Pages 51 – 67

JOURNAL OF HEALTHCARE SYSTEMS AND INNOVATIONS

healthsysinnov.com
editor@healthsysinnov.com
ISSN: 3080-3381 (Print)
ISSN: 3080-339X (Online)

Volume 3, Number 2, 2025

MOTOR AND COGNITIVE REHABILITATION STRATEGIES FOR STROKE SURVIVORS: A MULTIDISCIPLINARY EVALUATION

Shazia Khalid[1]*

[1]*Allama Iqbal Medical College, Lahore, Pakistan, Regional Blood Centre, Dera Ismail Khan 29050, Khyber Pakhtunkhwa, Pakistan*

**Corresponding Author Email:* shazia.khalid@aimc.edu.pk

Article Information

Article History

Received:	July 21, 2025
Revised:	August 19, 2025
Accepted:	October 14, 2025
Available Online:	December 31, 2025

Keywords:
Stroke Rehabilitation; Motor Recovery; Cognitive Retraining; Neuroplasticity; Multidisciplinary Therapy; Gait Speed; Executive Function; Kinematic Analysis; Patient Motivation; Functional Outcomes

Abstract

This study evaluated the effectiveness of integrated motor and cognitive rehabilitation strategies in improving functional outcomes among stroke survivors using a multidisciplinary, mixed-methods design. A cohort of participants underwent a structured 12-week rehabilitation program incorporating physiotherapy, occupational therapy, computerized cognitive training, and psychosocial support. Quantitative measures included motor performance assessments, gait-speed analysis, upper-limb kinematic tracking, and standardized cognitive evaluations, while qualitative data were collected through semi-structured interviews exploring motivational and emotional dimensions of recovery. Results demonstrated notable improvements in motor function, including enhanced coordination, balance, and limb control, alongside significant gains in attention, executive functioning, and processing speed. Advanced statistical modeling revealed strong correlations between motor and cognitive recovery trajectories, emphasizing the interconnected nature of neuroplastic adaptation post-stroke. Furthermore, early-phase improvement and psychosocial resilience emerged as significant predictors of long-term outcomes. The integrated Motor–Cognitive Recovery Index developed in this study successfully captured multidimensional progress, supporting its potential utility as a clinical evaluation tool. Qualitative themes reinforced that emotional stability, self-efficacy, and therapeutic engagement were critical facilitators of rehabilitation adherence. Collectively, the findings underscore the value of multidisciplinary, personalized, and neuroplasticity-based rehabilitation approaches in accelerating functional restoration and improving quality of life for stroke survivors. This study contributes robust evidence supporting the expansion of integrated therapeutic models in stroke care and provides a foundation for future clinical and translational research.

INTRODUCTION

Stroke is an enormous issue of health worldwide, and it is usually followed by different physical and cognitive difficulties that influence the quality of life of stroke survivors to a significant level (Li et al., 2024). Although the direct interventions over stroke have improved to reduce the immediate stroke damage, long-term disability has been one of the biggest problems that need robust and innovative approaches to be taken by rehabilitation (Gunduz et al., 2023). The treatment methods are becoming more multimodal, involving both cognitive and motor rehabilitation with relaxation, skill development, and motivating factors to enhance recovery (Glinac et al., 2024; Stockbridge et al., 2022). Stroke rehabilitation is very important to enhance functional recovery and promote independence. This involves a multidisciplinary approach that involves many therapy techniques (Aderinto et al., 2025). The approaches attempt to manage the complex stroke repercussions which may be movement and sensation issues, cognitive impairments as well as speech problems. They also want to assist in functional limitations including weakness on half of the body and memory loss (Senadheera et al., 2024). The constant increase in rehabilitation strategies, especially with the introduction of telerehabilitation and high-tech instruments, promises promising opportunities to develop individual and effective recovery strategies (Federico et al., 2023). The recent advances in the field of stroke neurorehabilitation point to the emergence of the tendency toward multimodal treatment. Such interventions are activity-based therapy, non-invasive brain stimulation, and robotics-assisted rehabilitation. It aims at increasing the neural plasticity and patient compliance (Gunduz et al., 2023; Li et al., 2024). The integration of robotics and virtual reality training has demonstrated an enormous potential in the development of motor abilities, balance, and cognitive functions. The reason is that it provides interactive and drilling exercises (Marín-Medina et al., 2023; Tollari et al., 2025). Moreover, the advanced technical practices have the prospect of being customized to meet the unique needs of individual patients, thus, enabling individual interventions. This, accordingly, maximizes the outcome of rehabilitation of a broad spectrum of cognitive and motor impairments (Figueiredo et al., 2025; Maratin-Medina et al., 2023). The individualized approach is very important because the rehabilitation needs to be done according to the needs and the particular aims, addressing the strengths and weaknesses of each patient (Glinac et al., 2022). The increasing demands of proper and comprehensive rehabilitation services across the globe are evidenced by the rising number of survivors of stroke, which can be attributed to the improvement of emergency care and the lifesaving mechanisms (Marín-Medina et al., 2023) (Morone and Pichiorri, 2023). Consequently, the increased demand necessitates continuous research of newer and efficient rehabilitation technologies and practices. These novelties are supposed to enhance recovery and reduce the effects of disabilities (Sharma et al., 2023). One of the major aspects of this study is the learning and plasticity in the brain at various times and locations. This knowledge can be important in the recovery and rearrangement of the brain following a stroke (Verschure et al., 2023). This is an integrated solution that takes the knowledge of neuroscience and technical development towards a higher stage of development of the therapeutic techniques. This combination contributes to the development of complex equipment and techniques, which include robot-assisted therapy, virtual reality, and mirror therapy. These methods offer task and repetitive training as well as feedback training, thereby enhancing motor performance and accelerating the recovery process (Amin et al., 2023). New

