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EVALUATING THE EFFECTIVENESS OF COGNITIVE REHABILITATION ON COGNITIVE PERFORMANCE

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Abstract
This study examined the effectiveness of cognitive rehabilitation exercises in improving general cognitive functioning among stroke patients. A quasi-experimental design was employed with a sample of 40 stroke patients recruited from government and private hospitals in Lahore. Participants were randomly assigned to an experimental group (n=20) and a control group (n=20). Cognitive functioning was assessed using the Mini-Mental Status Examination (MMSE) at both pre- and post-intervention stages. The experimental group received targeted cognitive rehabilitation exercises aimed at enhancing cognitive abilities, while the control group received no such intervention. Paired sample t-test analysis revealed significant improvements in cognitive functioning within the experimental group, whereas no notable change was observed in the control group. These findings highlight the potential of culturally relevant, evidence-based cognitive rehabilitation approaches in supporting stroke recovery, with implications for clinical practice, caregivers, and rehabilitation programs.

INTRODUCTION

Brain vascular diseases are among the most prevalent neurological conditions. Among the vascular illnesses of the brain, stroke is a very significant condition. It frequently affects the brainstem, parietal and frontal lobes, which can be thought of as impairments in language, memory, and concentration (Yoo et al., 2015). Neurological disorders are often associated with neurocognitive deficits (e.g., Fatima, 2019a,b). Stroke, as a neurological condition, damages the blood vessels in the brain, which reduces the effectiveness of synaptic connections in the brain's neurological system impacting the neurocognitive functions such as concentration, visual spatial skills, speaking, reasoning, and executive functions like problem solving (Yoo et al., 2015). Among adults, stroke is one of the main causes of lasting acquired disability (Ma et al., 2014). Stroke incidence has risen by 24% for people over 50 and 13% for people over 60 years in the past ten years, even though strokes are most common people in 70 and older (Renton et al., 2017). After a stroke, individuals usually enroll in rehabilitation programs for the treatment of a variety of cognitive, emotional, and physical impairments (Panel, 2006). Though 40% of stroke survivors report a loss in cognitive functions (particularly memory) following the incidence of stroke, there aren't many published studies that specifically target cognitive rehabilitation for such patients.

Literature reports different types of strokes. Among these, transient Ischemic Stroke, warning indicators may occasionally appear, persist for a brief period of time, then disappear. Transient ischemic attacks are very brief occurrences that are frequently referred to as mini strokes (Sheet, 2016). Ischemic stroke, according to pathophysiology, occurs when blood flow to an area of the brain disturbs, causing some degree of irreparable neurological damage. The most

prevalent category of stroke, an ischemic stroke occurs by a congested blood vessel in the brain or neck (Wallace, 2016). A clot that forms inside a blood vessel in the brain or neck (called thrombosis); a lump that travels from an alternative area of the body, such the heart, to the brain (called an intercalation); or an acute contraction of an artery in or leading to the brain (called stenosis) can all be source of blockage. Around 85% of stroke victims pass away from ischemic obstructions, through intracerebral hemorrhage considering for the left-over fatalities. In the brain, ischemic occlusion is the consequence of thrombotic and embolic conditions (Musuka et al., 2015). Almost 10-15% of the strokes are hemorrhagic strokes, which consume a high death proportion. Blood vessels rupture in this disease as a consequence of inner injuries as well stress in the brain tissue. It affects the vascular system to develop toxicity, which leads to infarction (Flaherty et al., 2005).

Prevalence of Stroke and the Current State of Healthcare in Pakistan

In low- to middle-income countries, the total number of cases of stroke increased by 20% during the past ten years (Danaei et al., 2011). About one in four persons in Pakistan, a low- to middle-income country, suffers from hypertension, type II diabetes, or cardiovascular disease; due to these extremely common factors, Pakistanis are particularly vulnerable to stroke (Jafar et al., 2016). An estimated 250 cases per 100,000 people is the annual incidence, which translates to 35,000 new cases annually (Khalid et al., 2016). The severe effects of stroke extend to social, physical, and psychological domains (Srivastava et al., 2010). Two third of Pakistan's population cover their own medical costs out of pocket (Nishtar et al., 2013). The stroke caregiver is frequently a close relative as there are neither professional chronic home support services nor inpatient rehabilitation programs (Rathore et al., 2013).

