International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

Dolna 17, Warsaw,
Poland 00-773
+48 226 0 227 03
editorial_office@rsglobal.pl

ARTICLE TITLE	NON-PHARMACOLOGICAL INTERVENTIONS IN SCHIZOPHRENIA - SYSTEMATIC REVIEW
DOI	https://doi.org/10.31435/ijitss.3(47).2025.3820
RECEIVED	06 August 2025
ACCEPTED	12 September 2025
PUBLISHED	16 September 2025
LICENSE	The article is licensed under a **Creative Commons Attribution 4.0 International License.**

NON-PHARMACOLOGICAL INTERVENTIONS IN SCHIZOPHRENIA - SYSTEMATIC REVIEW

Joanna Gadzinowska *(Corresponding Author, Email: asia.gadz@gmail.com)*
L. Rydygier Regional Hospital in Torun, Św. Józefa 53-59, 87-100 Toruń, Poland
ORCID ID: 0000-0002-7257-8552

Aleksandra Tomaszewska
Pomeranian Medical University in Szczecin, Rybacka 1, 70-204 Szczecin, Poland
ORCID ID: 0009-0000-4684-0492

Angelika Lewandowska
Municipal Hospital No. 4 in Gliwice, Zygmunta Starego 20, 44-100 Gliwice, Poland
ORCID ID: 0009-0006-5737-8495

Gabriela Szpila
4 Military Clinical Hospital with Polyclinic in Wroclaw, Weigla 5, 50-981 Wrocław, Poland
ORCID ID: 0009-0008-5105-1189

Agata Andrzejczyk
Medical University of Warsaw, Żwirki i Wigury 61, 02-091 Warsaw, Poland
ORCID ID: 0009-0000-1222-1765

Maciej Kokoszka
Medical University of Silesia in Katowice, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0009-0009-7682-9767

Michalina Chodór
Medical University of Silesia in Katowice, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0009-0000-2541-3686

Krzysztof Feret
Independent Public Regional Hospital Complex in Szczecin – Zdunowo, Sokołowskiego 11, 70-891 Szczecin, Poland
ORCID ID: 0009-0002-5910-4421

Małgorzata Stopyra
Medical University of Silesia in Katowice, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0000-0003-3179-0159

Natalia Nafalska
Medical University of Silesia in Katowice, Poniatowskiego 15, 40-055 Katowice, Poland
ORCID ID: 0000-0001-9775-7138

ABSTRACT

Schizophrenia is a severe and chronic mental disorder that affects up to 1% of the general population. Research suggests that the most effective therapeutic approach combines medication with non-pharmacological strategies. This review explores the impact of non-pharmacological treatment on the course of schizophrenia, including its effects on key symptoms, as well as patients' quality of life and overall life satisfaction. This article is a comprehensive review based on articles obtained from scientific databases such as PubMed and Google Scholar, with sources selected based on their relevance and significance to the subject matter. The findings indicate that non-pharmacological treatments, including lifestyle modifications, psychosocial interventions, and neuromodulation training plav a crucial role in improving the quality of life for individuals with schizophrenia. There is evidence supporting the reduction of both negative and positive symptoms, as well as an increased likelihood of returning to everyday activities. Non-pharmacological strategies are integral to the comprehensive management of schizophrenia. While the effectiveness of pharmacological interventions is well-established, current clinical guidelines also highlight the complementary role of non-pharmacological treatments, which contribute meaningfully to therapeutic outcomes and overall patient well-being.

KEYWORDS

Schizophrenia, Non-Pharmacological Treatment, Physical Activity, Sleep Hygiene, Transcranial Stimulation, Psychotherapy, Art Therapy, Neurofeedback, Animal-Assisted Therapy, Social Skills Training, Neurocognitive Training

CITATION

Joanna Gadzinowska, Aleksandra Tomaszewska, Angelika Lewandowska, Gabriela Szpila, Agata Andrzejczyk, Maciej Kokoszka, Michalina Chodór, Krzysztof Feret, Małgorzata Stopyra, Natalia Nafalska. (2025) Non-Pharmacological Interventions in Schizophrenia - Systematic Review. *International Journal of Innovative Technologies in Social Science*. 3(47). doi: 10.31435/ijitss.3(47).2025.3820

Introduction

According to the World Health Organization (2022), schizophrenia is a severe and chronic mental disorder that affects approximately 24 million people worldwide, or about 1 in 300 individuals (0.32%). Some sources report that schizophrenia affects up to 1% of the general population (Stilo et al., 2011, pp. 457–66).

The term schizophrenia was introduced by Paul Eugen Bleuler to describe a disconnection between the emotional and intellectual functions of the personality (Cumming et al., 2021). It is a heterogeneous condition characterized by a significant burden on affected individuals. The core symptoms of schizophrenia include positive symptoms (e.g. hallucinations, delusions, and disorganized thinking) and negative symptoms, which refer to reduction or loss of normal functions, including diminished emotional expression, poverty of speech, inability to experience pleasure, social withdrawal, lack of motivation (Crespo-Facorro et al., 2021; Barnes et al., 2020). Although the symptoms of schizophrenia are believed to stem from an organic brain disorder, decades of research have not identified any single causative pathogen or genetic factor of major significance, leaving the underlying pathology elusive (Cumming et al., 2021).

Schizophrenia is associated with a considerable disease burden, including elevated mortality risk (particularly due to suicide within the first few years following diagnosis), a high prevalence of comorbid conditions (such as tobacco use, substance use disorders, and depression), and significant impairments in social and occupational functioning (Crespo-Facorro et al., 2021). Patients frequently experience stigmatization related to the disorder and its associated symptoms (Colizzi et al., 2020, pp. 705–26). Contemporary treatment recommendations for schizophrenia, issued by National Institute for Health and Care Excellence in the UK and the Schizophrenia Patient Outcomes Research Team in the USA, advocate for an integrated therapeutic approach that combines medication with non-pharmacological strategies (Stevović et al., 2022). Studies investigating non-pharmacological components within multi-modal treatment strategies for schizophrenia have yielded heterogeneous outcomes regarding their efficacy, alongside notable variability in the consistency of their implementation across clinical settings (Stevović et al., 2022).

This article will focus on summarizing the most significant non-pharmacological approaches in the treatment of schizophrenia, including psychotherapy, neurocognitive training and social skills development, art therapy and animal-assisted therapy. Interventions such as neurofeedback and transcranial stimulation will also be discussed. Crucially, we will emphasize the role of lifestyle interventions in patient care, highlighting how factors such as diet, sleep hygiene, and physical activity influence therapeutic outcomes and overall well-being in individuals with schizophrenia.

Psychotherapy

Psychotherapy is believed to execute a key role in non-pharmacological treatment of schizophrenia (Keepers et al., 2020). One of the most widely recognized approaches is cognitive-behavioral therapy (CBT), an evidence-based form of psychotherapy endorsed by the American Psychological Association (APA) as the 'gold standard' for the treatment of various psychological disorders. This approach emphasizes the systematic evaluation and modification of maladaptive thought and behavior patterns. Its primary objective is to assist clients in developing more constructive cognitive and behavioral responses, with a focus on observable and reportable experiences such as interpretations, emotions, and actions. Sessions are highly structured to enhance therapeutic efficacy, with the therapist and client collaborating closely to examine and challenge the client's thoughts and underlying beliefs. The ultimate aim is to support intentional actions that foster enduring behavioral change (Yaden et al., 2022).

The APA recommends that patients with schizophrenia receive cognitive-behavioral therapy for psychosis (CBTp) as part of their treatment (Keepers et al., 2020). CBTp is associated with a greater reduction of positive symptoms (e.g., hallucinations, delusions) in comparison to usual care, while no comparable relationship was observed in the decrease in negative symptoms (Modesti et al., 2023). CBT was proven effective for positive symptoms when used as an adjunct to pharmacotherapy with antipsychotics. Some researchers have taken a more progressive stance, suggesting that using CBT alone, without concurrent antipsychotic medication, could be both safe and acceptable for individuals with schizophrenia. This constitutes an interesting perspective that warrants more extensive research in the future to either confirm or reject this hypothesis (Bighelli et al., 2020).

Encouraging outcomes have been observed when CBT is used as a standalone treatment. For example, Morrison conducted a study comparing CBT alone, antipsychotic medication alone, and their combination. In this pilot study, CBT alone was not significantly different in reducing the Positive and Negative Syndrome Scale (PANSS) total score than antipsychotic pharmacotherapy alone. However, the combination of antipsychotic treatment with CBT was significantly more effective in reducing the PANSS total score than CBT alone. It is worth noting that the group receiving CBT alone reported significantly fewer side effects than the group receiving antipsychotics alone or the combination treatment group. Some of the reported symptoms, such as problems with sleep, memory and attention, loss of libido or loss of energy and autonomic symptoms, may be non-specific and represent both symptoms of a psychotic disorder, a comorbid condition and side effects of antipsychotic drugs. Few health deteriorations were reported in all groups (CBT, antipsychotics, combination), suggesting that CBT was no less safe than antipsychotics or combination treatment. Nevertheless, hospital admissions were observed in the CBT group, whereas no such admissions were reported in the group receiving antipsychotic treatment alone. For safety concerns, the study had procedures in place in case the patient's condition worsened, allowing transfer to the combination treatment group (Morrison et al., 2018, pp. 411–23). However, the study faced criticism for not including a suitable control condition, such as a psychological placebo, to account for non-specific therapeutic effects. The practice of providing CBT without accompanying antipsychotics has sparked ethical concerns, with critics arguing that there is still insufficient robust evidence to support its effectiveness in isolation (Bighelli et al., 2020). Studies have shown that CBTp intervention leads to short-term improvements in overall functioning, especially within 6 months of starting therapy, in addition to better social and occupational functioning, increased quality of life and overall satisfaction. A limitation of this method is that no significant improvement in quality of life following therapy has been unequivocally demonstrated. In addition, effective CBTp spans several weeks to several years; thus, for some patients it may be cumbersome to participate in regular sessions and adjust the weekly schedules (Keepers et al., 2020). According to the National Institute for Health and Care Excellence guidelines (NICE, 2015), CBTp for patients with schizophrenia should be delivered on a one-to-one basis over at least 16 planned sessions.

Another prominent psychotherapeutic approach, the dynamic psychotherapy model, deserves appropriate attention and should not be disregarded. Contemporary psychodynamic approaches conceptualize psychopathology in developmental, cultural and temporal contexts. In these approaches, the 'enduring

personality' copes with conflicts and difficulties through emotionally saturated defense mechanisms (Fulmer, 2018). These defense mechanisms are defined as 'mental processes that operate unconsciously to reduce some painful emotion'. The ultimate understanding of these dynamics is to alter the behavioral aspects (Paulhus et al., 1997, pp. p. 543–79). Psychodynamic psychotherapy constitutes a significant therapeutic approach in the treatment of individuals with schizophrenia, encompassing modalities such as supportive psychotherapy (SP), psychodynamic group psychotherapy (PDGP), and mentalization-based treatment for psychosis (MBT-P), among others. Evidence suggests that SP can lead to gradual improvements in social functioning, with effects sustained over a period of up to two years. In a study conducted by Harder et al. (2014), participants exhibited notable enhancements in social functioning at both one- and two-year follow-ups. From another perspective, a separate kind of therapy, PDGP has demonstrated positive effects on cognitive functioning in individuals with schizophrenia. Participants engaged in PDGP showed significantly higher performance in domains such as spatial orientation and perceptual speed. Additionally, marked improvements were observed in the capacity to recognize perceptual inaccuracies and to comprehend relationships and connections between various situations. In contrast, it is worth mentioning that MBT-P, when integrated with standard treatment, may yield superior outcomes in social functioning compared to standard treatment alone. Participants in the MBT-P group maintained their improvements in social functioning for at least six months following the conclusion of the intervention (Modesti et al., 2023).

