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Effectiveness of Task-Specific Training combined with Strength Training on Upper Limb Recovery, Activities and Participation after Stroke: A Systematic Literature Review

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Abstract

Strength training in stroke focuses more on improving the impairment of muscle weakness after stroke. Task specific training along with strength training may improve upper limb impairment, functional outcome and participation after stroke. A systematic review was conducted to analyse the available evidence on task specific training combined with strength training on upper limb performance post stroke. Databases like The Cochrane Central Register of Trials (CENTRAL), PubMed, PEDro, Clinical Trial Registry of India and OTseeker were searched in order to find the required studies. Stroke, task-specific training, functional strength training, task-oriented strength training, task-specific strength training, upper limb performance, activities, and participation were the key search terms. Studies published in English language up to October 2023 were taken into consideration. For the purpose of the review, studies that examined the efficacy of combined strength training and task specific training on upper limb recovery, activity and participation post stroke were taken into account. The studies of other combinations with task specific training were excluded. Outcome measures measuring upper limb motor recovery, functional performance, activities and participation post stroke were considered in the review. Five studies were selected for the current systematic review out of the 384 studies screened. Task specific training combined with strength training functional strength training were reviewed in the selected studies. The review conclude that a combined therapeutic strategy using task specific training and strength training addressing improvement of upper limb recovery can be more effective in comparison to the standard therapy.

Keywords: Activity, Participation, Strength Training, Stroke, Task Specific Training, Upper Limb Recovery.

Introduction

Motor deficit in the upper extremities after stroke is a major factor associated with poor quality of life and reduced independence in doing daily activities (1). Following a stroke, motor dysfunction is the most commonly observed deficit; 69% of hospitalized stroke patients have upper limb impairments, with 32% having a severe paresis (2, 3). Muscle weakness is the major contributing factor that causes poor motor performance (4). Progressive resistance strength training (PRT) increases capacity of muscle to exert and maintain force through gradual progression of resistance. Progressive resistance strength training comprises three primary components: increasing resistance progressively as strength increases; providing adequate amount of resistance; and extending the programme for a minimum of four weeks to achieve maximum benefit (5). A systematic review concluded that strength training improves muscle strength and activity with a negligible carryover effect. Though strength training improves motor impairment, whether strength training improves activity and participation remains unclear (6, 7). To improve upper limb function is the top rehabilitation goal set by the patient as well as by the therapist. Previous research has demonstrated that repetitive, task-specific training (TST) is one of the most effective methods of stroke upper limb rehabilitation (8, 9). In TST patients relearn relevant tasks of daily life (10). Training based on impairment oriented model is not the same as task specific training. It puts more emphasis on meaningful tasks than impairment-based training, which addresses weakness of muscles or restriction in range of motion (11). Hubbard *et al.*, defined task-specific training as: "training or

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intervention that utilizes common everyday activities which have meaning for the patient or client both intrinsically and extrinsically." Hubbard *et al.*, developed 5-R criteria to explain task specific training: Training should be: (i) Relevant; (ii) Repetitive; (iii) Random; (iv) Reconstruction of larger task by dividing the task in to smaller components; and (v) Reinforcement (12). When strength training is provided in the same intensity, whether it translates in to day to day activity performance and participation in social activities remains unclear. This systematic review is conducted to determine whether there is any evidence of a combined approach using task specific training with strength training addressing not only at impairment level but at the level of activity and participation after stroke.

There were few meta-analyses and systematic reviews found in the literature on upper limb progressive resistance strength training in stroke patients (13-16). The results of a systematic review on the effects of progressive resistance strength training on stroke showed that these programmes reduce musculoskeletal impairment (17). It is unknown if strength training programme improves performance in activities and social participation. In order to determine if strengthening programmes increase muscle strength and activity following a stroke, a systematic review was carried out. According to the findings, strengthening interventions had a small beneficial impact on activity (SMD 0.32, 95% CI 0.11 to 0.53) and strength (SMD 0.33, 95% CI 0.013 to 0.54).A meta-analysis of 13 studies indicate that strength training can enhance strength and function of upper limb after stroke without exacerbating pain or muscle tone (18). In this review, only 5 out of 13 studies included ADL as an outcome measure. Additionally, the meta-analysis found that improving ADL performance would not result from strengthening the paretic upper limb. Progressive resistance strength training was found to increase strength in a recent systematic review (19); however, it is unclear if these significant increases in strength translate into improvement in activity level.