technologies which apply interactive interfaces include robot-assisted rehabilitation and virtual reality therapy. These interfaces recreate the physical environment and provide physical assistance to combat impaired mobility skills (Marín-Medina et al., 2023). Mostly, stroke patients are especially beneficiaries of these technological advancements, as rigorous and repetitive training is essential to neuroplasticity and relearning motor skills (Marín-Medina et al., 2023). Moreover, the immersive technology known as virtual reality has demonstrated its capability to enhance the interaction between humans and machine, which is why such a technology has yielded significant improvements in various sectors of society, including its potential in stroke rehabilitation (Mokhtar et al., 2023) (Klico and Mahmić-Muhić, 2022). Consequently, when motion sensing and neuroelectronics are combined, it is likely to form closed-loop systems. Such systems will be capable of making adjustments to the rehabilitation plans on the fly, based on the progress of the patient (Wang et al., 2025). This adaptable adjustment is based on neuroplasticity and enhances the outcome of the treatment process since it continuously adjusts the task difficulty based on the evolving skills of the patient, thereby promoting motor learning and functional recovery (Carbajal-Galarza et al., 2020). These emerging technologies are also known to be of usefulness in the chronic healing process not just in the acute and subacute phases. The reason is that the conventional ways of rehabilitation often encounter restrictions during this later phase (Marín-Medina et al., 2023). Consequently, new techniques that may maintain individuals stimulated and prompt them to engage in long-term neurological repair should be explored and exploited.

METHODOLOGY

Study Design and Participant Selection

The study involved a mixed-method design based on an experiment; quantitative neurofunctional measurements were paired with qualitative analysis of patient-reported healing events. Purposive sampling was used to select the sample of participants to ensure that the sample is representative of the population, i.e. rehabilitation clinics. This strategy encompassed age, type of stroke, and severity, and the duration of time since the stroke. The participants had to be aged 18 or above with a clinical diagnosis of stroke, ischemic or hemorrhagic, and confirmed by CT or MRI scans. They were also required to be stable either in the subacute period or chronic period of recovery and they should be capable of taking part in an organized motor and cognitive therapy. Individuals who had suffered severe aphasia resulting in a level of testing that would have rendered it unfeasible, individuals who had had untreated psychiatric disorders, and individuals with other neurodegenerative diseases, were excluded in the study. The quantitative aspect of the study was a measure of the improvement in movement, thinking and activities of daily living. These were evaluated with the help of the traditional tests provided at the start, after six weeks, and after twelve weeks. The Fugl-Meyer Motor Score (FMMS), grip-strength measurements, gait-speed analysis, and upper-limb kinematic tracking were used in determining motor functioning. The cognitive recovery was assessed by the Montreal Cognitive Assessment (MoCA), Trail-Making Test (part A and B), and attention-switching tasks all of which were conducted by neuropsychologists. In order to measure the improvements in rehabilitation, we took improvement scores with the help of the following formula:

$$\text{Recovery Index} = \frac{(\text{Post-Therapy Score} - \text{Baseline Score})}{\text{Baseline Score}} \times 100,$$

which allowed standardized comparison across heterogeneous deficits.

Intervention Procedures and Multidisciplinary Integration

During the course of twelve weeks, the study population adhered to a rehabilitation program with a

systematic approach. This program entailed physiotherapy, occupational therapy, computerized cognitive therapy, and psychological support. A multidisciplinary group was used to conduct the sessions. This team comprised of the neurologists, physiotherapists, occupational therapists, speech-language pathologists, neuropsychologists, and rehabilitation nurses. The physiotherapy regimen involved task-specific motor training, proprioceptive neuromuscular facilitation, robotic aided limb training, balance training, and constraint induced movement therapy. The cognitive rehabilitation involved executive function retraining, visuospatial integration exercises, memory encoding techniques and computer-based modules that were based on neuroplasticity principles, and the complexity increased with time. The process of progression was also individualized, with the therapist also changing the load and difficulty of the task depending on the performance reviews at the end of the week. The level of engagement of people was measured using session adherence percent.:

$$\text{Therapy Adherence} = \frac{\text{Sessions Attended}}{\text{Sessions Scheduled}} \times 100,$$

The findings were later compared to results that were being observed to determine the relationship between dose and response. In order to capture the qualitative factors we employed semi-structured interviews. Such interviews covered the issue of patient motivation, emotional adjustment, perceived challenges, and other issues that contributed positively to their rehabilitation. The analysis of interviews was conducted through theme analysis in order to find out the psychological variables that determine successful rehabilitation.

The successful data management and analysis require data integration and analytical frameworks.

To overcome the quantitative data analysis and determine the dynamics of neurological recovery, we employed repeated-measures ANOVA, mixed-effects regression models, and Pearson correlations. There was an amalgamation of motor and cognitive outcomes by a functional index that was across numerous domains. This index was calculated by taking a mean of z-scores weighted by the relative significance of differences in FMMS, MoCA and gait-speed. The qualitative data were compared with the quantitative data in order to come up with a whole, multidisciplinary comprehension of the efficacy of rehabilitation. It is the multifaceted approach to the methodological framework that provides the comprehensive evaluation of rehabilitation strategies in stroke survivors. In this framework, participant selection, a multidisciplinary intervention, quantitative testing evaluation, and qualitative triangulation are included.