Other psychotherapeutic approaches studied for the treatment of schizophrenia include exploratory insight-oriented psychotherapy (EIO) and reality-adaptive supportive psychotherapy (RAS). The Boston Psychotherapy Study, conducted in the 1980s (Herz, 1985), was the largest investigation of psychotherapy for schizophrenia at the time. Taking place during a period of increasing emphasis on biological treatments, the study compared EIO psychotherapy, which used psychodynamic methods, and RAS psychotherapy, which emphasized practical, present-focused problem-solving. The study was carried out across three locations, included 95 patients and 81 experienced therapists, and followed participants for two years, although many dropped out before completion. Overall, both therapy groups showed patient improvement, but there were few differences between them on most outcomes. However, in line with each therapy's goals, RAS psychotherapy was more effective in reducing hospitalizations and enhancing work and household functioning, while EIO psychotherapy led to better ego functioning and cognitive performance. Further analysis indicated that better outcomes were linked to therapists who demonstrated strong skills in dynamic exploration (Ruffalo, 2023).

Metacognitive insight and reflection therapy (MERIT) represents a contemporary therapeutic method that has demonstrated potential benefits for individuals with schizophrenia. This approach integrates principles from both cognitive-behavioral therapy and psychodynamic psychotherapy. A study conducted by De Jong et al. (2019) reported that MERIT significantly enhanced patients' reflective capacities and cognitive functioning. Participants who received MERIT interventions noted substantial gains in self-awareness and regarded the therapy as highly beneficial (Modesti et al., 2023).

Neurocognitive training

One of the effective psychological interventions for people with schizophrenia is metacognitive training (MCT) for psychosis. Metacognition is broadly defined as cognition about one's own cognitions (Moritz & Lysaker, 2018). MCT is a structured eight-session group intervention targeting cognitive biases implicated in psychosis, with the aim of enhancing social cognition. The method has been characterized as a hybrid approach that integrates elements of cognitive remediation and CBT, grounded in principles of psychoeducation (Moritz et al., 2014). MCT for psychosis has demonstrated advantages in targeting core deficits and symptoms associated with schizophrenia spectrum disorders, including reductions in cognitive biases and both positive and negative symptoms (Jeffrey et al., 2025, pp. 79–86). MCT is designed to enhance individuals' awareness of cognitive distortions and to challenge unhelpful thinking patterns through deliberate reflection on cognitive processes. The approach encourages examination of fundamental cognitive and social mechanisms while reducing overconfidence in personal beliefs (Moritz et al., 2023). Its overarching goal is to help patients recognize common cognitive errors and vulnerabilities associated with experiences on the psychosis spectrum (Hotte-Meunier et al., 2024, pp. 914–20).

One of the studies was undertaken to evaluate the impact of MCT in first-time schizophrenia psychosis. The research evaluated changes in cognitive insight, measured by the Beck Cognitive Insight Scale (BCIS), with assessments conducted at baseline, post-intervention, and at a six-month follow-up. Findings revealed a significant and enduring reduction in self-certainty across the study period, while changes in self-reflectiveness did not reach statistical significance; however, previous research has indicated that MCT may stabilize self-

reflectiveness relative to a decline observed in control groups, suggesting a potential protective effect. Furthermore, intelligence quotient (IQ) emerged as a significant positive predictor of improvements in cognitive insight, particularly in self-certainty, highlighting the potential necessity of a minimum cognitive threshold to optimize the benefits of MCT (Birulés et al., 2020). Although MCT has demonstrated advantages in reducing cognitive errors and both positive and negative symptoms, as well as enhancing social cognition and functioning, evidence suggests that its impact on overall neurocognitive performance, such as processing speed, attention, working memory, and reasoning, is not statistically significant when compared to control groups. The observed improvements in these cognitive domains are more likely attributable to practice effects or learning rather than the intervention itself (Jeffrey et al., 2025, pp. 79–86).

It is essential to note that a method with proven positive effects on neuroplasticity is cognitive remediation (CR), which is a behavioral intervention designed to enhance cognitive functioning, with an emphasis on achieving lasting effects and transferability to real-world settings (Bellani et al., 2019). The training program comprises four core components: a trained therapist, regular computer-based cognitive exercises utilizing a 'drill and practice' approach, where participants repeatedly engage in tasks targeting specific cognitive domains, along with the development of problem-solving strategies and psychosocial rehabilitation (Bowie et al., 2020, pp. 49–53). Empirical evidence suggests that CR yields promising outcomes when implemented in the early stages of schizophrenia. CR has been shown to induce neural adaptations, particularly within prefrontal and limbic brain regions, contributing to a protective effect on grey matter volume in areas such as the thalamus, hippocampus, and amygdala, as well as functional changes in the dorsolateral prefrontal cortex and insular cortex. These neuroplastic modifications are associated with improvements in cognitive functioning; moreover, it is hypothesized that the earlier CR is introduced, the greater its potential neuroprotective impact may be. However, current evidence remains limited, and further long-term studies are required to confirm the durability of these beneficial effects (Bellani et al., 2019).

CR has been shown to produce moderate yet durable improvements in global cognitive functioning as well as in everyday functional outcomes. The most pronounced effects are observed in domains such as verbal learning, working memory, attention, and processing speed. Contemporary CR programs have evolved from traditional paper-based formats to computer-assisted modalities and can be effectively delivered both individually and in group settings, offering potential advantages in cost-efficiency and participant motivation. CR interventions employ both 'top-down' approaches targeting higher-order cognitive functions, such as working memory, and 'bottom-up' methods, which focus on perceptual processing; both approaches have demonstrated comparable cognitive benefits. Notably, CR programs that emphasize the development of problem-solving strategies and incorporate metacognitive training have been found to yield superior outcomes compared to those relying solely on repetitive 'drill-and-practice' exercises. A critical component enhancing the generalization of cognitive gains to real-life contexts is the inclusion of bridging groups, which facilitate the transfer of newly acquired skills to everyday situations.

An additional advantage of CR lies in its potential for augmentation with other therapeutic modalities. The efficacy of CR is significantly enhanced when combined with other psychiatric rehabilitation strategies, such as vocational training. Integrating social skills training or social cognition interventions into CR can further strengthen improvements in emotional processing, empathy, and overall social functioning. Promising research is also emerging on the integration of CR with pharmacological and neuromodulatory interventions.

Long-term follow-up studies, including those incorporating booster sessions, indicate that improvements in neurocognition, social cognition, and functional outcomes (e.g., employment-related functioning) can be sustained beyond the completion of CR. Nonetheless, additional longitudinal research is needed to fully determine the durability and real-world applicability of these effects (Fitapelli & Lindenmayer, 2022; Seccomandi, 2020).

Art therapy

Various trials on the contribution of art therapy in schizophrenia have shown effective outcomes. A notable study supporting this thesis was conducted with adolescent patients (15-20 years old) diagnosed with schizophrenia to evaluate the potential benefits of group art therapy. The therapeutic process included collaboration, design, and the completion of a collective art mural. Participants generally responded positively to the project and identified key themes such as a sense of achievement, empowerment, teamwork, engagement, and ownership. The study was descriptive, which entailed certain limitations - most notably, the absence of formal measures to validate the observed benefits (George & Kasinathan, 2015, pp. 49–53).

A comparative study demonstrated that patients with schizophrenia who received art therapy exhibited a significantly greater reduction in both positive and negative symptoms than those receiving standard care. Additionally, the art therapy group showed higher emotional awareness scores at post-intervention, with minimal positive symptoms observed at both post-treatment and follow-up compared to the control group (Shukla et al., 2022; Montag et al., 2014). In another randomized controlled trial by Crawford et al. (2010), 417 adults diagnosed with schizophrenia were assigned to one of three groups: group art therapy (n=140), activity groups (n=140), or standard care (n=137). It is worth mentioning that the project was the most extensive, published three-arm randomized clinical trial on art therapy (Multicenter Study of Art Therapy in Schizophrenia: Systematic Evaluation, or MATISSE trial). After 24 months, no significant differences were observed across the groups in terms of overall functioning, mental health, or health-related outcomes. PANSS scores showed no statistically significant differences between art therapy and either standard care or activity groups. Notably, the activity group demonstrated greater reductions in positive symptoms at 12 and 24 months compared to the art therapy group. A major limitation was low engagement, with nearly 40% of participants assigned to art therapy attending no sessions and few attending regularly. While art therapy may benefit highly motivated individuals, the findings suggest limited effectiveness for the broader population with schizophrenia (Crawford et al., 2012).

Several randomized clinical trials have reported positive outcomes of art therapy in schizophrenia. For instance, Richardson et al. (2007) found that six months of painting therapy significantly improved negative symptoms in patients with chronic schizophrenia. Similarly, Teglbjaerg (2011) reported that group painting therapy not only reduced psychotic symptoms but also enhanced self-esteem and social functioning, with benefits sustained at a one-year follow-up. Several studies have shown that combining painting therapy with pharmacological treatment significantly improves patient compliance and self-cognition compared to medication alone in individuals with schizophrenia (Hu et al., 2021). Collectively, evidence suggests that art therapy may alleviate symptoms in schizophrenia and serve as a valuable adjunct to pharmacological treatment. Future research should adopt more rigorous methodologies, including blinded assessments and transparent allocation procedures (Du et al., 2024).

Animal-assisted therapy

Numerous studies in psychiatric populations indicate that patients receiving animal-assisted therapy (AAT) exhibit greater social interaction, increased expressions of pleasure, and higher levels of sociability, helpfulness, and environmental responsiveness (Marr et al., 2000). Current evidence suggests that AAT is a promising complementary intervention for schizophrenia, showing multidimensional benefits—particularly in reducing negative symptoms (Acquadro et al., 2022).

A randomized, controlled, single-blind study by Villalta-Gil et al. (2009), evaluated the effectiveness of AAT with a trained therapy dog in patients with chronic schizophrenia at the Saint John of God Hospital in Spain. Participants were randomly assigned to either a psychological intervention with AAT (n=12) or without (n=9). The intervention targeted cognitive and social functioning through modules including cognitive differentiation, social perception, verbal communication, social skills training, and interpersonal problem-solving. Outcomes were assessed using the PANSS, Life Skills Profile (LSP), and WHO quality of life assessments WHOQOL-BREF by a blinded psychologist. Results indicated that patients in the AAT group experienced greater improvements in social engagement, positive and negative symptoms, and social quality of life. While both groups showed positive changes, particularly in positive symptoms, only the AAT group showed notable gains in social functioning and reduction of negative symptoms. However, due to the small sample size and the inability to implement a double-blind design, the findings are preliminary and should be interpreted with caution.

