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A SYSTEMATIC REVIEW OF STRUCTURED EXERCISES AND MUSIC THERAPY ON THE FUNCTIONAL STATUS OF STROKE SURVIVORS

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ABSTRACT

Background: Stroke, a leading cause of disability worldwide, often leaves survivors grappling with functional impairments that significantly impact their daily lives. Enhancing the functional status of stroke survivors is not only a personal achievement but also a critical public health concern. **Aim:** A systematic review of literature was conducted to identify the various forms of structured exercises and music therapy used in enhancing the functional status of stroke survivors, and the various outcome measures used in measuring the functional status of the stroke survivors. **Design:** A systematic review **Data Sources:** A systematic literature search was performed for publications using PubMed, Scopus, Google Scholar, Embase, CINAHL, ISI, and ScienceDirect Databases. **Eligibility Criteria:** The review included published studies which reported use of structured exercises and music therapy in enhancing the functional status of stroke survivors aged 18 years and above, and published in English between June 2012 and June 2022. **Data Extraction:** The titles and abstracts of articles were screened and studies that did not meet the eligibility criteria were excluded. Full texts of eligible studies were further scrutinized. The results were interpreted and reported with respect to their level of evidence, design, sample size, duration, quality appraisal and risk of bias. **Result:** A total of 2,427 studies were identified through initial search of the databases. Additional 8 records were identified through other sources making it a total of 2,435 records. 2,350 duplicate studies were removed after screening. The remaining 85 full-text articles were screened for eligibility criteria and further reduced to 26. Of these 26 studies, 17 were Randomized Controlled Trials (RCTs), 7 quasi-experimental studies, 1 case series, and 1 case

study. Hand function exercise (23.0%) was the most used form of structured exercise while music-supported therapy (29.1%) was the most used music therapy intervention. Motor function (41.6%) was the most investigated construct of functional status. The most used outcome measures were Box and Blocks Test (BBT) (10.4%) and 9 Hole Pegboard Test (9HPT) (10.4%) which were used for measuring motor function of the stroke survivors. **Conclusion:** Various forms of structured exercises and music therapy were found to improve the functional status of stroke survivors. Also, various outcome measures for measuring the functional status of the stroke survivors were reported as well. Clinicians and researchers should choose the appropriate outcome measures for the right constructs in the course of their practice and research programmes.

Keywords: Structured Exercises, Music Therapy, Stroke Survivors, Functional Status, Systematic Review.

Study Registration: This systematic review was registered with PROSPERO (Reference ID: CRD42023445692).

INTRODUCTION

Stroke is a leading cause of disability worldwide, and the second leading cause of death and years of life lost after heart disease [1, 2]. It is the leading cause of long-term disability, functional impairment, reduced quality of life and socio-economic status [3-6]. It leads to functional impairments in Activities of Daily Living (ADL) including mobility [7, 8]. According to Turan et al., [9], mobility is positively related to functional independence. Disability levels among stroke survivors tend to increase with advancing age, previous stroke, type of stroke, and the presence of co-morbidities [10]. Stroke affects one in four individuals worldwide [11]. In 2016, 79.5 million people were affected by stroke globally, 13.6 million of which were new strokes [1].

About 15 million people suffer stroke worldwide each year, out of which 5 million die and the other 10 million are left permanently with disability [12, 13]. Approximately 700, 000 stroke cases occur each year in the United States, leaving 500,000 survivors with disability, and economic loss resulting from stroke approaches an estimated $51.2 billion annually [14]. In Nigeria, more young adults in their productive age now have stroke, and are functionally impaired and dependent on care-givers, families and the society [15]. Majority of stroke survivors live with significant neurological deficits which affect their functional ability, limit activity performance and participation within the Nigerian community [16]. Many stroke survivors are physically deconditioned and have a high prevalence of cardiovascular and musculoskeletal problems resulting in functional limitations that are potentially modifiable with exercise [17]. Activity intolerance is common among stroke survivors, especially in elderly [18].

Structured exercises are specific exercise regiments given to patients based on their health condition as at the time of assessment. These exercise programmes provide an opportunity for stroke survivors to enhance and/or maintain their functional mobility and independence [19]. Most structured exercises in stroke rehabilitation fall under the broad category known as task-specific training. This approach (task-specific training) involves repetition of functional movements and activities. It can also be combined with other techniques and protocols [20]. According to Hubbard et al., [21], task specific training

leads to better performance in motor function together with cortical re-organization of the affected hemispheres in stroke survivors.

Music therapy, on the other hand, can be defined as the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship. Music therapy interventions include: improvisation, receptive music listening, song writing (composition), lyric discussion and music performance. According to Grau-Sánchez et al. [22], music-based interventions can be broadly divided into passive and active interventions. Passive music interventions usually refer to listening to music, which has been shown to be effective in different neurological conditions to enhance cognition and mood [23]. On the other hand, active music-based interventions require the production of music [24].

The aim of the systematic review was to identify the various forms of structured exercises and music therapy used in enhancing the functional status of stroke survivors, and the various outcome measures used in measuring the functional status of these survivors. The review questions were as follows:

1. What are the various forms of structured exercises and music therapy used in improving the functional status of stroke survivors?
2. How are these structured exercises and music therapy interventions utilized (in terms of design, duration, number of sessions, and findings)?
3. What are the various constructs of functional status of stroke survivors and the outcome measures used in measuring them?

METHODS

This systematic review was carried out in line with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline. All ethical procedures were followed during the review. The study was registered with PROSPERO, an International Prospective Register for Systematic Reviews. The reference ID is CRD42023445692.

Literature Search

There was a systematic search for worldwide published literature from PubMed, Scopus, Google Scholar, Embase, CINAHL, ISI, and ScienceDirect Databases. The review followed a top-down search strategy. The reference lists from retrieved studies on the effects of structured exercises and music therapy on the functional status of stroke survivors were hand-searched to look for further studies that might not have been retrieved by the database searches. There were no restrictions on the type of study design. Some of the additional records that were searched included PhD thesis. Searches included MeSH and text words terms, with combinations and Boolean operator.

The following search strategies were used for the search:

1. MeSH descriptor structured exercises; this term only
2. MeSH descriptor music therapy; this term only
3. MesH descriptor functional status; this term only
4. MeSH descriptor stroke survivors; this term only

5. MeSH descriptor outcome measures; this term only
6. MeSH descriptor forms of exercises; this term only
7. MeSH descriptor forms of music therapy; this term only
8. MeSH descriptor 'therapy'; this term only
9. MeSH descriptor 'effects'; this term only
10. (#1 or/and #2 or/and #3 or/and #4 or/and #5 or/and #6 or/and #7 or/and #8 or/and #9)

In order to retrieve only the studies published in English language, language restrictions were applied.