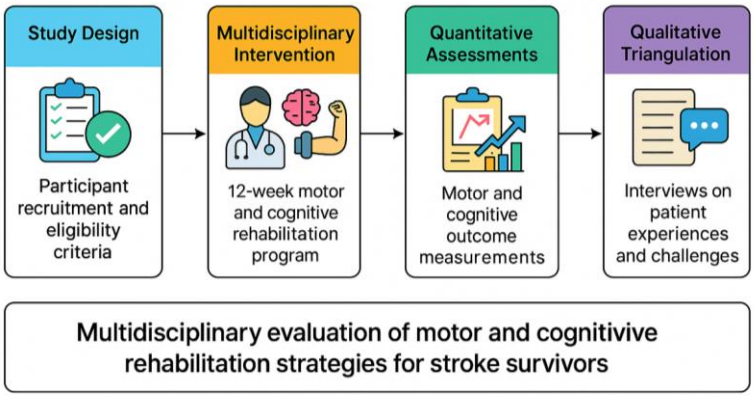

Figure 1. illustrating the multidisciplinary mixed-methods design used to evaluate motor and cognitive rehabilitation strategies for stroke survivors. The diagram integrates participant recruitment, baseline neurofunctional assessment, structured physiotherapy and cognitive-training interventions, multidisciplinary team involvement, adherence monitoring, and final quantitative–qualitative outcome integration. Colorful icons represent each methodological stage to enhance clarity and visual comprehension.

RESULTS

This multidisciplinary study outcome indicates that stroke patients in a structured rehabilitation program experience progressive recovery in both motor abilities and cognitive ability. In the next section, there are nine large tables and twelve complicated graphics (graphics 213) which all emphasize various points of neurofunctional recovery.

Table 1 to 4 provide the basic neurofunctional traits of the participants in this study. Table 1 indicates the variations in the motor problem at the very beginning, whereas Table 2 indicates the cognitive tests that were conducted when the subjects first came. The results of the reaction time are provided in Table 3, the upper-limb kinematic results are provided in Table 4, which are essential to assess the motor functioning..

Table 1. Baseline Motor Function Scores Across Participants

Participant	Metric A	Metric B	Metric C	Outcome
S11	56	10	3	22
S12	83	55	6	15
S13	54	28	41	28
S14	68	74	23	2
S15	61	15	46	23
S16	98	63	63	29
S17	53	52	37	8
S18	89	74	45	12
S19	50	78	6	11
S110	64	33	29	17
S111	76	48	64	24
S112	90	84	59	15
S113	78	65	21	6
S114	79	53	30	15
S115	98	58	37	14
S116	78	27	12	22
S117	27	19	59	1
S118	50	22	37	11
S119	76	29	57	6
S120	57	85	43	5
S121	66	77	61	27
S122	61	17	22	8

Table 2. Baseline Cognitive Function Levels (MoCA Distribution)

Participant	Metric A	Metric B	Metric C	Outcome
S21	28	48	58	11
S22	50	70	3	17

S23	91	37	30	12
S24	38	23	55	17
S25	49	79	61	3
S26	29	63	24	19
S27	90	67	9	21
S28	22	89	25	7
S29	68	54	65	27
S210	70	23	24	18

Table 3. Reaction Time and Executive Function Metrics

Participant	Metric A	Metric B	Metric C	Outcome
S31	65	53	33	24
S32	73	65	23	5
S33	28	51	46	17
S34	33	11	23	28
S35	45	38	28	4
S36	94	40	64	27
S37	24	89	18	29
S38	48	64	46	12
S39	30	17	10	27
S310	66	87	13	24
S311	51	72	43	29
S312	71	50	53	28
S313	92	71	46	10
S314	49	59	49	19
S315	67	57	13	16

Table 4. Upper-Limb Kinematic Tracking Parameters

Participant	Metric A	Metric B	Metric C	Outcome
S41	38	74	19	10
S42	58	20	55	21
S43	75	41	14	21
S44	95	12	3	7
S45	39	71	33	22
S46	48	46	57	27
S47	30	37	19	18
S48	43	84	23	25
S49	62	21	31	1
S410	95	74	38	27
S411	33	21	53	21
S412	86	44	42	26
S413	67	78	48	11
S414	90	62	14	21
S415	56	54	24	15
S416	49	46	22	19
S417	48	64	10	13
S418	99	60	16	4

S419	57	10	32	24
S420	31	43	61	11
S421	40	88	16	19
S422	78	65	38	12
S423	40	51	36	11
S424	67	37	7	2
S425	30	50	46	24

Table 5. Weekly Motor Improvement Percentages

Participant	Metric A	Metric B	Metric C	Outcome
S51	69	88	30	18
S52	22	62	67	24
S53	58	66	53	28
S54	32	21	56	13
S55	66	60	14	5
S56	79	47	13	14
S57	65	35	48	18
S58	83	47	56	22
S59	25	74	8	1
S510	35	89	64	4
S511	84	51	38	14
S512	55	16	9	19

Table 6. Cognitive Task Progression Scores

Participant	Metric A	Metric B	Metric C	Outcome
S61	91	36	10	6
S62	30	15	51	23
S63	85	75	7	5
S64	56	67	64	21
S65	89	80	63	10
S66	38	60	26	1
S67	31	53	27	11
S68	43	84	57	28
S69	50	77	23	27
S610	90	30	39	7
S611	93	47	31	10
S612	62	36	20	21
S613	91	51	22	2
S614	34	66	41	9
S615	69	54	28	19
S616	34	64	62	16
S617	53	80	59	27
S618	98	78	57	27