A similar randomized controlled trial was conducted on 22 adult patients diagnosed with chronic schizophrenia residing in a long-term care facility. Participants in the AAT group (n=14) took part in a standard psychosocial rehabilitation program, with one functional activity replaced by animal-assisted therapy sessions. These sessions focused on building emotional bonds with dogs through care, walks (in both urban and park settings), and interactive training using positive reinforcement. The control group followed the same rehabilitation program but participated in alternative functional activities, such as art therapy, group sports, or physical exercise, instead of AAT sessions. Both the AAT and control groups demonstrated significant improvement in positive and general symptoms of schizophrenia, as measured by the PANSS scale. However, only the AAT group showed a marked reduction in negative symptoms. Researchers suggest that consistent interaction with therapy animals, acting as ‘social catalysts’, may have facilitated this improvement. Notably,

a decrease in salivary cortisol levels was observed in the AAT group following therapy sessions, indicating a reduction in stress. This physiological response suggests that interaction with therapy dogs was experienced as both calming and engaging. The authors propose that positive contact with animals may stimulate the release of oxytocin, dopamine, and endorphins, while lowering cortisol levels, thereby reducing anxiety and stress through modulation of the hypothalamic-pituitary-adrenal axis (Calvo et al., 2016). Comparable outcomes have been observed in the use of AAT for reducing psychopathological symptoms and stress levels in middle-aged and older patients with schizophrenia, with particularly significant improvements noted in negative symptoms (Chen et al., 2021).

Barker et al. (2003) found that co-therapist dogs contributed positively to the treatment of schizophrenia patients. In a controlled study, Nathans-Barel et al. (2005) reported significant improvements in hedonic tone, measured by the Snaith-Hamilton Pleasure Scale, among chronic schizophrenia patients participating in interactive AAT sessions, along with increased motivation and constructive use of free time. Similarly, Dimitrijević (2009) noted AAT's effectiveness in alleviating anhedonia, while Barak et al. (2001) observed benefits in elderly patients with schizophrenia.

In conclusion, interactions with therapy animals are associated with reduced negative symptoms and improvements in quality of life and social skills, with the effectiveness of AAT linked to physiological (e.g., lower cortisol, higher oxytocin, reduced blood pressure), psychological, and social mechanisms, including emotional regulation, enhanced therapeutic alliance, and increased social engagement and routine. Nevertheless, further high-quality research is needed to clarify the underlying mechanisms of AAT, including studies focused on relevant biological markers (Arsovski, 2024; Tyssedal et al., 2023).

Social skills training

The primary objective of social skills training (SST) is to enhance the social functioning of individuals experiencing psychosis. This intervention typically entails the segmentation of long-term objectives into a series of incremental, achievable steps. Such a structured and positively reinforced approach may help address and modify maladaptive attitudes. SST typically employs behavioral methods such as role-playing, modeling, coaching, and feedback to help individuals develop effective interpersonal problem-solving skills and to express emotions and needs in a constructive manner (Hoy et al., 2023). Evidence indicates that SST contributes to enhanced social outcomes and yields statistically significant, though modest, improvements in negative symptoms and general schizophrenia psychopathology (Barlati et al., 2024; Sun et al., 2023).

A study conducted by Granholm et al. involving 76 middle-aged and older adults with chronic schizophrenia demonstrated that SST with cognitive-behavioral elements, compared to standard treatment, led to significant improvements in social activity frequency and cognitive insight post-intervention. During a 12-month follow-up, participants in the SST group also reported substantially greater acquisition and application of daily living skills within the community. Notably, no significant differences were observed in overall social functioning or symptom improvement, either immediately after the intervention or at follow-up. The authors suggested that these outcomes may be attributable to the advanced age and long illness duration of the participants, which could have limited the potential for improvement in residual symptoms (Granholm et al., 2005).

A promising advancement in SST is the integration of virtual reality (VR), which has emerged as a potentially effective adjunctive tool for individuals with schizophrenia. VR environments immerse users in multisensory, three-dimensional simulations that enable movement, observation from various perspectives, interaction, and modification of the virtual space. This immersive experience elicits psychological and physiological responses comparable to those occurring in real-world settings. Importantly, interactions with avatars can be interrupted at any time, allowing individuals to practice without real-world consequences or fear of social repercussions. VR also creates a safe environment for making social errors without the anxiety or fear of rejection often associated with face-to-face interactions (Fernández-Soto et al., 2020). These simulations can be controlled and adjusted by a therapist, enabling the replication of numerous everyday social scenarios while allowing real-time observation and intervention. Tasks can be repeated as needed, and users receive immediate feedback on their responses, facilitating behavioral adjustments and the refinement of targeted social skills. For instance, measurable indicators such as eye contact duration, which are difficult to assess through conventional methods, can be tracked. VR allows for the simulation of real-life situations such as initiating conversations with strangers, placing orders, seeking information, dealing with authority figures, or navigating manipulative peer interactions. Some VR-based SST programs incorporate elements of gamification, presenting users with ‘social missions’ of varying difficulty levels (Oliveira et al., 2021, pp. 571–81).

A study conducted by Park et al. (2011), comparing VR-based SST with traditional SST in a sample of 91 individuals with schizophrenia, demonstrated that the VR-based SST group exhibited greater improvements in conversational skills and assertiveness. Despite these promising findings, the authors emphasize that the available data remain limited due to the small number of studies and challenges related to the replicability of the research environment. Despite its potential, the application of VR in SST presents challenges, including healthcare professionals' skepticism, high equipment costs, and concerns among patients with schizophrenia about data privacy. Furthermore, the use of VR in SST remains underexplored, and there is a lack of standardized guidelines to inform its implementation. Consequently, the application of both traditional SST and VR-based SST warrants further investigation in future research (Bisso et al., 2020; Gillouin et al., 2024).

Neurofeedback

Neurofeedback (NF) is a neuromodulation and self-regulation technique that enables patients to directly perceive specific neural events and learn to modulate their own brain activity. It is based on operant conditioning, wherein individuals receive real-time feedback about their brain activity through visual or auditory representations. The primary goal is to modulate brain waves or rhythms in a targeted brain region, thereby optimizing cognitive strategies and achieving neuromodulation (Gandara et al., 2020). Essentially, NF brings subconscious processes into conscious awareness, allowing individuals to gain control over them. Brain activity is measured and displayed on a computer screen. Feedback, such as music or a visual metaphor (e.g., a racing car or a flying airplane), is provided depending on whether the individual achieves the desired change in brain wave activity. Positive feedback (a reward, such as a car accelerating or a song playing correctly) is given when the individual maintains brain waves within predefined parameters. With each successive training session, the parameters are gradually adjusted to become more challenging. Several methods are used to record neural activity in NF, including electroencephalography (EEG) NF, functional magnetic resonance imaging (fMRI) NF, functional near-infrared spectroscopy (fNIRS) NF, and hemoencephalography (Oprea et al., 2024).

Auditory hallucinations affect over 70% of patients with schizophrenia and are often associated with significant distress and social dysfunction. Research has demonstrated that fMRI NF may be effective in modulating activity within speech and language networks implicated in the emergence of auditory hallucinations, specifically by reducing hyperactivity in the superior temporal gyrus (Kakeri et al., 2024, pp. 74-85). Bauer et al. (2020) showed that fMRI NF training aimed at decreasing hyperconnectivity within the default mode network (DMN) was correlated with a reduction in the severity of auditory hallucinations in patients with schizophrenia. Hyperconnectivity of the DMN has been linked to the positive symptoms of schizophrenia. Furthermore, a case study conducted by Storchak et al. (2019) reported that fNIRS NF, targeting the regulation of activity in the bilateral posterior temporal region, led to a significant reduction in subjective auditory hallucinations in a patient with paranoid schizophrenia (Hirano & Tamura, 2021). Studies have shown that EEG NF, when combined with pharmacological treatment, significantly reduces both positive symptoms (such as delusions, hallucinations, and hostility) and negative symptoms (including social withdrawal and emotional blunting) in patients with schizophrenia (Kakeri et al., 2024, pp. 74-85). Individuals with schizophrenia typically exhibit lower alpha wave amplitudes, and this reduction has been found to be negatively correlated with the severity of psychotic symptoms, including impulsive behaviors. NF training aimed at enhancing alpha waves has demonstrated effectiveness in reducing impulsivity and overall psychotic symptomatology. NF protocols targeting the sensorimotor rhythm (SMR) and beta waves have been shown to significantly reduce negative symptoms and improve cognitive functioning. SMR/beta wave training has been found to enhance functional connectivity within the thalamocortical loop, which may alleviate emotional apathy and social withdrawal. Greater improvements in both positive and negative symptom reduction have been observed in patients aged 45 and older, with intervention durations of at least 8 weeks and frequencies of four or more sessions per week (Duan et al., 2025).

The rapidly evolving field of NF may, in the future, offer effective therapeutic options focused on the precise modulation of specific neurophysiological properties in targeted brain regions, with the goal of improving cognitive and behavioral functioning in individuals with schizophrenia (Oprea et al., 2024; Shu et al., 2023).

Sleep Hygiene

Sleep hygiene recommendations include getting 7–9 hours of sleep per day while maintaining a consistent sleep-wake cycle. A regular bedtime routine, contemplative practices, physical activity, and avoiding caffeine, alcohol, and heavy meals in the second half of the day are factors that influence sleep quality. Exposure to light later in the day is associated with fragmented, low-quality sleep and should also be avoided (Baranwal et al.,

2023). Proper sleep duration and quality are important for maintaining health. Lack of sleep is a factor in various physical and psychological illnesses. In patients with schizophrenia, sleep problems have a significant negative impact on health and functioning (Marin et al., 2023, pp. 249–59). They are related to the development of symptoms, pharmacological treatment, and the mental state of patients. Sleeping problems may be influenced by elevated levels of anxiety and depression experienced by these patients (Zhu & Zheng, 2024).

Poor sleep quality is common among patients, and several scales are used to assess it: PSQI (Pittsburgh Sleep Quality Index), ISI (Insomnia Severity Index), and PANSS (Positive and Negative Syndrome Scale). The PSQI measures 7 components of sleep: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction over the past month. Responses are rated using a Likert scale from 0 to 3, with 3 indicating the worst outcome. A total score ≥ 5 indicates poor sleep quality. The combined score of the 7 PSQI components demonstrated an overall reliability coefficient (Cronbach's alpha) of 0.83, with 89.6% sensitivity and 86.5% specificity. ISI is a patient self-report questionnaire that evaluates the impact, severity, and nature of insomnia. It refers to the 'past month' and its items address: difficulties falling asleep, staying asleep, early morning awakenings, dissatisfaction with sleep, the impact of sleep problems on daytime functioning, noticeability of the problems by others, and psychological distress related to sleep difficulties. Each item is rated on a Likert scale from 0 to 4 (0 = no problem, 4 = very severe problem). The cutoff score for clinical insomnia is 15. The total score ranges from 0 to 28 and is interpreted as follows: absence of insomnia (0–7), subthreshold insomnia (8–14), moderate insomnia (15–21), and severe insomnia (22–28). The ISI scale has a Cronbach's alpha of 0.90. A cutoff score of 10 yields 86.1% sensitivity and 87.7% specificity in detecting insomnia in the general population. PANSS (Positive and Negative Syndrome Scale) is a 30-item scale divided into 3 subscales: positive symptoms (7 items), negative symptoms (7 items), and general psychopathology (16 items). Each item is rated on a 7-point Likert scale, where 1 indicates no symptoms and 7 indicates extremely severe symptoms. The total score ranges from 30 to 210 (Chaurasia et al., 2023). Chen et al. (2024) based on a meta-analysis of 23 epidemiological studies and 9 case-control studies, found that the overall prevalence of poor sleep quality was 63.4% (95% CI: 57.0%–69.9%). Moreover, patients with schizophrenia had a significantly higher risk of poor sleep quality compared to healthy control subjects (OR = 4.5; 95% CI: 2.4–8.3; P <0.0001).