Eligibility Criteria

The review included published studies which reported the use of structured exercises and Music therapy in enhancing the functional status of stroke survivors aged 18 years and above, and published in English between June 2012 and June 2022. However, study protocols and studies not published in English language were excluded.

Main outcome

The main outcome is functional status of the stroke survivors. Functional status has several constructs, and the various outcome measure used in measuring the functional status of stroke survivors were identified.

Data extraction

The titles and abstracts of articles were screened and studies that did not meet the eligibility criteria were excluded. Full texts of eligible studies were further scrutinized. Information such as name of authors, title/purpose of the study, study designs, number of study participants, type of intervention (exercise/music interventions), duration of study, number of sessions and findings were obtained and recorded in prepared data extraction form.

Data synthesis

Obtained data were synthesized and descriptively analyzed. It was done in line with the objectives of the review. An aggregated data analysis could not be used because of the heterogeneity of the interventions and primary outcome measures. The results were interpreted and reported with respect to their level of evidence, design, sample size, duration, intervention, findings, quality and risk of bias.

Quality Appraisal and Risk of bias assessment

The quality appraisal for the Randomized Controlled Trials (RCTs) was done according to the JADAD scale, an Oxford quality scoring system for RCTs [25]. The scale has 7 items with a minimum score of 0 and a maximum score of 5. Each study was graded and scores assigned accordingly. Higher scores denote higher quality, while lower scores denote lower quality. For the other studies (quasi-experimental, case study and case series), the revised JBI critical appraisal tool was used in accordance to the following levels of appraisal: study level, outcome level, and result level [26].

For the overall rating of all the included studies, the Cochrane Risk of Bias Tool was used to rate the risk of bias level. This tool gives a clear distinction among the following risk of bias – low risk of bias,

moderate risk of bias, high risk of bias or unclear risk. The risk of bias of each included study was assessed against key criteria - selection bias, performance bias, detection bias, attrition bias (incomplete outcome data), and reporting bias (selective outcome reporting), inadequate sample size etc. If all criteria are met, there is low risk of bias. There is moderate risk of bias if one or more criteria are partly met and a high risk of bias if one or more criteria are not met. It is declared as 'unclear' for either lack of information or uncertainty over the potential for bias.

RESULTS

A total of 2,427 studies were identified through initial search of the databases (PubMed = 480, Scopus = 201, Google Scholar = 702, Embase = 305, CINAHL = 327, ISI = 161, ScienceDirect Databases = 251). An additional 8 records were identified from other sources, making it a total of 2,435 records. 2,350 duplicate studies were removed after screening. The remaining 85 full-text articles were screened for eligibility and further reduced to 50. Out of the 50 studies, 24 did not report the scope of the research questions, and the remaining 26 studies were used for the synthesis. Therefore, a total of 59 full text articles were excluded with reasons. Of these remaining 26 studies, 17 were RCTs (Ghasemi et al., [19], Basha [27]; Fujioka et al., [28]; Grau-Sánchez et al., [29]; Street et al., [30]; Bunketorp-Kall et al., [31]; Jeba et al., [32]; Van Vugt et al., [33]; Zondervan et al, [34]; Tong et al., [35]; Yoon et al., [36]; Van Vugt et al., [37]; Friedman et al., [38]; Monticone et al., [39]; Thieme et al., [40]; Fritz et al., [41]; Liao et al., [42]), 7 quasi-experimental studies (Yoo, [43]; Nikmaram et al., [44]; Raglio et al, [45]; Raghavan et al., [46]; Scholz et al., [47]; Villeneuve et al., [48]; Amengual et al., [49]), 1 case series (Villeneuve et al., [50]), and 1 case study (Grau-Sánchez et al., [51]).

The details are presented in the PRISMA flowchart below:

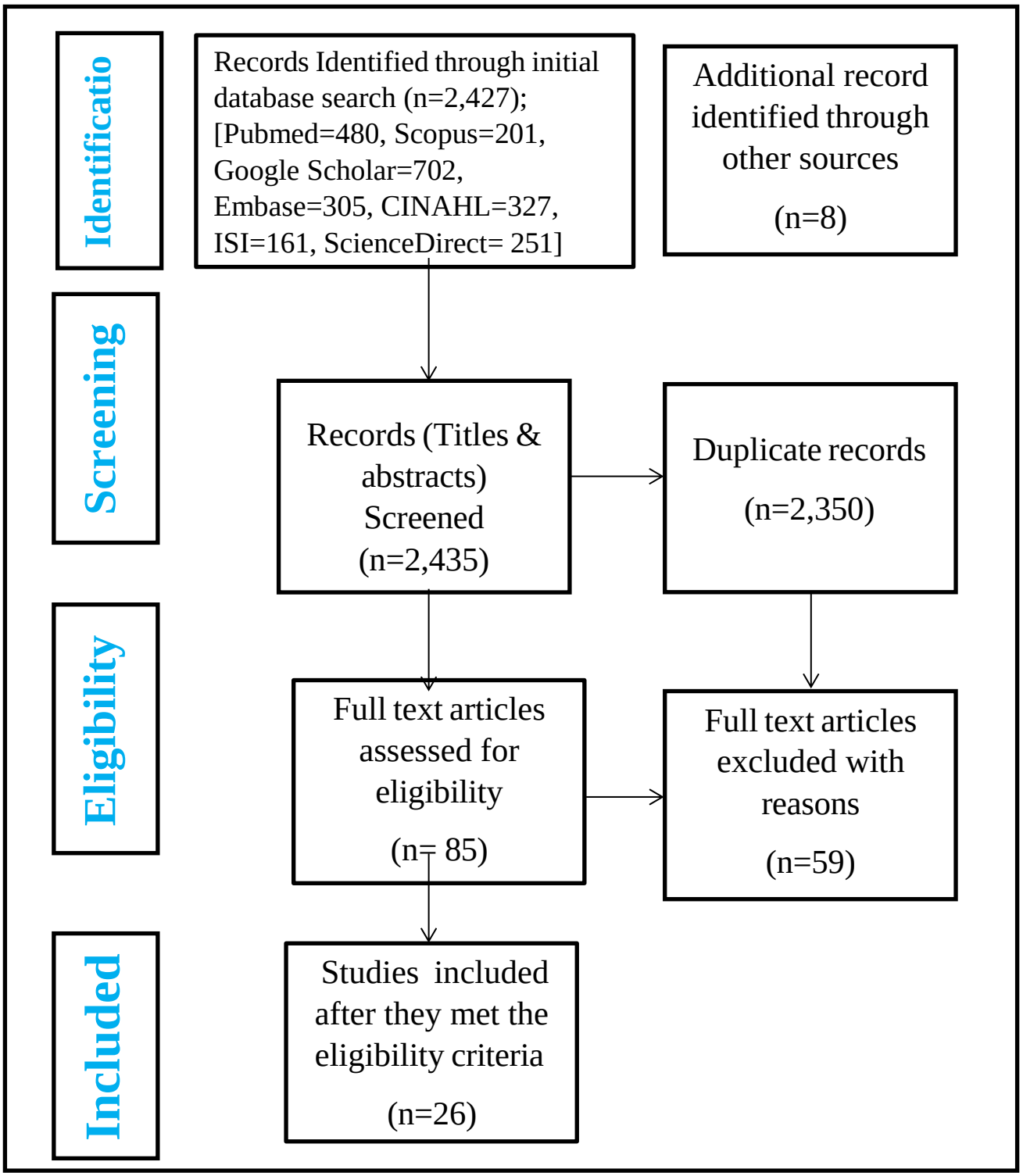

Table 1 *(Overview of Included Studies.)*

AUTHORS	TOPIC	STUDY DESIGN	SAMPLE SIZE	OUTCOME MEASURE	INTERVENTION Experimental	Control	DURATION OF INTERVENTION/ NUMBER OF SESSIONS	FINDINGS	QUALITY APPRAISAL	RISK OF BIAS
Basha [27]	Effect of structured home exercise on functional independence in stroke survivors	2-armed Randomized Controlled Trial (RCT)	100	Modified Barthel Index (MBI)	Structured home-based exercise program consisting of head and neck exercises, shoulder exercises, arm exercises, hand exercises, lying down exercises, hip and trunk exercises, leg and ankle exercises	Conventional Physiotherapy	12 weeks, 72 sessions	The MBI score of both the groups improved significantly after 12 weeks of intervention ($P < 0.05$) and no significant difference was seen in the improvement of the score between the two groups ($P > 0.05$).	JADAD Scale: 5	Low risk
Ghasemi et al [19]	The effect of functional stretching exercises on functional outcomes in spastic stroke patients: A randomized controlled clinical trial	2-armed Randomized Controlled Trial (RCT)	30	Modified Ashworth Scale (MAS). Timed Up and Go (TUG) test and the Timed 10-Meter Walk Test (MWT)	Functional stretching exercises thrice a week		4 weeks, 12 sessions	Functional stretching exercises is effective in reducing spasticity and improving the functional outcomes of chronic spastic stroke patients	JADAD Scale: 4	Low risk

Fujioka et al., [28]	The effects of music-supported therapy on motor, cognitive, and psychosocial functions in chronic stroke.	2-armed Randomized Controlled Trial (RCT)	28	Chedoke Arm and Hand Activity Inventory (CAHAI)	Music-Supported therapy (MST)	Graded repetitive arm supplementary program (GRAPS)	10 weeks, 30 sessions	There were minor motor improvements in both groups. Both groups reduced negative affect and improved overall quality of life.	JADAD Scale: 4	Low risk
Grau-Sánchez et al., [29]	Music-Supported Therapy (MST) in the rehabilitation of motor deficits after stroke	2-armed Randomized Controlled Trial (RCT)	39	Action Research Arm Test (ARAT)	Music-Supported Therapy (MST) plus conventional treatment	Conventional treatment	4 weeks, 20 sessions	Patient's intrinsic motivation to engage in musical activities was associated with better motor improvement.	JADAD Scale: 4	Low risk
Street et al., [30]	Home-based neurologic music therapy for arm hemiparesis following stroke: results from a pilot, feasibility randomized controlled trial	Randomized Controlled Trial (RCT)	10	Action Research Arm Test (ARAT) and Nine-hole Pegboard Test (9HPT)	Therapeutic instrumental music performance	Nil	6 weeks, 12 sessions	Music interventions were motivating as perceived by the participants. It was also found out that the musical instruments facilitated movements.	JADAD Scale: 3	Moderate risk
Bunketorp-Kall et al., [31]	Long-Term Improvements After Multimodal Rehabilita	3-armed Randomized Controlled Trial (RCT)	122	Stroke Impact Scale (SIS)	Rhythm and music based therapy	Horse-riding therapy	12 weeks, 24 sessions	Patients treated with rhythm and music-based	JADAD Scale: 5	Low risk

	tion in Late Phase After Stroke							therapy showed increased working memory		
Jeba et al., [32]	Effects of music therapy on spasticity, functional independence and quality of life in hemiplegic subjects	2-armed Randomized Controlled Trial (RCT)	20	Modified Ashworth Scale (MAS), Functional Independence Measure (FIM), Stroke Specific Quality of Life scale (SSQoL).	Music therapy plus conventional treatment	Conventional treatment	3 days, 3 session	There was a significant reduction in the level of spasticity in both groups (P<0.05). Also, there were significant improvement in functional independence and quality of life of both groups (P<0.05). None of the variables yielded significant difference when compared between the groups.	JADAD Scale: 3	Moderate risk
Van Vugt et al.,[33]	The role of auditory feedback in music-supported stroke rehabilitation: a single-blinded randomized controlled intervention	2-armed Randomized Controlled Trial (RCT)	34	9 Hole Pegboard test (9HPT)	Music-Supported Therapy (MST)	Music-Supported Therapy (MST) with delayed feedback	4 Weeks, 10 sessions	Both groups improved in their upper function but improvement was more prominent in the control group (music supporte	JADAD Scale: 5	Low risk

								d therapy with delayed feedback).		
Zonder van et al, [34]	Home-based hand rehabilitation after chronic stroke: randomized, controlled single-blind trial comparing the Music Glove with a conventional exercise program	2-armed Randomized Controlled Trial (RCT)	17	Box and Blocks Test (BBT)	Home music glove therapy	Self-guided hand function exercise	3 Weeks	Both groups improved in their functional use of the upper extremity	JADAD Scale:3	Moderate risk
Tong et al., [35]	Music-supported therapy (MST) in improving post-stroke patients' upper-limb motor function: a randomized controlled pilot study	2-armed Randomized Controlled Trial (RCT)	33	Wolf Motor Function Test (WMT)	Music-supported therapy	Mute Music-Supported Therapy	4 Weeks, 20 sessions	All participants in both groups showed significant improvements in motor functions of upper limbs after 4weeks' treatment, but subjects in experimental group demonstrated greater improvement than those in Control group.	JADAD Scale: 4	Low risk

