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IMPACT OF DUAL TASK TRAINING ON FINE MOTOR ACTIVITIES IN SUBJECTS WITH CHRONIC STROKE

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Abstract:

BACKGROUND: Stroke is a cerebrovascular disease in which the brain's blood vessel supplying it is damaged or blocked, leading to complex dysfunction and neurological impairment leading to brain's damage. The level of Stroke is dependent on the area or lesion of the brain injury. Stroke is usually caused by a vascular injury including cerebral infarction, intracerebral haemorrhage, and subarachnoid hemorrhage. Most common dysfunctions after stroke include motor disorders, cognitive disorders, balance problems, fine motor skills are affected. Fine motor disability is an inability or impairment of an individual to perform tasks that require a degree of manual dexterity. To complete even simple fine motor movements, it requires communication between the premotor and motor cortex, cerebellum, basal ganglia, corticospinal tracts, and peripheral nerves. Dual task training involves performing two or more tasks simultaneously with different characteristics that occur in daily life. Dual-task training improves fine motor skills in stroke patients by enhancing the brain's capacity to coordinate motor and cognitive functions, strengthening the brain network connections, and promoting neuroplasticity to support recovery and functional independence in daily activities. By engaging in simultaneous cognitive and motor tasks, patients improve their attention and executive functions, which are crucial for managing the complexities of movement and improving upper limb function.

AIM OF STUDY: The study was aimed to determine the impact of dual task training on fine motor skills in stroke patients.

METHODOLOGY: Tsubjects were selected based on the inclusion and exclusion criteria and were asked to perform the Action Research Arm Test to assess their fine motor ability and scoring was done based on the completion of the task. The inclusion criteria was patients with more than 3 months or more of stroke, age group of 45-65 years, those in Brunnstrom Recovery stage 3 or more, those who take less than 60 seconds to complete the task. The exclusion criteria was people who have hearing or vision problems, those who take more than 60 seconds to complete one task. Then the selected subjects performed dual task training that is one fine motor activity along with attention task in one session and one fine motor activity and executive task in another session alternatively for 4 days for 4 weeks. After 4 weeks, again the subjects performed the Action Research Arm Test to know out the progression.

RESULTS: The study was aimed to investigate the Impact of dual task training on fine motor skills in subjects with chronic stroke. The statistical analysis was done using SPSS 23.0. The categorical variables were represented in frequency and percentage. Numerical variables were presented using mean and standard deviation. Pre post comparison was done using Paired sample t test. A p value <0.05 was considered statistically significant. The pre-test mean score was 33.50 ± 8.77, while the post-test mean score increased to 36.25 ± 8.74. The mean difference of 2.74 indicates a measurable improvement in upper limb function following the intervention. A paired t-test yielded a t-value of 4.410 with a p-value less than 0.001, suggesting that the improvement was statistically significant.

CONCLUSION: This study was based on Impact of Dual task training on fine motor skills in chronic stroke patients. The patients were selected based on proper inclusion and exclusion criteria. A total of 20

patients with an inclusion of 14 males and 6 females were in the study. The patients were assessed with Action Research Arm Test and the treatment was given for 4 days for 4 weeks with a alternate session of 1 fine motor activity + attention task and 1 fine motor activity + executive task. After 4 weeks of treatment, the patients were reassessed using the Action Research Arm Test to evaluate their improvement. The statistical data reveals that there is a significant improvement of fine motor skills in chronic stroke patients.

Keywords: Chronic stroke, Dual task training, fine motor skills, Action Research Arm Test.