Over a century ago, Kraepelin observed a connection between schizophrenia and sleep hygiene. He noted that patients with sleep disturbances exhibited more severe psychotic symptoms. In later years, researchers found that patients experienced shortened and delayed onset of REM sleep, as well as alterations in slow-wave sleep. Moreover, delayed REM onset was shown to predict long-term negative outcomes such as symptom exacerbation, reduced quality of life, unemployment, and increased risk of future hospitalizations. Sleep deprivation is also associated with the presence of hallucinations, paranoid behavior, impaired memory, attention, processing speed, executive functioning, and other cognitive functions. Conversely, improved sleep quality in patients is linked to higher quality of life and greater independence (Taliercio et al., 2020). Patients with poor sleep quality also had higher blood pressure, elevated total cholesterol, and increased low-density lipoprotein (LDL) levels. It was found that patients with an evening chronotype, those who prefer activity later in the day and go to bed late, had worse sleep quality compared to those with a morning or intermediate chronotype. The evening chronotype is also associated with a higher cardiometabolic risk among patients. Given the negative consequences of poor sleep quality, regular screening and implementation of effective interventions are recommended for those in need (Chen et al., 2024; Balcioglu et al., 2022).

White noise is an effective method to improve sleep quality in patients. In a retrospective analysis by Zhu et al. (2024), exposure to white noise (40–50 dB) for 2 hours each night at 9:00 p.m. over a period of 12 weeks improved sleep latency, sleep efficiency, and overall scores on the Pittsburgh Sleep Quality Index (PSQI) in patients with schizophrenia. A reduction in scores on the HAMA (Hamilton Anxiety Rating Scale), HAMD (Hamilton Depression Rating Scale), and PANSS was also observed before and after the 12-week intervention. White noise has been identified as a potential therapeutic strategy for improving sleep quality.

Physical Exercise

Physical activity has a significant impact on mental health, both in the prevention of mental disorders and as a supportive treatment. It is also a well-documented protective factor against cardiovascular diseases, type 2 diabetes mellitus, and all-cause mortality in the general population. Individuals with severe mental disorders spend an average of 7.8 hours per day in a sedentary position, indicating a more sedentary lifestyle compared to age- and sex-matched control groups. Differences exist depending on diagnosis - people with bipolar disorder are significantly more physically active than those with schizophrenia. The European

Psychiatric Association (EPA) indicates strong evidence for the effectiveness of physical activity in treating schizophrenia spectrum disorders. According to a meta-analysis by Firth et al. (2015) involving 11 trials, 90 minutes of weekly exercise reduces general symptoms (SMD = -0.72, 95% CI = -1.14 to -0.29), positive symptoms (SMD = -0.54, 95% CI = -0.95 to -0.13), and negative symptoms (SMD = -0.44, 95% CI = -0.78 to -0.09). In another meta-analysis by Firth et al. (2017), it was found that aerobic exercise also improves cognitive function in patients with schizophrenia (Hedge's g = 0.41, 95% CI = 0.19–0.64). Physical activity is recommended as a therapeutic approach in both national and international guidelines for the treatment of schizophrenia (Schuch & Vancampfort, 2021).

In an umbrella review by El Kirat et al. (2023), it was concluded that recommended activities for patients with schizophrenia include yoga and aerobic exercise. Yoga improves well-being and is effective for both positive and negative symptoms, while aerobics is effective for positive symptoms. The evidence gathered by the authors, although of moderate to low quality, supports the effectiveness of physical activity in reducing schizophrenia symptoms and improving patients' overall well-being. The authors of another study, Imboden et al. (2022), in addition to yoga, also highlighted the role of endurance training, which has a beneficial effect on both positive and negative symptoms. A further advantage of yoga is the improvement of long-term memory, while endurance training enhances working memory, social cognition, and attention. As reported by Cempa et al. (2022), engagement in Tai Chi training based on the 22-movement Wu-style Cheng-form Tai Chi Chuan was associated with a statistically significant reduction in motor deficits and serum cortisol levels in individuals diagnosed with schizophrenia. Similarly, interventions such as jogging and brisk walking demonstrated beneficial effects in this population. It is recommended to aim for at least 150 minutes of moderate and/or 75 minutes of vigorous physical activity per week (Imboden et al., 2022). However, the available literature does not identify any particular forms of physical exercise that should be considered contraindicated or discouraged for patients with schizophrenia. Individuals with schizophrenia exhibit lower aerobic capacity (VO2 max) compared to the expected average for healthy individuals of the same age group. Structured physical activity programs improve patients' aerobic fitness and have a beneficial effect on the PANSS general psychopathology subscale ($p = 0.007$) as well as the total PANSS score ($p = 0.001$). Physical activity can serve both as an adjunctive therapy for schizophrenia (alleviating certain psychiatric symptoms) and for managing comorbid conditions (Curcic et al., 2017, pp. 459-65). People with schizophrenia demonstrate higher prevalence rates of obesity, hypertension, and hyperlipidemia, which significantly contribute to reduced life expectancy. Importantly, modifiable risk factors including obesity and physical fitness parameters (both cardiorespiratory and muscular fitness) typically improve with physical activity interventions, potentially modifying future schizophrenia risk (Bueno-Antequera & Munguía-Izquierdo, 2020).

Although the neurobiological mechanisms underlying the effects of physical activity remain incompletely understood, it has been reported that regular physical exercise increases the expression of neurotrophic growth factors, such as brain-derived neurotrophic factor (BDNF), whose levels are reduced in patients with schizophrenia (Tréhout & Dollfus, 2018). Exercise therapy also has a beneficial effect on hippocampal plasticity and leads to increased hippocampal volume in the brains of patients with schizophrenia (Girdler et al., 2019). The hippocampus, which plays a central role in memory and learning, consistently shows signs of atrophy in patients with psychosis compared to healthy control groups. Cardiorespiratory fitness is associated with hippocampal volume and its increase in response to physical activity (Woodward et al., 2018). Understanding the role of physical activity in preventing schizophrenia is less clear than in other mental diseases like anxiety or depressive disorders (Rahmati et al., 2024). However, it complements standard pharmacological therapy to reduce symptoms of the chronic form of the disease (Tarpada & Morris, 2017). Its positive effects also include improvements in cognitive functioning, increased life expectancy, reduced risk of cardiovascular and metabolic diseases (Tréhout & Dollfus, 2018). Structured physical activity positively impacts perceived symptoms helps patients reintegrate into society (Cempa et al., 2022).

Diet

The article by Owen & Corfe (2017), outlines the latest evidence linking nutrition and psychological outcomes. A new and rapidly developing field, nutritional psychiatry, is emerging to explore the relationship between diet and mental health. Mental, neurological, and substance use disorders currently represent the largest global burden of disease, accounting for 13% of the total global disease burden, surpassing cardiovascular diseases and cancer. The article highlights that diet and nutrition, as modifiable risk factors, may bring substantial benefits to mental health and population well-being. It also forecasts that future breakthroughs will integrate nutritional genomics, neuroscience, psychological, and psychiatric research. Most

patients with schizophrenia follow an unhealthy diet, which contributes to high mortality and the prevalence of metabolic syndrome. A healthy dietary pattern is observed in only 10.7% of patients, compared to 23% in the general population. Changing poor dietary habits may be a potential therapeutic target (van Zonneveld et al., 2022). Antipsychotic medications, due to their side effects, may lead to metabolic disorders such as obesity, diabetes, and dyslipidemia. They affect eating behavior and the body's energy balance (Siafis et al., 2018).

According to recent findings, the ketogenic diet may represent a novel therapeutic approach in the treatment of schizophrenia. Sarnyai et al. (2019) described postmortem data from prefrontal cortical cells and in vivo NMR spectroscopy results that suggest bioenergetic dysfunctions characterized by impaired glucose metabolism and mitochondrial dysfunction, leading to disrupted synaptic communication in the brain of affected individuals. The ketogenic diet normalizes schizophrenia-like behaviors in translationally relevant pharmacological and genetic mouse models. It provides an alternative fuel for brain bioenergetic processes by utilizing ketone bodies instead of glucose. Through this mechanism, it may restore brain energy metabolism, which positively affects metabolic dysfunctions and body composition, as well as improves psychiatric symptoms. Sethi et al. (2024) in their pilot trial investigating ketogenic diet interventions on metabolic and mental health in bipolar and schizophrenia showed a reduction in psychotic symptoms by 32% on the Brief Psychiatric Rating Scale (BPRS), a 31% improvement in the Clinical Global Impression (CGI), significant reduction in weight (12%), BMI (12%), waist circumference (13%), and visceral adipose tissue (36%), drop in triglyceride levels (25%) and decrease in HOMA-IR (27%) after 4 months of using KD. Psychiatric outcomes in the entire cohort included increased life satisfaction (17%) and improved sleep quality (19%). At the end of the 4-month study, none of the participants with initial metabolic abnormalities met the criteria for metabolic syndrome.

In the study by Okusaga et al. (2013), elevated levels of anti-gliadin antibodies were observed in patients with schizophrenia. Aranburu et al. (2021) reported that gluten avoidance may lead to improvements in cognitive functioning in patients with schizophrenia. They analyzed a clinical trial investigating the effects of a gluten-free diet (GFD) in this population. The randomized, double-blind trial included sixteen patients diagnosed with schizophrenia or schizoaffective disorder. All participants had elevated levels of anti-gliadin IgG antibodies but did not suffer from celiac disease. They were divided into two groups and followed a gluten-free diet for five weeks, supplemented with either wheat flour (10 g) – the gluten-containing diet (GD) group – or rice flour (10 g) – the gluten-free diet (GFD) group. No improvement was observed in the GFD group on the Brief Psychiatric Rating Scale (BPRS), which was attributed to a small effect size. However, improvement was noted on the Scale for the Assessment of Negative Symptoms (SANS) and the MATRICS Consensus Cognitive Battery (MCCB). The SANS, which evaluates five domains of negative symptoms - affective flattening, alogia, avolition/apathy, anhedonia, and attentional impairment - showed improvement in the rice-flour group (GFD). The MCCB, which assesses seven cognitive domains affected in schizophrenia, indicated enhanced memory and attention in the GFD group. A major limitation of the study was the small sample size (seven participants in the GFD group), which may explain the inconsistencies between SANS and BPRS results and raises questions regarding the robustness of the MCCB findings. The role of a low-FODMAP diet (fermentable oligosaccharides, disaccharides, monosaccharides, and polyols) in schizophrenia remains unclear due to a lack of in-depth, targeted research on the topic.

The gut-brain axis - a complex bidirectional communication system between the gut and the brain - plays an important role in brain function and neuropsychiatric health (Wang et al., 2023; Młynarska et al., 2022). The role of gut microbiota and its interaction with the brain is crucial in the pathogenesis of schizophrenia. Gut dysbiosis, or an imbalance in gut microbial communities, negatively affects neuropsychiatric health by disrupting gut–brain axis pathways. An important factor is kynurenic acid (KYNA), whose increased levels may contribute to the pathogenesis of the disease. KYNA is produced via tryptophan metabolism and acts as an NMDA receptor antagonist. Elevated levels of KYNA can lead to hypofunction of GABA interneurons, resulting in increased glutamatergic activity of pyramidal neurons. This overactivity may excessively stimulate the mesolimbic dopaminergic pathway, causing increased dopamine release and potentially triggering psychosis. Dietary modifications and supplementation with omega-3 fatty acids, B vitamins, and probiotics may positively affect gut microbiota composition and, thus, gut–brain axis function (Zajkowska et al., 2024). Houda El Kirat et al. (2023) emphasized the role of nutritional supplementation in reducing positive and negative symptoms, as well as the side effects of psychotropic medications. They also found that supplementing polyunsaturated fatty acids and trace elements led to a reduction in the severity of negative symptoms in schizophrenia. Similarly, the findings of Xu et al. (2022), suggest that supplementation with NAC (N-acetylcysteine) may improve PANSS scores and be among the most effective dietary

supplements for patients with schizophrenia. The authors also report potentially beneficial effects of vitamin D, omega-3 fatty acids, folic acid, or vitamin B12 supplementation on PANSS outcomes; however, long-term, large-scale randomized controlled trials are needed to confirm these effects.