Yoon et al., [36]	Effect of Constraint-Induced Movement Therapy (CIMT) and Mirror Therapy for Patients With Subacute Stroke	3-armed Randomized Controlled Trial (RCT)	26	Box and block test, 9-hole Pegboard test, Wolf motor function test, Fugl-Meyer assessment, Modified Barthel Index	CIMT combined with mirror therapy group and CIMT only	Conventional occupational therapy	2 weeks, unknown sessions	CIMT groups with and without mirror therapy showed higher improvement ($p<0.05$) than the control group. The CIMT combined with mirror therapy group showed higher improvement than CIMT only group in box and block test, 9-hole Pegboard test, and grip strength	JADAD Scale: 3	Moderate risk
Van Vugt et al., [37]	Music-supported motor training after stroke reveals no superiority of synchronization in group therapy	2-armed Randomized Controlled Trial (RCT)	28	9 Hole Pegboard test (9HPT)	Music Supported Therapy in pairs (together)	Music Supported Therapy in turns (one after the other)	3-4 weeks, 10-sessions	Both groups showed improvements in fine motor control. However, patients treated in turns(control group) showed more improvement in function	JADAD Scale: 3	Moderate risk
Friedman et al., [38]	Retraining and assessing hand	2-armed Randomized Controlled Trial (RCT)	12	Box and Blocks Test (BBT)	Music glove	Self-guided hand	2 weeks, 6 sessions	Both groups improved but	JADAD Scale: 3	Moderate risk

	movement after stroke using the Music Glove comparison with conventional hand therapy and isometric grip training					function exercises		more improvements were seen in the intervention group (music glove).		
Monticone et al., [39]	'Regent Suit'training improves recovery of motor and daily living activities in subjects with subacute stroke: a randomized controlled trial	2-armed Randomized Controlled Trial (RCT)	60	6-minute walking test (6-MWT), Berg Balance Scale (BBS), Functional Independence Measure (FIM), and the Barthel Index (BI)	Neuromotor exercises (e.g. sit-to-stand, balance, gait training) wearing the 'Regent Suit'	Neuromotor exercises without the 'Regent Suit'.	6 months, 20 sessions	There were no significant between-group differences at baseline, but the experimental group also showed greater improvement in Functional Independence Measure and Barthel Index.	JADAD Scale: 5	Low risk
Thieme et al., [40]	Mirror therapy for patients with severe arm paresis after stroke–a randomized controlled trial	3-armed Randomized Controlled Trial (RCT)	60	Fugl-Meyer Assessment (FMA), Action Research Arm Test, Barthel Index (BI), Stroke Impact Scale)	Individual mirror therapy and group mirror therapy	Control intervention with restricted view on the affected arm.	5 weeks, unknown sessions	There was no effect on sensorimotor function of the arm, activities of daily living and quality of life of mirror therapy compare	JADAD Scale: 5	Low risk

								d to a control intervention after stroke		
Fritz et al., [41]	Active video-gaming effects on balance and mobility in individuals with chronic stroke: a randomized controlled trial	2-armed Randomized Controlled Trial (RCT)	30	Fugl-Meyer Assessment (FMA), Berg Balance Scale (BBS), Dynamic Gait Index (DGI), Timed Up & Go test, 6-minute walk test, 3-meter walk (self-selected and fast), and perception of recovery.	Game-play, in standing position, without physical therapy.	No special intervention and participants continued with normal activity	5 weeks, 20 sessions	There were no statistically significant differences between or within groups were found	JADAD Scale: 4	Low risk
Liao et al., [42]	Effects of robot-assisted upper limb rehabilitation on daily function and real-world arm activity in patients with chronic stroke: a randomized controlled trial	2-arm Randomized Controlled Trial	20	Fugl-Meyer Assessment (FMA), Functional Independence Measure (FIM), Motor Activity Log and ABILHAND questionnaire.	Robot-assisted therapy	Dose-matched active control therapy	4 weeks, 20 sessions	Robot-assisted therapy group significantly increased motor function, hemiplegic arm activity and bilateral arm coordination when compared to the dose-matched	JADAD Scale: 3	Moderate Risk

								active control group		
Yoo [43]	Therapeutic Instrumental Music Performance to Improve Upper Extremity Function in Patients with Paresis and Apraxia after Stroke	Quasi-Experimental Study	7	Fugl-Meyer Assessment (FMA), Wolf Motor Function Test (WMFT), Box and Block Test (BBT), and Stroke Impact Scale (SIS)	Therapeutic instrumental music performance (TIMP)	Nil	3 weeks	Patients with post-stroke Ideomotor Apraxia (IMA) were able to benefit from the TIMP intervention, as shown by improvement in their upper extremity functions	Revised JBI critical appraisal: All levels reported	High risk
Nikmaram et al., [44]	Musical sonification of arm movements in stroke rehabilitation yields limited benefits	Quasi-Experimental Study	40	Fugl-Meyer Assessment of Motor Recovery (FMA)	Musical sonification therapy	Sham sonification	Unknown weeks, 15 sessions	Patients undergoing musical sonification treatment showed slight improvements in movement smoothness	Revised JBI critical appraisal: All levels reported	Low risk

Raglio et al, [45]	Active music therapy approach for stroke patients in the post-acute rehabilitation	Quasi-Experimental Study	38	Functional Independence Measure (FIM)	Active Music Therapy	Conventional treatment	7 weeks, 20 sessions	Music therapy enhances the motor and psychological functions of the stroke survivors. There was improvement in the functional level and gross mobility of both groups. Increased group strength was observed in the experimental group.	Revised JBI critical appraisal: All levels reported	Low risk
Raghavan et al., [46]	Music upper limb therapy-integrated: an enriched collaborative approach for stroke rehabilitation	Quasi-Experimental Study	13	Fugl-Meyer Assessment of Motor Recovery (FMA)	Music Upper limb therapy - Integrated	No control	6 weeks, 12 sessions	Reduced activity limitation, sensory and motor impairment. There was an increase in general well-being and participation among the stroke survivors.	Revised JBI critical appraisal: All levels reported	Moderate risk

Scholz et al., [47]	Sonification of arm movements in stroke rehabilitation – a novel approach in neurologic music therapy	Quasi-Experimental Study	25	Fugl-Meyer Assessment of Motor Recovery (FMA)	Musical sonification therapy	Sham sonification	unknown weeks, 12 sessions	There was an improvement in the functional use of the affected extremity in both groups but there was pain reduction in the experimental group	Revised JBI critical appraisal: All levels reported	Moderate risk
Villeneuve et al., [48]	A piano training program to improve manual dexterity and upper extremity function in chronic stroke survivors	Quasi-Experimental Study	13	Box and Blocks Test (BBT), 9 Hole Pegboard test (9HPT)	Home music supported therapy	No control	3 weeks, 9 sessions	Significant improvement in motor function of the stroke survivors.	Revised JBI critical appraisal: All levels reported	Moderate risk
Amengual et al., [49]	Sensorimotor plasticity after music-supported therapy in chronic stroke patients revealed by transcranial magnetic stimulation	Quasi-Experimental Study	20	Action Research Arm Test (ARAT)	Music supported therapy	No control	4 weeks, 20 sessions	Improvement in the functional use of the affected extremity and movement kinematics among the stroke survivors.	Revised JBI critical appraisal: All levels reported	Moderate risk
Villeneuve et al., [50]	Playing piano can improve upper extremity function after stroke:	Case-series	3	Box and Blocks Test (BBT), 9 Hole Pegboard test (9HPT)	Music supported therapy	No control	3 weeks, 9 sessions	There was improvement in motor function	Revised JBI critical appraisal: All levels reported	Unclear

	case studies.							after therapy.		
Grau-Sánchez et al., [51]	Time course of motor gains induced by music-supported therapy after stroke: an exploratory case study	Case study	1	Action Research Arm Test (ARAT)	Music supported therapy	No control	4 weeks, 12 sessions	Improvement in movement in the functional use of the affected extremity after Music-supported Therapy.	Revised JBI critical appraisal: All levels reported	Unclear