Stroke presents major problems to individuals and healthcare systems worldwide as it is a primary reason of impairment and death. Stroke is one of the most common non-communicable illnesses that kill people in low- and middle-income nations like Pakistan (Dans et al., 2011). Due to a lack of neurology specialists, inadequately developed neuro-rehabilitation services, and cultural norms that cause delays in seeking care for stroke-related consequences, these post-stroke problems are frequently poorly handled in Pakistan. As of 2020, there are only about 200 neurologists for every 200 million people in the nation, and there are only 80 qualified rehabilitation medicine doctors working all over the country. There are currently just ten specialized stroke centers in Pakistan, despite efforts by the Pakistan Stroke Society to enhance stroke services in the nation (Farooq et al., 2021). Furthermore, Pakistan's stroke fighters still have struggle getting access to quality rehabilitation treatments, despite enhancements in medical expertise and treatment techniques. Persons with stroke in the Pakistan face more problems as a consequence because of lack of access to health care and socioeconomic differences (Jafar et al., 2016).

Cognitive Impairment after Stroke

The term, cognitive impairment, defines an extensive variety of deficiencies in decision-making function, linguistic, memory, attention, as well as visuospatial abilities (Lees et al., 2014). Considering the significant implications of neurocognitive functions in wellbeing, quality of life, and other life outcomes (Fatima, Hassan et al., 2024; Fatima, Jamil et al., 2019; Fatima, Mehmood et al., 2022; Meher et al., 2024), it is important to develop cognitive rehabilitation programs focusing on improvement of cognitive functions in patients with stroke.

Typically, after a stroke, cognitive damage can have a main share in predicting standard of life and lasting prognosis. Following a stroke, cognitive damage is related to higher rates of hospitalization, increased impairment, as well dependence on daily life tasks. Individual differences exist in the degree and nature of cognitive impairments; some may have moderate impairments, while others may experience more severe symptoms resembling dementia (Sachdev et al., 2006).

Significant functional and cognitive impairment may result following a stroke. Memory, attention, executive functions, and social behavior impairment are the primary cognitive symptoms. The most prevalent cognitive symptoms following brain damage in the chronic phase were executive function

impairment (75%), attention disorder (82%), and memory impairment 90%, according to national epidemiological cohort research (Nakajima et al., 2016). Unfortunately, post-stroke cognitive impairment can appear in a variety of ways. Along with demographic and socioeconomic factors, the mechanism of injury is one of several factors that determine the severity and scope of cognitive symptoms. Particularly prevalent, attention problem impairment is observed in 24–51% of individuals at the time of acute care discharge (Hyndman et al., 2008). Beyond the acute phase of recovery, cognitive impairment may continue; for instance, 11–31% of people still have memory impairment a year after a stroke (Cappa et al., 2011). Moreover, these cognitive problems result in major functional limitations, including reduced ability to resume employment and daily functioning, and the requirement for additional support (Brown et al., 2011; Hart et al., 2003).

Neuroplasticity and Cognitive Rehabilitation for Stroke Patients

Neuroplasticity, which is also recognized as neural plasticity or brain plasticity, is a method that includes changeable structure as well as functional modifications in the brain. It is described as the aptitude of the nervous system to modify its action in response to interior and the exterior stimuli by rearranging its functional and structural associations after the trauma like stroke and traumatic brain injury (Mateos-Aparicio & Rodríguez-Moreno, 2019). These alterations can be neutral (no change), pessimistic (may have pathological consequences), or beneficial (restoration for function following injury). These modifications happen throughout life and may become enhanced after an injury (Dancause et al., 2005). Modifications in the structure as well as functions of brain areas and networks, cellular and synaptic alterations, and behavioral changes like increased skill and adaptability are all examples of evidence of Neuro plastic changes (Murphy & Corbett, 2009; Pekna et al., 2012).