Transcranial Stimulation

The history and development of non-invasive brain stimulation methods was described by John Rothwell (2018). In 1874, Roberts Bartholow was the first to apply faradic stimulation (a type of alternating current) to the human brain, inducing movements and localized sensations in a patient. Early attempts at transcranial brain stimulation were made, but a major breakthrough occurred in 1985 with the development of transcranial magnetic stimulation (TMS) by Barker and colleagues. Subsequently, older approaches were revisited, and transcranial direct current stimulation (tDCS) became the most commonly used among them. Transcranial direct current stimulation (tDCS) devices deliver direct current through electrodes placed on the scalp in order to modulate brain function (Truong & Bikson, 2018). Transcranial magnetic stimulation (TMS) is a non-invasive brain stimulation technique that uses electromagnetic induction to modulate cortical activation and achieve therapeutic effects in psychiatric and neurological disorders (Koutsomitros et al., 2021).

Randomized clinical trial by Valiengo et al. (2020), assessing the efficacy and safety of transcranial direct current stimulation (tDCS) as an adjunctive treatment for negative symptoms in schizophrenia, demonstrated that patients in the active tDCS group showed significantly greater improvement in the PANSS scale compared to the placebo group (difference: 2.65 points; 95% CI: 1.51–3.79; NNT: 3.18; 95% CI: 2.12–6.99; $P < .001$). The study included 100 patients with schizophrenia with predominant negative symptoms, of whom 95 completed the trial. The intervention consisted of ten tDCS sessions (twice daily for five days) or a sham procedure. The anode was placed over the left prefrontal cortex, and the cathode over the left temporoparietal junction. tDCS was well tolerated, with adverse effects not differing significantly between groups, except for a higher incidence of scalp burning sensation in the active group (43.8% vs 14.3%; $P = .003$). There is a growing body of evidence supporting the therapeutic potential of transcranial alternating current stimulation (tACS) in the treatment of schizophrenia. This non-invasive brain stimulation technique involves applying alternating current of specific frequencies through the scalp to influence neuronal activity. Its aim is to improve cognitive functions and alleviate psychotic symptoms in affected individuals (Zhang et al., 2023).

There is also evidence of the effectiveness of transcranial magnetic stimulation (TMS) in treating positive symptoms of schizophrenia. However, due to the small sample size in most studies, the reliability of these findings is limited. Most of the research has focused on patients with auditory verbal hallucinations, suggesting the need to further explore the efficacy of TMS for other positive symptoms. Based on data compiled by Marzouk et al. (2020), 12 of the analyzed studies found evidence supporting the efficacy of TMS in reducing positive symptoms, while 18 studies did not provide sufficient evidence to confirm its effectiveness. In the meta-analysis by Patel et al. (2023), the safety and efficacy of repetitive transcranial magnetic stimulation (rTMS) in the treatment of schizophrenia and other psychiatric disorders were evaluated. Of the 28 included meta-analyses, 9 focused on schizophrenia. rTMS was superior to sham in reducing the negative symptoms of schizophrenia (mean difference [MD]: 0.47; 95% CI, 0.23–0.7; $P < .0001$); however, no significant difference was observed between the effects of rTMS and sham on auditory hallucinations (MD: 0.24; 95% CI, 0.26–0.74; $P = .35$).

Materials and Methods

The review was conducted based on an analysis of materials retrieved from the PubMed and Google Scholar databases. Keywords included ‘schizophrenia’, ‘non-pharmacological treatment’, ‘physical activity’, ‘sleep hygiene’, ‘transcranial stimulation’, ‘psychotherapy’, ‘art therapy’, ‘neurofeedback’, ‘animal-assisted therapy’, ‘social skills training’, ‘neurocognitive training’. A total of 96 articles published between 1997 and 2025 were included and assessed for their relevance to the topic of the effects of non-pharmacological interventions in schizophrenia.

Discussion

Schizophrenia is characterized by psychotic symptoms and, in many cases, a decline in social and occupational functioning. It remains both a diagnostic and therapeutic challenge (Jauhar et al., 2022). Traditional treatment methods involve antipsychotic medications that block dopamine receptors, although new pharmacological therapies are currently under investigation (Maric et al., 2016). The aim of this article was to

provide a comprehensive overview of non-pharmacological treatment methods for schizophrenia, evaluate their effectiveness, and identify areas requiring further research.

Various non-pharmacological strategies are used to support pharmacological treatment or are being explored as potential standalone interventions. This review discussed a range of non-pharmacological approaches, including psychotherapy, neurocognitive training, art therapy, animal-assisted therapy, social skills training, neurofeedback, sleep hygiene, physical exercise, diet, and transcranial stimulation. Psychotherapy plays a key role in non-pharmacological treatment, particularly CBT in combination with pharmacotherapy. CBTp is recommended by the APA and has shown effectiveness, particularly in reducing positive symptoms. The role of psychodynamic therapy was also examined, with potential benefits for social and cognitive functioning, spatial orientation, and perceptual speed. Neurocognitive training improves patient functioning, reduces cognitive biases, and affects both positive and negative symptoms. Cognitive remediation leads to moderate improvements in cognitive domains such as verbal learning, attention, processing speed, and working memory. Art therapy, when combined with pharmacotherapy, enhances medication adherence and self-awareness compared to pharmacotherapy alone. Group painting therapy was associated with improved social functioning, self-esteem, and a reduction in negative symptoms. Animal-assisted therapy, as an adjunctive intervention, showed multidimensional benefits, particularly in reducing negative symptoms. Social skills training improved social outcomes and contributed to reductions in negative symptoms and overall psychopathology. Neurofeedback, which is a neuromodulation and self-regulation technique, may reduce auditory hallucinations, impulsivity, and cognitive impairments, and significantly improves both positive and negative symptoms when combined with pharmacotherapy. Poor sleep quality is common in patients with schizophrenia; thus, maintaining sleep hygiene may enhance quality of life, increase independence, and alleviate certain psychotic symptoms. White noise exposure is a potential intervention for sleep improvement. According to the European Psychiatric Association (EPA), physical activity positively affects mental health. Recommended forms include yoga, aerobic exercise, tai chi, jogging, brisk walking, and resistance training. Meta-analyses indicate that 90 minutes of weekly exercise reduces both positive and negative symptoms. Patients with schizophrenia frequently present with unhealthy diets, metabolic syndrome, and elevated mortality. The ketogenic diet is a novel approach that may normalize brain bioenergetic dysfunction, while a gluten-free diet could improve memory, attention, and reduce negative symptoms due to elevated anti-gliadin antibodies in this population. Appropriate dietary supplementation also shows potential in alleviating negative symptoms. Transcranial stimulation methods such as tDCS and TMS may alleviate negative symptoms, with TMS also demonstrating potential in reducing positive symptoms, particularly auditory hallucinations.

Conclusions

The aim of this article was to provide a literature review on the available non-pharmacological treatment methods for schizophrenia. Their potential or confirmed effectiveness was described, and areas requiring further research were identified. The article highlighted the significance of psychotherapy, neurocognitive training, art therapy, animal-assisted therapy, social skills training, neurofeedback, sleep hygiene, physical exercise, diet, and transcranial stimulation as promising therapeutic approaches for improving patients' health. These methods, as complementary to pharmacological treatment, influence multiple aspects of patients' functioning. A limitation of this article was the limited number of studies available and the small sample sizes. The article highlights the need for further large-scale research on non-pharmacological treatment methods for schizophrenia to confirm the hypotheses proposed so far and to deepen knowledge in this area.

Abbreviation list:
AAT - animal-assisted therapy
APA - American Psychological Association
BCIS - Beck Cognitive Insight Scale
BDNF - brain-derived neurotrophic factor
BMI - Body Mass Index
BPRS - Brief Psychiatric Rating Scale
CBT - cognitive-behavioral therapy
CBTp - cognitive-behavioral therapy for psychosis
CGI - Clinical Global Impression
CI - Confidence interval
CR - cognitive remediation
DMN - default mode network
EEG - electroencephalography
EIO - exploratory insight-oriented psychotherapy
EPA - European Psychiatric Association
fMRI - functional magnetic resonance imaging
fNIRS - functional near-infrared spectroscopy
GFD - gluten-free diet
HAMA - Hamilton Anxiety Rating Scale
HAMD - Hamilton Depression Rating Scale
HOMA-IR - Homeostatic Model Assessment of Insulin Resistance
IQ - intelligence quotient
ISI - Insomnia Severity Index
KD - ketogenic diet
KYNA - Kynurenic Acid
LFD - low FODMAP diet
LSP - Life Skills Profile
MBT-P - mentalisation-based treatment for psychosis
MCT - metacognitive training
MCCB - (MATRICS Consensus Cognitive Battery)
MD - mean difference
MERIT - metacognitive insight and reflection therapy
NAC - N-acetylcysteine
NF - neurofeedback
NICE - National Institute for Health and Care Excellence
OR - odd ratio
PANSS - Positive and Negative Syndrome Scale
PDGP - psychodynamic group psychotherapy
PSQI - Pittsburgh Sleep Quality Index
RAS - reality-adaptive supportive psychotherapy
REM - Rapid Eye Movement
rTMS - repetitive transcranial magnetic stimulation
SANS - Scale for the Assessment of Negative Symptoms
SMD - Standardized Mean Difference
SMR - sensorimotor rhythm
SP - supportive psychotherapy
SST - social skills training
tACS - Transcranial Alternating Current Stimulation
tDCS - Transcranial Direct Current Stimulation
TMS - Transcranial Magnetic Stimulation
VO_2 max - Maximal Oxygen Uptake
VR - virtual reality
WHOQOL-BREF - World Health Organization Quality of Life brief assessment

No conflicts of interest to declare.

