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The Benefits of Music Therapy in Stroke Rehabilitation: A Systematic Literature Review

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Abstract

Stroke, a leading cause of disability and death, results in impairments affecting daily activities and quality of life. Traditional rehabilitation often includes physical, occupational, and speech therapies. However, complementary therapies such as music therapy are gaining attention for their additional benefits. This systematic literature review investigates the effects of music therapy on motor recovery, cognitive rehabilitation, and emotional well-being in stroke survivors. The review includes randomized controlled trials, cohort studies, and case studies sourced from databases like PubMed and ResearchGate. Findings show that Rhythmic Auditory Stimulation (RAS) significantly improves motor functions, particularly gait and upper limb movements, by improving motor control and coordination and promoting neuroplasticity. Also, music therapy benefits cognitive functions such as memory and attention, and improves emotional well-being by reducing anxiety and depression. Implementing RAS in rehabilitation requires customization to individual patient needs, and it can be integrated into home-based programs for continuous improvement. Beyond physical benefits, music therapy supports cognitive and emotional recovery, offering a holistic approach to stroke rehabilitation. Integrating music therapy into rehabilitation programs can significantly improve recovery and quality of life for stroke survivors.

Keywords: Stroke, Rehabilitation, Music Therapy, Alternative Medicine, Special Education

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Introduction

Stroke, a leading cause of disability and death worldwide happens when the part of blood supply of the brain is interrupted or reduced, preventing brain tissue from receiving oxygen and nutrients. (Tadi et al., 2023) This interruption can be due to a blocked artery (ischemic stroke) or rupture of a blood vessel (hemorrhagic stroke). The resulting brain damage can result in a variety of physical, cognitive, and emotional impairments, depending on the location and size of the stroke. (Unnithan et al., 2024) These impairments can affect ability to perform daily activities and impact people's quality of life. Early intervention and comprehensive rehabilitation are crucial for maximizing recovery and minimizing long-term disabilities. (Barman et al., 2016) Traditional rehabilitation approaches often focus on physical, occupational and speech therapies, but there is increasing interest in complementary therapies, such as music therapy. (Paul et al., 2000) The rehabilitation process is crucial for improving functional outcomes and quality of life, but its often long-lasting and complex. Traditional rehabilitation approaches including physical, occupational and speech therapies play essential roles. (Pollock et al., 2014) However, there is a growing interest in complementary therapies that can increase these conventional methods. Among these, music therapy came out as a promising intervention with many benefits (Halim, 2002).

Music therapy involves the use of music by a trained therapist to achieve therapeutic goals customized to the individual needs of patients. Its application in stroke rehabilitation is based on the understanding that music can stimulate various brain regions simultaneously, promoting neuroplasticity and recovery (Strzemecka, 2013). The rhythmic and repetitive nature of music can also help in retraining motor functions and improving cognitive abilities, which are often impaired following a stroke (Zhang et al., 2016). One of the key benefits of music therapy in stroke rehabilitation is its ability to increase motor recovery (Xu et al., 2022). Rhythmic Auditory Stimulation (RAS) is a therapeutic technique that is focused on the rhythmic and repetitive elements of music to facilitate motor recovery in persons with neurological impairments, including stroke survivors (Scataglini et al., 2023). The basic principle of RAS is that rhythmic cues can improve motor control by entraining the motor system through auditory pathways. This technique has been studied and applied in the rehabilitation of gait and upper limb functions, showing promising results in improving motor outcomes (Tian et al., 2020).

The effectiveness of RAS is confirmed in its ability to gain multiple neural pathways at the same time. When a patient listens to rhythmic auditory cues such as a metronome beat or music with a steady tempo, these auditory signals are processed by the brain's auditory cortex. The rhythmic patterns then are passed to the motor cortex, which is responsible for planning and executing movements. This process is known as auditory-motor coupling. (Ashoori et al., 2015) Auditory-motor coupling helps to fit motor responses with the external rhythmic stimuli, leading to improved timing and coordination of movements. For stroke survivors, whose motor functions are impaired because of neural damage, this synchronization can significantly improve motor performance. This effect of rhythmic cues provides an external timing mechanism that can compensate for disrupted