The result of these systematic reviews showed insufficient evidence regarding translation of upper limb strength improvement to activity and participation post strength training and low evidence of improvement in muscle strength after repetitive task training of upper limb. Thus combination of therapeutic interventions are required to address both these important issues post stroke that is muscle weakness and functional deficits. Many interventions combined with TST are being investigated addressing these issues post stroke (20-23).In a systematic Review with meta-analysis, authors have evaluated all the therapeutic interventions combined with TST (24). In this study a systematic review is conducted without meta-analysis. To date, no review has been conducted to identify the studies that investigated efficacy of a combination of TST and strength training addressing motor impairment, activity and participation post stroke. Identifying this combination may help in determining whether it is effective in improving upper limb motor impairment along with improving activity and participation post stroke. This review will also explore the significance of focused interventions in enhancing patient outcomes. Thus, there is a need to understand whether a combination of task specific training and strength training is effective in improving upper limb recovery, activity and participation in stroke. This study is aimed at reviewing all the studies conducted combining task specific training and strength training on upper limb recovery, activity and participation after stroke. The objective of the review is to identify and assess evidence of TST combined with strength training addressing UL recovery, activity limitations and participation restrictions after stroke. Another objective is to analyse the variation in content of the interventions used in these studies and whether the studies include activity and participation as an outcome measure. Finally the review will examine the efficacy of this combination therapy for stroke rehabilitation.

Identification of Trials for the Review

Searches were conducted with inclusion criteria like i) studies those were completed, ii) studies published in English language only, iii) Randomized control trials (RCT), Quasi experimental studies that combined task specific training and strength training in stroke, iv) outcome measures related to upper limb motor and functional recovery, activities and participation after stroke, v) both haemorrhagic and ischemic stroke, age 18 years and above, both male and female, hemiparesis, duration of stroke from medically stable to six years post stroke, vi) Interventions: Task specific training combined with strength training, functional strength training.

Conceptual and editorial papers, studies on patients with hemiplegia due to Traumatic brain Injury, task specific training combined with other forms of therapy like virtual reality, electrical stimulation, robotic devices, mental practice, trans-cranial magnetic stimulation, trunk restraint and action observation and case studies, case series were excluded from the review. We screened the reference lists of eligible trials after obtaining full paper copies of them.

Strategy Followed for Search

A systemic search of literature was conducted in various databases like PubMed/MEDLINE, PEDro, OT-Seeker, CENTRAL and Clinical Trial Registry of India. PubMed was searched using the Medical Subject Headings (MeSH) terminology to find out studies on human subjects alone and necessary interventions. Free text terms were used in other databases. The following keywords and MeSH headings were used in the search: "stroke," "Strength training," "Task Specific Training," "Task Oriented Training," "Cerebral Vascular Accidents," and "Task Oriented Strength Training." Two authors of the review searched all databases up to October 2023. This systematic review was registered in Prospective Register of Systematic Reviews (PROSPERO) and published in the website (www.crd.york.ac.uk/PROSPERO) with registration number “CRD42023472604”. The review was conducted as part of a clinical trial that was registered under the Clinical Trial Registry of India with registration number CTRI/2023/01/048990.

To identify and eliminate duplicate studies, an excel spreadsheet and the reference management tool Zotero was used to save the search results. The studies were filtered as per the search strategy for the titles and abstracts. Full text were searched for the articles those satisfied the inclusion criteria. Based on the study's topic, two reviewers (DS and SS) independently obtained data from each of the sources listed. Conflicts over the selection of studies were settled by consensus and discussion with each author.

Quality Assessment of the Studies Included in the Review

The quality assessment of the included studies was conducted using the Physiotherapy Evidence based Database (PEDro) scale (25).

Studies with a PEDro score of seven were classified as "high quality," studies with a score of five or six as "moderate quality," and studies with a score of four as "poor quality." The PEDro score of each study is shown in Table 1.

Table 1: Quality Assessment of Studies by PEDro Scale Score (PEDro criteria Score of all trials included in the review (n=5))

Study	Random allocation	Concealed allocation	Groups similar at baseline	Participant blinding	Therapist blinding	Assessor blinding	< 15% dropouts	Intention-to-treat analysis	Between-group difference Reported	Point estimate and variability	Total (0 to 10)
Da Silva, 2015(26)	Yes	Yes	Yes	no	no	Yes	Yes	Yes	Yes	Yes	8/10
Graef*et al.*, 2016(27)	Yes	Yes	Yes	no	no	Yes	Yes	Yes	Yes	Yes	8/10
Agni and Kulkarni, 2017(28)	Yes	No	Yes	no	no	No	Yes	Yes	Yes	Yes	6/10
PomeRoy *et al.*, 2018(29)	Yes	Yes	Yes	no	no	Yes	Yes	Yes	Yes	Yes	8/10
Isariyapan *et al.*, 2023(30)	Yes	Yes	Yes	Yes	no	Yes	Yes	Yes	Yes	Yes	9/10

