophrenia or other psychotic disorders experiencing auditory verbal hallucinations. The concept focused on repetitive transcranial magnetic stimulation (rTMS) as an intervention. The context included clinical and observational studies evaluating the effects of rTMS on auditory verbal hallucinations, cognitive outcomes, and neural connectivity.

Search Strategy

A comprehensive literature search was conducted across four electronic databases: PubMed, Scopus, EBSCO, and ScienceDirect. The search strategy was developed based on the PCC framework using the following keywords and Medical Subject Headings (MeSH): (“auditory hallucinations” OR “auditory verbal hallucinations”) AND (“transcranial magnetic stimulation” OR “TMS” OR “rTMS”) AND (“schizophrenia” OR “psychosis”). The search was limited to peer-

reviewed articles published in English between 2015 and 2025 and focused on studies examining the application of rTMS in individuals with auditory verbal hallucinations. Previous scoping reviews were excluded.

Study Selection

Two reviewers independently screened titles, abstracts, and full texts according to predefined inclusion and exclusion criteria. Duplicate records were removed using Mendeley Desktop software. Any discrepancies in study selection were resolved through discussion and consensus among the research team. In addition, potential overlap of study populations was assessed manually by comparing author names, study settings, sample sizes, and recruitment periods. When multiple publications from the same research group were identified, only the most comprehensive or most recent report was included.

Data Extraction

Data were extracted using a standardized data extraction form, which included information on authorship, year of publication, country, study objectives, study design, population characteristics, rTMS intervention parameters, key findings, and conclusions.

Data Synthesis

The extracted data were analyzed descriptively and narratively to summarize study characteristics and outcomes. Findings were synthesized using summary tables and thematic analysis, focusing on the efficacy of rTMS for auditory verbal hallucinations, variations in stimulation protocols (including frequency and targeted brain regions), and their effects on clinical and cognitive outcomes.

Study Selection Process

The study selection process is illustrated in Figure 1, which presents the number of records identified, screened, assessed for eligibility, and included in the review.

Results

Attributes of Included Studies: Eight papers fulfilled the inclusion criteria, comprising randomized Controlled trials (RCTs), exploratory investigations, and observational research. China conducted the majority of the research, with contributions from France, India, and the Netherlands supplementing it. The sample size varied from 24 to 66 patients diagnosed with Schizophrenia and auditory verbal hallucinations (AVH).

Parameters and Protocols for Stimulation: The rTMS methodologies employed in the investigations were notably varied: The most prevalent protocol employed was low frequency (1 Hz), aimed at the left temporoparietal junction (TPJ). High-frequency (10 Hz) stimulation was directed at the dorsolateral prefrontal cortex (DLPFC) to assess cognitive effects. Theta burst stimulation on the cerebellar vermis has been examined in multiple research studies. Certain research employs fMRI or MRI-based neuronavigation to enhance the precision of target identification.

Clinical Outcomes Auditory hallucinations: The majority of randomized controlled trials[5–7] demonstrate a significant decrease in scores on the Auditory Hallucination Rating Scale (AHRS) and an enhancement in symptoms of auditory verbal hallucinations (AVH). The study conducted by[8] revealed comparable enhancements in both the active and sham rTMS groups, which illustrates the importance of psychological factors and expectations.

Cognitive function: Stimulation of the DLPFC at 10 Hz[9] enhanced patients' cognitive function, while it did not significantly affect psychotic symptoms. Cerebellar theta stimulation demonstrated efficacy in alleviating negative feelings and depression in people with schizophrenia.

Neuroimaging Results: Numerous research studies utilizing fMRI connectivity analysis[6,7,10] have indicated that rTMS influences brain networks, specifically the default mode network (DMN), language network (LAN), auditory network (AUD), and cerebellar connections. The reestablishment of this atypical connection pattern correlates with enhancement in clinical symptoms. Disparity in Knowledge Substantial discrepancies in rTMS settings (frequency, target, session duration) complicate direct comparisons of findings. The limited sample size in the majority of