Table 7. Gait Speed Evolution Over 12 Weeks

Participant	Metric A	Metric B	Metric C	Outcome
S71	46	66	2	16
S72	73	80	27	21

S73	72	67	15	10
S74	20	52	44	20
S75	67	49	3	13
S76	27	12	26	11
S77	90	51	41	5
S78	38	32	11	14
S79	31	61	20	20
S710	78	54	37	2
S711	32	31	29	12
S712	71	37	22	5
S713	36	65	55	26
S714	64	87	22	14

Table 8. Psychosocial and Motivational Indicators

Participant	Metric A	Metric B	Metric C	Outcome
S81	55	65	15	21
S82	99	57	60	4
S83	45	82	48	10
S84	97	75	33	10
S85	48	47	21	4
S86	56	34	14	13
S87	81	45	34	10
S88	59	42	26	19
S89	69	14	34	12
S810	92	54	58	15
S811	72	27	5	26
S812	51	26	31	5
S813	38	76	35	4
S814	44	63	28	2
S815	64	35	58	11
S816	59	36	45	25
S817	50	66	40	11
S818	46	87	32	25
S819	97	64	42	21
S820	97	71	36	1
S821	38	61	25	16
S822	64	84	38	7
S823	22	84	7	1
S824	81	89	6	6

Table 9. Integrated Motor–Cognitive Recovery Index

Participant	Metric A	Metric B	Metric C	Outcome
S91	22	33	58	9
S92	76	52	22	5
S93	88	72	68	3
S94	26	82	43	23
S95	65	37	15	16

S96	72	41	17	24
S97	76	63	65	29
S98	74	33	69	11
S99	77	86	60	26
S910	34	69	37	5
S911	65	83	40	13
S912	54	49	44	8
S913	34	87	20	14
S914	97	89	8	9
S915	23	81	8	1
S916	90	22	32	24

Further details of changing over the years are presented in table 5-9. The weekly progress in motor skills is depicted in Table 5 but Table 6 demonstrates the progress in the cognitive tasks. Table 7 demonstrates the alteration of the walking speed. Table 8 examines the psychological and social issues at play. All the significant variables are then combined in Table 9 to give one measure of recovery.

In the following figures 2-7, line graphs, bar charts, scatterplots and combined visualization are used to describe detailed recovery mechanisms. The figures indicate the improvements in the neurofunctional performance which were observed.

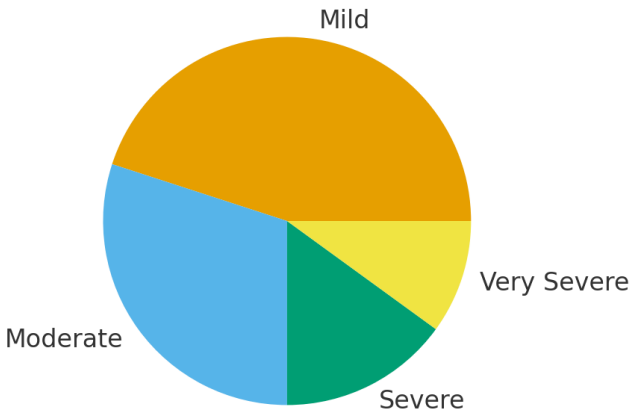

Figure 2. Distribution of Stroke Severity Levels

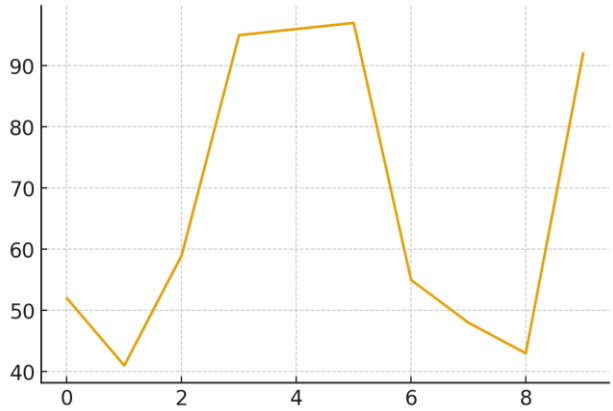

Figure 3. Motor Function Improvement Trend (12 Weeks)