Table 2 *(Forms of Structured Exercises of Included Studies.)*

FORMS OF STRUCRURED EXERCISES	REFERENCES	NUMBER OF STUDIES n (%)
Structured home-based exercise program consisting of head and neck exercises, shoulder exercises, arm exercises, hand exercises, exercises carried out while lying down, hip and trunk exercises, leg and ankle exercises	Basha [27]	1 (7.7)
Functional stretching exercises	Ghasemi et al [19]	1 (7.7)
Horse-riding therapy	Bunketorp-Kall et al., [31]	1 (7.7)
Hand function exercises	Jeba et al., [32] ; Zondervan et al, [34] ; Friedman et al., [38]	3 (23.0)
Constraint-Induced Movement Therapy (CIMT)	Yoon et al., [36]	1(7.7)
Mirror therapy	Yoon et al., [36]; Thieme et al., [40]	2 (15.4)
Neuromotor exercises (e.g. sit-to-stand, balance, gait training) with the 'Regent Suit'	Monticone et al., [39]	1(7.7)

Neuromotor exercises (e.g. sit-to-stand, balance, gait training) without the 'Regent Suit'	Monticone et al., [39]	1(7.7)
Active video-gaming	Fritz et al., [41]	1(7.7)
Robot-assisted therapy	Liao et al., [42]	1(7.7)
		13 (100%)

Table 3 *(Forms of Music Therapy of Included Studies.)*

FORMS OF MUSIC THERAPY	REFERENCES	NUMBER OF STUDIES n (%)
Therapeutic instrumental music performance	Street et al., [30]; Yoo [43]	2 (8.3)
Music-supported therapy	Fujioka et al., [28]; Grau-Sánchez et al., [29]; Van Vugt et al., [33]; Tong et al., [35]; Amengual et al., [49]; Villeneuve et al., [50]; Grau-Sánchez et al., [51]	7 (29.1)
Music-supported therapy with delayed feedback	Van Vugt et al., [33]	1 (4.2)
Rhythm and music based therapy	Bunketorp-Kall et al., [31]	1 (4.2)
Passive music therapy	Jeba et al., [32]	1 (4.2)
Home music glove therapy	Zondervan et al, [34]	1 (4.2)
Mute music-supported therapy	Tong et al., [35]	1 (4.2)
Music-supported therapy in pairs	Van Vugt et al., [37]	1 (4.2)
Music-supported therapy in turns	Van Vugt et al., [37]	1 (4.2)
Music glove therapy	Friedman et al., [38]	1 (4.2)
Active music therapy	Raglio et al., [45]	1(4.2)
Music upper limb therapy-integrated	Raghavan et al., [46]	1(4.2)
Musical sonification therapy	Nikmaram et al., [44]; Scholz et al., [47]	2 (8.3)
Sham sonification	Nikmaram et al., [44]; Scholz et al., [47]	2 (8.3)

Home music-supported therapy	Villeneuve et al., [48]	1(4.2)
		24 (100%)

Table 4 *(Functional Status Constructs and Outcome Measures of Included Studies.)*

CONSTRUCT	OUTCOME MEASURE	REFERENCES	NUMBER OF STUDIES n (%)
Functional Independence	MBI	Basha [27]; Yoon et al., [36]	2 (4.2)
	FIM	Liao et al., [42]; Jeba et al., [32]; Raglio et al, [45]; Monticone et al., [39]	4 (8.3)
	BI	Monticone et al., [39]; Thieme et al., [40]	2 (4.2)
			8 (16.7)
Motor Impairment	MAS	Ghasemi et al [19]; Jeba et al., [32]	2 (4.2)
	FMA	Liao et al., [42]; Yoo [43]; Raghavan et al., [46]; Scholz et al., [47]; Thieme et al., [40]; Fritz et al., [41] ; Yoon et al., [36]	7 (14.6)
Motor Function	BBT	Zondervan et al, [34]; Friedman et al., [38]; Villeneuve et al., [50]; Yoo [43]; Yoon et al., [36]	5 (10.4)
	9HPT	Street et al., [30];; Van Vugt et al.,[33]; Van Vugt et al.,[37]; Villeneuve et al., [50]; Yoon et al., [36]	5 (10.4)
	ARAT	Street et al., [30]; Amengual et al., [49]; Grau-Sánchez et al., [51]; Thieme et al., [40]	4 (8.3)
	WMT	Yoo [43]; Tong et al., [35]; Yoon et al., 36]	3 (6.2)
	CAHAI MAL ABILHAND questionnaire	Fujioka et al., [28] Liao et al., [42] Liao et al., [42]	1 (2.1) 1 (2.1) 1 (2.1)
			20 (41.6)
Balance	BBS	Monticone et al., [39]; Fritz et al., [41]	2 (4.2)
Functional Mobility	TUG	Ghasemi et al [19] ; Fritz et al., [41]	2 (4.2)
Gait	10 MWT	Ghasemi et al [19]	1 (2.1)
	6 MWT	Monticone et al., [39]	1 (2.1)
	3 MWT	Fritz et al., [41]	1 (2.1)
	DGI	Fritz et al., [41]	1 (2.1)
Quality of Life	SSQoL	Ghasemi et al [19]	1 (2.1)

	SIS	Thieme et al., [40]	1 (2.1)
Perception of recovery	SIS	Yoo [43]; Bunketorp-Kall et al., [31]; Thieme et al., [40]	3 (6.2)
			48 (100%)

MBI = Modified Barthel Index; FIM = Functional Independence Measure; BI = Barthel Index; MAS = Modified Ashworth Scale; FMA = Fugl-Meyer Assessment of Motor Recovery; BBT = Box and Blocks Test; 9HPT = 9 Hole Pegboard test; ARAT = Action Research Arm Test; WMT = Wolf Motor Function Test; CAHAI = Chedoke Arm and Hand Activity Inventory; MAL = Motor Activity Log ; TUG = Timed Up and Go test; 10 MWT = Timed 10-Meter Walk Test; 6MWT = 6-Minutes' Walk Test; 3MWT = 3-Minutes' Walk Test; DGI = Dynamic Gait Index; BBS = Berg Balance Scale; SSQoL = Stroke Specific Quality of Life scale; SIS = Stroke Impact Scale.