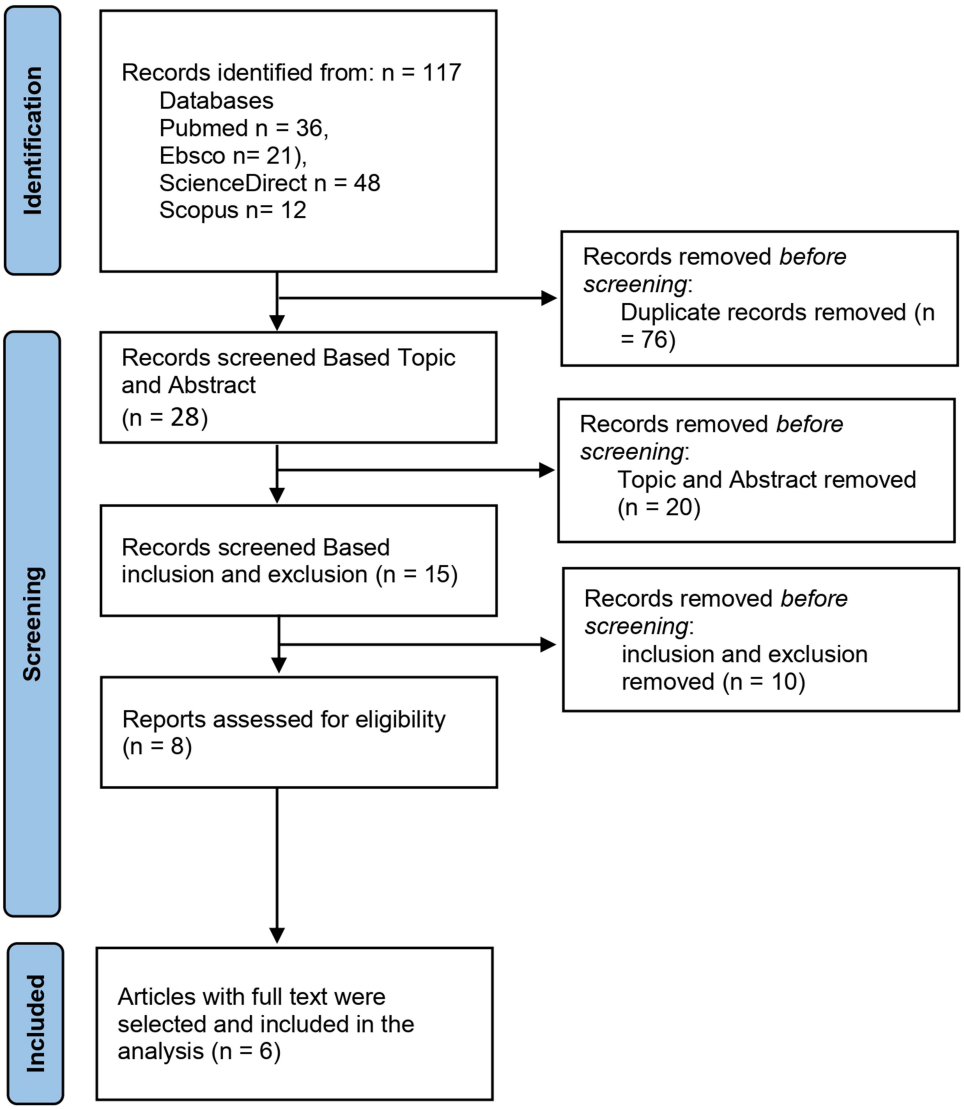

Figure 1 PRISMA flow diagram of study selection.

studies constrains the generalizability of the results. The long-term follow-up is somewhat restricted; hence, the sustainability of the effects remains unverified. The pronounced placebo effect underscores the necessity for more rigorous methodologies in forthcoming clinical trials. A summary of the characteristics and key findings of the included studies is presented in Table 1. Details regarding the study design, sample size, stimulation targets, and key results of each study can be found in Table 1. The general characteristics of the included studies are summarized in Table 1. To provide a more detailed comparison of stimulation parameters and clinical outcomes, the main results of each study are presented in Table 2. Although ten studies were included in the scoping review, only eight studies reported sufficient rTMS stimulation parameters and auditory verbal hallucination–specific outcomes to allow comparative analysis and were therefore included in Table 2.

