

Impact of Telerehabilitation on Functional Outcomes in Rural Neurological Patients: A Hospital-Based Observational Study.

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Abstract

Background

Neurological disorders cause long-term disability, while access to rehabilitation remains limited in rural areas. This study evaluated telerehabilitation outcomes among rural neurological patients.

Methods

A hospital-based observational study was conducted in the Department of Physical Medicine and Rehabilitation, Uttar Pradesh University of Medical Sciences, Saifai, Etawah, over one year. A total of 110 adult patients with neurological disorders receiving telerehabilitation were included. Functional improvement was assessed using the Functional Independence Measure (FIM), Barthel Index (BI), and Modified Rankin Scale (mRS) at baseline and after 12 weeks. Data were analyzed using IBM SPSS Statistics version 26.0.

Results

Among 110 patients, the mean age was 58.6 ± 13.7 years, and males constituted 61.8% of the study population. Stroke was the most common neurological diagnosis (54.5%), followed by Parkinson's disease (18.2%), spinal cord injury (12.7%), traumatic brain injury (9.1%), and multiple sclerosis (5.5%). Significant improvements were observed after 12 weeks of telerehabilitation. Mean Functional Independence Measure increased from 79.8 ± 13.4 to 96.5 ± 12.2 ($p < 0.001$), while Barthel Index improved from 58.6 ± 15.8 to 78.9 ± 14.1 ($p < 0.001$). Modified Rankin Scale scores demonstrated significant functional recovery. Treatment adherence exceeded 90%, and 88.2% of participants reported high satisfaction with telerehabilitation services.

Conclusion

Telerehabilitation was associated with improved functional outcomes, treatment adherence, and patient satisfaction among rural neurological patients.

Recommendation

Structured telerehabilitation may be considered to improve access to rehabilitation services in rural settings. Further multicenter studies with larger samples and longer follow-up are recommended.

Keywords: Telerehabilitation; neurological rehabilitation; Functional Independence Measure; Barthel Index; rural health; observational study.

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Introduction

Neurological disorders constitute one of the major causes of disability and dependency worldwide, affecting hundreds of

millions of individuals across all age groups. According to the Global Burden of Disease Study, neurological disorders collectively account for a substantial proportion of

disability-adjusted life years (DALYs) and remain among the leading contributors to long-term functional impairment globally. Stroke, Parkinson's disease, traumatic brain injury, spinal cord injury, multiple sclerosis, cerebral palsy, and peripheral neurological disorders frequently result in persistent motor deficits, impaired balance, cognitive dysfunction, communication difficulties, and reduced independence in activities of daily living (ADLs). These disabilities often require prolonged multidisciplinary rehabilitation to maximize recovery and improve quality of life.^{1,2}

Neurological rehabilitation aims to restore functional independence through individualized interventions focusing on mobility training, balance improvement, muscle strengthening, gait re-education, speech therapy, occupational therapy, cognitive rehabilitation, and psychosocial support. Early initiation and continuity of rehabilitation have consistently been associated with improved neurological recovery, reduced disability, decreased caregiver burden, and enhanced community reintegration. Numerous clinical guidelines therefore recommend sustained rehabilitation following acute neurological injury, particularly after stroke and traumatic brain injury.³⁻⁵

Despite the proven benefits of rehabilitation, access to these services remains inadequate in many low- and middle-income countries, especially in rural areas. India faces considerable disparities in rehabilitation service delivery because specialized rehabilitation centers are largely concentrated in urban regions. Patients residing in rural communities frequently encounter barriers including long travel distances, transportation costs, financial limitations, shortage of physiotherapists and rehabilitation physicians, poor accessibility for disabled individuals, and limited awareness regarding rehabilitation services. These challenges often result in delayed treatment initiation, interrupted therapy sessions, and suboptimal functional recovery.^{6,7}

Recent advances in information and communication technology have facilitated the development of telerehabilitation, an approach that enables healthcare professionals to deliver rehabilitation services remotely through video conferencing, mobile applications, internet-based platforms, wearable sensors, and digital monitoring systems. Telerehabilitation permits real-time assessment, individualized exercise prescription, patient education, caregiver training, remote monitoring of progress, and regular follow-up without requiring frequent hospital visits. The COVID-19 pandemic further accelerated the adoption of telehealth and highlighted its potential to ensure

uninterrupted rehabilitation while minimizing travel and infection-related risks.^{8,9}