INTRODUCTION

The World Health Organization(WHO) defines stroke as rapidly developed clinical signs of focal disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than of vascular origin.1Stroke is a cerebrovascular condition where a blood vessel supplying the brain either ruptures or becomes blocked, leading to significant dysfunction and neurological impairments due to brain damage.2The specific type and severity of the disorder depend on the location and extent of the brain damage.3 The brain's blood supply Is controlled by two internal carotid arteries at the front and two vertebral arteries at the back (forming the circle of Willis). Ischemic stroke occurs when there is an insufficient supply of blood and oxygen to the brain, while hemorrhagic stroke results from bleeding or ruptured blood vessels. Ischemic occlusions account for approximately 85% of stroke-related deaths, with the remaining cases attributed to intracerebral hemorrhage. These occlusions lead to thrombotic and embolic conditions in the brain.4In thrombosis, blood flow is disrupted due to the narrowing of blood vessels caused by atherosclerosis. The accumulation of plaque gradually reduces the vessel's diameter and leads to clot formation, resulting in a thrombotic stroke.5Hemorrhagic stroke represents around 10–15% of all strokes and is associated with a high mortality rate. This condition occurs when stress on brain tissue and internal damage lead to the rupture of blood vessels. The rupture causes toxic effects in the vascular system, leading to infarction.6Hemorrhagic stroke is divided into two types: intracerebral hemorrhage and subarachnoid hemorrhage. In intracerebral hemorrhage, blood vessels break, leading to an abnormal buildup of blood in brain.The primary causes of ICH include hypertension, damaged blood vessels, and excessive use of anticoagulants. In subarachnoid hemorrhage, blood collects in the subarachnoid space of the brain, typically as a result of head injury or cerebral aneurysm.7Common post stroke dysfunctions include motor impairments, upper limb dysfunction, cognitive issues.8 Up to 85% of stroke survivors experience hemiparesis affecting the upper limb on one side, with fewer than half being able to recover full arm function within 6 months of stroke. Generally, hemiparesis has a greater impact on hand and wrist movement than on the shoulder and elbow. Hand movement is essential for upper limb function, as it plays a crucial role in daily activities. Many important tasks, such as using a fork, buttoning a shirt, turning a door handle, require diverse hand functions.9 In our everyday lives, we rely heavily on the functionality of our hands. Fine motor skills are crucial for holding, grasping, and manipulating objects, requiring the coordination of multiple sensorimotor systems. Visual, haptic, auditory, and sensory inputs must be integrated with sensorimotor predictions based on the mechanical properties of the objects being handled, such as weight and surface texture. Moreover, reactive adjustments to changing loads are also key to this process"10 This intricate interaction can be disrupted by neurological conditions like stroke-related brain damage. Individuals who have had a stroke often experience altered tactile sensitivity and commonly struggle to apply appropriate grip force during fine motor tasks.11 Depending on the degree of paresis, these impairments can significantly limit patients' ability to perform everyday activities.12 Fine motor disability refers to the inability or difficulty an individual experiences when performing tasks that require a certain level of manual dexterity.13 Executing even basic fine motor movements involves communication between the premotor and motor cortex, cerebellum, basal ganglia, corticospinal tracts, and peripheral nerves, along with the processing of visuospatial, sensory, and executive functions.14 Two essential motor factors influencing manual dexterity are force generation (strength) and force control (variability).15 Dexterous finger movements likely depend on the ability to both generate and regulate

force. For instance, during object manipulation, sufficient strength is needed to lift and hold an object, while precise force control ensures successful transfer and release. Strength deficits are a well-established clinical indicator of functional recovery after stroke.16As a result, past research on stroke patients has primarily focused on the connection between grip strength and manual dexterity, with findings suggesting that greater grip strength is associated with improved dexterity.17 Dual-task training is an intervention that involves performing two or more complex tasks, which are often of different natures and commonly occur in daily life. It is a training method where an additional task is carried out while performing a basic task, or multiple tasks are performed simultaneously. Dual-task training, which involves performing cognitive and motor tasks simultaneously, has been used in clinical settings to aid in the recovery of motor control in patients with neurological impairments, such as those following a stroke18

NEED OF THE STUDY

Dual task training has proven to be effective in various functional performances in stroke patients. However there is no literary evidence or research data available on its impact on fine motor skills in stroke patients. As we know fine motor skills are affected in almost all stroke patients therefore the need for this experimental study arises. It is to determine the impact of dual task training on fine motor skills in stroke patients Fine motor disability refers to the inability or difficulty an individual experiences when performing tasks that require a certain level of manual dexterity. Executing even basic fine motor movements involves communication between the premotor and motor cortex, cerebellum, basal ganglia, corticospinal tracts, and peripheral nerves, along with the processing of visuospatial, sensory, and executive functions.