DISCUSSION

This systematic review has identified the various forms of structured exercises and music therapy used in enhancing the functional status of stroke survivors, as well as the various outcome measures used in measuring the functional status of these survivors between June 2012 and June 2022. Hand function exercise was the most used form of structured exercise followed by mirror therapy. Music supported therapy, on the other hand, was the most used form of music therapy intervention used in enhancing the functional status of the stroke survivors. Several constructs of the functional status of stroke survivors were identified as well. These include functional independence, motor impairment, motor function, functional mobility, gait, balance, quality of life, and perception of recovery. Motor function was the most measured construct followed by functional independence and motor impairment. This finding of motor function being the most measured construct is in tandem with the finding of Ekechukwu et al., [52].

Furthermore, several outcome measures for measuring these constructs were also identified. Modified Barthel Index (MBI), Functional Independence Measure (FIM), and Barthel Index (BI) were used to measure the functional independence of the stroke survivors. Modified Ashworth Scale (MAS) and Fugl-Meyer Assessment of Motor Recovery (FMA) were used in measuring the motor impairment of the stroke survivors, while Box and Blocks Test (BBT), 9 Hole Pegboard test (9HPT), Action Research Arm Test (ARAT), Wolf Motor Function Test (WMT), and Chedoke Arm and Hand Activity Inventory (CAHAI), Motor Activity Log (MAL), and ABILHAND questionnaire were used to measure motor functions. In the same vein, Berg Balance Scale (BBS) was used to measure the balance control of the stroke survivors. Timed Up and Go (TUG) test was used to measure functional mobility, while Timed 10-Meter Walk Test (10 MWT), 6-Minutes' Walk Test (6MWT), 3-Minutes' Walk Test (3MWT), and Dynamic Gait Index (DGI) were used to measure the gait of the stroke survivors. Stroke Specific Quality of Life Scale (SSQoL) and Stroke Impact Scale (SIS) were used to measure the quality of life of the stroke survivors, while Stroke Impact Scale (SIS) was used to measure the Perception of recovery of the stroke survivors.

The use of outcome measures in stroke rehabilitation cannot be over-emphasized. According to Moore et al., [53], "the use of outcome measures in adult neurologic physical therapy is essential for monitoring changes in a patient's status over time, quantifying observations and patient-reported function, enhancing communication, and increasing the efficiency of patient care". The progress of interventions when it comes to the enhancement of the functional status of stroke survivors cannot be tracked and

even quantified without the use of appropriate outcome measures [54]. As shown in this systematic review, each functional status construct has an outcome that is specific for its measurement. Improvements in the functional status of the stroke survivors are expected as the interventions (structured exercises and music therapy) are given to the stroke survivors over a period of time. The use of appropriate outcome measures as seen in this review makes it possible for clinicians and researchers to know the level of improvement of the stroke survivors.

Some of the included studies in this review show that conventional treatment (otherwise known as 'standard care' or 'usual care') which is usually used as control also improved the functional status of the stroke survivors. However, improvement in the functional status of the stroke survivors was more in the experimental group as reported by most of the studies. In some other studies, there was no significant difference observed between the groups. For instance, Basha, [27] in a 2-armed RCT employed conventional physiotherapy (usual care at the physiotherapy clinic) as the control group and structured home-based exercise program as the experimental group. The result of this study revealed that the Modified Barthel Index (MBI) score of both groups improved significantly after 12 weeks of intervention and no significant difference was seen in the improvement of the score between the two groups. Conventional treatments in these studies are usually exercises-based interventions and can be conventional physiotherapy, occupational therapy etc.

Systematic reviews on exercise interventions among stroke survivors have been documented. Van Duijnhoven et al., [55] conducted a systematic review and meta-analysis on the effect of exercise therapy on balance capacity of chronic phase stroke survivors. They found out that balance capacities can be improved by well-targeted exercise therapy programs in the chronic phase after stroke. Specifically, balance and/or weight-shifting and gait training were identified as successful training regimens. In this study, Balance capacity was measured using the Berg Balance Scale (BBS), Functional Reach Test (FRT), Sensory Organization Test (SOT), and Postural Sway Velocity. Another systematic review by Pollock et al., [56] reported several exercise-based interventions for improving upper limb function in post-stroke individuals. These interventions include Constraint-Induced Movement Therapy (CIMT), mental practice, mirror therapy, interventions for sensory impairment, virtual reality and a relatively high dose of repetitive task practice. The findings of these systematic reviews are similar to that of this present study even though the focus of the reviews could be different.

CONCLUSION

Various forms of structured exercises and music therapy employed in enhancing the functional status of stroke survivors were found. These studies employed various designs and the interventions were found to improve the functional status of the stroke survivors. Also, various constructs of functional status and the outcome measures used in measuring them were reported as well. It is therefore, recommended that clinicians and researchers should choose appropriate interventions and outcome measures suitable for each functional status construct in the course of stroke rehabilitation and related research programmes.

IMPLICATIONS FOR PRACTICE

It has been documented that several forms of structured exercises and music based interventions are aimed at improving the functional status of stroke survivors. This review has shown that most of these interventions actually improve the functional status of the stroke survivors, though in different ways.

However, the study designs and duration of these interventions differ. This difference could account for the peculiarity of the findings of these studies. In the same vein, this review is of paramount importance as clinicians and researchers can leverage on any existing gap on the background, aim, methodology and results of these studies to design future studies that would bridge the identified gaps, providing better interventions that improves the functional status of stroke survivors in the society.

STUDY LIMITATION

The major perceived limitation in this review is that only explicitly reported data were extracted from the included studies. Studies that did not explicitly report the scope of the review questions were not included in the review. This approach may have possibly excluded some potential studies that could have been part of the review.

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CONFLICT OF INTEREST DECLARATION

The authors declare no conflict of interest whatsoever.

REFRENCES

1. Disease and Injury Incidence and Prevalence Collaborators. Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990-2015: A systematic analysis for the Global Burden of Disease Study 2015. Lancet 2016; 388:1545-602.
2. Katan M, Luft A. Global burden of stroke. InSeminars in neurology 2018 Apr (Vol. 38, No. 02, pp. 208-211). Thieme Medical Publishers.
3. Thrift AG, Thayabaranathan T, Howard G, Howard VJ, Rothwell PM, Feigin VL, Norrving B, Donnan GA, Cadilhac DA. Global stroke statistics. International journal of stroke. 2017 Jan; 12 (1):13-32.
4. Diener HC, Hankey GJ. Primary and secondary prevention of ischemic stroke and cerebral hemorrhage: JACC focus seminar. Journal of the American College of Cardiology. 2020 Apr 21; 75 (15):1804-18.
5. Oti IK, Babatunde S. Quality of Life and Lifestyle Factors among Stroke Survivors and People Living With Osteoarthritis in Port Harcourt Metropolis, Rivers State. International Journal of Current Science Research and Review. 2023; 6 (4), 2299- 2309
6. OTI IK, BABATUNDE S. SOCIO-ECONOMIC STATUS OF STROKE SURVIVORS AND PEOPLE LIVING WITH OSTEOARTHRITIS IN PORT HARCOURT METROPOLIS, RIVERS STATE. Journal of Biomedical Investigation. 2023; 11(1):47-53.

