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# Impact of Music Therapy on Neuro-Rehabilitation and Palliative Care in patients of Stroke: A Systematic Review of Randomised Control Trials (RCTs)

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## Introduction

Stroke, an emerging epidemic of the 21st century, is one of the most prevalent causes of death and the leading factor in acquired and long-term disability in adults globally. In terms of the total number of cases, the burden increased significantly between 1990 and 2019 (70.0% more incident strokes, 43.0% more stroke deaths, 102.0% more prevalent strokes, and 143.0% more disability-adjusted life years), with lower- and lower-middle-income countries bearing the majority of the burden (86.0% of deaths and 89.0% of DALYs) (LMIC). Among newly diagnosed stroke patients, 26% still have difficulty performing basic daily tasks and 50% have decreased mobility as a result of hemiparesis. Two more common causes of impairment are aphasia and depression. Over US$721 billion, or 0.66 percent of the world's GDP, is the projected total cost of stroke worldwide.

Growing interest in music as a neurorehabilitation aid, particularly for stroke, has emerged during the past ten years. This has been made possible by advances in music neuroscience, which have revealed the extensive cortical and subcortical networks underlying the auditory, motor, cognitive, and emotional processing of music and their malleability by musical training. This has been made possible by the rapidly rising prevalence of stroke, its significant socioeconomic burden, and the growing need for cost-effective rehabilitation tools. Music can be seen as a type of environmental enrichment (EE) in the rehabilitation context, increasing activity-dependent neuroplasticity in the large-scale brain network it stimulates [**1, 2**].

For the brain, listening to music is a complex process since it sets off a chain of cognitive and emotional components with diverse neurological underpinnings. Recent brain imaging studies have demonstrated that neural activity related to music listening involves a vast bilateral network of frontal, temporal, parietal and subcortical areas related to attention, semantic and music-syntactic processing, memory and motor functions, as well as limbic and paralimbic regions related to emotional processing [**1,2**]. This neural activity extends well beyond the auditory cortex. Music has a well-established impact on reducing pain, anxiety, and sadness in patients with somatic illnesses [**3,5**]. Recent cognitive and neuropsychological studies suggest that it may also improve a range of cognitive abilities, including memory, attention, learning, and communication, in both healthy participants and in clinical diseases like dementia, multiple sclerosis, autism, and schizophrenia [**8**]. Physiotherapy and speech therapy have both used parts of music in the past to help stroke patients recover their ability to speak and move. Nonverbal auditory stimuli have also been demonstrated to temporarily improve left visual neglect following a stroke. However, understanding the long-term impact of regular music consumption on the restoration of cognitive and emotional abilities after a stroke is very limited [**9,11**].

In the field of aphasia therapy, vocal music is particularly intriguing. The ability to form words by singing is frequently retained in nonfluent aphasia, and aphasic individuals are also

able to learn new verbal material when using a sung auditory model [**1**]. In particular, when given at the subacute post-stroke stage, singing-based speech training interventions like melodic intonation therapy (MIT) have been found to improve the production of trained speech content and the recovery of verbal communication in aphasia [**12, 13**]. It is unknown at this time if routinely listening to vocal music could have favorable long-term benefits on aphasia patients' early language rehabilitation [**17**].

As a possible functional indicator of the general health condition, functional mobility is being employed more frequently as an endpoint in clinical investigations. Functional mobility refers to a person's capacity to move independently in a range of locations in order to engage in everyday activities or to complete functional tasks including bed mobility, transfers, ambulation, or certain duties. [**3**] One of the top priorities for stroke survivors is improved gait capability, and clinical investigations have shown that therapeutic approach-induced increases in gait speed are a significant factor in this regard.[**4**] In order to become independent, be able to carry out everyday tasks, and reintegrate into society, mobility must be significantly improved.It is believed that even if other, mostly categorical metrics are unable to identify it, an increase in walking speed implies a real improvement in mobility[**13,14**]. A responsive strategy to identify changes in walking performance over time has been confirmed by repeated evaluation using a straightforward timed walking test. In these investigations, which generally include stroke patients, additional gait metrics such step length and step rate or cadence have frequently been analyzed. Walking speed, step length, and step frequency have been found to be significantly correlated in those who have recently had a stroke. It is believed that even if other, mostly categorical metrics are unable to identify it, an increase in walking speed implies a real improvement in mobility [**16,17**].