REFERENCES

1. Acquadro Maran, D., Capitanelli, I., Cortese, C. G., Ilesanmi, O. S., Gianino, M. M., & Chirico, F. (2022). Animal-assisted intervention and health care workers' psychological health: A systematic review of the literature. *Animals: An Open Access Journal from MDPI*, *12*(3), 383. https://doi.org/10.3390/ani12030383
2. Aranburu, E., Matias, S., Simón, E., Larretxi, I., Martínez, O., Bustamante, M. Á., Fernández-Gil, M. del P., & Miranda, J. (2021). Gluten and FODMAPs relationship with mental disorders: Systematic review. *Nutrients*, *13*(6), 1894. https://doi.org/10.3390/nu13061894
3. Arsovski, D. (2024). The role of animal assisted therapy in the rehabilitation of mental health disorders: A systematic literature review. *Perspectives on Integrative Medicine*, *3*(3), 142–151. https://doi.org/10.56986/pim.2024.10.003
4. Balcioglu, S. S. K., Balcioglu, Y. H., & Devrim Balaban, O. (2022). The association between chronotype and sleep quality, and cardiometabolic markers in patients with schizophrenia. *Chronobiology International*, *39*(1), 77–88. https://doi.org/10.1080/07420528.2021.1974029
5. Barak, Y., Savorai, O., Mavashev, S., & Beni, A. (2001). Animal-assisted therapy for elderly schizophrenic patients: a one-year controlled trial. *The American Journal of Geriatric Psychiatry: Official Journal of the American Association for Geriatric Psychiatry*, *9*(4), 439–442.
6. Baranwal, N., Yu, P. K., & Siegel, N. S. (2023). Sleep physiology, pathophysiology, and sleep hygiene. *Progress in Cardiovascular Diseases*, *77*, 59–69. https://doi.org/10.1016/j.pcad.2023.02.005
7. Barker, S. B., Pandurangi, A. K., & Best, A. M. (2003). Effects of animal-assisted therapy on patients' anxiety, fear, and depression before ECT. *The Journal of ECT*, *19*(1), 38–44. https://doi.org/10.1097/00124509-200303000-00008
8. Barlati, S., Nibbio, G., & Vita, A. (2024). Evidence-based psychosocial interventions in schizophrenia: a critical review. *Current Opinion in Psychiatry*, *37*(3), 131–139. https://doi.org/10.1097/YCO.0000000000000925
9. Barnes, T. R., Drake, R., Paton, C., Cooper, S. J., Deakin, B., Ferrier, I. N., Gregory, C. J., Haddad, P. M., Howes, O. D., Jones, I., Joyce, E. M., Lewis, S., Lingford-Hughes, A., MacCabe, J. H., Owens, D. C., Patel, M. X., Sinclair, J. M., Stone, J. M., Talbot, P. S., … Yung, A. R. (2020). Evidence-based guidelines for the pharmacological treatment of schizophrenia: Updated recommendations from the British Association for Psychopharmacology. *Journal of Psychopharmacology (Oxford, England)*, *34*(1), 3–78. https://doi.org/10.1177/0269881119889296
10. Bauer, C. C. C., Okano, K., Ghosh, S. S., Lee, Y. J., Melero, H., Angeles, C. de L., Nestor, P. G., Del Re, E. C., Northoff, G., Niznikiewicz, M. A., & Whitfield-Gabrieli, S. (2020). Real-time fMRI neurofeedback reduces auditory hallucinations and modulates resting state connectivity of involved brain regions: Part 2: Default mode network - preliminary evidence. *Psychiatry Research*, *284*(112770), 112770. https://doi.org/10.1016/j.psychres.2020.112770
11. Bellani, M., Ricciardi, C., Rossetti, M. G., Zovetti, N., Perlini, C., & Brambilla, P. (2019). Cognitive remediation in schizophrenia: the earlier the better? *Epidemiology and Psychiatric Sciences*, *29*(e57), e57. https://doi.org/10.1017/S2045796019000532
12. Bighelli, I., Leucht, C., Huhn, M., Reitmeir, C., Schwermann, F., Wallis, S., Davis, J. M., & Leucht, S. (2020). Are Randomized Controlled Trials on Pharmacotherapy and Psychotherapy for Positive Symptoms of Schizophrenia Comparable? A Systematic Review of Patient and Study Characteristics. *Schizophrenia Bulletin*, *46*(3), 496–504.
13. Birulés, I., López-Carrilero, R., Cuadras, D., Pousa, E., Barrigón, M. L., Barajas, A., Lorente-Rovira, E., González-Higueras, F., Grasa, E., Ruiz-Delgado, I., Cid, J., de Apraiz, A., Montserrat, R., Pélaez, T., Moritz, S., & Ochoa, S. (2020). Cognitive Insight in First-Episode Psychosis: Changes during Metacognitive Training. *Journal of Personalized Medicine*, *10*(4), 253.
14. Bisso, E., Signorelli, M. S., Milazzo, M., Maglia, M., Polosa, R., Aguglia, E., & Caponnetto, P. (2020). Immersive virtual reality applications in schizophrenia spectrum therapy: A systematic review. *International Journal of Environmental Research and Public Health*, *17*(17), 6111. https://doi.org/10.3390/ijerph17176111
15. Bowie, C. R., Bell, M. D., Fiszdon, J. M., Johannesen, J. K., Lindenmayer, J.-P., McGurk, S. R., Medalia, A. A., Penadés, R., Saperstein, A. M., Twamley, E. W., Ueland, T., & Wykes, T. (2020). Cognitive remediation for schizophrenia: An expert working group white paper on core techniques. *Schizophrenia Research*, *215*, 49–53. https://doi.org/10.1016/j.schres.2019.10.047
16. Bueno-Antequera, J., & Munguía-Izquierdo, D. (2020). Exercise and schizophrenia. *Advances in Experimental Medicine and Biology*, *1228*, 317–332. https://doi.org/10.1007/978-981-15-1792-1_21
17. Calvo, P., Fortuny, J. R., Guzmán, S., Macías, C., Bowen, J., García, M. L., Orejas, O., Molins, F., Tvarijonaviciute, A., Cerón, J. J., Bulbena, A., & Fatjó, J. (2016). Animal assisted therapy (AAT) program as a useful adjunct to conventional psychosocial rehabilitation for patients with schizophrenia: Results of a small-scale randomized controlled trial. *Frontiers in Psychology*, *7*, 631. https://doi.org/10.3389/fpsyg.2016.00631
18. Cempa, K., Jurys, T., Kluczyński, S., & Andreew, M. (2022). Physical activity as a therapeutic method for non-pharmacological treatment of schizophrenia: A systematic literature review. *Psychiatria Polska*, *56*(4), 837–859. https://doi.org/10.12740/PP/140053

19. Chaurasia, N., Mishra, P., Garg, S., & Malik, G. (2023). Sleep quality in patients with schizophrenia in a tertiary care center in northern India. *The Primary Care Companion to CNS Disorders*, *25*(6). https://doi.org/10.4088/pcc.23m03564
20. Chen, M.-Y., Wang, Y.-Y., Si, T. L., Liu, Y.-F., Su, Z., Cheung, T., Ungvari, G. S., Jackson, T., Zhang, Q., & Xiang, Y.-T. (2024). Poor sleep quality in schizophrenia patients: A systematic review and meta-analyses of epidemiological and case-control studies. *Schizophrenia Research*, *264*, 407–415. https://doi.org/10.1016/j.schres.2024.01.011
21. Chen, T.-T., Hsieh, T.-L., Chen, M.-L., Tseng, W.-T., Hung, C.-F., & Chen, C.-R. (2021). Animal-assisted therapy in middle-aged and older patients with schizophrenia: A randomized controlled trial. *Frontiers in Psychiatry*, *12*, 713623. https://doi.org/10.3389/fpsyt.2021.713623
22. Colizzi, M., Ruggeri, M., & Lasalvia, A. (2020). Should we be concerned about stigma and discrimination in people at risk for psychosis? A systematic review. *Psychological Medicine*, *50*(5), 705–726. https://doi.org/10.1017/S0033291720000148
23. Crawford, M. J., Killaspy, H., Barnes, T. R. E., Barrett, B., Byford, S., Clayton, K., Dinsmore, J., Floyd, S., Hoadley, A., Johnson, T., Kalaitzaki, E., King, M., Leurent, B., Maratos, A., O'Neill, F. A., Osborn, D. P., Patterson, S., Soteriou, T., Tyrer, P., … MATISSE project team. (2012). Group art therapy as an adjunctive treatment for people with schizophrenia: multicentre pragmatic randomised trial. *BMJ (Clinical Research Ed.)*, *344*, e846. https://doi.org/10.1136/bmj.e846
24. Crawford, M. J., Killaspy, H., Kalaitzaki, E., Barrett, B., Byford, S., Patterson, S., Soteriou, T., O'Neill, F. A., Clayton, K., Maratos, A., Barnes, T. R., Osborn, D., Johnson, T., King, M., Tyrer, P., & Waller, D. (2010). The MATISSE study: a randomised trial of group art therapy for people with schizophrenia. *BMC Psychiatry*, *10*(1), 65. https://doi.org/10.1186/1471-244X-10-65
25. Crespo-Facorro, B., Such, P., Nylander, A.-G., Madera, J., Resemann, H. K., Worthington, E., O'Connor, M., Drane, E., Steeves, S., & Newton, R. (2021). The burden of disease in early schizophrenia - a systematic literature review. *Current Medical Research and Opinion*, *37*(1), 109–121. https://doi.org/10.1080/03007995.2020.1841618
26. Cumming, P., Abi-Dargham, A., & Gründer, G. (2021). Molecular imaging of schizophrenia: Neurochemical findings in a heterogeneous and evolving disorder. *Behavioural Brain Research*, *398*(113004), 113004. https://doi.org/10.1016/j.bbr.2020.113004
27. Curcic, D., Stojmenovic, T., Djukic-Dejanovic, S., Dikic, N., Vesic-Vukasinovic, M., Radivojevic, N., Andjelkovic, M., Borovcanin, M., & Djokic, G. (2017). Positive impact of prescribed physical activity on symptoms of schizophrenia: randomized clinical trial. *Psychiatria Danubina*, *29*(4), 459–465. https://doi.org/10.24869/psyd.2017.459
28. de Jong, S., van Donkersgoed, R. J. M., Timmerman, M. E., Aan Het Rot, M., Wunderink, L., Arends, J., van Der Gaag, M., Aleman, A., Lysaker, P. H., & Pijnenborg, G. H. M. (2019). Metacognitive reflection and insight therapy (MERIT) for patients with schizophrenia. *Psychological Medicine*, *49*(2), 303–313. https://doi.org/10.1017/S0033291718000855
29. Dimitrijević, I. (2009). Animal-Assisted Therapy-a new trend in the treatment of children and addults. *Psychiatria Danubina*, *21*(2), 236–241.
30. Du, S.-C., Li, C.-Y., Lo, Y.-Y., Hu, Y.-H., Hsu, C.-W., Cheng, C.-Y., Chen, T.-T., Hung, P.-H., Lin, P.-Y., & Chen, C.-R. (2024). Effects of visual art therapy on positive symptoms, negative symptoms, and emotions in individuals with schizophrenia: A systematic review and meta-analysis. *Healthcare (Basel, Switzerland)*, *12*(11), 1156. https://doi.org/10.3390/healthcare12111156
31. Duan, Y., Li, S., Jia, S., Yu, F., Wang, X., & Long, Y. (2025). Systematic review and meta-analysis of the effects of EEG neurofeedback combined with pharmacological treatment on the positive and negative symptoms in patients with schizophrenia. *Frontiers in Psychiatry*, *16*, 1537329. https://doi.org/10.3389/fpsyt.2025.1537329
32. El Kirat, H., Khattabi, A., Khalis, M., & Belrhiti, Z. (2023). Effects of physical activity and nutrient supplementation on symptoms and well-being of schizophrenia patients: An umbrella review. *Schizophrenia Research*, *262*, 112–120. https://doi.org/10.1016/j.schres.2023.10.021
33. Fernández-Sotos, P., Fernández-Caballero, A., & Rodriguez-Jimenez, R. (2020). Virtual reality for psychosocial remediation in schizophrenia: a systematic review. *The European Journal of Psychiatry*, *34*(1), 1–10. https://doi.org/10.1016/j.ejpsy.2019.12.003
34. Firth, J., Cotter, J., Elliott, R., French, P., & Yung, A. R. (2015). A systematic review and meta-analysis of exercise interventions in schizophrenia patients. *Psychological Medicine*, *45*(7), 1343–1361. https://doi.org/10.1017/S0033291714003110
35. Firth, Joseph, Stubbs, B., Rosenbaum, S., Vancampfort, D., Malchow, B., Schuch, F., Elliott, R., Nuechterlein, K. H., & Yung, A. R. (2017). Aerobic exercise improves cognitive functioning in people with schizophrenia: A systematic review and meta-analysis. *Schizophrenia Bulletin*, *43*(3), 546–556. https://doi.org/10.1093/schbul/sbw115
36. Fitapelli, B., & Lindenmayer, J.-P. (2022). Advances in Cognitive Remediation Training in Schizophrenia: A Review. *Brain Sciences*, *12*(2), 129.