Stroke has a major negative effect on stroke survivors' long-term functional independence and is the important reason for acquired impairment in addition to being second important reason of deaths among adults (Karatzetzou et al., 2022). During World War I, cognitive rehabilitation was introduced to help patients with brain impairments for their survival. Based on diagnosis and comprehension of brain and behavioral abnormalities, cognitive rehabilitation is a planned set of healing exercises designed to reeducate memory, attention, and decision-making processes, or generally the cognitive functions (Cicerone et al., 2005). Cognitive rehabilitation treatments can be broadly divided into two categories: computerized rehabilitation and conventional (paper/pencil exercises). The cognitive rehabilitation strategies target improvement in patient's concentration and focus, visual processing, linguistic, recall, problem-solving and reasoning skills, and decision-making function deficiencies.

Among the interventions utilized in cognitive rehabilitation include conversation skills, computer-assisted retraining programs, modeling, distributed practice, guided practice, flawless learning and direct teaching with suggestions, and the use of memory aids. Both one-on-one and small-group settings are possible for the interventions. Cognitive rehabilitation has grown in popularity since 1980s. However, research on the effectiveness of cognitive rehabilitation is lacking in Pakistan. To enhance the cognitive functioning of individuals with chronic brain injuries, numerous attempts have been made in advanced countries to develop training methods and underlying theoretical frameworks. Based on the evaluation and comprehension of the patients' cognitive impairment, cognitive rehabilitation is an organized therapy approach that is functionally oriented (Cicerone et al., 2000). Interventions for cognitive rehabilitation might be restorative, educational, or compensatory (Reinkensmeyer et al., 2016). The goal of restorative therapies, which includes generalized cognitive impairment and domain-specific interventions, is to directly restore the compromised function of patients with post stroke cognitive damage. Adaptive interventions change the environment or the way activity is approached in order to maximize the ability to do important tasks. Thus, despite impairment, adaptive techniques encourage participation in important activities and life responsibilities (Cheeran et al., 2009). Compensatory interventions aim to enhance patients' ability to employ tools and aid to overcome

their disabilities by adapting to their external environment. These techniques are coupled with education-based therapies to help patients and their loved ones gain a better awareness of post stroke cognitive impairment. Pharmacological and non-pharmacological therapies are included in generalized cognitive rehabilitation (El Husseini et al., 2023). Pashang et al. (2021), using a quasi-experimental with a pre-post intervention and follow-up design found that cognitive rehabilitation program improved attention performance in stroke patients and had a positive effect on visual and auditory attention performance in ischemic stroke patients. Moreover, Vafa et al. (2024) concluded based on a quasi-experimental research design that both computer-based and conventional therapy should be utilized to enhance the memory of stroke survivors.

Chen and colleagues explored the effect of visual training through games and cognitive exercises in the stroke patients. Their study findings showed that stroke patients significantly improved in their attention, focus, executive functioning, memory, visual abilities, abstract thoughts and computational ability (Chen et al., 2015). Similarly, Khanjani et al. (2018) found that cognitive rehabilitation improved selective attention but had no effect on executive functioning or divided attention.

Objective and Hypothesis

Based on the literature review, the primary objective of the study was to evaluate the effectiveness of cognitive rehabilitation exercises in improving cognitive functioning of patients with stroke. More specifically, it was hypothesized that cognitive rehabilitation would be effective in improving cognitive functions in patients with stroke.