7. Jeong H, Han SJ, Jang SJ, Lee JE. Factors affecting activities of daily living in severely disabled stroke patients. Brain & Neurorehabilitation. 2018 Jul 12; 11(2).
8. Baumann, M et al. Increased residual disability among post-stroke survivors and the repercussions for the lives of informal caregivers. Topics in Stroke Rehabilitation, 2011; v. 18, n. 2, p. 162-171,. http://dx.doi.org/10.1310/tsr1802-162.
9. Turan, E., Yanardag, M., & Aras, O. Functional independence, quality of life, and level of mobility of elderly people living at home and nursing home. Topics in Geriatric Rehabilitation, 2012; 28(3), 201-207.
10. Inumanye N, O., & Uchenna, D. A. Disability Levels and Associated Factors of Functional Dependence among Stroke Survivors in South-South, Nigeria. Asian Journal of Advanced Research and Reports, 2022; 16(3), 12-21.
11. Feigin VL, Brainin M, Norrving B, Martins S, Sacco RL, Hacke W, Fisher M, Pandian J, Lindsay P. World Stroke Organization (WSO): global stroke fact sheet 2022. International Journal of Stroke. 2022 Jan;17(1):18-29.
12. Abdo R, Abboud H, Salameh P, El Hajj T, Hosseini H. Mortality and predictors of death poststroke: data from a multicenter prospective cohort of Lebanese stroke patients. Journal of Stroke and Cerebrovascular Diseases. 2019 Apr 1;28(4):859-68.
13. Balakumar P, Maung-U K, Jagadeesh G. Prevalence and prevention of cardiovascular disease and diabetes mellitus. Pharmacological research. 2016 Nov 1;113:600-9.
14. Heart Disease and Stroke Statistics. Dallas, Tex: American Heart Association; 2003
15. Naidoo P, Akinyemi R, Sarfo FS. Conceptual framework for establishing the African Stroke Organization. 2021.
16. Oyewole OO, Ogunlana MO, Oritogun KS, Gbiri CA. Post-stroke disability and its predictors among Nigerian stroke survivors. Disability and health journal. 2016 Oct 1;9(4):616-23.
17. Saunders DH, Greig CA, Mead GE. Physical activity and exercise after stroke: review of multiple meaningful benefits. Stroke. 2014 Dec;45(12):3742-7.
18. Billinger SA, Arena R, Bernhardt J, Eng JJ, Franklin BA, Johnson CM, MacKay-Lyons M, Macko RF, Mead GE, Roth EJ, Shaughnessy M. Physical activity and exercise recommendations for stroke survivors: a statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2014 Aug;45(8):2532-53.
19. Ghasemi E, Khademi-Kalantari K, Khalkhali-Zavieh M, Rezasoltani A, Ghasemi M, Baghban AA, Ghasemi M. The effect of functional stretching exercises on functional outcomes in spastic stroke

patients: A randomized controlled clinical trial. Journal of bodywork and movement therapies. 2018 Oct 1; 22(4):1004-12.

20. Winstein CJ, Stein J, Arena R, Bates B, Cherney LR, Cramer SC, Deruyter F, Eng JJ, Fisher B, Harvey RL, Lang CE. Guidelines for adult stroke rehabilitation and recovery: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke. 2016 Jun; 47(6):e98-169.
21. Hubbard IJ, Carey LM, Budd TW, Levi C, McElduff P, Hudson S, Bateman G, Parsons MW. A randomized controlled trial of the effect of early upper-limb training on stroke recovery and brain activation. Neurorehabilitation and neural repair. 2015 Sep;29(8):703-13.
22. Grau-Sánchez J, Münte TF, Altenmüller E, Duarte E, Rodríguez-Fornells A. Potential benefits of music playing in stroke upper limb motor rehabilitation. Neuroscience & Biobehavioral Reviews. 2020 May 1; 112:585-99.
23. Särkämö T, Tervaniemi M, Laitinen S, Numminen A, Kurki M, Johnson JK, Rantanen P. Cognitive, emotional, and social benefits of regular musical activities in early dementia: randomized controlled study. The Gerontologist. 2014 Aug 1;54(4):634-50.
24. Sihvonen AJ, Särkämö T, Leo V, Tervaniemi M, Altenmüller E, Soinila S. Music-based interventions in neurological rehabilitation. The Lancet Neurology. 2017 Aug 1;16(8):648-60.
25. Halpern SH, Douglas MJ. Appendix: Jadad scale for reporting randomized controlled trials. Evidence-based obstetric anesthesia. 2005 Jun:237-8.
26. Barker TH, Habibi N, Aromataris E, Stone JC, Leonardi-Bee J, Sears K, Hasanoff S, Klugar M, Tufanaru C, Moola S, Munn Z. The revised JBI critical appraisal tool for the assessment of risk of bias for quasi-experimental studies. JBI Evidence Synthesis. 2024 Jan 30:10-1124.
27. Basha AK. Effect of structured home exercises on functional independence in stroke survivors. Physiotherapy-The Journal of Indian Association of Physiotherapists. 2021 Jan 1;15(1):43-9.
28. Fujioka T, Dawson DR, Wright R, Honjo K, Chen JL, Chen JJ, Black SE, Stuss DT, Ross B. The effects of music-supported therapy on motor, cognitive, and psychosocial functions in chronic stroke. Annals of the New York Academy of Sciences. 2018 Jul;1423(1):264-74.
29. Grau-Sánchez J, Duarte E, Ramos-Escobar N, Sierpowska J, Rueda N, Redón S, Veciana de las Heras M, Pedro J, Särkämö T, Rodríguez-Fornells A. Music-supported therapy in the rehabilitation of subacute stroke patients: a randomized controlled trial. Annals of the New York Academy of Sciences. 2018 Jul;1423(1):318-28.