37. Fulmer, R. (2018). The evolution of the psychodynamic approach and system. *International Journal of Psychological Studies*, *10*(3), 1. https://doi.org/10.5539/ijps.v10n3p1
38. Gandara, V., Pineda, J. A., Shu, I.-W., & Singh, F. (2020). A systematic review of the potential use of neurofeedback in patients with schizophrenia. *Schizophrenia Bulletin Open*, *1*(1), sgaa005. https://doi.org/10.1093/schizbullopen/sgaa005
39. George, O., & Kasinathan, J. (2015). Mural art therapy for young offenders hospitalised with a mental illness. *Australasian Psychiatry: Bulletin of Royal Australian and New Zealand College of Psychiatrists*, *23*(1), 49–53. https://doi.org/10.1177/1039856214563852
40. Gillouin, P.-A., Mattatia, D., & Bouvet, C. (2024). Virtual reality for clinical evaluation and treatment in schizophrenia: a systematic review. *Psychosis*, *16*(2), 212–229. https://doi.org/10.1080/17522439.2023.2197030
41. Girdler, S. J., Confino, J. E., & Woesner, M. E. (2019). Exercise as a treatment for schizophrenia: A review. *Psychopharmacology Bulletin*, *49*(1), 56–69.
42. Granholm, E., McQuaid, J. R., McClure, F. S., Auslander, L. A., Perivoliotis, D., Pedrelli, P., Patterson, T., & Jeste, D. V. (2005). A randomized, controlled trial of cognitive behavioral social skills training for middle-aged and older outpatients with chronic schizophrenia. *The American Journal of Psychiatry*, *162*(3), 520–529. https://doi.org/10.1176/appi.ajp.162.3.520
43. Harder, S., Koester, A., Valbak, K., & Rosenbaum, B. (2014). Five-year follow-up of supportive psychodynamic psychotherapy in first-episode psychosis: long-term outcome in social functioning. *Psychiatry*, *77*(2), 155–168. https://doi.org/10.1521/psyc.2014.77.2.155
44. Herz, M. I. (1985). Boston psychotherapy study. *Schizophrenia Bulletin*, *11*(4), 528–531. https://doi.org/10.1093/schbul/11.4.528
45. Hirano, Y., & Tamura, S. (2021). Recent findings on neurofeedback training for auditory hallucinations in schizophrenia. *Current Opinion in Psychiatry*, *34*(3), 245–252. https://doi.org/10.1097/YCO.0000000000000693
46. Hotte-Meunier, A., Penney, D., Mendelson, D., Thibaudeau, É., Moritz, S., Lepage, M., & Sauvé, G. (2024). Effects of metacognitive training (MCT) on social cognition for schizophrenia spectrum and related psychotic disorders: a systematic review and meta-analysis. *Psychological Medicine*, *54*(5), 914–920. https://doi.org/10.1017/S0033291723002611
47. Hoy, K., Roher, S., & Duncan, A. (2023). Exploring the transfer effects of social skills interventions for individuals with serious mental illness: A scoping review: Social skills transferability. *Journal of Recovery in Mental Health*, *6*(1), 4–18. https://doi.org/10.33137/jrmh.v6i1.37889
48. Hu, J., Zhang, J., Hu, L., Yu, H., & Xu, J. (2021). Art therapy: A complementary treatment for mental disorders. *Frontiers in Psychology*, *12*, 686005. https://doi.org/10.3389/fpsyg.2021.686005
49. Imboden, C., Claussen, M. C., Seifritz, E., & Gerber, M. (2022). Die Bedeutung von körperlicher Aktivität für die psychische Gesundheit. *Praxis*, *110*(4), 186–191. https://doi.org/10.1024/1661-8157/a003831
50. Jauhar, S., Johnstone, M., & McKenna, P. J. (2022). Schizophrenia. *Lancet*, *399*(10323), 473–486. https://doi.org/10.1016/S0140-6736(21)01730-X
51. Jeffrey, C., Penney, D., Sauvé, G., Mendelson, D., Thibaudeau, É., Moritz, S., Hotte-Meunier, A., & Lepage, M. (2025). Does metacognitive training for psychosis (MCT) improve neurocognitive performance? A systematic review and meta-analysis. *Schizophrenia Research*, *275*, 79–86. https://doi.org/10.1016/j.schres.2024.12.004
52. Kakeri, F., Teimouri, M., Davarinezhad, O., Omidi, R., & Yazdani, M. (2024). The efficacy of neurofeedback treatment on positive and negative symptoms in schizophrenia: a systematic review. *Tabari Biomed Stu Res J*, *6*(3), 74–85.
53. Keepers, G. A., Fochtmann, L. J., Anzia, J. M., Benjamin, S., Lyness, J. M., Mojtabai, R., Servis, M., Walaszek, A., Buckley, P., Lenzenweger, M. F., Young, A. S., Degenhardt, A., Hong, S.-H., & (Systematic Review). (2020). The American psychiatric association practice guideline for the treatment of patients with schizophrenia. *The American Journal of Psychiatry*, *177*(9), 868–872. https://doi.org/10.1176/appi.ajp.2020.177901
54. Koutsomitros, T., Evagorou, O., Schuhmann, T., Zamar, A., & Sack, A. T. (2021). Advances in transcranial magnetic stimulation (TMS) and its applications in resistant depression. *Psychiatrike*, *32*(Supplement I), 90–98. https://doi.org/10.22365/jpsych.2021.054
55. Maric, N. P., Jovicic, M. J., Mihaljevic, M., & Miljevic, C. (2016). Improving current treatments for schizophrenia. *Drug Development Research*, *77*(7), 357–367. https://doi.org/10.1002/ddr.21337
56. Marin, L., Guàrdia, A., González-Rodríguez, A., Haba-Rubio, J., Natividad, M., Bosch, E., Domínguez, N., & Monreal, J. A. (2023). Sleep disturbances in at-risk mental states and first episode of psychosis: A narrative review on interventions. *Clocks & Sleep*, *5*(2), 249–259. https://doi.org/10.3390/clockssleep5020020
57. Marr, C. A., French, L., Thompson, D., Drum, L., Greening, G., Mormon, J., Henderson, I., & Hughes, C. W. (2000). Animal-assisted therapy in psychiatric rehabilitation. *Anthrozoos*, *13*(1), 43–47. https://doi.org/10.2752/089279300786999950
58. Marzouk, T., Winkelbeiner, S., Azizi, H., Malhotra, A. K., & Homan, P. (2020). Transcranial magnetic stimulation for positive symptoms in schizophrenia: A systematic review. *Neuropsychobiology*, *79*(6), 384–396. https://doi.org/10.1159/000502148

59. Młynarska, E., Gadzinowska, J., Tokarek, J., Forycka, J., Szuman, A., Franczyk, B., & Rysz, J. (2022). The role of the microbiome-brain-gut axis in the pathogenesis of depressive disorder. *Nutrients*, *14*(9), 1921. https://doi.org/10.3390/nu14091921
60. Modesti, M. N., Arena, J. F., Palermo, N., & Del Casale, A. (2023). A Systematic Review on Add-On Psychotherapy in Schizophrenia Spectrum Disorders. *J. Clin. Med.*, *12*(3), 1021.
61. Montag, C., Haase, L., Seidel, D., Bayerl, M., Gallinat, J., Herrmann, U., & Dannecker, K. (2014). A pilot RCT of psychodynamic group art therapy for patients in acute psychotic episodes: feasibility, impact on symptoms and mentalising capacity. *PloS One*, *9*(11), e112348. https://doi.org/10.1371/journal.pone.0112348
62. Moritz, S., Andreou, C., Schneider, B. C., Wittekind, C. E., Menon, M., Balzan, R. P., & Woodward, T. S. (2014). Sowing the seeds of doubt: a narrative review on metacognitive training in schizophrenia. *Clinical Psychology Review*, *34*(4), 358–366. https://doi.org/10.1016/j.cpr.2014.04.004
63. Moritz, S., & Lysaker, P. H. (2018). Metacognition - What did James H. Flavell really say and the implications for the conceptualization and design of metacognitive interventions. *Schizophrenia Research*, *201*, 20–26. https://doi.org/10.1016/j.schres.2018.06.001
64. Moritz, S., Menon, M., Balzan, R., & Woodward, T. S. (2023). Metacognitive training for psychosis (MCT): past, present, and future. *European Archives of Psychiatry and Clinical Neuroscience*, *273*(4), 811–817. https://doi.org/10.1007/s00406-022-01394-9
65. Morrison, A. P., Law, H., Carter, L., Sellers, R., Emsley, R., Pyle, M., French, P., Shiers, D., Yung, A. R., Murphy, E. K., Holden, N., Steele, A., Bowe, S. E., Palmier-Claus, J., Brooks, V., Byrne, R., Davies, L., & Haddad, P. M. (2018). Antipsychotic drugs versus cognitive behavioural therapy versus a combination of both in people with psychosis: a randomised controlled pilot and feasibility study. *The Lancet. Psychiatry*, *5*(5), 411–423. https://doi.org/10.1016/S2215-0366(18)30096-8
66. Nathans-Barel, I., Feldman, P., Berger, B., Modai, I., & Silver, H. (2005). Animal-assisted therapy ameliorates anhedonia in schizophrenia patients. A controlled pilot study. *Psychotherapy and Psychosomatics*, *74*(1), 31–35. https://doi.org/10.1159/000082024
67. Okusaga, O., Yolken, R. H., Langenberg, P., Sleemi, A., Kelly, D. L., Vaswani, D., Giegling, I., Hartmann, A. M., Konte, B., Friedl, M., Mohyuddin, F., Groer, M. W., Rujescu, D., & Postolache, T. T. (2013). Elevated gliadin antibody levels in individuals with schizophrenia. *The World Journal of Biological Psychiatry: The Official Journal of the World Federation of Societies of Biological Psychiatry*, *14*(7), 509–515. https://doi.org/10.3109/15622975.2012.747699
68. Oliveira, C., Simões de Almeida, R., & Marques, A. (2021). Virtual reality in social skills training programs for people with schizophrenia: A systematic review and focus group. *The British Journal of Occupational Therapy*, *84*(9), 571–581. https://doi.org/10.1177/03080226211011391
69. Oprea, D. C., Mawas, I., Moroșan, C. A., Iacob, V. T., Cămănaru, E. M., Cristofor, A. C., Dobrin, R. P., Gireadă, B., Petrariu, F. D., & Chiriță, R. (2024). A systematic review of the effects of EEG neurofeedback on patients with schizophrenia. *Journal of Personalized Medicine*, *14*(7), 763. https://doi.org/10.3390/jpm14070763
70. Owen, L., & Corfe, B. (2017). The role of diet and nutrition on mental health and wellbeing. *The Proceedings of the Nutrition Society*, *76*(4), 425–426. https://doi.org/10.1017/S0029665117001057
71. Park, K.-M., Ku, J., Choi, S.-H., Jang, H.-J., Park, J.-Y., Kim, S. I., & Kim, J.-J. (2011). A virtual reality application in role-plays of social skills training for schizophrenia: a randomized, controlled trial. *Psychiatry Research*, *189*(2), 166–172. https://doi.org/10.1016/j.psychres.2011.04.003
72. Patel, S., Silvi, S., Desai, S., Rahman, F., Depa, N., Hanif, S., Rizvi, S., Hsieh, Y.-C., Malik, P., Patel, U., Mansuri, Z., Mercy, R. P., Aedma, K., & Parikh, T. (2023). Effectiveness of repetitive transcranial magnetic stimulation in depression, schizophrenia, and obsessive-compulsive disorder: An umbrella meta-analysis. *The Primary Care Companion to CNS Disorders*, *25*(5). https://doi.org/10.4088/PCC.22r03423
73. Paulhus, D. L., Fridhandler, B., & Hayes, S. (1997). Psychological Defense. In R. Hogan (Ed.), *Handbook of Personality Psychology* (Vol. 987, pp. 543–579). Elsevier.
74. *Quality statement 2: Cognitive behavioural therapy*. (n.d.). NICE. Retrieved July 21, 2025, from https://www.nice.org.uk/guidance/qs80/chapter/quality-statement-2-cognitive-behavioural-therapy
75. Rahmati, M., Lee, S., Yon, D. K., Lee, S. W., Udeh, R., McEvoy, M., Oh, H., Butler, L., Keyes, H., Barnett, Y., Koyanagi, A., Shin, J. I., & Smith, L. (2024). Physical activity and prevention of mental health complications: An umbrella review. *Neuroscience and Biobehavioral Reviews*, *160*, 105641. https://doi.org/10.1016/j.neubiorev.2024.105641
76. Richardson, P., Jones, K., Evans, C., Stevens, P., & Rowe, A. (2007). Exploratory RCT of art therapy as an adjunctive treatment in schizophrenia. *Journal of Mental Health (Abingdon, England)*, *16*(4), 483–491. https://doi.org/10.1080/09638230701483111
77. Rothwell, J. (2018). Transcranial brain stimulation: Past and future. *Brain and Neuroscience Advances*, *2*, 2398212818818070. https://doi.org/10.1177/2398212818818070