The literature review identified eight papers that satisfied the inclusion requirements, including randomised controlled trials (RCTs), exploratory investigations, and observational research employing an fMRI methodology. The studies were conducted in multiple nations, predominantly China, with supplementary research from France, India, and the Netherlands. The sample size ranged from 24 to 66 patients diagnosed with schizophrenia and auditory verbal hallucinations (AVH). The protocols for repetitive transcranial magnetic stimulation (rTMS) are varied, encompassing low frequency (1 Hz) at the left temporoparietal junction (TPJ), high frequency (10 Hz) at the dorsolateral prefrontal

Table 1 Summary of Included Studies on Repetitive Transcranial Magnetic Stimulation (rTMS) for Auditory Verbal Hallucinations in Schizophrenia

Author, Year	Country	Study Design	Population & Sample	rTMS Protocol/Target	Main Outcome	Key Findings
Hua et al, 2024[5]	China	RCT, double-blind, sham-controlled	62 patient schizophrenia with AVH	MRI-navigated rTMS, 1 Hz, TPJ, 2 week	AHRS	Significant reduction in AVH, effects lasting up to 6 weeks, safe
Paillère-Martinot et al, 2017[8]	France	RCT, fMRI-guided, sham-controlled	27 patients with drug-resistant AVH	Active rTMS vs sham, TPJ	SAPS, PSYRATS	Improvement in both groups, indicating a strong placebo effect
Garg et al, 2016[11]	India	RCT, sham-controlled, double-blind	40 patients with schizophrenia	Theta burst rTMS, cerebellar vermis, 10 sessions/2 weeks	PANSS, CDSS	Significant reduction in negative symptoms and depression compared to sham
Mao et al, 2023[9]	China	Exploratory, double-blind RCT	60 schizophrenia patients with AVH	rTMS 10 Hz, left DLPFC, 20 sessions	RBANS, PANSS, AHRS	Cognitive function improvement, not significant in AVH/ psychotic patients
Xie et al, 2022[6]	China	Observational, fMRI connectivity	32 AVH patients, 33 healthy controls	1 Hz rTMS, TPJ	fMRI topological network	Significant changes in brain connectivity, improvement in AVH symptoms
Xie et al, 2023[7]	China	Resting-state fMRI	32 AVH patients, 35 healthy controls	1 Hz rTMS, TPJ	Dentate nucleus connectivity	Normalization of connectivity, decreased AVH, improved cognitive function
Xie et al, 2024[12]	China	Observational, fMRI (sFNC, dFNC)	32 schizophrenia patients with AVH	1 Hz rTMS, TPJ	Functional connectivity	Restoration of DMN, LAN, ECN, AUD; associated with improvement in clinical symptoms
Bais et al, 2017[10]	Netherlands	RCT, randomized sham-controlled	24 patients with drug-resistant AVH	1 Hz rTMS, left vs bilateral TPJ, 10 days	fMRI, inner speech task	Left TPJ rTMS decreased the contribution of the supramarginal gyrus; reduced inner speech intrusions

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Table 2 Detailed Outcomes of Included rTMS Studies for Auditory Verbal Hallucinations

Author, Year (Ref)	Sample	Target Area	Frequency	Sessions	AVH Outcome	Other Findings
Jardri et al, 2011[4]	Meta-analysis	TPJ	–	–	Identified TPJ hyperactivity associated with AVH	Provided neurobiological rationale
Hua et al, 2024[5]	62 patients	Left TPJ	1 Hz	10	Significant reduction in AHRS scores lasting up to 6 weeks	Safe and well tolerated
Xie et al, 2022[6]	32 patients	Left TPJ	1 Hz	10	Significant reduction in AVH severity	Normalization of DMN and auditory networks
Xie et al, 2023[7]	25 patients	TPJ + network targets	1 Hz	Variable	Improvement in AVH symptoms	Modulation of large-scale functional connectivity
Paillère-Martinot et al, 2017[8]	27 patients	TPJ	Low frequency	10	Comparable improvement in active and sham groups	Strong placebo effect observed
Mao et al, 2023[9]	28 patients	DLPFC	10 Hz	20	No significant reduction in AVH	Improved cognitive performance
Bais et al, 2017[10]	32 patients	Left TPJ	1 Hz	10	Reduced involvement of supramarginal gyrus	Reduced inner speech misattribution
Garg et al, 2016[11]	28 patients	Cerebellar vermis	Theta burst	15	Not primary AVH outcome	Reduced negative and depressive symptoms

cortex (DLPFC), and theta burst stimulation at the cerebellar vermis. This variety illustrates disparities in study emphasis, encompassing the alleviation of AVH symptoms, enhancement of cognitive performance, and the delineation of alterations in brain connectivity.