Method

Participants

The research method was quasi experimental research design. In this study, the participants were patients with stroke with both ischemic and hemorrhagic stroke from private and government sector hospitals of Lahore. Participant selection was made using purposive sampling technique. A total sample of 40 patients was selected and randomly assigned to 2 groups of experimental and control groups with 20 participants in each group. All participants showed cognitive impairment following stroke. Demographic characteristics of the participants have been presented in Table 1. An overview of the demographic characteristics at baseline showed that distribution of the sample in terms of demographic characteristics across control and intervention groups was comparable. For most of the demographic characteristics including age and gender both groups were comparable. Similarly, regarding clinical variables including type of stroke, time since stroke, effected brain region, family history of stroke, and history of psychiatric illness, control and experimental groups were comparable.

Measurements

General Cognitive Functioning

General Cognitive functioning was assessed from Mini Mental State Examination (MMSE) Urdu version (Awan et al., 2015). It is an 11-items tool to assess cognitive functioning of an individual in 6 domains assessing orientation, attention/concentration, short-term memory, language skills, visuospatial skills, and ability to understand and follow instructions. The validity of the Urdu version as a screening instrument for cognitive impairment has been established (e.g., Awan et al., 2015). The tool has been widely used with Pakistani samples to assess general cognitive functioning (Fatima & Batool, 2024). A higher composite score with a maximum potential score of 30 on MMSE represents good cognitive ability and a lower score indicates cognitive impairment.

Procedure

Initially, the study's approval from the Departmental Advisory Committee was obtained from the Department of Humanities, COMSATS University. Then, a proper cognitive rehabilitation plan was designed for a 12-week time duration. The diverse exercises targeting attention, memory, and language skills were designed and included for patients as per the Pakistani cultural context in the cognitive rehabilitation plan. All patients and their caregivers were briefed about the study. Then, the consent of the patients and their guardians was obtained before formal proceedings of the study. Patients in both groups were assessed on MMSE for cognitive

functioning at the baseline level. Then, cognitive rehabilitation intervention was provided to the participants in experimental group for 12 weeks with three sessions per week. Each session with a 60-minute duration was provided in an individual setting for each patient. The control group did not engage in any type of cognitive rehabilitation training throughout the study. During the sessions, the control group only received standard medical care. After 12 weeks of cognitive rehabilitation intervention, participants in both groups were reassessed at post intervention level on MMSE for general cognitive functioning. All participants were cordially thanked for their cooperation in the study.

Table 1
Demographics Characteristic at Baseline Level for Control and Intervention Group

Variables	Control group (n=20)		Intervention group (n=20)	
	M (SD)	F (%)	M (SD)	F (%)
Gender				
Male		10 (50 %)		10 (50 %)
Female		10 (50 %)		10 (50%)
Age (Years)	47.05 (6.80)		49.65(6.24)	
Education Level (Years)	11.05 (2.39)		11.95(2.78)	
Type of Stroke				
Ischemic Stroke		14 (70 %)		12 (60 %)
Hemorrhagic Stroke		6 (30 %)		8 (40 %)
Affected Hemisphere				
Left		11 (45%)		12 (60%)
Right		9 (55%)		8 (40%)
Time since Stroke (weeks)	8.02 (2.86)		7.6 (3.56)	
Family History of Stroke				
Yes		8 (40 %)		9 (45 %)
No		12 (60 %)		11 (55 %)
Psychiatric History				
Yes		12 (60 %)		7 (35 %)
No		8 (40 %)		13 (65 %)
Previous Cognitive Rehabilitation				
Yes				
No		20(100%)		20 (100 %)

Data Analysis

Descriptive statistics were used to describe descriptive statistics of demographic variables and cognitive functioning. The paired sample t-test was used to compare pre and post intervention scores for both the control and intervention groups.

Results

Table 2

Table 2 provides the descriptive statistics for cognitive functioning as measured by the Mini-Mental State Examination at the baseline level for the control group and the intervention group. The Table indicates that both groups scored similarly on all cognitive domains assessed from MMSE.