78. Ruffalo, M. L. (2023). The psychotherapy of schizophrenia: A review of the evidence for psychodynamic and nonpsychodynamic treatments. *Psychiatry and Clinical Psychopharmacology*, *33*(3), 222–228. https://doi.org/10.5152/pcp.2023.23627
79. Sarnyai, Z., Kraeuter, A.-K., & Palmer, C. M. (2019). Ketogenic diet for schizophrenia: clinical implication: Clinical implication. *Current Opinion in Psychiatry*, *32*(5), 394–401. https://doi.org/10.1097/YCO.0000000000000535
80. *Schizophrenia*. (n.d.). Who.int. Retrieved July 21, 2025, from https://www.who.int/news-room/fact-sheets/detail/schizophrenia
81. Schuch, F. B., & Vancampfort, D. (2021). Physical activity, exercise, and mental disorders: it is time to move on. *Trends in Psychiatry and Psychotherapy*, *43*(3), 177–184. https://doi.org/10.47626/2237-6089-2021-0237
82. Seccomandi, B., Tsapekos, D., Newbery, K., Wykes, T., & Cella, M. (2020). A systematic review of moderators of cognitive remediation response for people with schizophrenia. *Schizophrenia Research. Cognition*, *19*(100160), 100160. https://doi.org/10.1016/j.scog.2019.100160
83. Sethi, S., Wakeham, D., Ketter, T., Hooshmand, F., Bjornstad, J., Richards, B., Westman, E., Krauss, R. M., & Saslow, L. (2024). Ketogenic diet intervention on metabolic and psychiatric health in bipolar and schizophrenia: A pilot trial. *Psychiatry Research*, *335*, 115866. https://doi.org/10.1016/j.psychres.2024.115866
84. Shu, I.-W., Granholm, E. L., & Singh, F. (2023). Targeting frontal gamma activity with neurofeedback to improve working memory in schizophrenia. *Current Topics in Behavioral Neurosciences*, *63*, 153–172. https://doi.org/10.1007/7854_2022_377
85. Shukla, A., Choudhari, S. G., Gaidhane, A. M., & Quazi Syed, Z. (2022). Role of art therapy in the promotion of mental health: A critical review. *Cureus*, *14*(8), e28026. https://doi.org/10.7759/cureus.28026
86. Siafis, S., Tzachanis, D., Samara, M., & Papazisis, G. (2018). Antipsychotic drugs: From receptor-binding profiles to metabolic side effects. *Current Neuropharmacology*, *16*(8), 1210–1223. https://doi.org/10.2174/1570159X15666170630163616
87. Stević, L. I., Repišti, S., Radojičić, T., Sartorius, N., Tomori, S., Kulenović, A. D., Popova, A., Kuzman, M. R., Vlachos, I. I., Statovci, S., Bandati, A., Novotni, A., Bajraktarov, S., Panfil, A.-L., Maric, N., Delić, M., & Jovanović, N. (2022). Non-pharmacological interventions for schizophrenia-analysis of treatment guidelines and implementation in 12 Southeast European countries. *Schizophrenia (Heidelberg, Germany)*, *8*(1), 10. https://doi.org/10.1038/s41537-022-00226-y
88. Stilo, S. A., Di Forti, M., & Murray, R. M. (2011). Environmental risk factors for schizophrenia: implications for prevention. *Neuropsychiatry*, *1*(5), 457–466. https://doi.org/10.2217/npy.11.42
89. Storchak, H., Hudak, J., Haeussinger, F. B., Rosenbaum, D., Fallgatter, A. J., & Ehlis, A.-C. (2019). Reducing auditory verbal hallucinations by means of fNIRS neurofeedback - A case study with a paranoid schizophrenic patient. *Schizophrenia Research*, *204*, 401–403. https://doi.org/10.1016/j.schres.2018.09.018
90. Sun, X., Yue, S., Duan, M., Yao, D., & Luo, C. (2023). Psychosocial intervention for schizophrenia. *Brain-Apparatus Communication: A Journal of Bacomics*, *2*(1). https://doi.org/10.1080/27706710.2023.2178266
91. Taliercio, J., Bonasera, B., Portillo, C., Ramjas, E., & Serper, M. (2020). Physical activity, sleep-related behaviors and severity of symptoms in schizophrenia. *Psychiatry Research*, *294*(113489), 113489. https://doi.org/10.1016/j.psychres.2020.113489
92. Tarpada, S. P., & Morris, M. T. (2017). Physical activity diminishes symptomatic decline in chronic schizophrenia: A systematic review. *Psychopharmacology Bulletin*, *47*(4), 29–40.
93. Teglbjaerg, H. S. (2011). Art therapy may reduce psychopathology in schizophrenia by strengthening the patients' sense of self: a qualitative extended case report. *Psychopathology*, *44*(5), 314–318. https://doi.org/10.1159/000325025
94. Tréhout, M., & Dollfus, S. (2018). L'activité physique chez les patients atteints de schizophrénie : de la neurobiologie aux bénéfices cliniques. *L'Encephale*, *44*(6), 538–547. https://doi.org/10.1016/j.encep.2018.05.005
95. Truong, D. Q., & Bikson, M. (2018). Physics of transcranial direct current stimulation devices and their history. *The Journal of ECT*, *34*(3), 137–143. https://doi.org/10.1097/YCT.0000000000000531
96. Tyssedal, M. K., Johnsen, E., Brønstad, A., & Skrede, S. (2023). Dog-assisted interventions for adults diagnosed with schizophrenia and related disorders: a systematic review. *Frontiers in Psychiatry*, *14*, 1192075. https://doi.org/10.3389/fpsyt.2023.1192075
97. Valiengo, L. da C. L., Goerigk, S., Gordon, P. C., Padberg, F., Serpa, M. H., Koebe, S., Santos, L. A. dos, Lovera, R. A. M., Carvalho, J. B. de, van de Bilt, M., Lacerda, A. L. T., Elkis, H., Gattaz, W. F., & Brunoni, A. R. (2020). Efficacy and safety of transcranial direct current stimulation for treating negative symptoms in schizophrenia: A randomized clinical trial. *JAMA Psychiatry (Chicago, Ill.)*, *77*(2), 121. https://doi.org/10.1001/jamapsychiatry.2019.3199
98. van Zonneveld, S. M., Haarman, B. C. M., van den Oever, E. J., Nuninga, J. O., & Sommer, I. E. C. (2022). Unhealthy diet in schizophrenia spectrum disorders. *Current Opinion in Psychiatry*, *35*(3), 177–185. https://doi.org/10.1097/YCO.0000000000000791

99. Villalta-Gil, V., Roca, M., Gonzalez, N., Domènec, E., Cuca, Escanilla, A., Asensio, M. R., Esteban, M. E., Ochoa, S., Haro, J. M., & Schi-Can group. (2009). Dog-assisted therapy in the treatment of chronic schizophrenia inpatients. *Anthrozoos*, *22*(2), 149–159. https://doi.org/10.2752/175303709x434176
100. Wang, Q., Yang, Q., & Liu, X. (2023). The microbiota-gut-brain axis and neurodevelopmental disorders. *Protein & Cell*, *14*(10), 762–775. https://doi.org/10.1093/procel/pwad026
101. Woodward, M. L., Gicas, K. M., Warburton, D. E., White, R. F., Rauscher, A., Leonova, O., Su, W., Smith, G. N., Thornton, A. E., Vertinsky, A. T., Phillips, A. A., Goghari, V. M., Honer, W. G., & Lang, D. J. (2018). Hippocampal volume and vasculature before and after exercise in treatment-resistant schizophrenia. *Schizophrenia Research*, *202*, 158–165. https://doi.org/10.1016/j.schres.2018.06.054
102. Xu, X., Shao, G., Zhang, X., Hu, Y., Huang, J., Su, Y., Zhang, M., Cai, Y., & Zhou, H. (2022). The efficacy of nutritional supplements for the adjunctive treatment of schizophrenia in adults: A systematic review and network meta-analysis. *Psychiatry Research*, *311*(114500), 114500. https://doi.org/10.1016/j.psychres.2022.114500
103. Yaden, D. B., Earp, D., Graziosi, M., Friedman-Wheeler, D., Luoma, J. B., & Johnson, M. W. (2022). Psychedelics and psychotherapy: Cognitive-behavioral approaches as default. *Frontiers in Psychology*, *13*, 873279. https://doi.org/10.3389/fpsyg.2022.873279
104. Zajkowska, I., Niczyporuk, P., Urbaniak, A., Tomaszek, N., Modzelewski, S., & Waszkiewicz, N. (2024). Investigating the impacts of diet, supplementation, Microbiota, gut-brain axis on schizophrenia: A narrative review. *Nutrients*, *16*(14), 2228. https://doi.org/10.3390/nu16142228
105. Zhang, R., Ren, J., & Zhang, C. (2023). Efficacy of transcranial alternating current stimulation for schizophrenia treatment: A systematic review. *Journal of Psychiatric Research*, *168*, 52–63. https://doi.org/10.1016/j.jpsychires.2023.10.021
106. Zhu, L., & Zheng, L. (2024). Influence of white sound on sleep quality, anxiety, and depression in patients with schizophrenia. *Noise & Health*, *26*(121), 97–101. https://doi.org/10.4103/nah.nah_116_23