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internal motor control, easing smoother and more coordinated movements. (Koshimori et al., 2019)

Gait impairments are common after a stroke, affecting mobility and independence. RAS has been commonly used in gait training to improve walking patterns in stroke survivors. By synchronizing their steps with rhythmic auditory cues, patients can reach better step length, walking speed and general gait symmetry. Studies have shown that RAS can lead to significant improvements in gait parameters, often surpassing the gains achieved with conventional gait training alone. (Wang et al., 2022) RAS is also applied to upper limb rehabilitation, focusing on issues such as reduced range of motion, impaired coordination and muscle weakness. Rhythmic cues can guide patients in performing repetitive arm and hand movements, improving the precision and fluidity of these actions. With RAS, patients might practice reaching, grasping, or manipulating objects in time with a rhythmic beat, which helps to reinforce motor patterns and improve functional use of the upper limbs. (Braun et al., 2022) One of the key benefits of RAS is its potential to promote neuroplasticity, the brain's ability to reorganize and form new neural connections. By repeatedly engaging in movements synchronized with rhythmic cues, stroke survivors can strengthen the neural pathways involved in motor control. Over time, patients can incorporate these rhythmic patterns, leading to strengthen improvements in motor functions even in the absence of external cues. (Chatterjee et al., 2021)

Methodology

This systematic literature review aimed to explore and integrate the current evidence on the benefits of music therapy in stroke rehabilitation. The review is focused on three primary areas: motor recovery, cognitive rehabilitation and emotional well-being. By examining the impact of music therapy on these aspects, this review is providing a comprehensive interpretation of its potential as a supplement to traditional rehabilitation methods. The objectives of this review are:

- To evaluate the effects of music therapy in improving motor functions in stroke survivors.
- To assess the impact of music therapy on cognitive rehabilitation and cognitive function recovery.
- To explore the role of music therapy in improving emotional well-being and reducing psychological distress in stroke survivors.

To achieve these objectives, a systematic search of relevant literature was conducted across multiple databases, including PubMed, ResearchGate and others. The search included peer-reviewed articles published in the last two decades to make sure the inclusion of the most recent and relevant studies. Keywords such as "music therapy," "stroke rehabilitation," "motor recovery," "cognitive rehabilitation," and "emotional well-being" were used to identify relevant studies. The scope of this review includes studies that recruit various music therapy interventions, such as rhythmic auditory stimulation, instrumental training and group music therapy sessions. This review examined randomized controlled trials, cohort studies and case studies to provide a broad perspective on the evidence available.

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Inclusion criteria for the review is consist of studies that involve adult stroke survivors, use of music therapy as an intervention and measure outcomes related to motor, cognitive, or emotional recovery. Studies that do not meet these criteria are excluded. The quality of the included studies was assessed using standardized tools, and the findings are integrated to draw conclusions about the effects and benefits of music therapy in stroke rehabilitation. The findings of this systematic literature review will contribute to the knowledge on the role of music therapy in stroke rehabilitation. By providing a complete analysis of the current evidence, this review will show the potential of music therapy as a valuable supplement to traditional rehabilitation methods. Information received from this review can inform clinical practice and healthcare professionals in incorporating music therapy into rehabilitation programs for stroke survivors.

Results

Several studies focus attention on the positive effects of Rhythmic Auditory Stimulation on gait recovery in stroke survivors. One study investigated the effects of music-based rhythmic auditory stimulation combined with conventional physiotherapy on gait parameters and walking ability in subacute stroke patients. The primary outcomes measured were gait and balance parameters along with walking ability, while secondary outcomes included trunk control, use of assistive devices, functional independence and stroke severity and disability. The results indicated that while both the intervention group and the control group showed improvements in gait and balance parameters, there were no significant differences between the two groups for these primary outcomes. This suggests that adding music-based rhythmic auditory stimulation to conventional physiotherapy did not improves gait and balance gains more than conventional physiotherapy alone. However, a significant improvement was observed in the Functional Ambulation Category for the intervention group compared to the control group. This finding implies that music-based rhythmic auditory stimulation might improve walking ability more effectively than conventional physiotherapy alone, focusing on its potential benefit in improving functional ambulation in subacute stroke patients. These results line up with previous research that has demonstrated the positive effects of rhythmic auditory stimulation on motor control and gait parameters in stroke rehabilitation. The findings suggest that while music-based rhythmic auditory stimulation can improve specific aspects of walking ability, its general impact on gait and balance parameters may not be better than the benefits of conventional physiotherapy. (Gonzalez-Hoelling et al., 2021)