Hence, there is an unmet need for a cost effective, easily administered, practical and highly distributable method of rehabilitation and palliative care that is applicable within the rural as well as home-delivery settings, which would prevent further mortalities and improve the quality of life in survivors of stroke. Various innovations in the field of palliative care have revolutionized music therapy's role as a tool for neuro-rehabilitation in stroke patients and lessen the enormous socioeconomic burden associated with this condition.

## Objectives

- **In the long run**, the ability to provide adequate and efficacious rehabilitation and palliative care for stroke patients all over the world despite the setting and condition of their recovery, would walk hand-in-hand to support the realization of **SDG number 3** (Specifically target 3.4, which aims to reduce premature mortality from non-communicable diseases) and **SDG number 10** (Which strives to reduce inequality by empowering persons with disabilities).
- The focus of this paper is to **systematically review the efficacy of music therapy** to provide neuro-rehabilitation for stroke survivors in a limited-resource setting.
- Provide and develop an **evidence-based, cost-effective, and sustainable plan of action** for the global stroke community.

## Methodology

### Eligibility Criteria

#### a) Inclusion Criteria

1. Published from January 1980-Present
2. English language full-text studies only given the language capacity of the researchers. *However, abstracts of all languages will be screened after being translated to English using DeepL: https://www.deepl.com/translator . Full-text reviews of the aforementioned languages will only take place.*
3. Patients who had suffered stroke and demonstrated need for Rehabilitation in the recovery phase
4. Articles discussing the impact of music therapy on **a.** Cognition & Affect b. Language & Speech recovery. c. Functional Mobility
5. Study types- Randomized Controlled Trials were only included into this study.

#### b) Exclusion Criteria

1. Literature with irretrievable full text.
2. Non-research articles such as Reviews, letters, commentaries, conference abstracts.
3. Incomplete/Unreported RCTs.
4. Studies in languages other than English.
5. Studies before 1980
6. Unpublished studies, book excerpts and chapters will be excluded.

#### c) Information Sources

Literature search for this systematic review was conducted in accordance to PRISMA (Preferred reporting items for systematic review and meta-analysis) as per BMC September 2021 Update on databases & registers namely

- Pubmed
- ClinicalTrials.gov
- Science Direct
- ProQuest
- Cochrane

To obtain the relevant studies, the keywords “Music Therapy”, “Stroke”, “Gait”, “Aphasia” and “Cognition” were used, altogether with the use of MeSH terms and synonyms where appropriate.

#### d) Study Selection Process

Study selection will be conducted on the basis of the

inclusion and exclusion criteria outlined above. Three researchers screened the studies compiled through our search strategy in two separate stages. At each stage, the researchers were blinded to each other's selection results.

Screening Stage-1: Three researchers (x, y, z) independently screened only the study titles and abstracts of all studies identified by our search strategy. All studies were included in this screen except those which explicitly fulfill one or more of the exclusion criteria in the study title. A decision for an article is final after two different reviewers have indicated whether to include or exclude an article into the second round of review. If the two reviewers disagree, the article was flagged and a third reviewer will make the final decision, forming a simple majority of 2:1.

Screening Stage-2: 2 reviewers (x,y) independently reviewed the full text of the studies included at Stage-1. Articles which were included by both reviewers were included in the final synthesis. In case of a dispute (an article is included by one reviewer and not the other), a third reviewer and the lead author (z) mediated to decide whether to include the study in the final synthesis.