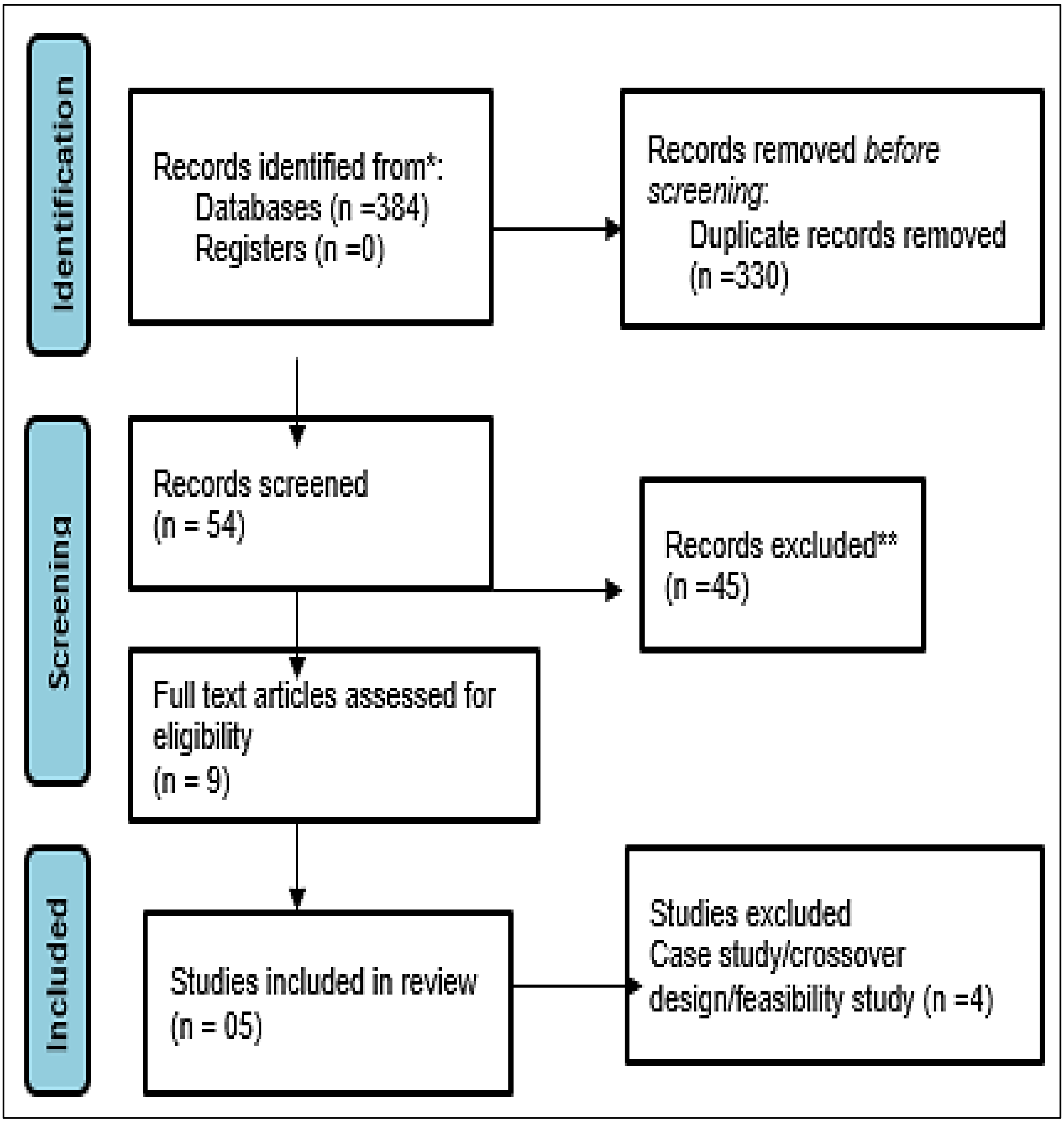

Figure 1. PRISMA Flow Diagram Showing the Process of Selection of Studies (31)

Table 2: Characteristics of the Excluded Study (n=9)