Another study explored the effects of intensive gait training with rhythmic auditory stimulation on postural control and gait performance in people with chronic hemiparetic stroke. The intervention group received RAS during gait training, while the control group went through conventional intensive gait training without RAS. The study used the Berg Balance Scale, Stroke-Specific Quality of Life Scale and a two-dimensional gait analysis system to assess outcomes. The findings demonstrated that the intervention group showed significant improvements in balance, gait velocity, cadence, stride length, double support period on the affected side and quality of life compared to the control group. These results suggest that incorporating RAS into gait training can improve motor relearning with rhythmic cues that facilitate more effective and coordinated

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movements. The improvements in gait parameters indicate that RAS helps in better timing and execution of steps, likely due to the improved motor planning and execution that rhythmic cues provide. (Cha et al., 2014)

Another study by Suh et al., investigated the impact of rhythmic auditory stimulation on standing balance and gait parameters in hemiplegic stroke patients. Sixteen participants were divided into two groups: one receiving gait training with RAS and the other undergoing conventional gait training without RAS over a three-week period. The primary outcomes measured were standing balance using the Biosway system and gait parameters including stride length, gait velocity, and cadence during a 10-meter walk. The results indicated that the RAS group experienced significant improvements in standing balance, as evidenced by improved general stability index, mediolateral index and anteroposterior index. Additionally, the RAS group showed gains in gait velocity, stride length and cadence compared to the control group. These findings suggest that RAS is a valuable therapeutic tool for improving both static and dynamic aspects of postural control and gait in hemiplegic stroke patients. (Suh et al., 2013)

One systematic review and meta-analysis by Yoo et al., examined the effects of rhythmic auditory cueing on motor rehabilitation outcomes in stroke patients. Analyzing data from 10 randomized controlled or clinically controlled trials involving 356 individuals, the study focused on key motor outcomes such as gait and upper-extremity function. The findings revealed significant improvements in walking velocity, cadence, stride length and Fugl-Meyer test scores with large effect sizes observed across these variables. The substantial effect sizes (Hedges's $g = 0.984$ for walking velocity, $g = 0.840$ for cadence, $g = 0.760$ for stride length, and $g = 0.456$ for Fugl-Meyer test scores) indicates the efficacy of rhythmic auditory cueing in improving motor function post-stroke. The subgroup analysis, although not showing statistically significant differences based on the type of rhythmic cueing or the stage of stroke, suggested possible variations in treatment effects. This suggest that while RAS is broadly effective, its impact might be optimized by modifying the type and intensity of cueing to individual patient needs and the specific phase of stroke recovery. (Yoo et al., 2016)

Another study explored the responsiveness of temporal gait asymmetry (TGA) to rhythmic auditory stimulation (RAS) in stroke patients, considering the potential influence of individual rhythm abilities. TGA is a common and persistent post-stroke gait deficit and previous research has shown that RAS can positively impact TGA. This study aimed to further understand how individual differences in rhythm perception and production might affect the effects of RAS in improving TGA. The findings indicated that most participants with stroke were able to maintain or improve their TGA with a single session of RAS. Participants with strong rhythm abilities showed significant improvements in TGA when walking to a metronome, but those with weak rhythm abilities showed higher variability and less consistent improvement. This suggests that rhythm ability might influence the effects of RAS in correcting gait asymmetry. In general, these preliminary findings draw attention to the potential of RAS as a therapeutic tool for improving

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TGA in stroke patients and underscore the importance of considering individual differences in rhythm abilities when designing and implementing rhythm-based treatments. (Crosby et al., 2020)