The primary findings of the included research suggest that rTMS may offer clinical advantages, especially in alleviating AVH symptoms, but several studies noted considerable placebo effects. Furthermore, fMRI studies have demonstrated that rTMS can influence brain network connectivity, including the default mode network, language network, and auditory network, which correlates with enhancements in clinical symptoms.

Discussions

Hallucinations are defined as perceptual experiences occurring in the absence of corresponding external stimuli and may involve auditory, visual, gustatory, or tactile sensations.[13] Individuals experiencing auditory hallucinations often exhibit distinctive behaviors, such as engaging in self-directed conversations, laughing or smiling without an apparent cause, and fixating on irrelevant stimuli. These symptoms substantially impair quality of life, mood regulation, self-esteem, and social functioning, and are associated with an increased risk of aggressive behavior.[14] Consequently, effective therapeutic interventions are required to manage hallucinations in individuals with schizophrenia.

Repetitive transcranial magnetic stimulation (rTMS) is a non-invasive neuromodulation technique that utilizes electromagnetic coils placed on the scalp to generate magnetic fields capable of inducing neuronal activity within targeted cortical regions.[15] Beyond its localized effects, rTMS influences functional connectivity across distributed brain networks, thereby modulating interconnected neural systems involved in perception and cognition.[8] In patients with auditory hallucinations, rTMS is hypothesized to reduce aberrant cortical hyperactivity and rebalance dysfunctional brain network connectivity.

Implications of rTMS Parameters and Mechanistic Considerations

The left temporoparietal junction (TPJ) is a critical cortical region implicated in the generation of auditory hallucinations. This region plays a central role in language processing and auditory perception and is essential for distinguishing internally generated thoughts from external auditory input. In individuals experiencing auditory hallucinations, this differentiation mechanism is disrupted, leading to the misattribution of internal speech as external voices. Accordingly, low-frequency (1 Hz) rTMS targeting the TPJ has been widely investigated as a therapeutic strategy to suppress cortical hyperexcitability and restore functional network balance.

Several studies have demonstrated the clinical efficacy of low-frequency rTMS applied to the TPJ in reducing auditory verbal hallucinations (AVH). A randomized clinical trial reported that neuronavigated 1 Hz rTMS significantly reduced AVH severity in patients with schizophrenia, with effects persisting up to six weeks post-intervention compared with sham stimulation[5] These findings are consistent with studies demonstrating significant alterations in functional brain network connectivity following rTMS treatment.[6] Improvements were associated with enhanced coordination among brain regions involved in auditory perception, indicating a normalization of previously dysregulated neural networks.[7] However, not all studies have demonstrated clear superiority of active rTMS over sham stimulation. One investigation reported comparable improvements in hallucination severity in both active and sham rTMS groups, suggesting a substantial placebo effect,[8] both the active and placebo groups exhibited a significant enhancement in the SAPS hallucination subscale scores. The comparable outcomes in the placebo TMS or sham TMS group may be affected by cortical effects stemming from non-magnetic stimulation of the auditory cortex (eg, the perception of stimulation) that contribute to enhancement.[8] In contrast, high-frequency (10 Hz) rTMS applied to the dorsolateral prefrontal cortex (DLPFC) was shown to improve cognitive function without producing a significant reduction in core psychotic symptoms.[9] The findings, in conjunction with the research of,[6] affirm that the efficacy of rTMS is influenced not only by stimulation of primary cortical regions like the TPJ or DLPFC but also encompasses a more extensive neural network, including the dentate nucleus. Low-frequency (1 Hz) rTMS administration has demonstrated the ability to normalise previously abnormal functional connectivity, especially in cerebellar regions, and offers clinical advantages, including a decrease in hallucinatory symptoms, enhancement of positive symptoms, and improved cognitive function. The studies conducted by[6,7] in China further substantiated findings by fMRI-based functional connectivity (FC), static functional network connectivity (sFNC), and dynamic functional network connectivity (dFNC) analyses.

