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RESEARCH ARTICLE

Impact of Upper Extremity Training Under Partial Supervision on Functional Recovery in Stroke Patients

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ABSTRACT

Background: Stroke, a major cause of disability, often results in upper limb dysfunction, impaired daily activities, and reduced independence. Rehabilitation strategies, including home-based interventions, have shown promise for enhancing motor recovery during the subacute phase of stroke. This study aimed to evaluate the efficacy of home-based upper-extremity training on functional recovery in patients with subacute stroke. **Methods:** A quasi-experimental design was employed with 30 participants aged 40-70 years diagnosed with subacute stroke (30-150 days post-stroke). Participants underwent six weeks of home-based upper extremity training, focusing on functional, goal-directed exercises using minimal equipment. Pre- and post-intervention functional recovery were assessed using the Fugl-Meyer Assessment (FMA), Action Research Arm Test (ARAT), and Chedoke Arm and Hand Activity-9 (CAHAI-9). **Results:** Significant improvements were observed in the ARAT, FMA, and CAHAI-9 scores (mean increases: 3.3, 3.47, and 4.43, respectively). These results indicate substantial functional gains in upper limb mobility, strength, and daily activity performance after six weeks of home-based training. **Conclusion:** This study contributes to the growing evidence supporting home-based rehabilitation as an effective, cost-efficient alternative to traditional rehabilitation methods, particularly for subacute stroke patients with limited access to institutional care.

Keywords: Stroke Rehabilitation; Home-Based Training; Upper Extremity; Functional Recovery; Sub-Acute Stroke

1 INTRODUCTION

The abrupt loss of neurological function brought on by a disruption in blood flow to the brain is known as a stroke or brain attack. This can be brought on by ischaemia, apoplexy, embolism, or leakage, which happens when a vein bursts and blood spills into or around the brain. The intense stage is regarded as a sub-acute stage of stroke that lasts from the hour of start to one month to six months, whereas the stage lasting more than six months is regarded as a chronic stage.[1]

One of the most common disabilities in stroke is upper limb dysfunction, with 85% of survivors experiencing hemiparesis immediately after stroke and 55% to 75% continuing life with motor deficits. Stroke patients often experience impaired arm function, characterized by weakness, reduced hand skill, and unusual movements, which can significantly hinder their ability to perform daily living tasks.[1,2] For everyday life activities, stroke victims may require some help or be totally reliant on family members or caretakers.[3,4] The prevalence of stroke also varies significantly across different regions of India, influenced by socioeconomic conditions and access to healthcare.

Diabetes plays a particularly significant role, with diabetic individuals facing more than twice the risk of stroke than non-diabetic individuals. The presence of additional comorbidities, such as cardiovascular diseases, further increases the stroke risk in these patients.[5] Therefore, to write or grasp a glass of water can be difficult or even impossible. The main goal of rehabilitation, agreed upon by both the patient and therapist, is to boost the upper limb capabilities. Research has repeatedly demonstrated that repetitive goal-directed training is a highly successful strategy for enhancing stroke-related upper limb rehabilitation outcomes. Additionally, rehabilitation is a crucial aspect in treating patients with disabilities. It is recommended to conduct a thorough evaluation, involving experts such as occupational, physical, and speech therapists, to grasp the patient's requirements

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and take into account the psychological and social factors that impact their condition.[6,7] "Training or intervention that utilizes common everyday activities which have meaning for the patient or client both intrinsically and extrinsically" is how Hubbard et al. defined task-oriented training procedures. additionally created the 5-R criteria to describe task-specific training: Repetitive, random, relevant, reinforcement, and reconstruction of the overall task by breaking it down into smaller parts are all important aspects of training.[8]

Full recovery of daily living skills takes at least 6 months after a stroke and is influenced by multiple factors, such as age, gender, motor weakness, and cognitive difficulties.[9–13] Several studies have shown that home-based upper extremity training can yield significant improvements in motor function, but evidence specific to the subacute stroke population remains limited. Given the neuroplastic potential during this recovery phase, it is important to explore whether home-based interventions can effectively support functional recovery of the upper limbs, improve patient outcomes, and reduce reliance on institutional rehabilitation. This study aimed to assess the efficacy of home-based upper-extremity training on functional recovery in patients with subacute stroke.