Several systematic reviews and meta-analyses have demonstrated that telerehabilitation produces functional outcomes comparable to conventional face-to-face rehabilitation for various neurological disorders. Cramer et al. reported significant improvements in upper-limb recovery among stroke survivors using home-based telerehabilitation programs. Similarly, Laver and colleagues concluded that telerehabilitation is effective for improving motor function, activities of daily living, and patient satisfaction while reducing healthcare costs.^{10,11} Evidence also suggests that structured telerehabilitation enhances treatment adherence because patients can perform supervised exercises within their home environment under regular virtual guidance.¹²

Among stroke survivors, telerehabilitation has shown particular promise in improving balance, gait, upper-limb function, and overall independence. Randomized controlled trials have demonstrated that remotely supervised rehabilitation yields functional outcomes comparable to conventional outpatient rehabilitation while significantly reducing travel burden and improving access to specialist care. Similar benefits have been reported among patients with Parkinson's disease, where remote physiotherapy programs have improved gait performance, balance, freezing episodes, and quality of life.¹³⁻¹⁵

Technological innovations including smartphone applications, wearable motion sensors, artificial intelligence-assisted movement analysis, virtual reality, and interactive gaming platforms have further expanded the capabilities of telerehabilitation. These technologies provide objective performance monitoring, immediate feedback, personalized exercise progression, and increased patient engagement, thereby enhancing rehabilitation effectiveness. Nevertheless, implementation in rural populations remains challenging because of internet connectivity issues, digital illiteracy, limited availability of smart devices, and socioeconomic disparities.^{16,17}

India has witnessed substantial growth in digital health infrastructure following the implementation of the National Digital Health Mission and expansion of telemedicine services. However, published evidence regarding neurological telerehabilitation in rural Indian populations remains relatively scarce. Most available studies have been conducted in high-income countries, and their findings may not be directly applicable to rural Indian settings owing to differences in healthcare infrastructure, socioeconomic conditions, cultural practices, caregiver involvement, and technology accessibility. Consequently, locally generated

evidence is necessary to determine the feasibility and effectiveness of telerehabilitation among rural neurological patients.^{18,19}

Furthermore, patient satisfaction and treatment adherence represent important determinants of successful long-term rehabilitation. Home-based rehabilitation delivered through telecommunication technologies may reduce caregiver burden, improve convenience, and encourage sustained participation in prescribed exercise programs. Understanding these factors is essential for planning future rehabilitation services within resource-constrained healthcare systems.²⁰

Considering the increasing burden of neurological disability, expanding digital healthcare infrastructure, and the need to improve rehabilitation accessibility in rural India, the present observational study was undertaken to evaluate the impact of telerehabilitation on functional outcomes among rural neurological patients attending Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, Etawah. The study aimed to assess changes in functional independence, activities of daily living, treatment adherence, and patient satisfaction following a structured telerehabilitation program.

Materials and methods

Study design

This was a hospital-based observational longitudinal study conducted to evaluate changes in functional outcomes among rural neurological patients receiving a structured telerehabilitation program over a 12-week follow-up period.

Study setting

The study was conducted in the Department of Physical Medicine and Rehabilitation, Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, Etawah, Uttar Pradesh, India. UPUMS is a tertiary care teaching institution serving patients from rural and semi-urban areas of Uttar Pradesh and neighboring regions. The institution provides multidisciplinary medical and surgical services through various clinical departments, including Physical Medicine and Rehabilitation. The Department of Physical Medicine and Rehabilitation provides rehabilitation services for patients with neurological and other disabling conditions, including stroke, Parkinson's disease, spinal cord injury, traumatic brain injury, and other conditions requiring functional rehabilitation.

Study duration

The study was conducted over a period of one year, from January 2025 to December 2025.

Study population

Adult patients diagnosed with neurological disorders who were enrolled in the institutional telerehabilitation program during the study period were considered for inclusion. A total of 110 patients fulfilling the eligibility criteria were included in the study.

Sample size determination

A total of 110 patients fulfilling the eligibility criteria were included in the study. Consecutive sampling was employed, and all eligible patients receiving telerehabilitation during the study period were included until the required sample size was achieved.

Sampling technique

Consecutive sampling was employed. All eligible patients receiving telerehabilitation during the study period were included until the required sample size was achieved.

Inclusion criteria

Patients fulfilling all of the following criteria were included:

1. Age ≥ 18 years.
2. Diagnosed with a neurological disorder requiring rehabilitation.
3. Resident of a rural area.
4. Enrolled in the institutional telerehabilitation program.
5. Availability of baseline and follow-up functional assessment records.
6. Minimum follow-up duration of 12 weeks.
7. Ability to participate in telerehabilitation directly or with caregiver assistance.

Exclusion criteria

Patients were excluded if they had:

1. Severe cognitive impairment preventing participation.
2. Severe psychiatric illness interfering with rehabilitation.
3. Progressive terminal neurological disease.
4. Unstable cardiovascular or medical illness.
5. Incomplete medical records.
6. Failure to complete the scheduled telerehabilitation program.