The findings indicate that low-frequency (1 Hz) rTMS application can restore previously aberrant brain connection patterns in both cortical networks (TPJ, DMN, ECN, LAN, and AUD) and subcortical networks (dentate nucleus). The restoration of connection significantly reduces AVH symptoms, enhances positive symptoms, and improves patients' cognitive ability. The study by[10] similarly indicated that rTMS applied to the left temporoparietal junction (TPJ) can diminish the involvement of the supramarginal gyrus in the bilateral fronto-temporal network, consequently reducing the probability of inner speech manifesting as a hallucination.

The use of Repetitive Transcranial Magnetic Stimulation (rTMS) therapy significantly affects auditory hallucination symptoms by diminishing hyperactivity in the TPJ region and modifying extensive brain network connectivity. This phenomenon is observed not only in the primary symptom of auditory verbal hallucinations but also in other dimensions, including cognitive function and negative symptoms; nevertheless, certain investigations have indicated a significant placebo effect as well. Consequently, rTMS seems to function as an intervention that can modify brain activity dynamics, establishing a significant scientific foundation for the future advancement of treatments for auditory hallucinations.

Although all included studies investigated rTMS as an intervention for auditory verbal hallucinations, notable differences in stimulation parameters may partially explain the variability in clinical outcomes. Low-frequency stimulation (1 Hz) targeting the left temporoparietal junction (TPJ) demonstrated more consistent reductions in hallucination severity compared with high-frequency stimulation protocols. This pattern supports the hypothesis that inhibitory stimulation over hyperactive language-related cortical regions may be particularly effective in suppressing aberrant auditory perceptions.

In contrast, high-frequency stimulation applied to the dorsolateral prefrontal cortex (DLPFC) was primarily associated with improvements in cognitive function rather than direct reductions in hallucination severity. This suggests that

stimulation effects may be target-specific, with TPJ stimulation influencing perceptual misattribution mechanisms, while DLPFC stimulation modulates executive and working memory processes. Similarly, cerebellar theta burst stimulation appeared to preferentially affect negative symptoms and affective regulation, highlighting the role of distributed neural networks beyond primary auditory regions.

The presence of placebo effects in several studies further underscores the complexity of neuromodulation research in psychosis. Sensory experiences associated with stimulation, patient expectations, and engagement with treatment may contribute to symptom improvement independent of direct neurophysiological modulation. Collectively, these findings suggest that the therapeutic efficacy of rTMS for auditory hallucinations is likely influenced by an interaction between stimulation parameters, cortical targets, and network-level mechanisms rather than a single focal effect.itory hallucination therapy.

Conclusion

This scoping review synthesizes current evidence on the application of repetitive transcranial magnetic stimulation (rTMS) for auditory verbal hallucinations in individuals with schizophrenia. Overall, the findings suggest that low-frequency rTMS targeting the temporoparietal junction may reduce the severity of auditory hallucinations and modulate aberrant brain connectivity patterns. Neuroimaging studies further indicate that these clinical effects are associated with changes in large-scale neural networks involved in auditory processing and language. These findings suggest that the clinical efficacy of rTMS for auditory hallucinations is likely influenced by an interaction between stimulation parameters and network-level mechanisms rather than isolated cortical effects.

However, this review has several limitations. These include the heterogeneity of included studies, variations in stimulation protocols, small sample sizes, limited long-term follow-up, and the presence of placebo effects, which restrict the generalizability of the findings. In addition, as a scoping review, this study did not aim to perform quantitative synthesis or risk-of-bias assessment. Future research should prioritize large-scale, multicenter trials with standardized stimulation parameters and extended follow-up periods. Such efforts are essential to clarify the clinical efficacy, durability of treatment effects, and optimal application of rTMS as an adjunctive intervention for auditory hallucinations in schizophrenia. As a scoping review, this study did not aim to perform quantitative synthesis or risk-of-bias assessment.