2 MATERIALS AND METHODS

The study employed a quasi-experimental design involving 30 participants, comprising 14 females and 16 males within, age group–40-70 years. Patients with a sub-acute stroke diagnosis (within 30–150 days) were included, while those with dementia, a history of stroke, mental retardation, chronic pulmonary disease, or other neurological problems were excluded. This research was conducted at the Krupanidhi Physiotherapy Centre in Bangalore. Approval was obtained from the Institutional Ethics Committee (IEC). The participants provided written consent and were evaluated using the Fugl-Meyer Assessment (FMA) to assess their sensory-motor recovery after a stroke. Additionally, upper limb abilities were measured using the Chedoke Arm and Hand Activity-9 (CAHAI-9) and the Action Research Arm Test (ARAT).

The participants underwent a training regimen that consisted of a conventional exercise protocol followed by a series of functional, goal-directed home exercises performed regularly to enhance the functioning of their affected upper limbs. To complete these exercises, individuals required minimal and affordable equipment (ball, zipper, towel, paper clips, hand gripper, blocks, and Lego). The exercise protocol aimed to improve the range of motion (stretching and active motions), gross and fine motor skills, and overall ability to perform daily living tasks. Activities were designed to mimic real-life scenarios (e.g. folding, buttoning, pouring, and lifting) and stimulate the specific skills needed for independence in daily activities.

The therapy comprised three sets of five repetitions, with each session lasting for 60 minutes. For the first week, sessions were held six days a week, and for the following five weeks, three days a week. Once the 21 sessions were completed, the recorded data were statistically analyzed using SPSS 16.0. Significance was assessed at the 5% level of significance, with a p-value of 0.05. Statistical significance was set at $P < 0.05$.

3 RESULTS

Thirty individuals, comprising both males and females, took part in the study, with an average age of 58.7 $\pm$ 7.13 years in which 53.33% were male and 46.7% were female patients. The mean time since the stroke was 2.4 $\pm$ 1.19 months (Table 1).

Table 1: Demographic and Clinical Characteristics of the patients studied

n	Age (years) Mean $\pm$ SD	Gender		Time since Stroke (months) Mean $\pm$ SD
		Male	Female	
30	58.7 $\pm$ 7.13	16	14	2.4 $\pm$ 1.19

Table 2: Comparison of mean of ARAT, FMA (UE), and CAHAI-9 scores before and after intervention

Outcome scores	Baseline (M $\pm$ SD)	After intervention (M $\pm$ SD)	't' value	df	P-value	Table value
ARAT	32.97 $\pm$ 1.992	32.97 $\pm$ 2.35	5.41	29	<0.01*	2.045
FMA (UE)	41.43 $\pm$ 1.583	44.9 $\pm$ 2.32	2.49	29	<0.01*	2.045
CAHAI-9	35.67 $\pm$ 2.42	40.1 $\pm$ 2.42	5.14	29	<0.01*	2.045

*Significant

Table 2 presents the initial and follow-up data for all the outcome measures. At the outset, the ARAT score was 32.67 $\pm$ 1.99, the FMA score was 41.43 $\pm$ 1.58, and the CAHAI-9 score was 35.67 $\pm$ 2. All participants were right-handed before the stroke.As expected, in the sub-acute phase after stroke, significant improvements were observed in the ARAT, FMA, and CAHAI-9 scores compared to the baseline. Following the intervention, the ARAT score were 35.97 $\pm$ 2.35, the FMA score was 44.9 $\pm$ 2.32, and the CAHAI-9 score was 40.1 $\pm$ 2.42, respectively. The mean differences between the baseline and post-test scores were 3.3 for ARAT, 3.47 for FMA, and 4.43 for CAHAI-9. Notably, the CAHAI-9 score showed the greatest improvement after intervention. Following the analysis of outcome measures from pre-intervention to post-intervention, ARAT, FMA, and CAHAI 9 scores showed a substantial increase after the intervention. Consequently, all

participants achieved significant functional improvements through training within the 6-week intervention period.

4 DISCUSSION

The current study set out to assess the functional performance of the paretic upper limb in patients who had suffered a subacute stroke following home-based upper-extremity training. Following six weeks of intense at-home training, the patients' upper extremity function improved in a way that was both statistically and clinically significant. The current study supports earlier investigations that showed how beneficial home-based rehabilitation is for stroke victims.

