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Emerging trends in neuromodulation for schizophrenia: a global bibliometric analysis

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Abstract: The utilization of neuromodulation techniques is increasingly capturing the attention of researchers and clinicians as potential non-pharmaceutical interventions for treating schizophrenia, especially among drug-resistant schizophrenia patients. Assessing the existing landscape of research activity and identifying gaps in neuromodulation-schizophrenia research is crucial for strategic planning and guiding future research in this domain. This bibliometric analysis paper aims to discern the publications and research trends in neuromodulation schizophrenia studies spanning 2019 to 2023. The Scopus database search was performed using the related keywords. Neuromodulation-schizophrenia-related publications were retrieved from the Scopus database from 2019 to 2023. Bibliometric analyses were performed using Harzing's Publish or Perish, Microsoft Excel and VOS viewer software programs. Three hundred fifty-three publications from the Scopus database were retrieved and analyzed to answer the research questions. The highest number of publications, 87, was observed in 2022. The United States led the way in publishing neuromodulation schizophrenia research with 96 articles. Keyword analysis revealed that "transcranial direct current stimulation" (tDCS) and "transcranial magnetic stimulation" (TMS) were the most prevalent neuromodulation techniques investigated in schizophrenia research. Transcranial-focused ultrasound (TUS) emerged as a novel and current neuromodulation technique explored in treating schizophrenia, as indicated by the analysis of selected journal articles. This bibliometric paper provides insights into the current status, knowledge base, and future directions of neuromodulation-schizophrenia studies, which will serve future researchers in focusing on applying neuromodulation techniques as potential non-pharmaceutical interventions for schizophrenia.

Keywords: Neuromodulation; Schizophrenia; Neurostimulation; Non-pharmaceutical treatment; Bibliometric

1.0 INTRODUCTION

Schizophrenia is a chronic and disabling neurological disorder. The World Health Organization (WHO) estimates that approximately 24 million individuals worldwide – or one in every 300 people (0.32%) are affected by schizophrenia (WHO, 2022). It results in psychosis and is linked to serious impairment. Numerous aspects of life are impacted by this impairment, including social, familial, professional, educational, and personal functioning (WHO, 2022).

There are quite a few treatment options for schizophrenia, which include pharmaceutical and non-pharmaceutical treatments. Pharmaceutical treatments, such as the usage of second-generation antipsychotic (SGA) drugs, are the agents of choice for the first-line treatment of schizophrenia. However, adverse effects such as weight gain, hyperlipidemia, and diabetes mellitus can contribute to the increased risk of cardiovascular mortality observed in schizophrenia patients (Chiliza et al., 2015; Patel et al., 2014; Raedler, 2010). Furthermore, tardive Dyskinesia (TD), a severe, abnormal involuntary movement disorder, is a common comorbidity in schizophrenia patients due to long-term exposure to antipsychotic drugs (Uludag et al., 2021). This could also result in an increase in nonadherence rates among them. Meanwhile, some patients are drug-resistant and thus require non-pharmaceutical treatments.

Non-pharmaceutical treatments include the usage of neuromodulation. Neuromodulation is a fast-expanding field of study encompassing a broad range of implantable and non-invasive technology-based techniques for treating neurological and neuropsychiatric disorders (Johnson et al., 2013; Krames et al., 2009). It is the process of interacting with and intervening with the neurological system using electrical, electromagnetic, pharmacological, or optogenetic methods with the purpose of long-term activation, inhibition, alteration, and/or regulation of neuronal activity (Johnson et al., 2013; Krames et al., 2009).

For example, the non-invasive neuromodulation therapy induced by neurofeedback training (NFT) using electroencephalography (EEG), magnetoencephalography (MEG), or functional magnetic resonance imaging (fMRI) can train the brain activity to enhance cognitive-motor abilities that disrupted due to neurological or neuropsychological disorders (Grosselin et al., 2021; Okazaki et al., 2015; Sorger et al., 2019).

Meanwhile, transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) are the neuromodulation strategies that involve the delivery of magnetic or electrical current, respectively, through probes positioned at the scalp of the head (Hamani & Moro, 2012). The stimulation sites depend on the symptoms of the patients, intending to specifically influence the cognitive, emotional, and behavioral aspects of the patients. Invasive neuromodulation strategy includes deep brain stimulation (DBS). The DBS requires surgical intervention to implant electrodes (Luo et al., 2021).

The usage of neuromodulation therapy has proven to have good prognosis with other neurological and neuropsychiatric disorders such as depression (Akhtar et al., 2016; Bloom et al., 2023; Downar & Daskalakis, 2013), Alzheimer's (Chang et al., 2018; Luo et al., 2021), Parkinson (Schuepbach et al., 2013; Yuan et al., 2020), stroke (Ting et al., 2021; Yin et al., 2020), obsessive-compulsive disorder (OCD) (Bergfeld et al., 2021; Zhou & Fang, 2022), attention deficit hyperactivity disorder (ADHD) (Okazaki et al., 2015; Wong & Zaman, 2019) and anxiety disorder (Cui et al., 2019; Rodrigues et al., 2019).

As research on neuromodulation of non-pharmaceutical treatment for schizophrenia continues to expand, a bibliometric analysis of these studies could provide valuable insights into the recent trends and directions of neuromodulation schizophrenia research. This is done so that future researchers can consider specific areas of neuromodulation-schizophrenia research that can be investigated further, laying the groundwork for the use of neuromodulation techniques in the treatment of schizophrenia.

To gain insights into the current global trajectory of neuromodulation schizophrenia research, we conducted a comprehensive bibliometric analysis of relevant literature published from 2019 to 2023. The bibliometric analysis focused on publications employing neuromodulation devices such as EEG, MEG and fMRI neurofeedback, DBS, TMS, repetitive transcranial magnetic stimulation (rTMS), tDCS, transcranial focused ultrasound stimulation (tFUS), and transcranial alternating current stimulation (tACS). To our knowledge, no bibliometric studies have been undertaken to examine the landscape of neuromodulation-schizophrenia research comprehensively. Consequently, there is no comprehensive overview of neuromodulation-schizophrenia publications and the trends in this field over the past five years.