One randomized controlled trial investigated the effects of gait training with bilateral rhythmic auditory stimulation (GTBR) on lower extremity rehabilitation in stroke patients. This study involved 44 participants who were less than six months post-stroke. The participants were divided into two groups: the GTBR group, which received gait training with bilateral RAS in addition to conventional therapy, and the control group, which received gait training without RAS alongside conventional therapy. The results demonstrated significant improvements in gait symmetry for the GTBR group, as measured by step time, compared to baseline. This improvement was not observed in the control group, suggesting that bilateral RAS is particularly effective in addressing gait asymmetry in stroke patients. Both groups showed significant improvements in gait ability, balance, and lower extremity function, as indicated by the Timed Up and Go test (TUG), Berg Balance Scale (BBS), and Fugl-Meyer Assessment (FMA). However, the GTBR group exhibited significantly greater improvements in gait ability compared to the control group. These results focuses on the efficacy of GTBR in promoting symmetric gait patterns, which is a critical aspect of functional mobility and overall recovery post-stroke. The study also suggests that matching the RAS beat frequency to the patient's fast step time could further improve gait symmetry. (Lee et al., 2018)

Discussion

Implementing RAS in stroke rehabilitation requires careful consideration of individual patient needs and preferences. Therapists must select appropriate rhythmic stimuli, such as metronome beats, drum patterns or music with a consistent tempo, based on the patient's musical tastes and therapeutic goals. The tempo of the rhythmic cues should be customized to the patient's current motor abilities, gradually increasing as they progress in their rehabilitation. In addition to its clinical applications, RAS can be integrated into home-based rehabilitation programs, allowing patients to continue their motor training independently. Portable devices and digital applications that provide rhythmic auditory cues can support patients in practicing their movements outside of therapy sessions, promoting sustained engagement and progress. (Weller et al., 2010) Cognitive rehabilitation is another area where music therapy has shown considerable promise. Stroke survivors very often experience cognitive impairments, such as difficulties with attention, memory, and executive functions. Music therapy can stimulate cognitive processes and facilitate cognitive rehabilitation through activities that require active engagement and mental processing. For instance, learning to play an instrument or engaging in musical improvisation can improve memory and problem-solving skills, contributing to overall cognitive recovery. (Lin et al., 2023)

In addition to physical and cognitive benefits, music therapy also give an address to the emotional and psychological well-being of stroke survivors. The emotional impact of a stroke can be profound, leading to feelings of frustration, depression, and anxiety. Music therapy provides an emotional outlet and can improve mood and reduce anxiety levels. Group music therapy sessions

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offer social interaction and support, encouraging a sense of community and belonging, which is vital for emotional healing. (Kim et al., 2011) Music therapy can be adjusted to individual preferences and needs, making it a highly personalized form of treatment. The flexibility in the types of music and therapeutic activities used allows therapists to design interventions that resonate most with each patient. This individualization improves patient engagement and motivation, which are critical factors in the success of rehabilitation programs. (Archambault et al., 2019) The rehabilitation of stroke patients is a many-sided process that requires an interdisciplinary approach for addressing the various needs of patients. Despite advancements in medical treatments and rehabilitation techniques, many stroke patients continue to experience significant deficits in motor and cognitive functions, as well as emotional distress. Traditional rehabilitation methods while effective, often focus primarily on the physical aspects of recovery. (Gunduz et al., 2023)

Music therapy offers a unique and adaptable approach that can complement conventional rehabilitation methods. The therapeutic use of music is established in its ability to capture multiple brain regions, facilitating neural connections and promoting neuroplasticity. Neuroplasticity, the brain's ability to reorganize itself by forming new neural connections is crucial for recovery after a stroke. (O'Kelly, 2016) The benefits of RAS are not limited to gait recovery. Studies have also demonstrated its effects in improving upper limb function. One study explored the potential of a music therapy intervention to improve upper limb function in stroke patients, a common but challenging area of rehabilitation. The focus on using musical instrument playing and rhythmic techniques to aid upper limb movements reflects a growing interest in integrating rhythmic auditory stimulation (RAS) into therapeutic practices. The study design involved a small sample of 14 participants randomized into treatment and wait-list control groups, that aims to test the practical aspects of implementing the intervention, such as recruitment, adherence and treatment practicability. By using a cross-over design with repeated measures, the study seeks to provide information about the practice of a larger-scale trial while evaluating preliminary effects on arm function and finger dexterity through the Action Research Arm Test (ARAT) and the Nine-Hole Peg Test (9HPT). While the small sample size limits the ability to draw definitive conclusions about the efficacy of the intervention, the study is well-positioned to address critical questions about the practicability and potential impact of home-based music therapy. This study is an important step in evaluating the practicality and initial effects of music therapy for upper limb rehabilitation in stroke patients. (Street et al., 2015)