**e) Critical Appraisal**

Risk of bias assessment was conducted using the Cochrane Risk of Bias tool for Randomised Controlled Studies 2.0 in order to evaluate methodological quality. This ROB assessment tool is made up of five domains which attempts to address bias from:

a. The randomisation process
b. Deviations from intended intervention
c. Measurement of outcome
d. Any missing outcome data
e. Selection of the reported results.

For each domain low, moderate or high risk of bias was depicted in accordance to the agency for healthcare research and quality.

| | a. | b. | c. | d. | e. | OB |
|---|---|---|---|---|---|---|
| Sihvonen *et al;* 2020 | | | | | | |
| Särkämö et al; 2008 | | | | | | |
| Cm *et al*; 2021 | | | | | | |
| Jun *et al; 2013* | | | | | | |
| Fotakopoulos & Kotlia; 2018 | | | | | | |
| Jeong & Kim; 2007 | | | | | | |

**Table 1.1**

| | a. | b. | c. | d. | e. | OB |
|---|---|---|---|---|---|---|
| Bunketorp-Käll et al; 2017 | | | | | | |
| Sihvonen *et al; 2021* | | | | | | |
| Raglio *et al; 2016* | | | | | | |
| Aravantinou-Fatorou & Fotakopoulos: *2021* | | | | | | |
| Bunketorp-Käll et al; 2019 | | | | | | |

**Table 1.2**

| | a. | b. | c. | d. | e. | OB |
|---|---|---|---|---|---|---|
| Street *et al;* 2018 | | | | | | |
| Tong *et al* ; 2015 | | | | | | |
| Altenmüller et al ; 2009 | | | | | | |
| Raglio *et al; 2021* | | | | | | |

**Table 1.3**

| | a. | b. | c. | d. | e. | OB |
|---|---|---|---|---|---|---|
| Suh *et al*; 2014 | | | | | | |
| Schauer and Mauritz; 2003 | | | | | | |
| Cha *et al;* 2014 | | | | | | |
| Yakupov *et al;* 2017 | | | | | | |

**Table 1.4**

**Table 1.1-1.4:** Summary of Bias Assessment using ROB 2

- Green - Low Risk
- Yellow - Moderate Risk
- Red - High Risk

## Data Extraction & Management

### a. Study characteristics

1. Author & year of publication.
2. Location & study design.
3. Population size.
4. Music therapy administration: Type & Duration.