Cognitive Functioning Assessed from Mini Mental Status Examination at Baseline Level for Control and Intervention Groups

Variables	Control Group	Intervention Group
	M (SD)	*M(SD)*
Orientation	6.65(1.08)	7.00(.72)
Registration	2.30(.47)	2.45(.51)
Attention & Calculation	2.05 (0.60)	2.45 (0.51)
Recall	1.95 (0.60)	1.65 (0.58)
Language & Praxis	5.00 (1.16)	4.85 (1.34)

The pre- and post-assessment differences in cognitive functioning for the control and intervention groups have been presented in Table 3. The results from the Table showed that participants in the intervention group showed improvement in all cognitive domains at post intervention level following the intervention application. The mean difference score was significant for all five domains for this group. Score for orientation, registration, attention, recall, and language increased notably from a pre-assessment mean score to post-assessment mean score, resulting in a highly significant t-value ($p < .001$). This significant improvement in attention highlights the positive impact of the intervention. While those in control group did not present any significant improvement in any of the assessed domains.

Table 3
Pre and Post Assessment of Cognitive Functioning for Control and Experimental group

	Pre-assessment	Post-assessment			
Groups	M *(SD)*	M *(SD*	*t(df=19)*	*p-value*	*Cohn's d*
Control group					
Orientation	6.65(1.08)	6.80(.76)	-0.82	0.42	0.10
Registration	2.30(.47)	2.25(.44)	-0.56	0.57	0.09
Attention & Calculation	2.05 (0.60)	2.10 (0.71)	-0.29	0.77	0.07
Recall	1.95 (0.60)	2.00 (0.55)	-0.37	0.71	0.08
Language & Praxis	5.00 (1.16)	5.00 (1.29)	0.00	1.00	0.00
Intervention group					
Orientation	7.00(.72)	8.30(.65)	-8.85	0.00	2.00
Registration	2.45(.51)	2.95(.22)	-4.35	0.00	1.18
Attention & Calculation	2.45 (0.51)	3.55 (0.51)	-11.00	0.00	2.15
Recall	1.65 (0.58)	2.40 (0.50)	-6.09	0.00	1.38
Language & Praxis	4.85 (1.34)	5.90 (1.16)	-3.80	.001	0.79

Discussion

The current study examined the efficiency of cognitive rehabilitation exercises on cognitive functions in patients with stroke. The assessments were conducted using Mini Mental Status Examination. The MMSC gave a general level of each participant's cognitive abilities before and after the intervention. Individuals in the intervention group attended twelve sessions of the cognitive rehabilitation therapy designed to improve cognitive functioning. Overall, the findings showed that participants in the intervention group showed improved performance on MMSE presenting better level of overall cognitive functioning. These findings underscore the efficacy of the cognitive rehabilitation intervention, as evidenced by significant improvements in all five domains of cognitive functioning in the intervention group. In contrast,

the control group did not exhibit significant changes, emphasizing the potential of targeted cognitive rehabilitation to enhance cognitive performance in specific domains.

The study showed that participants in the experimental group showed improvement in orientation and attentional abilities following cognitive rehabilitation. The results supported the hypothesis by providing evidence for the effectiveness of cognitive rehabilitation for improving these cognitive abilities. Previous literature based on empirical evidence supports the findings. For example, Pashang et al. (2020) based on a quasi-experimental design found that cognitive rehabilitation exercises enhance visual and auditory attentional processes in patients with stroke.

Moreover, supporting the study hypothesis the current study observed significant improvement in memory and language functions following cognitive rehabilitation among participants in the experimental compared to control group. Participants in the intervention group showed statistically significant improvement in memory and language functions from pre assessment to the post assessment level. In comparison, the control group did not show significant improvement in both of these functions from pre assessment to the post assessment level. The finding further supports the effectiveness of the cognitive rehabilitation intervention in improving language abilities and memory functions. These findings are supported from a review study by Elloitt & Parente (2014). The authors concluded based on a meta-analysis that cognitive rehabilitation techniques developed to enhance memory were effective therapeutic approaches for neurological patients, particularly patients with traumatic brain injury and stroke. Pertaining to the language function, these findings are similar and consistent with other studies. For example, Breitenstein et al., (2017) showed that stroke patients with chronic aphasia received three weeks of intense speech and language therapy under standard clinical settings. Therapy enhanced their ability to communicate verbally in everyday situations. The findings further showed that intensive speech and language therapy significantly improved language performance in post stroke aphasia patients highlighting the importance of early and intensive intervention. These findings are also consistent with Azimian et al., (2024) who provided evidence for the efficacy of neuropsychological rehabilitation on cognitive and communicative recovery.