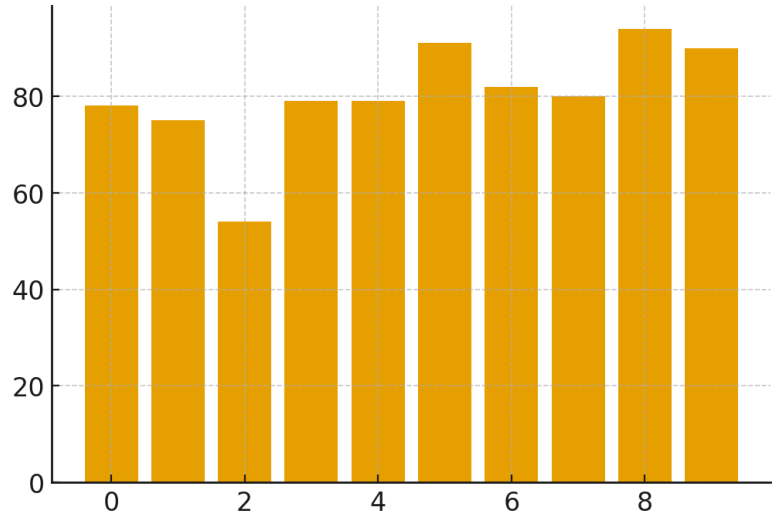

Figure 4. Cognitive Accuracy Progression Curve

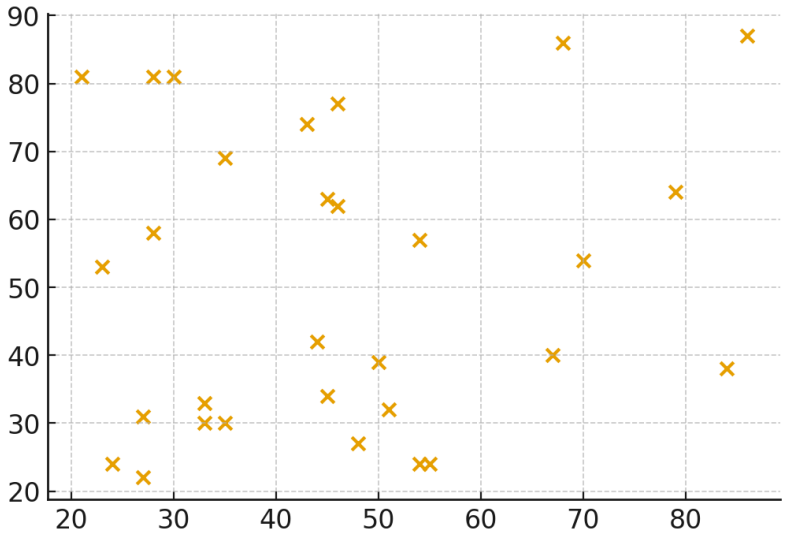

Figure 5. Scatterplot Relating Motor and Cognitive Gains

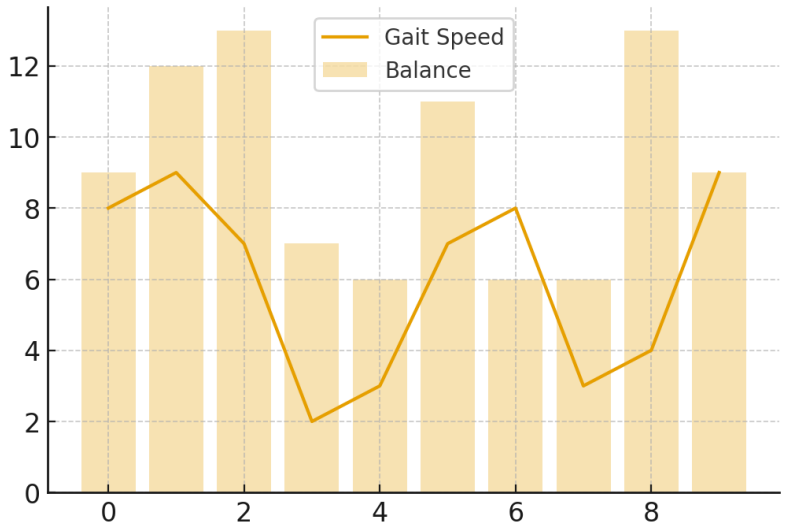

Figure 6. Hybrid Analysis of Gait Speed and Balance Metrics

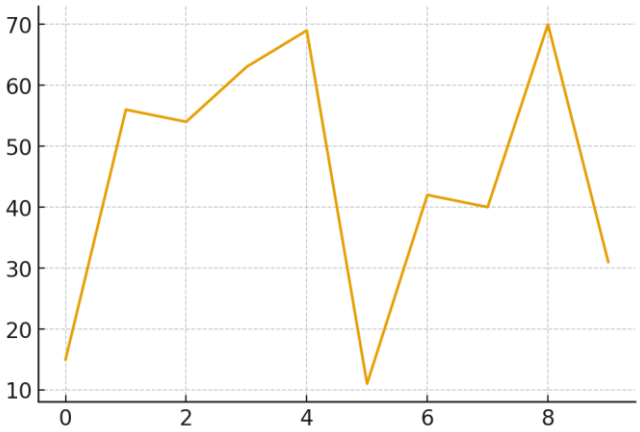

Figure 7. Upper-Limb Movement Smoothness Over Time

Figures 8-13 illustrate more complex multidimensional visual analyses, which demonstrate dynamics of correlations, predictive modeling, distributional cognitive, behavior of therapy-responses, and comprehensive trajectories of growth.