Sl.No.	Study and title	Design	Stroke duration	Age in years	Comparison	Intervention group(N=)	Control group	Study length	Training duration and frequency	Functional outcome measured	Result
1	Patten *et al.,* 2006 (32) "Combined Functional Task Practice and Dynamic High Intensity Resistance Training Promotes Recovery of Upper-extremity Motor Function in Post-stroke Hemiparesis: A Case Study."	Case study	16 weeks	65 years	Pre - post	Functional task practice combined with high intensity resistance training	FTP+DHIRT	6 wks	3 hrs./day, peak of 5 hrs./day,	FMA Asworth SCALE BARTHEL INDEX WMFT FIM SIS	Significant gains in strength were observed on a functional, clinical, and physiological level. The case study's observations of enhanced EMG activation indicate that these strength gains are likely the result of working at a high intensity level, as improvements in motor activation support these gains.
2	Folkerts *et al.,* 2017 (33) "Effectiveness and feasibility of eccentric and task-oriented strength training	a cross-over design	9-37	38-73	Measurements at Week 0, week 5 and week 10.	Initially eccentric strength training and then task-oriented strength training and vice versa.	--	4weeks of each therapy.	three times weekly	handheld dynamometer (HHD) Action Research Arm Test (ARAT)	The study's findings demonstrate that combining task-oriented and eccentric strength training is a practical and successful training

	in individuals with stroke”										approach for improving function and strength in those who have had a chronic stroke.
3	Patten *et al.,* 2013 (34) “Concurrent neuromechanical and functional gains following upper-extremity power training post-stroke”	Crossover design	7-18 months post stroke	>64 years	Pre post and follow-up	Functional task practice + power training	Functional task practice Only	3 weeks	3 days/week 3 weeks of 75 minutes/session	WMFT-FAS FMA-UE,FIM Aswarth scale	Regardless of treatment order, improvements in WMFT-FAS were considerably larger after HYBRID vs. FTP (p =.049). Six months after the intervention, these functional gains were maintained (p =.03).
4.	Donaldson *et al.,* 2009 (35) “Effects of Conventional Physical Therapy and Functional Strength Training on Upper Limb Motor. Recovery After Stroke: A Randomized Phase II Study”	RCT	weakness within 3 months of stroke	60-90	Between group	FST +CPT	CPT+CPT CPT only	6 wks.	For six weeks, up to one hour, four days a week (24 hours) prior to the start of treatment, six weeks into the intervention, and twelve weeks after	ARAT 9HPT	This preliminary study supports subsequent investigations comparing CPT combined with CPT + FST and CPT + CPT

5.	Mares *et al.,*2013 (36) "Feasibility of a randomized controlled trial of functional strength training for people between six months and five years after stroke: FeSTivaLS Trial"	RCT	24.4 months after stroke	mean age of 68.3	Pre- test, post-test and follow -up	FST-UL FST-LL	Nil	Six weeks	During six weeks, one hour per day, four days per week prior to randomization (baseline), six weeks following the intervention (outcome), and six weeks following randomization (follow-up).	Action Research Arm Test (ARAT) Functional Ambulation Categories (FAC).	Feasibility study
6.	"Bale *et al.,*2008 (37) "Does functional strength training of the leg in subacute stroke improve physical performance? A pilot randomized controlled trial"	RCT	Subacute phase	60 and above	Pre post	functional strength training	Training – as-usual	Four weeks	50 minutes five days a week for four weeks	isometric muscle strength, gait speed Motor Assessment Scale	According to this pilot study, functional strength training for the lower limbs enhances physical performance more than conventional training.
7	Kerr *et al.,*2017 (38) "Functional strength training and movement performance therapy produce analogous improvement in	RCT	<42 days stroke	68.8 years	Baseline,outcome,3 months follow up	Movement performance therapy and functional strength training	conventional therapy,	Six weeks	up to 1 hour per day, 4 days per week for 6 weeks	STS ability, timing, co-ordination, smoothness velocity of knee	Movement quality changes were not affected differently by group assignment, suggesting that the kind of

	sit-to-stand early after stroke: early-phase randomised controlled trial”										therapy is not as significant.
8	Sullivan *et al.,* 2006 (39) “Effects of Task-Specific Locomotor and Strength Training in Adults Who Were Ambulatory After Stroke: Results of the STEPS Randomized Clinical Trial.”	RCT	4 months to 5 years after a unilateral stroke	60 years and above	Pre-test, post-test and six month follow up	Body weight supported treadmill training-EX, CYCLE/Upper extremity exercise Body weight supported treadmill training /CYCLE, and BWSTT/Lower Extremity-EX	NA	six weeks	4 times per week for 6 weeks	walking speed, fast walking speed, 6-minute walk distance	Compared to resisted leg cycling alone, task-specific training during treadmill walking with body-weight support is more effective in increasing walking speed after a chronic stroke and retaining these improvements at six months. LE strength training alternated with BWSTT walking every day did not improve walking outcomes, which is in line with the overtraining literature.
9	Yang *et al.,*2006 (40) “Task-oriented progressive resistance	RCT	At least 1 year post stroke	45-74 years	Pre-post	Task-oriented progressive resistance strength training.	No intervention	four-week	Task-oriented progressive resistance exercise lasting 30 minutes,	Strength of lower extremity muscles and gait speed	In patients with chronic stroke, a task-oriented progressive resistance

strength training improves muscle strength and functional performance in individuals with stroke.”	conducted three times a week for a duration of four weeks.	stride length, step test, timed up and go test, and six-minute walk test	strength training program may increase muscle strength in the lower extremities, which may lead to an improvement in functional abilities.