METHODOLOGY

STUDY DESIGN: Experimental study

STUDY SETTING:

- (OPD) Department of Physiotherapy, DR BR Ambedkar Medical College and Hospital
- Community Dwelling

SAMPLE SIZE: 30 subjects

SAMPLING METHOD: Convenient sampling

MATERIALS USED:

- Chair without armrests
- Table
- Wooden blocks
- Cricket ball
- Stone
- Alloy tubes
- Washer and bolt
- Glasses
- Marbles
- Tin lid

CRITERIA FOR SAMPLE COLLECTION:

The participants are selected for the study based on the following criteria:

INCLUSION CRITERIA:

- People who have been diagnosed with stroke duration of 3months/ more
- Age group of 40-65 years
- Gender – male and female
- Subjects with stroke in Brunstrom Recovery Stage 3 or more
- Subjects with stroke who take less than 60 seconds to complete 1 task of Action Research Arm Test.

EXCLUSION CRITERIA:

- Subjects who have any hearing loss or visual impairment.
- Subjects who take more than 60 seconds to complete 1 task of Action Research Arm Test.

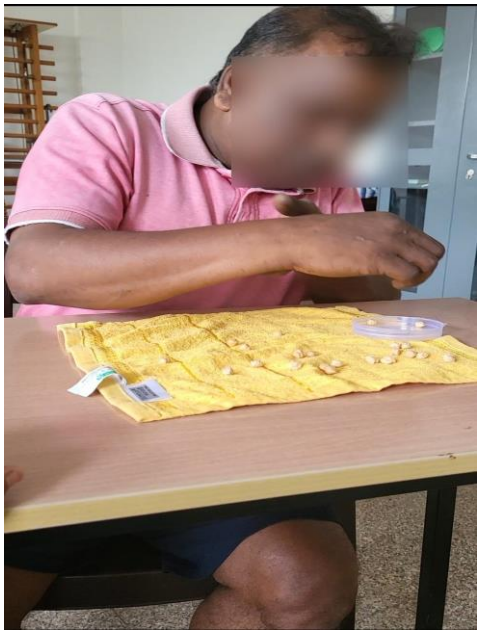
OUTCOME MEASURES:

Action Research Arm Test (ARAT) The Action Research Arm Test (ARAT) is a 19 item observational measure used by physical therapists and other health care professionals to assess upper extremity performance (coordination, dexterity and functioning) in stroke recovery, brain injury and multiple sclerosis populations

PROCEDURE

In this research study, 30 participants who had been diagnosed with stroke were included based on the inclusion and exclusion criteria. In the pre test, patients were asked to perform the Action Research Arm Test and the scores were determined. The total score on the Action Research Arm Test ranges from 0-57 with lowest score indicating that no movements performed and higher score indicating normal performance. Followed by this, the patients received intervention that includes Dual-task training along with Conventional Physiotherapy for 4days/week for 4 weeks which includes dual task training carried out by performing one fine motor task with attention task and one fine motor task with executive task alternative session respectively. Post test assessment was done again using Action Research Arm Test to evaluate the results. Then the results were statistically analyzed.


Enrolment of participants in this study based on selection criteria (n=20)
Informed consent
Pre test analysis using Action Research Arm Test
Intervention-Dual task training along with Conventional Physiotherapy
Dual task training
One fine motor + attention task
One fine motor+executive task
These was done on alternate sessions
Post test analysis using Action Research Arm Test
Results was statistically analyzed

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DUAL TASK TRAINING

Fine motor activities	Attention task	Executive task
Stacking up coins	Continuous subtraction	Presenting virtual situation
Buttoning/Unbuttoning	Simple addition	Explaining the order of wearing clothes
Moving beads	Counting numbers forward and backwards	Talking about daily routine
Writing /Drawing	Reading letters of the word backwards	Making a shopping list
Folding/Unfolding	Continuous addition	Categorization

DATA ANALYSIS

The statistical analysis was done using SPSS 23.0. The categorical variables were represented in frequency and percentage. Numerical variables were presented using mean and standard deviation. Pre post comparison was done using Paired sample t test. A p value <0.05 was considered statistically significant.