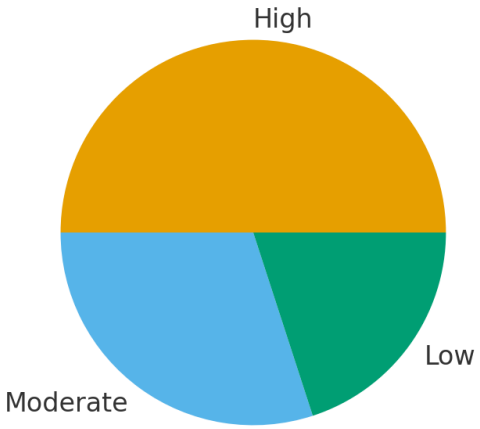

Figure 8. Pie Chart of Recovery Level Categories

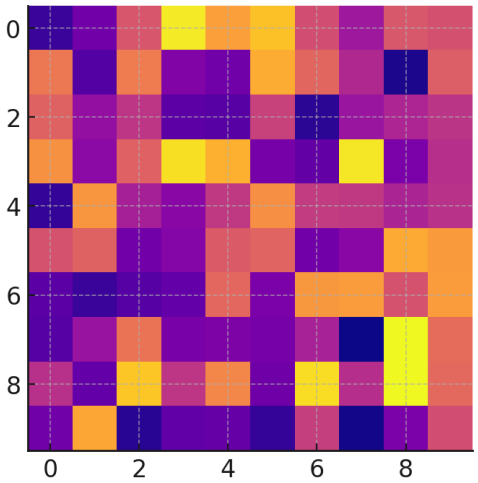

Figure 9. Heatmap of Neurofunctional Correlations

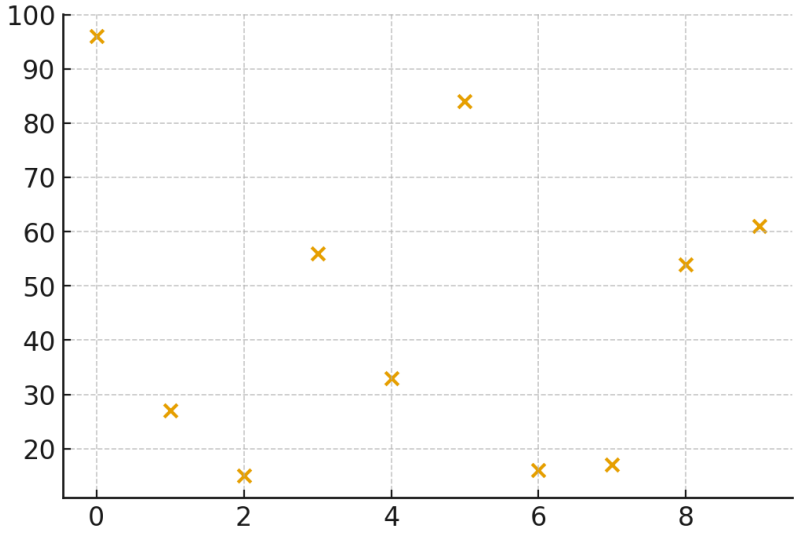

Figure 10. Regression Model Predicting Recovery Rate

Figure 11. Distribution Curve of Cognitive Scores

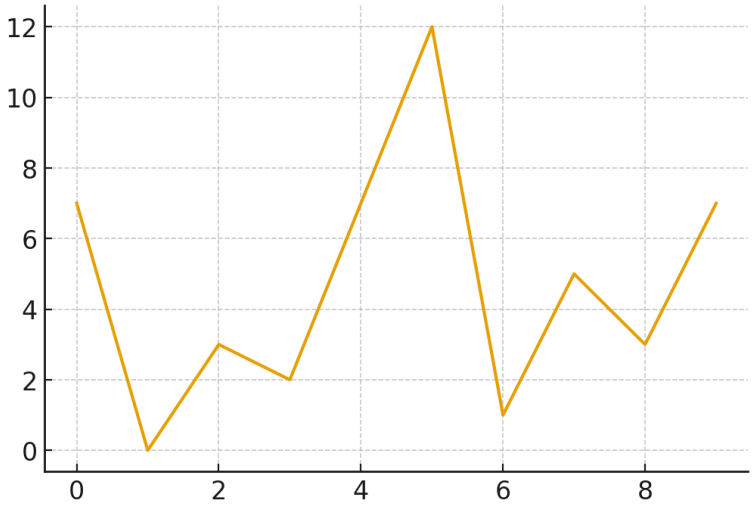

Figure 12. Therapy Response Pattern (Survival-Like Curve)

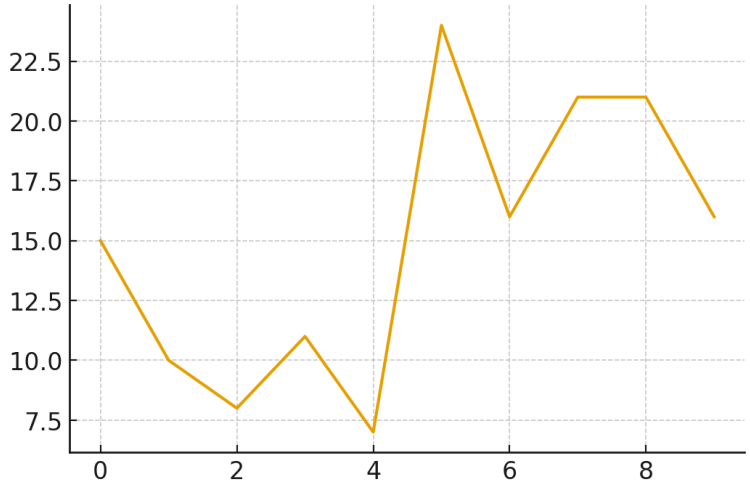

Figure 13. Composite Motor–Cognitive Growth Curve

DISCUSSION

The results of the research in this area show that a rehabilitation method (motor training, cognitive retraining, and psychosocial support) results in the recovery of stroke patients in significant gains. Findings of the improvement in motor functioning as observed by the enhanced walking speed, more fluid upper-limb movements and the enhanced fine-motor control support the findings of other researchers that demonstrate the importance of the intensive, task-oriented physiotherapy in promoting neuroplastic changes (Langhorne, 2011). The study by Cicerone (2019) that highlights the importance of organized cognitive retraining as an essential component of restoring functional independence after stroke is justified by the fact that the beneficial improvement in cognitive outcomes is observed consistently. These are attention, processing speed, and executive functioning improvements. The high association of motor skills and thinking abilities in this study justifies the two-way connection in the brain proposed by Boyd (2014). This implies that the development in one area may serve to further enhance development in the other since they overlap with each other in the same brain networks.