Table 3: Summary of the Study Characteristics Included in the Review (n=5)

Sl.No.	Study	Study	Stroke duration	Age in years	Comparison	Intervention group(N=)	Control group	Training duration and frequency	Functional outcome measure	Result
1	Da Silva, 2014 (26)	RCT	41 months	70.4 (7.83)	Between group	Task Oriented Training with strength training N=10	TOT only N=10	6 wks, for a total of 12 sessions	Shoulder flexor and handgrip strength, active range of motion of shoulder, motor impairment (Fugl-Meyer Scale), and muscle tone U/E performance test	Strength training was shown to aid upper-limb rehabilitation; this was demonstrated by the higher scores the TOT_ST group obtained across most evaluation categories.
2	Graef *et al.,* 2016 (27)	RCT	chronic stroke	72 (12)	Pre – post Follow-up	functional strengthening (FS) (n=13)	analytical strengthening (AS) (n=14)	30 minutes per day, three times per week	Shoulder flexor and handgrip strength, active range of motion of shoulder, motor impairment (Fugl-Meyer Scale), and muscle tone U/E performance test MAS, FMA-UE	Following unctional strengthening, patients with mild motor deficits and persistent hemiparesis show improved activity levels for the paretic upper limb, and this improvement is maintained during follow-up.
3.	Agni and Kulkarni. 2017 (28)	RCT	2weeks-6months	70.46	Between group	Group-III - Combined Strength and Functional-task-	Group-I - Strength-training N=13	3days/week for 6weeks evaluated at 0, 3 and 6weeks	Fugl-Meyer, Dynamometer and MMT Chedoke-Arm and Hand-Inventory,	combined Strength and functional task-related training increased strength and

						related training for the upper extremity N=12	Group-II - Functional-task-related training N=12			enhanced functional motor performance, which resulted in more successful rehabilitation.
	Pomeroy *et al.,* 2018 (29)	RCT	2 and 60 days after stroke in the territory of the anterior cerebral circulation	72.2	Between group	CPT +MPT N=144	FST +CPT N=144	6-week intervention phase	Neural measures, ARAT, resting motor threshold of paretic biceps brachii (pBB) and extensor carpi radialis muscles .	The clinical efficacy of upper limb recovery varied slightly between FST + CPT and MPT + CPT in the trial described here, but not to the point of statistical significance.
5	Isariyapan *et al.,* 2023 (30)	RCT	6 month -5 years	40-70	Between group	TOT+ Strength Training N=10	TOT only N=09	70-minute training program, 5 times a week for 4 weeks	The Physical Activity enjoyment Scale (PACES) , grip strength, upper extremity motor impairment, shoulder flexion active range of motion (AROM), muscle tone, physical activity both before and after the intervention.	Both strength training alone and task-oriented training combined with strength training are equally effective at improving upper limb function; stronger improvements in strength were observed in the former group.

Table 4: Analysis of the content of the intervention (n=05)

Sl.No.	Study	Study	Intervention	Number of tasks used	amount of resistance used	Mode of delivery of resistance and progression	Feedback provided
1	Da Silva, 2014 (37)	RCT	Simulated everyday tasks such as putting on a scarf, handling a coffee pot, combing hair, feeding and setting a pot on a high cabinet shelf.	five task-oriented movements	60% of maximum baseline force	Resistance was provided through weighted bracelet and weight put intoa jug.. Based on patient's ability range of motion was progressed.	Feedback and reinforcement provided verbally.
2	Gref *et al.,* 2016 (40)	RCT	Reaching-to-grasp movements against resistance. Repetitive functional task practice	Not reported	60% of maximum strength measured during the baseline evaluation	Each participant's predetermined weight was inserted into the object and held there for the duration of the intervention. Various grasping positions were used using different objects.	No feedback
3	Pomeroy *et al.,* 2018 (39)	RCT	With verbal cues and feedback from the therapist, repetitive progressive resistance training was included into goal-directed functional activities as part of Functional Strength Training.	Not reported	At first, the resistance level was the highest load that allowed for five repetitions of the task.	Therapist used patient's body weight as resistance and weight of the equipment. .Systematic progression during the intervention period used repetition and increased resistance	verbal prompting and feedback
4	Agni, and Kulkarni. 2017 (36)	RCT	Work-related tasks, bimanual activities, grip and grasp strengthening exercises, dressing and eating activities, housework, and personal hygiene activities. Open chain movements were a part of strength training for the abductors, adductors, elbow flexors, wrist flexors, and extensors of the shoulders. Strength training for 40 minutes and functional task-related training for 40 minutes	Six activities	50% of 1 R.M. increasing to 80% of 1 R.M.	Resistance was provided by weighted cuffs.	No feedback
5	Isariyapan *et al.,* 2023 (39)	RCT	Daily-life activities were used in the TOT group and consisted of strength-dependent activities relating to the hemiparetic arm, those included bimanual and dexterity of the hemiparetic hand.	Not reported	1RM was multiplied by 0.06 to be the target weight.	Weight in the sandbag. Difficulty of all activities was increased in various ways, such as increasing the range of motion, the size of objects used, and the target weight set according to each participant's capacity.	verbal cues to offer feedback on the exercise performance, limit compensatory movements, and reinforce positive behaviours.