### b. Study Outcomes

1. Cognition & affect.
2. Language & Speech recovery.
3. Functional mobility.

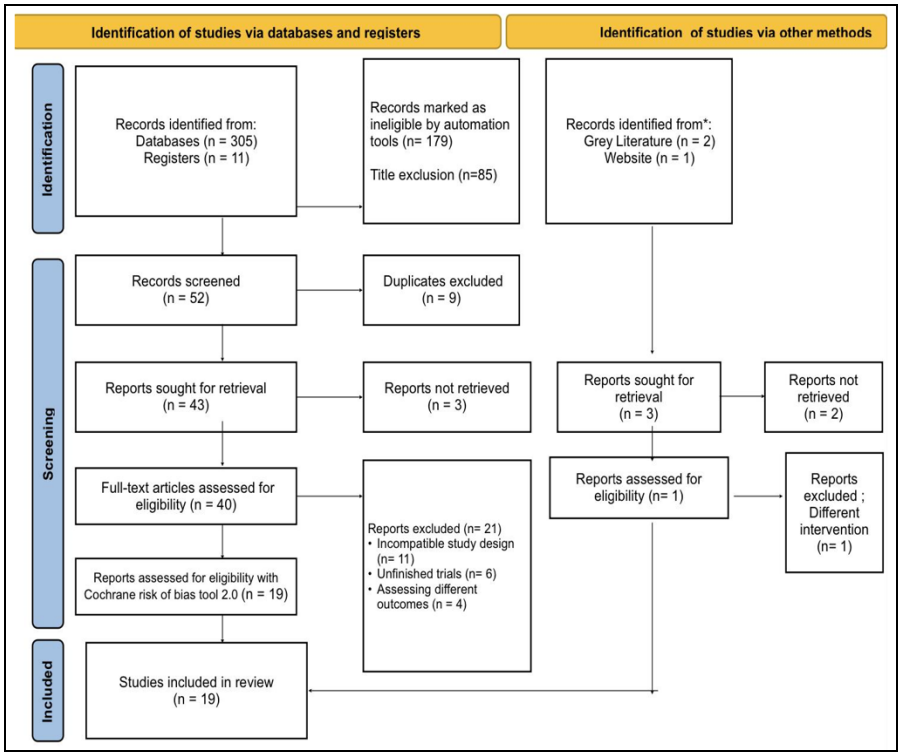


**Figure 1:** Prisma as per BMC September 2021 update.

## Intervention

Various types of Music Therapies utilized as interventions in patients of Stroke and were included in this review are as follows:

1. **Vocal music group (VMG), Instrumental music group (IMG) and Audiobook group (ABG)**: The therapist provided the patients with a portable player, over-ear headphones, and a collection of listening material, which was vocal music with sung lyrics in VMG, instrumental music (with no sung lyrics) in IMG, and narrated audiobooks (with no music) in ABG.
2. **Rhythm and music-based therapy (R-MT)**: Rhythmic auditory cueing is used to stabilize the movement patterns and simplify a motor plan.
3. **Portable cassette players and narrated audio books.**
4. **Therapeutic Instrumental Music Performance (TIMP)**: TIMP is an intervention that can be delivered following specialist neurologic music therapy training. It involves playing musical instruments or digital music equipment in a way that demands specific movement patterns.
5. **Music-movement therapy**: Integrated music with appropriate rhythmic movements.
6. **Rhythmic Auditory Stimulation (RAS)**: Therapeutic application of pulsed rhythmic or musical stimulation often involves treadmill training to simulate external cues and facilitate a normal gait pattern.

## Result

A total of 19 studies (N=889 participants) comparing music therapy's role in improving (i) Cognition and affect (ii) Language and speech recovery (iii) Functional mobility were studied.

| Author; Year | Study location | Study Design | Sample Size | Intervention | Study Outcome (Cognition & Affect) |
|---|---|---|---|---|---|
| Sihvonen et al; 2020 | Turku & Helsinki, Finland | Two single-blind randomized controlled trials | 83 | Vocal music, Instrumental music, Audiobooks | Vocal music listening enhanced the recovery of verbal memory |
| Särkämö et al; 2008 | Helsinki, Finland | Single blind randomized controlled trial | 54 | Portable cassette players and narrated audio books | Enhance cognitive recovery and prevent negative mood |
| Cm et al; 2021 | Toronto, Canada | Single blinded | 30 | Therapeutic Instrumental Music Performance (TIMP) | Positive impact on affective responding |
| Jun et al; 2013 | Busan, South Korea | Randomized controlled trial | Convenience sample | Music-movement therapy for 60 minutes, three times per week for 8 weeks | Improved mood state |
| n=8 (N=426 participants) studies reported statistically significant improvement in verbal memory, focussed attention and mood of stroke patients relative to regular care. | | | | | |

**Table 2.1:** Impact of Music Therapy on Cognition & Affect in Stroke Patients.

| Author; Year | Study location | Study Design | Sample Size | Intervention | Study Outcome (Cognition & Affect) |
|---|---|---|---|---|---|
| Fotakopoulos & Kotlia; 2018 | Greece | Single-Blinded | 65 | Daily listening to experiential/traditional music | Positive effect on Mood profile & Recovery rate |
| Jeong & Kim; 2007 | Baltimore, USA | Single-Blind Randomised Controlled Trial | 33 | 8 week Rhythmic Auditory Stimulation | Higher frequency of positive moods & Improved Quality of Interpersonal Relationships |
| Bunketorp-Käll et al; 2017 | Gothenburg, Sweden | Single-blind, 3-armed, randomized controlled design | 123 | Rhythm-and- Music Based Therapy, twice a week for 12 weeks | Improved working memory & Long-term perception of recovery |
| Sihvonen et al; 2021 | Helsinki, Finland | Single-Blind Randomised Controlled Trial | 38 | Daily listening to self-selected vocal music, instrumental music and audiobooks | Improved recovery of verbal memory |