30. Street AJ, Magee WL, Bateman A, Parker M, Odell-Miller H, Fachner J. Home-based neurologic music therapy for arm hemiparesis following stroke: results from a pilot, feasibility randomized controlled trial. Clinical rehabilitation. 2018 Jan;32(1):18-28.
31. Bunketorp-Käll L, Lundgren-Nilsson Å, Nilsson M, Blomstrand C. Multimodal rehabilitation in the late phase after stroke enhances the life situation of informal caregivers. Topics in sTroke rehabiliTaTion. 2018 Apr 3;25(3):161-7.
32. Jeba C, Joshi D. Influence of music therapy on spasticity, functional independence and quality of life in subjects with hemiplegia: a randomized controlled trial. International Journal of Neurorehabilitation. 2016;3(219):2376-0281.
33. Van Vugt FT, Kafczyk T, Kuhn W, Rollnik JD, Tillmann B, Altenmüller E. The role of auditory feedback in music-supported stroke rehabilitation: a single-blinded randomised controlled intervention. Restorative neurology and neuroscience. 2016 Jan 1;34(2):297-311.
34. Zondervan DK, Friedman N, Chang E, Zhao X, Augsburger R, Reinkensmeyer DJ, Cramer SC. Home-based hand rehabilitation after chronic stroke: Randomized, controlled single-blind trial comparing the MusicGlove with a conventional exercise program. Journal of rehabilitation research and development. 2016;53(4):457-72.
35. Tong Y, Forreider B, Sun X, Geng X, Zhang W, Du H, Zhang T, Ding Y. Music-supported therapy (MST) in improving post-stroke patients' upper-limb motor function: a randomised controlled pilot study. Neurological research. 2015 May 20;37(5):434-40.
36. Yoon JA, Koo BI, Shin MJ, Shin YB, Ko HY, Shin YI. Effect of constraint-induced movement therapy and mirror therapy for patients with subacute stroke. Annals of rehabilitation medicine. 2014 Aug;38(4):458.
37. Van Vugt FT, Ritter J, Rollnik JD, Altenmüller E. Music-supported motor training after stroke reveals no superiority of synchronization in group therapy. Frontiers in human neuroscience. 2014 May 20; 8:315.
38. Friedman N, Chan V, Reinkensmeyer AN, Beroukhim A, Zambrano GJ, Bachman M, Reinkensmeyer DJ. Retraining and assessing hand movement after stroke using the MusicGlove: comparison with conventional hand therapy and isometric grip training. Journal of neuroengineering and rehabilitation. 2014 Dec; 11:1-4.
39. Monticone M, Ambrosini E, Ferrante S, Colombo R. 'Regent Suit'training improves recovery of motor and daily living activities in subjects with subacute stroke: a randomized controlled trial. Clinical rehabilitation. 2013 Sep;27(9):792-802.

40. Thieme H, Bayn M, Wurg M, Zange C, Pohl M, Behrens J. Mirror therapy for patients with severe arm paresis after stroke–a randomized controlled trial. Clinical rehabilitation. 2013 Apr;27(4):314-24.
41. Fritz SL, Peters DM, Merlo AM, Donley J. Active video-gaming effects on balance and mobility in individuals with chronic stroke: a randomized controlled trial. Topics in stroke rehabilitation. 2013 May 1;20(3):218-25.
42. Liao WW, Wu CY, Hsieh YW, Lin KC, Chang WY. Effects of robot-assisted upper limb rehabilitation on daily function and real-world arm activity in patients with chronic stroke: a randomized controlled trial. Clinical rehabilitation. 2012 Feb;26(2):111-20.
43. Yoo J. Therapeutic Instrumental Music Performance to Improve Upper Extremity Function in Patients with Paresis and Apraxia after Stroke (Doctoral dissertation, University of Kansas), 2018.
44. Nikmaram N, Scholz DS, Großbach M, Schmidt SB, Spogis J, Belardinelli P, Müller-Dahlhaus F, Remy J, Ziemann U, Rollnik JD, Altenmüller E. Musical sonification of arm movements in stroke rehabilitation yields limited benefits. Frontiers in neuroscience. 2019 Dec 20; 13:454144.
45. Raglio A, Zaliani A, Baiardi P, Bossi D, Sguazzin C, Capodaglio E, Imbriani C, Gontero G, Imbriani M. Active music therapy approach for stroke patients in the post-acute rehabilitation. Neurological Sciences. 2017 May; 38:893-7.
46. Raghavan P, Geller D, Guerrero N, Aluru V, Eimicke JP, Teresi JA, Ogedegbe G, Palumbo A, Turry A. Music upper limb therapy—integrated: an enriched collaborative approach for stroke rehabilitation. Frontiers in Human Neuroscience. 2016 Oct 7; 10:498.
47. Scholz DS, Rohde S, Nikmaram N, Brückner HP, Großbach M, Rollnik JD, Altenmüller EO. Sonification of arm movements in stroke rehabilitation–a novel approach in neurologic music therapy. Frontiers in neurology. 2016 Jun 30; 7:106.
48. Villeneuve M, Penhune V, Lamontagne A. A piano training program to improve manual dexterity and upper extremity function in chronic stroke survivors. Frontiers in human neuroscience. 2014 Aug 22; 8:662.
49. Amengual JL, Rojo N, Veciana De Las Heras M, Marco-Pallarés J, Grau-Sánchez J, Schneider S, Vaquero L, Juncadella M, Montero J, Mohammadi B, Rubio F. Sensorimotor plasticity after music-supported therapy in chronic stroke patients revealed by transcranial magnetic stimulation. PLoS One. 2013 Apr 17;8(4):e61883.

50. Villeneuve M, Lamontagne A. Playing piano can improve upper extremity function after stroke: case studies. Stroke research and treatment. 2013 Feb 24;2013.
51. Grau-Sánchez J, Ramos N, Duarte E, Särkämö T, Rodríguez-Fornells A. Time course of motor gains induced by music-supported therapy after stroke: An exploratory case study. Neuropsychology. 2017 Sep;31(6):624.
52. Ekechukwu EN, Olowoyo P, Nwankwo KO, Olaleye OA, Ogbodo VE, Hamzat TK, Owolabi MO. Pragmatic solutions for stroke recovery and improved quality of life in low-and middle-income countries—a systematic review. Frontiers in Neurology. 2020 Jun 25; 11:531709.
53. Moore JL, Potter K, Blankshain K, Kaplan SL, O'Dwyer LC, Sullivan JE. A core set of outcome measures for adults with neurologic conditions undergoing rehabilitation: a clinical practice guideline. Journal of Neurologic Physical Therapy. 2018 Jul 1;42(3):174-220.
54. Reeves M, Lisabeth L, Williams L, Katzan I, Kapral M, Deutsch A, Prvu-Bettger J. Patient-reported outcome measures (PROMs) for acute stroke: rationale, methods and future directions. Stroke. 2018 Jun; 49(6):1549-56.
55. Van Duijnhoven HJ, Heeren A, Peters MA, Veerbeek JM, Kwakkel G, Geurts AC, Weerdesteyn V. Effects of exercise therapy on balance capacity in chronic stroke: systematic review and meta-analysis. Stroke. 2016 Oct; 47(10):2603-10.
56. Pollock A, Farmer SE, Brady MC, Langhorne P, Mead GE, Mehrholz J, van Wijck F. Interventions for improving upper limb function after stroke. Cochrane Database of Systematic Reviews. 2014(11).