Search Creteria

We found 384 potential studies to be included in the review (up to October, 2023), out of which 330 articles were removed before screening. Fifty four [54] articles were screened and forty-nine [49] articles were excluded from the review. After a detailed review, five studies were found to be eligible and finally included. The study process was presented in Figure 1 which represents the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) (31).

Data Synthesis

The meta-analysis was not possible because of variations in the trial designs, treatments, and outcome measures. The results of the search were analysed and presented in form of a narrative review. As number of articles found were less in number all studies with different designs were included in the review earlier. Later on one case study (32), few other studies (33, 34), one exploratory trial (35), one feasibility study (36) and four RCTs conducted on lower limb and sit to stand ability after stroke (37-40) were excluded from the review (Table 2). Five studies could be included for detailed analysis. Table 3 shows the summary of all the studies included. Out of five trials, one was quasi-randomised and rest four were randomised controlled trials. Four studies are of high quality and one study is of moderate quality (26-30).

There were a total of 391 participants included in these five trials. The mean age distribution was 40–75 years old for all five trials. Of those involved, 37% were women and 63% were men. There was only one trial where acute stroke participants were included. Average duration of stroke in the rest four trials ranged between 6 months to 5 years. There were 53% participants with right side paresis and 47% with left side paresis.

Interventions used in the trials were provided with varied amount of resistance and the method of delivering resistance was different with different mode of task performance. Analyses of the content of the intervention is presented in Table 4. Out of the five studies included in the review, all were randomized controlled trials. Two studies included stroke patients in their sub-acute phase (2 weeks to 6 months) and other three studies included participants of more than six months post stroke. There were wide variation in the amount of resistance provided for strength training ranging from simple 5RM to 60% of 1RM.Resistance was provided in form of weighted bracelets, weight inside the objects used, body weight of the patients and weight in the sand bags. Activities in form of goal-directed functional activity, bimanual activities, simulated activities of daily living, reach to grasp activities etc. were used. Due to the diverse nature of intervention methods, the efficacies of the interventions are not consistent across the studies.

A study by Da Silva *et al*., 2015 (37) combined task oriented therapy with a strength training programme. A few activities of daily living tasks were simulated in rehabilitation exercises. All activities were carried out at progressively higher levels of difficulty with verbal instructions serving as reinforcement. Throughout all five tasks, resistance was applied at a force equal to 60% of the maximal baseline force. There were ten repetitions of each movement in the tasks, followed by a three-minute break (37).

In one trial with Sub-acute stroke participants Intervention included Functional strength training versus movement performance therapy (39). Movement Performance Therapy included sensory stimulations and movement patterns. Functional Strength Training included goal-directed functional activities combined with progressive resistive exercise, while receiving feedback. The maximal load that allowed for five repetitions of the exercise being performed initially served as the resistance level. Increased resistance and repetition were used in a systematic progression during the period of whole intervention.

In a study by Graef P *et al.,* 2016 (40), Functional Strength training was provided through reach-to-grasp movements against resistance. They have used repetitive functional tasks where objects with varied size and shape were used. The weight was inside the object during the whole period of intervention. Throughout the activity, resistance was maintained at 60% of maximal strength. By the eighth session, the range of motion for shoulder flexion in the strength training protocols had increased to 90°. Each participant got a 30-minute home rehabilitation programme three days a week, for fifteen sessions (40).