**Table 2.2:** Impact of Music Therapy on Cognition & Affect in Stroke Patients.

| Author; Year | Study location | Study Design | Sample Size | Intervention | Study Outcome (Language & Aphasia) |
|---|---|---|---|---|---|
| Sihvonen et al; 2020 | Turku & Helsinki, Finland | Two single-blind randomized controlled trials | 83 | Vocal music, Instrumental music, Audiobooks | Vocal music listening enhanced early language recovery in aphasia |
| Raglio et al; 2016 | Milan, Italy | Single-Blind Randomised Controlled Trial | 20 | 15 week Individual Music Therapy (MT) Sessions along with Speech Language Therapy (SLT) | Sig. Improvement in Spontaneous Speech (MT + SLT) |
| Yakupov et al; 2017 | Kazan, Russia | Single-blind, randomized controlled design | 45 | Music Therapy + Exercise | Improved Speech |
| Aravantinou-Fatorou and Fotakopoulos: | Pyrgos Ilias, Greece | Single-Blind Prospective Randomised | 79 | Daily traditional experiential music listening | Higher recovery rate of Post-stroke aphasia |

| | | | | | |
|---|---|---|---|---|---|
| 2021 | | Controlled Trial | | | |
| n=4 (N=227 participants) studies demonstrated music therapy's role in improving aphasia in the rehabilitation phase. | | | | | |

**Table 3.1:** Impact of Music Therapy on Language & Aphasia in Stroke Patients.

| Author; Year | Study location | Study Design | Sample Size | Intervention | Study Outcome (Functional Mobility) |
|---|---|---|---|---|---|
| Bunketorp-Käll et al; 2019 | Greece | Single-Blinded, 3-armed, randomized controlled design | 123 | Rhythm-and- Music Based Therapy | Improved Gait and Functional Task Performance |
| Jun et al; 2013 | Busan, South Korea | Randomized controlled trial | Convenience sample | Music-movement therapy for 60 minutes, three times per week for 8 weeks | Increased Shoulder flexion & Elbow joint flexion |
| Yakupov et al; 2017 | Kazan, Russia | Single-blind, randomized controlled design | 45 | Music Therapy + Exercise | Improved Motor functions |
| Street et al; 2018 | Cambridgeshire, UK | Pilot feasibility randomized controlled trial, with cross-over design | 10 | Therapeutic instrumental music performance(TIMP) in 12 individual clinical contacts, twice weekly for six weeks. | Improved recovery in arm hemiparesis patients |
| n=12 (N=520 participants) studies pointed to music therapy as an effective therapeutic method to improve gait velocity, standing balance and upper limb motor functions in hemiplegic stroke patients. | | | | | |

**Table 4.1:** Impact of Music Therapy on Functional Mobility in Stroke Patients

| Author; Year | Study location | Study Design | Sample Size | Intervention | Study Outcome (Functional Mobility) |
|---|---|---|---|---|---|
| Tong et al ; 2015 | China | Single-Blinded | 33 | 20 sessions of audible musical instrument training over 4 weeks | Sig. improvement in upper limb motor function after 4 weeks |
| Altenmüller et al; 2009 | Hannover, Germany | Single-Blind Randomised Controlled Trial | 62 | 15 sessions of music-supported therapy using a manualized step-by-step approach | Sig. improvement in fine as well as gross motor skills |
| Jeong & Kim; 2007 | Baltimore, USA | Single-Blind Randomised Controlled Trial | 33 | 8 week Rhythmic Auditory Stimulation | Increased range of motion and flexibility |
| Raglio et al; 2021 | Pavia, Italy | Single-Blind Randomised Controlled Trial | 65 | Music based Sonification Approach | Improved upper limb movements and reduced pain |