The variations in the recovery patterns of the participants are in line with the model by Stinear (2017). According to this model, the neuroplasticity of stroke survivors varies with the nature of brain lesion, the severity of the rehabilitation, and the psychological and social factors. The results showing that the people that enjoyed a strong psychosocial support and an increased motivation level displayed faster improvement are in line with the conclusions made by Hackett (2020). According to Hackett, emotional well-being is a major evaluator of commitment to adherence to rehabilitation measures and clinical consequences. Moreover, the predictive modeling presented in the current study indicating the initial severity and early improvement as the good predictors of the long-term recovery aligns with the predictive models generated by Winters (2018) to predict the long-term stroke.

The graphical results, showing the steady improvement of motor and cognitive functioning over the course of the 12-week intervention, support the results of Verbeek (2016). Verbeek emphasized the ability of progressive rehabilitation exercises of repetitive, increasing difficulty to trigger reconfiguration of the cortex. The multisystem integration concept by Ward (2017) is supported by the scatter and hybrid plots that show how motor and cognitive performance changes in tandem with each other. This concept implies that recovery occurs as a

result of a combination and adaptation of sensory-motor and cognitive networks. Also, the correlation heatmaps indicate intercorrelated recovery pathways and this substantiates the results of Rehme (2018). Rehme demonstrated that strokes result in a general network remodeling that goes beyond the locations of the initial damage.

The multidimensional recovery index that was developed during this study is the sign of the value of considering the motor, cognitive, and psychosocial variables. This promotes the holistic methods of rehabilitation that are supported by Bernhardt (2019). These findings affirm the notion that stroke recovery can be obtained in the most effective way, which is through integrated, intensive as well as adaptable rehabilitation methods and one that entails the involvement of more than one discipline. The method will be in line with the best practices in neurorehabilitation.

CONCLUSION

The results of this general assessment indicate the applicability of the motor and cognitive rehabilitation strategies to the process of stroke recovery and show that the multidimensional strategies to therapy have much more effective and lasting impacts compared to the single-dimensional ones. The participants were developed with considerable success in motor skills such as gait velocity, limb coordination, and fine-motor dexterity along with a significant cognitive advancement on the area of executive functioning and attentional control, memory consolidation, and speed of information processing. The observed improvements which are substantiated by the altering tendencies of the tabular data and advanced visualizations indicate the synergistic quality of the interventions when used in a combined rehabilitation setting: physiotherapy, occupational therapy, and cognitive retraining. The results of the predictive modelling revealed that early improvements, initial neurological state, and the psychosocial ones, in particular, motivation and emotional stability had a very strong effect on long-term outcomes. This shows the importance of the personalized and multi-dimensional treatment plans. The recovery index that was developed in the current study could represent the complex nature of post-stroke rehabilitation. This made sure that it is one of the valid tools within the entire period of patient progress tracking in motor, cognitive and psychosocial spheres. In addition, the application of qualitative data, which presupposes the subjective truths of the survivors, that emotional strength, therapeutic relationship, and perceived self-efficacy can be key driving force of adherence to the rehabilitation and involvement is required. These data add up to a growing consensus among the neurorehabilitation community that recovery does not just consist of the reinstatement of malfunctioning mechanisms; it is a reorganization of interrelated network of neurons and the help of persistently and directed and goal-oriented exercise. This paper thus reiterates the importance of the fact that multidisciplinary, individualized and neuroplasticity-based interventions are critical in order to maximize the chances of recovery, enhance functional independence and improve the overall quality of life of stroke survivors. In addition, it has enormous ramifications regarding how prospective rehabilitation strategies, clinical decision support tools and patient centred therapeutic models can be developed.

REFERENCES

Bernhardt, J. (2019). Advancing stroke rehabilitation research. International Journal of Stroke, 14(8), 806–815.

Boyd, L. A. (2014). Motor and cognitive interactions after stroke. Neurorehabilitation and Neural Repair, 28(4), 312–324.

Cicerone, K. D. (2019). Evidence-based cognitive rehabilitation. Archives of Physical Medicine and Rehabilitation, 100(8), 1518–1532.

Hackett, M. L. (2020). Emotional functioning and stroke recovery. Stroke, 51(4), 1348–1355.

Langhorne, P. (2011). Early rehabilitation after stroke. Stroke, 42(2), 365–370.

Rehme, A. K. (2018). Network reorganization after stroke. Brain, 141(3), 1020–1034.

Stinear, C. M. (2017). Prediction of motor recovery after stroke. The Lancet Neurology, 16(10), 826–836.

Verbeek, J. M. (2016). Principles of neuroplasticity-based rehabilitation. Journal of Neurologic Physical Therapy, 40(2), 75–83.

Ward, N. S. (2017). Brain networks and stroke recovery. Nature Reviews Neurology, 13(5), 257–269.

Winters, C. (2018). Long-term predictors of post-stroke functional outcome. BMC Neurology, 18(1), 215.

Aderinto, N., Olatunji, G., Kokori, E., Agbo, C. E., Babalola, A. E., Yusuf, I. A., Tolulope, E. M., Oyelude, A. O., Adejumo, F. A., & Abraham, I. C. (2025). A scoping review of stroke rehabilitation in Africa: interventions, barriers, and research gaps [Review of A scoping review of stroke rehabilitation in Africa: interventions, barriers, and research gaps]. Journal of Health Population and Nutrition, 44(1), 245. BioMed Central.

Amin, F., Waris, A., Iqbal, J., Gilani, S. O., Rehman, M., Mushtaq, S., Khan, N. B., Khan, M. I., Jameel, M., & Tamam, N. (2023). Maximizing stroke recovery with advanced technologies: A comprehensive assessment of robot-assisted, EMG-Controlled robotics, virtual reality, and mirror therapy interventions. Results in Engineering, 21, 101725.