Table 1: Distribution based on Age The study sample consisted of 20 participants. The majority (60%) were in the age group of 45–54 years, while 40% were between 55–64 years. The ages ranged from 45 to 60 years, with a mean age of 52.20 ± 6.00 years.

Figure 1: Representation based on age

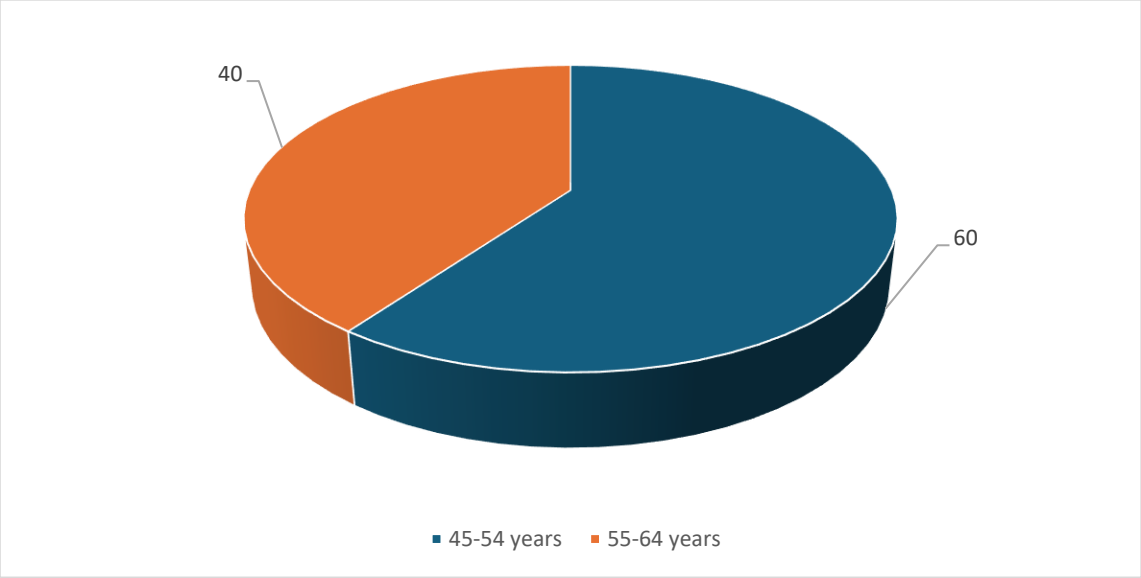


Table 2: Classification based on Gender

	Frequency	Percent
Female	6	30.0
Male	14	70.0
Total	20	100.0

The study included 20 participants, of which 70% were male (n = 14) and 30% were female (n = 6). This indicates a predominance of male participants in the sample.