**Table 4.2:** Impact of Music Therapy on Functional Mobility in Stroke Patients

| Author; Year | Study location | Study Design | Sample Size | Intervention | Study Outcome (Functional Mobility) |
|---|---|---|---|---|---|
| Suh et al; 2014 | Seoul, Republic of Korea | Randomised Controlled Trial | 16 | 3 week Rhythmic Auditory Stimulation | Improved gait vel., stride length,cadence, & standing balance |
| Bunketorp-Käll et al; 2017 | Gothenburg, Sweden | Randomized controlled design | 123 | Rhythm-and- Music Based Therapy, twice a week for 12 weeks | Improved balance, gait and grip strength |

| | | | | | |
|---|---|---|---|---|---|
| Schauer and Mauritz; 2003 | Leipzig, Germany | Single-blind, 3-armed, randomized controlled design | 23 | Rhythmic Auditory Stimulation (RAS) - 15 Therapy sessions | Improved gait velocity, step duration, gait symmetry, stride length and foot rollover path length |
| Cha et al; 2014 | Seoul, Republic of Korea | Single-Blind Randomised Controlled Trial | 20 | Intensive gait training + RAS - 6 weeks (30 min/day, five days/week) | Improved balance and gait performance |

**Table 4.3:** Impact of Music Therapy on Functional Mobility in Stroke Patients.

## Conclusion

- The present study sets out to verify and extend previous results on beneficial effects of various forms of music therapies on cognitive, emotional, speech and functional mobility after stroke.
- The results of our study demonstrate that music therapy delivered in various forms of auditory stimulation is **a simple, cost-effective and convenient-to-use method for providing rehabilitative care in post-stroke patients**.
- Its widespread use therefore can be beneficial in lowering the socio-economic burden and improving the quality of life of those affected. Further investigation into its quantitative impact and practical integration into effective care pathways shall form the basis for future research.

## Discussion

### Strength and Limitations of Studies

#### a) Strengths

1. Only Randomized Controlled Trials (RCTs) were included in this review, thus reducing the impact of bias and other confounding factors in the conduction of this review.
2. One health and collaborative approach aimed at improving the utilization and involvement of various stakeholders into improvement of outcomes for patients of stroke.
3. Quantitative measurement of outcomes.
4. Results have been supported by several studies.

#### b) Limitations

1. Single blinded studies could have led to demoralization of the control group, thus impacting outcomes in the control group.
2. Multifactorial influences.

## Recommendation

This study provides a unique framework to improve neuro rehabilitation and enhance quality of life in stroke patients thereby increased word of mouth and compliance to music therapy via collaboration with local leaders would lead to increased awareness and eventually increased utilization of music therapy which would also require maximization of training programmes in palliative care.

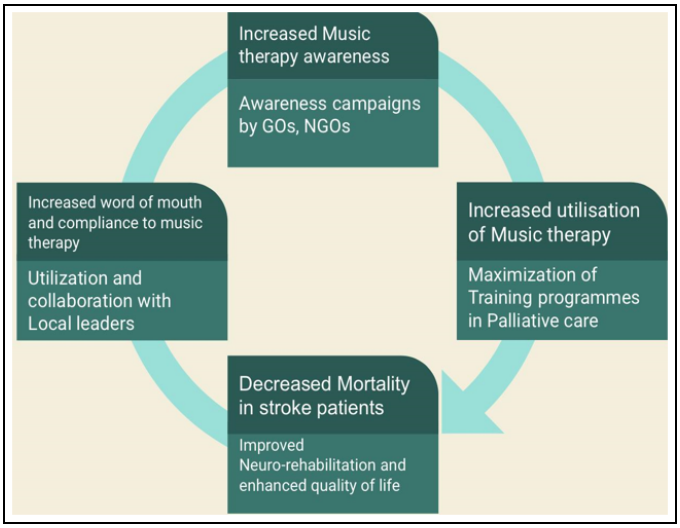


**Figure 2:** Cause-Effect Diagram for Utilisation of Music Therapy in Stroke Patients.

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