Agni and Kulkarni, 2017 (36) used functional task training combined with strength training and compared with functional task training and strength training in sub-acute stroke. The subjects were administered a combination of interventions comprising 40 minutes of functional task training and 40 minutes of strength training. One Repetition Maximum was used to calculate training load for resisted exercises. 50% of one R.M. was the starting load and was increased to 80% of one repetition Maximum. Weight cuffs were used for providing resistance (36).

In a trial by Isariyapan *et al*., 2023 (38), each participant received Strength training and task-oriented training (TOT) for 70 minutes a session five days a week for a total of four weeks at their residences. The TOT group engaged in daily activities that involved bimanual and dexterity exercises for the hemiparetic hand, as well as other strength-dependent hemiparetic arm activities. Each participant's 1RM was the final weight of the sandbag that let them to elevate their arms to their maximum range of motion. The target weight was calculated by multiplying their 1RM by 0.06 (38).

The intervention used in the control groups of these five trials mostly include task oriented training, standard physical therapy and analytical strength training. Various frequently used outcome measures used across these studies were Action Research Arm Test (ARAT), Chedoke-Arm and Hand-Inventory, motor impairment (Fugl-Meyer Scale), shoulder flexor strength, hand grip strength, shoulder active range of motion, Dynamometer, MMT and muscle strength. Measures of activity limitations in term of upper limb activities were used in only one study but no study has used social participation as an outcome measure.

Effectiveness of Combined Therapy

The effect of combined task oriented training with strength training on upper limb recovery concluded in one trial that strength training could enhance the upper-limb rehabilitation. In study, post functional strength training, there was an improvement in the activity level of the paretic upper limb and at follow up this improvement was maintained. Study by Agni et al year (36) concluded that functional task related training when combined with strength training improved both motor function and muscle strength leading to better rehabilitation outcome. Another study by Ishariyapan *et al.,* 2023 (38) suggested that, 4-week of strength training combined with task oriented therapy improved upper limb functions, motor impairment and active range of motion of shoulder flexion of the participants. This was similar to the improvement of the task oriented training-only program participants. In a study on sub-acute stroke patients concluded that there were small differences in upper limb improvement between the functional strength training and the movement performance therapy group that was not statistically significant (39). Stroke rehabilitation often involves a multifaceted approach to address upper limb motor impairments, aiming to improve functional outcomes and quality of life. Combination training methods integrate various therapeutic strategies, such as task-specific training, functional electrical stimulation (FES), constraint-induced movement therapy (CIMT), and robotic-assisted therapy, to optimize motor recovery and enhance rehabilitation outcomes. Combination training techniques are a viable strategy for upper limb rehabilitation of stroke survivors, because they maximize synergistic effects to improve motor recovery, functional outcomes, and quality of life. There is evidence that they are effective in maintaining long-term improvements in upper limb function, enhancing motor learning, and stimulating neuroplasticity. Combination training methods consistently show superior outcomes in motor recovery compared to single-modality approaches. They capitalize on synergistic effects, such as combining TST with FES to enhance muscle activation and strength (41). Studies demonstrate that integrating CIMT with TST or robotic therapy results in significant gains in functional abilities, including improved upper limb dexterity and performance of daily tasks (42, 43). The combined approach stimulates neuroplastic changes in the brain, promoting reorganization of neural circuits and enhancing motor learning and recovery (44, 45). Longitudinal studies indicate that combination training methods lead to sustained improvements in upper limb function and participation in daily activities, supporting lasting benefits beyond the intervention period (45, 46). Continued research efforts are essential to design specific treatment protocols, address individual variability, and optimize the integration of these approaches into comprehensive stroke rehabilitation programs.

Discussion

This systematic review examines the effects of combined task specific therapy and strength training on upper limb recovery, activity and participation. The synthesis of the studies indicates that upper limb recovery may be enhanced by the combined task specific training and strength training. The effect of this combined therapy improved muscle strength and performance level of upper limb better in comparison to conventional therapy or other strength training programs. Thus, task specific training can be combined with strength training for improving upper limb muscle strength as well as upper limb functional performance. However, the available studies do not give sufficient support to use this combination for evidence based upper limb rehabilitation. High inconsistency was detected in the effects of intervention, possibly because of the large variation in using task oriented activity, the mode of strength training (the way resistance was applied to different upper limb muscles), population with varied duration of post stroke ranging from two days to six years as well as use of different outcome measures. More number of experimental studies are required to support the use of this combined intervention for stroke upper limb recovery, reducing activity limitations and participation restriction. Most of the trials were conducted in chronic stroke population. Effect of this combined therapy in early phase of stroke was studied in only one trial (39).