Figure 2: Representation based on gender

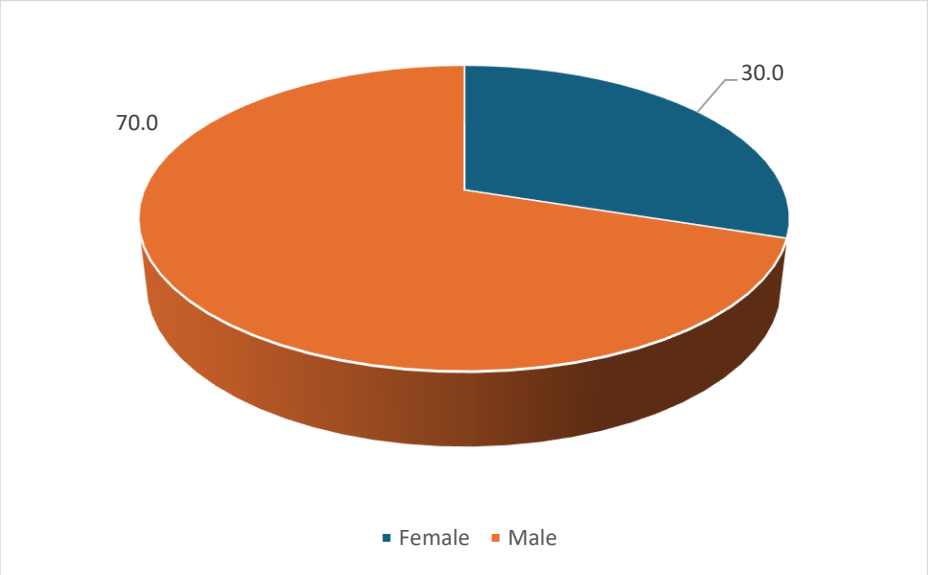
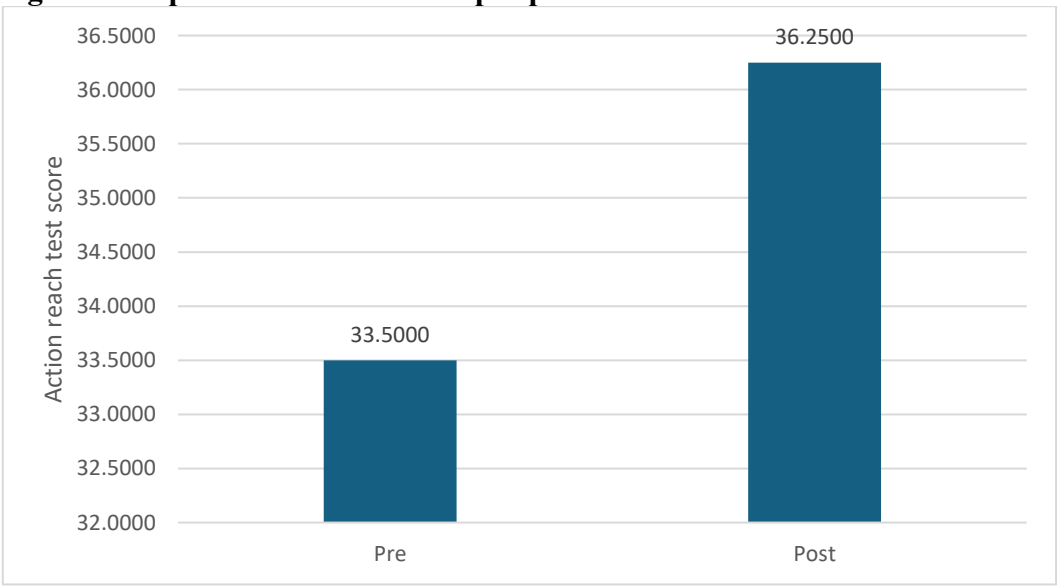


Table 3: Pre –Post comparison in Action Research Arm Test

	Mean	Std. Deviation	Mean difference	t value	p value
Pre	33.5000	8.77496	2.74000	4.41000	p<0.001
Post	36.2500	8.73514			

Table 3 shows the pre- and post-intervention scores of the Action Research Arm Test (ARAT). The pre-test mean score was 33.50 ± 8.77, while the post-test mean score increased to 36.25 ± 8.74. The mean difference of 2.74 indicates a measurable improvement in upper limb function following the intervention. A paired t-test yielded a t-value of 4.410 with a p-value less than 0.001, suggesting that the improvement was statistically significant.