The principle of neuroplasticity in the brain, often known as the neuroplasticity theory, explains and supports the current research findings. According to recent research on stroke victims' brain plasticity, spoiled cortical tissues had a great capacity for restructuring (Webster et al., 2006). Neurotic plasticity can also be facilitated by behaviors, ideas, emotions, and environmental stimuli through the activity-dependent plasticity process which is necessary for learning, memory, and brain injury healing, as well as for the growth of healthy persons. Although non-synaptic plasticity refers to modifications in their usual stimulus framework, synaptic plasticity at the cellular level relates to modifications in neural transmission (Keller & Just, 2016).

Limitations, Strengths, and Future Recommendations

The unique strength of the study is that this a priori study in Pakistan evaluating the effectiveness of cognitive rehabilitation exercises in improving cognitive functions in patients with stroke. Given the evidence that the neuropsychological assessment and rehabilitation is only in its initial stages in Pakistan (Fatima & Sharif, 2019), this is a significant step in providing evidence of effectiveness of cognitive rehabilitation from this underrepresented population in literature. However, the findings must be interpreted in light of certain limitations. First, the sample size in both groups was comparatively small, which could limit the generalizability of the findings to a larger population of stroke survivors. A large sample size may provide more robust conclusions. Secondly, the study assessed the efficacy of cognitive rehabilitation on short term basis, leaving the long-term effectiveness of cognitive rehabilitation unexplored. Lastly, a major challenge was the dropout rate of stroke patients in the study over a course of 12 weeks, as some participants did not return for follow up sessions. Future studies are recommended to assess the efficacy of rehabilitation over long term basis using varied and larger samples

to get clearer picture of how cognitive rehabilitation works.

Implications

The finding of this research has significant implications for both practitioners and researchers in clinical and research settings. Considering the significance of wellbeing during adversities and health crises (Fatima et al., 2022), it is imperative to develop rehabilitation programs for improving quality of life and wellbeing of patients. The results from this study emphasize the need for healthcare professionals in Pakistan to incorporate structured cognitive rehabilitation programs into their standard care for stroke patients. The study underscores the importance of developing cognitive rehabilitation services at hospitals and rehabilitation centers, ensuring that such intervention is accessible to stroke survivors across the country. Since no previous work in Pakistan has focused on developing or implementing the cognitive rehabilitation for stroke survivors, it gives hope to future patients by showing that cognitive recovery is possible for their better quality of life. Over time, these findings can help develop more advanced programs that are accessible to diverse clinical populations. From a research perspective this research provides avenues for further exploration into cognitive rehabilitation in Pakistan.

Conclusion

This study was conducted to explore the effectiveness of cognitive rehabilitation on cognitive deficits in individuals with stroke. The study assesses the effectiveness of cognitive rehabilitation by comparing participant's cognitive abilities before and after the intervention using pre assessment and post assessments. In general, the findings of the present study indicated that cognitive rehabilitation therapy significantly improved cognitive abilities in individuals with stroke. The results suggest that structured cognitive interventions focusing on cognitive domains may play a critical role in enhancing cognitive functioning and quality of life for stroke patients. Therefore, it is recommended to integrate cognitive rehabilitation programs as part of the standard care for individuals with stroke, particularly focusing on cognitive tasks. Further research should evaluate the long-term benefits of these interventions and explore their efficacy across diverse populations.

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