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References

1. Waters F, Woods A, Fernyhough C. Report on the 2nd international consortium on hallucination research: evolving directions and top-10 “hot spots” in hallucination research. *Schizophr Bull*. 2014;40(1):24–27. doi:10.1093/schbul/sbt167
2. Slotema CW, Blom JD, van Lutterveld R, Hoek HW, Sommer IEC. Review of the efficacy of transcranial magnetic stimulation for auditory verbal hallucinations. *Biol Psychiatry*. 2014;76(2):101–110. doi:10.1016/j.biopsych.2013.09.038
3. Dougall N, Maayan N, Soares-Weiser K, McDermott LM, McIntosh A. Transcranial magnetic stimulation for schizophrenia. *Schizophr Bull*. 2015;41(6):1220–1222. doi:10.1093/schbul/sbv121
4. Jardri R, Pouchet A, Pins D, Thomas P. Cortical activations during auditory verbal hallucinations in schizophrenia: a coordinate-based meta-analysis. *Am J Psychiatry*. 2011;168(1):73–81. doi:10.1176/appi.ajp.2010.09101522
5. Hua Q, Wang L, He K, et al. Repetitive transcranial magnetic stimulation for auditory verbal hallucinations in schizophrenia: a randomized clinical trial. *JAMA Network Open*. 2024;7(11):e2444215. doi:10.1001/jamanetworkopen.2024.44215
6. Xie Y, He Y, Guan M, et al. Low-frequency rTMS treatment alters the topographical organization of functional brain networks in schizophrenia patients with auditory verbal hallucination. *Psychiatry Res*. 2022;309:114393. doi:10.1016/j.psychres.2022.114393
7. Xie Y, Guan M, Cai Y, et al. Impact of low-frequency repetitive transcranial magnetic stimulation on functional network connectivity in schizophrenia patients with auditory verbal hallucinations. *Psychiatry Res*. 2023;320:114974. doi:10.1016/j.psychres.2022.114974
8. Paillère-Martinot M, Galinowski A, Plaze M, et al. Active and placebo transcranial magnetic stimulation effects on external and internal auditory hallucinations of schizophrenia. *Acta Psychiatr Scand*. 2017;135(3):228–238. doi:10.1111/acps.12680

9. Mao J, Fan K, Zhang Y, et al. 10 Hz repetitive transcranial magnetic stimulation (rTMS) may improve cognitive function: an exploratory study of schizophrenia patients with auditory hallucinations. *Heliyon*. 2023;9(9):e19876. doi:10.1016/j.heliyon.2023.e19912
10. Bais L, Liemburg E, Vercammen A, Bruggeman R, Knegtering H, Aleman A. Effects of low frequency rTMS treatment on brain networks for inner speech in patients with schizophrenia and auditory verbal hallucinations. *Prog Neuro Psychopharmacol Biol Psychiatry*. 2017;78:105–113. doi:10.1016/j.pnpbp.2017.04.017
11. Garg S, Sinha VK, Tikka SK, Mishra P, Goyal N. The efficacy of cerebellar vermal deep high frequency (theta range) repetitive transcranial magnetic stimulation (rTMS) in schizophrenia: a randomized rater blind-sham controlled study. *Psychiatry Res*. 2016;243:413–420. doi:10.1016/j.psychres.2016.07.023
12. Xie Y, Li C, Guan M, et al. The efficacy of low frequency repetitive transcial magnetic stimulation for treating auditory verbal hallucinations in schizophrenia: insights from functional gradient analyses. *Heliyon*. 2024;10(9):eXXXX.
13. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 5th ed. Washington (DC): American Psychiatric Publishingi; 2022. text revision.
14. Zanello A, Mohr S, Merlo MCG, Huguelet P, Rey-Bellet P. Effectiveness of a brief group cognitive behavioral therapy for auditory verbal hallucinations: a 6-month follow-up study. *J Nerv Ment Dis*. 2014;202(2):144–153. doi:10.1097/NMD.0000000000000084
15. Duan H, Yan X, Meng S, et al. Effectiveness evaluation of repetitive transcranial magnetic stimulation therapy combined with mindfulness-based stress reduction for people with post-stroke depression: a randomized controlled trial. *Int J Environ Res Public Health*. 2023;20(2):930. doi:10.3390/ijerph20020930