Figure 3: Representation based on pre post score of Action Research Arm Test

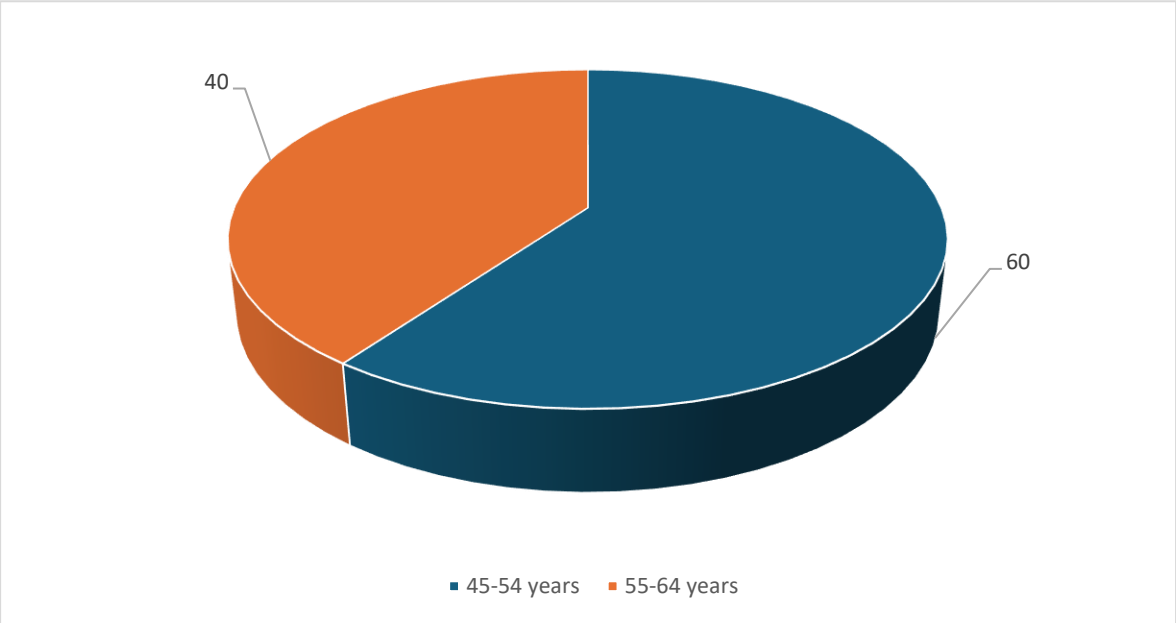


VAR00001

	Frequency	Percent	Valid percent	Cumulative percent
	4	20	20	20
	2	10	10	30
	2	10	10	40
	1	5	5	45
	2	10	10	55
	1	5	5	60
	1	5	5	65
	1	5	5	70
	2	10	10	80
	4	20	20	100
	20	100	100	

VAR00002

	Frequency	Percent	Valid percent	Cumulative percent
Female	6	30.0	30.0	30.0
Male	14	70.0	70.0	100.0
Total	20	100.0	100.0	



Paired sample statistics

		Mean	N	Standard deviation	Standard error mean
Pair	VAR00003	33.5000	20	8.77496	1.96214
	VAR00004	36.2500	20	8.73514	1.95324

AGE RELATED

AGE	FREQUENCY	PERCENT
45-54	12	60
55-64	8	40
Total	20	100

RESULTS

The study aimed to investigate the Impact of dual task training on fine motor skills in subjects with chronic stroke. The statistical analysis was done using SPSS 23.0. The categorical variables were represented in frequency and percentage. Numerical variables were presented using mean and standard deviation. Pre post comparison was done using Paired sample t test. A p value <0.05 was considered statistically significant.

Age Distribution

The majority of participants (60%, n = 12) were in the age group of 45–54 years, while 40% (n = 8) belonged to the age group of 55–64 years. The overall age range was between 45 and 60 years, with a mean age of 52.20 ± 6.00 years.

Gender Distribution

Among the participants, 70% (n = 14) were male and 30% (n = 6) were female, indicating a predominance of male participants in the study.