According to a comprehensive review by Gelaw et al., home-based rehabilitation helped people with physical disabilities—including stroke survivors—improve their physical function.[14] The viability and beneficial effects of such therapies were further supported by Beyazit and Koç's pilot trial, which demonstrated that structured home-based exercise programs dramatically improved activities of daily living (ADL) in sub-acute stroke patients.[15]

The present study further confirms these findings, suggesting that home-based training is a viable and cost-effective alternative for improving upper limb function in stroke recovery. Compared to more traditional physical therapy-based rehabilitation, which has been widely documented for its effectiveness, the present study found that home-based programs could offer similar, if not superior, outcomes. A recent systematic review and meta-analysis confirmed that physical therapy-based interventions significantly improved upper limb motor function, as evidenced by increased Fugl-Meyer Assessment scores and other functional measures. However, these conventional methods often incur high costs and logistical challenges, thereby limiting their accessibility. In contrast, the present study emphasizes the advantages of home-based rehabilitation, which requires minimal equipment and is more accessible to patients, especially in settings where hospital-based rehabilitation might not be feasible. Therefore, the findings of the present study contribute to the growing body of evidence suggesting that home-based rehabilitation programs may serve as feasible and effective alternatives, particularly for patients in the sub-acute phase.

The results of the present study also align with research into robotic therapy and functional electrical stimulation, although these interventions are less commonly utilized in sub-acute stroke rehabilitation due to cost and availability. Doumen et al. noted that while robotic therapy and functional electrical stimulation show promise, their superiority over standard care during the sub-acute phase of stroke recovery remains unproven.[16] In comparison, home-based rehabilitation offers a more accessible, low-cost alternative with similar effectiveness, especially when combined with innovative methods such as multi-sensor fusion to track patient progress, as used in this study. These findings suggest that home-based training could serve as an equally viable, if not superior, approach compared to more specialized rehabilitation techniques that are not universally accessible.

While the current study showed promising results, it also highlights some challenges associated with home-based rehabilitation. Gelaw et al. pointed out that home-based programs require significant patient motivation and consistent follow-up to achieve the best outcomes, which can be more difficult to maintain in a less structured environment.[14] However, the present study's success further supports the notion that home-based programs can overcome these challenges when designed properly. The convenience and reduced cost of home-based interventions make them particularly attractive in settings in which hospital-based care is not an option. This view is evident by Beyazit's study, who demonstrated the feasibility and benefits of home-based rehabilitation, particularly in low-resource settings.[15]

The significant improvements in functional recovery reported in the present study were evidenced by increases in the ARAT, FMA, and CAHAI-9 scores, with mean increases of 3.3 (ARAT), 3.47 (FMA), and 4.43 (CAHAI-9). These results are consistent with studies by Stangenberg-Gliss et al., which also demonstrated significant functional improvements in stroke survivors using home-based interventions.[17] And Toh et al. found that home-based interventions generally yielded better outcomes than conventional therapy, with a standardized mean difference of 0.28 in upper limb function, further supporting the effectiveness of home-based rehabilitation strategies.[18]

However, variability in the effectiveness of different home-based rehabilitation methods deserves attention. Several studies, including Stangenberg-Gliss et al. and Westlake et al., have highlighted that technologies such as telerehabilitation and self-managed programs can vary in effectiveness, with some demonstrating higher success rates than others.[17,19] Technology-assisted interventions such as virtual reality and gamified exercises have also been shown to enhance patient engagement and improve outcomes, an aspect that could potentially be incorporated into home-based rehabilitation to further improve results. These findings underscore the importance of intervention design and patient adherence in determining the success of home-based rehabilitation programmes.

Notwithstanding these encouraging results, the current study has many drawbacks. The lack of a control group and the small sample size were significant limitations that impacted how broadly the findings could be applied. Furthermore, even though the study showed notable gains following a six-week intervention, there was no follow-up to evaluate long-term impacts, which is a crucial knowledge gap regarding the long-term effects of home-based rehabilitation. Larger studies using standardized outcome measures, as recommended by Toh et al. and

Stangenberg-Gliss et al., are necessary to confirm the long-term efficacy of home-based rehabilitation.[17,18] And also, the variability in the types of home-based interventions and adherence rates across studies indicates that further research is needed to optimize these rehabilitation programs and maximize their effectiveness, as noted by Westlake et al.[19]

5 CONCLUSION

Findings for this study showed that home-based upper extremity training significantly improved functional recovery in subacute stroke patients, as evidenced by notable increases in ARAT, FMA, and CAHAI-9 scores. These findings suggest that home-based rehabilitation is a viable and cost-effective alternative to traditional rehabilitation methods, especially for patients in the subacute phase. However, further studies with larger sample sizes and long-term follow-up are necessary to better understand the sustained effects and optimize the design of home-based interventions for stroke recovery.

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