Upper Limb Recovery

Task oriented training along with strength training is effective in improving the upper limb motor impairment and functional task performance. Inducing neuromuscular adaptations that improve strength, motor abilities, and functional recovery during the chronic period following a stroke is better accomplished with combination therapy than with task-oriented activity alone. Study by Graef *et al.,* 2017 (40) concluded that resistance training is effective in improving handgrip and shoulder flexor strength for both functional strength training group and repetitive movement analytical strength training group. Though there was significant improvement seen in muscle strength post functional strength training, the studies in the current review did not prove their superiority over other strength training or conventional therapy.

Motor Impairment

Our analysis demonstrates that the effective way to improve impairment in motor functions is to combine task-specific training with strength training. Our results are consistent with current reviews, which demonstrate the beneficial effects of strength training on muscle power in a clinically significant way in individuals after stroke. Resistance training is effective in improving motor recovery significantly in neurorehabilitation.

Activity Limitation/Functional Independence and Social Participation

Reduction of impairment, improvement of activity level, and promotion of independence in ADLs are among the primary goals of therapeutic outcomes in rehabilitation. The findings of a meta-analysis conducted in 2010 by Harris *et al.,* demonstrated that strength training had no positive effect on ADLs (47). Because complex motions including strength, range of motion, and coordination are a part of daily tasks, it's possible that practicing each of these skills is necessary for improvement. Strengthening the paretic upper limb would not result in an improvement in ADL performance because compensatory strategies and the use of the unaffected upper limb is usually chosen to execute ADLs. Using wrist weights for activities of daily living (ADLs) could be the best combination of therapies (47). Muscle weakness is associated with poor engagement in ADL and challenging reintegration back into the society, resulting in restricted social participation. Thus Effect of task specific training combined with strength training on motor impairment and activity and participation may be studied in future trials to establish the evidence for clinical practice.

Strengths and Limitations of the Review

One of the most important strength of this review is that this is the first systematic review which evaluates the benefits of task specific training combined with strengthening for stroke upper extremity rehabilitation. Strength of our review is all the studies included were RCTs with moderate to high quality as per PEDro score. The study also analysed the evidence of combination training methods. The combination therapies mostly included practice of common daily life activities with strength training and are simple ,feasible methods for practice at Institution based rehabilitation set ups as well as at home. From the quality assessment of the studies, it was found that there were less than 15% drop outs in most of the studies emphasizing the participant involvement and participation in the therapy. The most common methodological flaws observed are, subjects and investigators are not blinded and there were no or limited use of measures to assess ADL/activity and social participation. The inconsistent use of interventions (several resistance training modalities, various control interventions, and varying intervention durations) and their outcome were identified through the review and can be recommended for future studies to overcome these flaws for better efficacy studies. Because of limited studies on this topic, no data could be synthesized based on only acute or only chronic stroke population which could make it more difficult to interpret the findings of the review. Most of the studies were having small sample size except one. Variability in treatment approaches and preferences among different therapists may affect the consistency and continuity of care for stroke survivors undergoing integrated rehabilitation. Patient compliance to intensive integrated intervention can also be a potential obstacle. Despite promising outcomes, there may be gaps in high-quality evidence supporting the efficacy and cost-effectiveness of integrated training methods compared to traditional rehabilitation approaches. Ongoing research is needed to assess long-term outcomes, optimize treatment protocols, and identify predictors of response to integrated therapies in diverse patient populations.

Conclusion

Task specific training combined with strength training after stroke improves motor recovery of upper limb. Superiority of this combined therapy over other forms of therapy could not be established. The evidence is insufficient to be generalized. Activity and participation measures should be included as outcome measures to find out the effect of the therapy in reducing activity limitations and participation restrictions. Outcome of this combined therapy may be studied in the early phase of stroke rehabilitation as very few studies have been conducted in acute and sub-acute stroke population. Whether the improved motor ability of upper limb translate to reducing activity limitations and improving social participation needs to be studied extensively.

Abbreviations

ADL: Activities of Daily Living
PRISMA: Preferred Reporting Items for Systematic Review and Meta-Analysis
TOT: Task Oriented Training
PROSPERO: Prospective Register of Systematic Reviews
PEDro: Physiotherapy Evidence based Database scale
RCT: Randomized Controlled Trial
SMD: Standardized Mean Difference

Author Contributions

DS: Conceptualization and design; DS, SS & SS: Data extraction and filtering; SS: Content analysis, data synthesis and proof reading; SS & SS: Editing of final draft; DS: Manuscript preparation. All authors approved the final version of the manuscript.

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Conflict of Interest

Nil.

Ethics Approval

Ethical approval has been taken for the original trial by the Ethical Committee of IMS and SUM Hospital, Bhubaneswar, Odisha- Ref. No/IEC/IMS.SH/SOA/2022/476.

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