Action Research Arm Test Scores

The pre-test mean score was 33.50 ± 8.77, while the post-test mean score increased to 36.25 ± 8.74. The mean difference of 2.74 indicates a measurable improvement in upper limb function following the intervention. A paired t-test yielded a t-value of 4.410 with a p-value less than 0.001, suggesting that the improvement was statistically significant.

DISCUSSION

Stroke is a major neurological condition that leads to severe disability in adults and ranks as the third leading cause of death. Over 50% of stroke patients develop sensory and motor deficits in the affected limbs, with one of the main long-term issues being the loss of independent finger movement. 36 Upper limb function depends on both sensory and motor abilities. Motor skills are categorized into gross and fine movements, with dexterity representing a fine motor skill that enables voluntary object manipulation. 37 This study aimed to assess the impact of dual task training on fine motor skills in chronic stroke patients. The findings indicated that after the treatment there was a significant improvement of the fine motor skills in stroke patients.

In this study, the subjects with chronic stroke were taken into consideration based on proper inclusion and exclusion criteria. The patients received intervention in terms of Dual task training for 4 days for 4 weeks with 1 fine motor activity + attention task and 1 fine motor activity + executive task alternative sessions in addition with Conventional Physiotherapy.

The outcome measure used was ACTION RESEARCH ARM TEST. Each component of the scale was assessed on the pre assessment and post assessment and the data was analyzed statistically. Statistical data reveals that there is significant improvement of fine motor skills in stroke patients after the post assessment.

In the present study, the results show the ages of stroke patients which had an average age of 52.20 ± 6.00 years. These findings are in line with the study done by Chuan Hong et al. 38 Yet another study done by Jun Hwan Choi et al 39 shows similar results corresponding to age. These findings are in line with the study done by Umair Ahmed et al40. Yet another study done by Yan ci Liu et al 41also shows similar results. This study done is in line with the study done by Mina Sadat Mirshoja et al42

In this present study, the overall gender outcome indicates that the study consists of 70% males and 30% females with a total of 20 participants. A study done by Jun Hwan Choi et al (38)yields similar results stating that prevalence of stroke is higher in males than females. Yet another study done by Turtzo LC et al43also shows similar results. These findings are in line with another study done by Pandian JD et al.44Another study done by Hussen Abdu et al45also shows similar results.

This study aimed to determine the impact of dual task training on fin motor skills on chronic stroke patients.The pre-test mean score was 33.50 ± 8.77, while the post-test mean score increased to 36.25 ± 8.74. The mean difference of 2.74 indicates a measurable improvement in upper limb function following the intervention.

Dual task training in fine motor skills refers to a rehabilitation technique where an individual performs a fine motor activity with a cognitive task to improve the efficiency and accuracy while engaging the brain in a secondary task, enhancing cognitive processing and neural pathways involved in motor control. This study is in line with the study done by Y Goverover PhD OT et al 46 which shows similar results corresponding to fine motor skills in Multiple Sclerosis. Yet another study done by Yi Xiao et al 47shows similar results corresponding to Parkinson disease in fine motor skills. The study done by Hee Su An et al 48 shows similar results corresponding to fine motor skills in stroke patients.

CONCLUSION

This study was based on Impact of Dual task training on fine motor skills in chronic stroke patients. The patients were selected based on proper inclusion and exclusion criteria. A total of 20 patients with an inclusion of 14 males and 6 females were in the study. The patients were assessed with Action Research Arm Test and the treatment was given for 4 days for 4 weeks with a alternate session of 1 fine motor activity + attention task and 1 fine motor activity + executive task. After 4 weeks of treatment, the patients were reassessed using the Action Research Arm Test to evaluate their improvement. The statistical data reveals that there is a significant improvement of fine motor skills in chronic stroke patients.

LIMITATIONS

- Sample size was small
- Age criteria was limited (45-60 years)
- This study includes only chronic stroke patients
- Duration of study was less
- Lack of family support, social withdrawal, financial concerns

RECOMMENDATIONS

- Extend the study duration
- Increase the sample size for more reliable findings
- Integration of advanced assessment tools
- Conduct follow ups to assess long term effects

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