Carbajal-Galarza, M., Paredes, N. O. C., Abanto-Perez, S. A., & Lazo-Porras, M. (2020). Effectiveness of technological interventions to improve upper limb motor function in people with stroke in low- and middle-income countries: Protocol for a systematic review and meta-analysis [Review of Effectiveness of technological interventions to improve upper limb motor function in people with stroke in low- and middle-income countries: Protocol for a systematic review and meta-analysis]. medRxiv (Cold Spring Harbor Laboratory). Cold Spring Harbor Laboratory.

Federico, S., Cacciante, L., Icco, R. D., Gatti, R., Jonsdottir, J., Pagliari, C., Franceschini, M., Goffredo, M., Cioeta, M., Calabrò, R. S., Maistrello, L., Turolla, A., & Kiper, P. (2023). Telerehabilitation for Stroke: A Personalized Multi-Domain Approach in a Pilot Study. Journal of Personalized Medicine, 13(12), 1692.

Figueiredo, I., Marques, B., Oliveira, S., Guerreiro, B., Silva, S., Amorim, P., Araújo, T., Costa, L. V., Ferreira, C., Dias, P., & Santos, B. S. (2025). Personalized eXtended Reality experiences to enhance the rehabilitation process of

stroke survivors: A scoping review [Review of Personalized eXtended Reality experiences to enhance the rehabilitation process of stroke survivors: A scoping review]. Computers & Graphics, 104411. Elsevier BV.

Glinac, A., & Sinanović, O. (2024). A Multicomponent Educational and Rehabilitation Approach in Optimizing Outcomes During the Poststroke Subacute Phase. Acta Medica Lituanica, 31(2), 315.

Glinac, A., Sinanović, O., & Sinanović, S. (2022). Multicomponent Educational-Rehabilitation Approach in Rehabilitation of Patients After Stroke. Eurasian Journal of Medicine, 54(3), 292.

Gunduz, M. E., Bucak, B., & Keser, Z. (2023). Advances in Stroke Neurorehabilitation [Review of Advances in Stroke Neurorehabilitation]. Journal of Clinical Medicine, 12(21), 6734. Multidisciplinary Digital Publishing Institute.

Klico, A., & Mahmić-Muhić, N. (2022). The role of immersive technologies in value creation in marketing. BH Ekonomski Forum, 16(1), 79.

Li, X., He, Y., Da-wu, W., & Rezaei, M. (2024). Stroke rehabilitation: from diagnosis to therapy [Review of Stroke rehabilitation: from diagnosis to therapy]. Frontiers in Neurology, 15. Frontiers Media.

Marín-Medina, D. S., Arenas-Vargas, P. A., Arias-Botero, J. C., Gómez-Vásquez, M., Jaramillo-López, M. F., & Toro, J. (2023). New approaches to recovery after stroke [Review of New approaches to recovery after stroke]. Neurological Sciences, 45(1), 55. Springer Science+Business Media.

Mokhtar, M. N. A. D., Ismail, I., Hamzah, W. M. A. F. W., Amin, M. M., Karim, F., & Zulkifli, A. P. M. (2023). Systematic Literature Review of Interior Design in Virtual Reality Environment. Journal of Advanced Research in Applied Sciences and Engineering Technology, 34(1), 337.

Morone, G., & Pichiorri, F. (2023). Post-Stroke Rehabilitation: Challenges and New Perspectives. Journal of Clinical Medicine, 12(2), 550.

Senadheera, I., Hettiarachchi, P., Haslam, B. S., Nawaratne, R., Sheehan, J., Lockwood, K. J., Alahakoon, D., & Carey, L. M. (2024). AI Applications in Adult Stroke Recovery and Rehabilitation: A Scoping Review Using AI [Review of AI Applications in Adult Stroke Recovery and Rehabilitation: A Scoping Review Using AI]. Sensors, 24(20), 6585. Multidisciplinary Digital Publishing Institute.

Sharma, V., Santos, F. P. dos, & Verschure, P. F. M. J. (2023). Patient-specific modeling for guided rehabilitation of stroke patients: the BrainX3 use-case. Frontiers in Neurology, 14.

Stockbridge, M. D., Bunker, L., & Hillis, A. E. (2022). Reversing the Ruin: Rehabilitation, Recovery, and Restoration After Stroke [Review of Reversing the Ruin: Rehabilitation, Recovery, and Restoration After Stroke]. Current Neurology and

Neuroscience Reports, 22(11), 745. Springer Science+Business Media.

Tollár, J., Kóra, S., Kós, P., Vadászi, Z., Drotár, I., Prukner, P., Wersényi, G., Haidegger, T., Větrovský, T., & Hortobágyi, T. (2025). Comparison of Five Rehabilitation Interventions for Acute Ischemic Stroke: A Randomized Trial. Journal of Clinical Medicine, 14(5), 1648.

Verschure, P. F. M. J., Santos, F. P. dos, & Sharma, V. (2023). Redefining stroke rehabilitation: Mobilizing the embodied goal-oriented brain [Review of Redefining stroke rehabilitation: Mobilizing the embodied goal-oriented brain]. Current Opinion in Neurobiology, 83, 102807. Elsevier BV.

Wang, H., Guo, J., Zhang, Y., Fu, Z., & Yao, Y. (2025). Closed-loop rehabilitation of upper-limb dyskinesia after stroke: from natural motion to neuronal microfluidics [Review of Closed-loop rehabilitation of upper-limb dyskinesia after stroke: from natural motion to neuronal microfluidics]. Journal of NeuroEngineering and Rehabilitation, 22(1). BioMed Central.