One pilot study aimed to evaluate the effectiveness of resisted bimanual therapy with rhythmic auditory cues compared to conventional therapy in improving various functional outcomes in stroke survivors. The study's findings indicate that incorporating rhythmic auditory cues into bimanual therapy results with significant improvements in arm function, balance,and endurance compared to conventional therapy alone. The results demonstrate that both treatment approaches, resisted bimanual therapy with rhythmic auditory cues and conventional therapy led to statistically significant improvements in arm function, as measured by the Wolf Motor Function Test (WMFT), trunk function (Trunk Impact Scale, TIS), balance (Berg's Balance Scale, BBS), gait (Dynamic

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Gait Index, DGI) and endurance (Six Minute Walk Test, 6MWT). These findings revealed the potential benefits of integrating rhythmic auditory cues into rehabilitation protocols for stroke survivors, especially those with upper limb motor impairments. The improved outcomes in arm function, balance, and endurance observed in the resisted bimanual therapy group draw attention to the need for further investigation into how rhythmic auditory cues can be optimized to maximize rehabilitation benefits. (Mishr et al., 2022)

RAS also positively affects cognitive function and emotional well-being in stroke survivors. One meta-analysis investigates the effects of rhythmic auditory stimulation-based movement training (RASMT) on cognitive function in people with cognitive impairment, including mild cognitive impairment (MCI). The findings are focused on the potential benefits of RASMT in improving cognitive functions, such as general cognitive status, memory, attention, and executive function. The analysis incorporated data from 12 randomized controlled trials, revealing that RASMT significantly improved overall cognitive status, attention, memory, and executive function. (Wang et al., 2024) Emotional well-being, often missed in rehabilitation is another area where RAS shows promise. One study evaluates the impact of combined music-movement therapy on both physical and psychological outcomes in hospitalized stroke patients, with a focus on early rehabilitation within two weeks of stroke onset. The findings reveal that integrating music with movement therapy can significantly improve physical and psychological recovery in stroke patients during the acute phase of hospitalization. The results indicate that patients in the experimental group who received music-movement therapy demonstrated significant improvements in physical function, specifically increased shoulder flexion and elbow joint flexion. These improvements in range of motion are crucial for restoring upper limb function, which is often compromised following a stroke. (Jun et al., 2013)

Long-term effects of RAS on motor recovery and neuroplasticity have been a focus of several studies. One research examines the impact of music therapy on the quality of life for stroke survivors undergoing neurorehabilitation. The findings indicate that participants in the experimental group, who received music therapy reported significant improvements in several aspects of their quality of life, including general health, vitality, mental health, communication, emotional condition and alertness. These results suggest that integrating music therapy into neurorehabilitation protocols can have a beneficial long term effect on the overall well-being of stroke patients. (Poćwierz-Marciniak et al., 2015) Another study assesses the effects of music-supported therapy in improving hand function in stroke patients by integrating data from twelve randomized controlled trials and controlled trials. The findings suggest that music-supported therapy can be an effective intervention for improving hand strength, range of motion, dexterity, arm function and overall quality of life in stroke survivors. (Huang et al., 2021)

Conclusion

This systematic literature review is focusing on the benefits of music therapy, particularly Rhythmic Auditory Stimulation (RAS) in stroke rehabilitation. RAS has shown to improve motor

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functions, especially gait and upper limb movements by taking multiple neural pathways. Music therapy positively influences cognitive recovery and emotional well-being, providing a comprehensive rehabilitation approach that complements traditional methods. The findings suggest that incorporating music therapy into stroke rehabilitation programs can improve functional outcomes, quality of life and support long-term recovery in stroke survivors.

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