7. Loss to follow-up before completion of outcome assessment.

Bias

Potential selection bias was minimized by using consecutive sampling and including all eligible patients enrolled in the institutional telerehabilitation program during the study period. Information bias was minimized by using standardized functional outcome measures, including the Functional Independence Measure (FIM), Barthel Index (BI), and Modified Rankin Scale (mRS), at predefined assessment points. The same assessment protocol was used at baseline and during follow-up. Potential confounding factors, including neurological diagnosis, treatment adherence, caregiver participation, and timing of initiation of telerehabilitation, were considered during the analysis.

Data collection

Patient information was obtained from hospital records, telerehabilitation logs, physiotherapy records, and follow-up assessments. Demographic variables included age, gender, residence, educational status, occupation, and socioeconomic status. Clinical variables included neurological diagnosis, duration of illness, side of neurological involvement, and associated comorbidities. Telerehabilitation-related variables included the communication platform used, number and duration of rehabilitation sessions, caregiver participation, treatment adherence, and internet connectivity quality.

Telerehabilitation protocol

All patients underwent a structured multidisciplinary telerehabilitation program supervised by rehabilitation physicians and physiotherapists. The program included individualized physiotherapy exercises, muscle strengthening, balance training, gait training, functional mobility training, range-of-motion exercises, home exercise programs, caregiver education, fall-prevention counseling, and lifestyle modification advice.

Sessions were conducted using secure video-conferencing platforms. Each patient received three supervised sessions per week, with each session lasting approximately 45 minutes, for 12 weeks. Patients were encouraged to perform prescribed home exercises daily between supervised sessions.

Follow-up Assessment

Functional assessment was performed at baseline, six weeks, and 12 weeks after initiation of telerehabilitation.

Outcome measures

The primary outcome was functional improvement assessed using the Functional Independence Measure (FIM). Secondary outcomes included the Barthel Index (BI), Modified Rankin Scale (mRS), treatment adherence, and patient satisfaction. Treatment adherence was calculated as the percentage of scheduled telerehabilitation sessions completed, with $\geq 80\%$ attendance considered high adherence. Patient satisfaction was assessed at the final follow-up using a five-point Likert scale.

Statistical analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean $\pm$ standard deviation (SD), while categorical variables were expressed as frequencies and percentages. Normality of continuous variables was assessed using the Shapiro–Wilk test. Comparisons between baseline and follow-up functional scores were performed using the paired Student's *t*-test. The Chi-square test was used for comparison of categorical variables when the expected cell frequencies were adequate, whereas Fisher's exact test was used when expected cell frequencies were small. Multivariable linear regression analysis was performed to identify independent predictors of functional improvement following telerehabilitation. A *p*-value < 0.05 was considered statistically significant.

Ethical considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee (IEC) of Uttar Pradesh University of Medical Sciences (UPUMS), Saifai, Etawah, before commencement of the study. Written informed consent was obtained from all participants or their legally authorized representatives prior to enrollment. Confidentiality of patient information was maintained by anonymizing all clinical records before statistical analysis. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki (2013 revision).

Results

A total of **110 patients** fulfilled the eligibility criteria and were included in the study. All included participants underwent the structured telerehabilitation program and were assessed at baseline and during follow-up. Of the 110 participants enrolled, **110 completed the 12-week follow-up and were included in the final analysis**. No participants

were excluded after enrollment because of incomplete follow-up or missing outcome data.

Patient Demographics and Clinical Characteristics

A total of **110 rural neurological patients** who fulfilled the eligibility criteria were included in the study. The mean age was **58.6 ± 13.7 years** (range: 21–84 years). Patients aged **≥60 years** constituted **52.7% (n=58)** of the study

population. Males accounted for **68 (61.8%)** patients, while females comprised **42 (38.2%)**.

Stroke was the most common neurological diagnosis (**54.5%**), followed by Parkinson's disease (**18.2%**), spinal cord injury (**12.7%**), traumatic brain injury (**9.1%**), and multiple sclerosis (**5.5%**). Hypertension (**52.7%**) and diabetes mellitus (**38.2%**) were the most common associated comorbidities. Baseline demographic and clinical characteristics are summarized in **Table 1**.

Table 1. Baseline demographic and clinical characteristics of the study population (N = 110)

Variable	Value
Age (years), mean ± SD	58.6 ± 13.7
Age ≥60 years	58 (52.7%)
Male	68 (61.8%)
Female	42 (38.2%)
Stroke	60 (54.5%)
Parkinson's disease	20 (18.2%)
Spinal cord injury	14 (12.7%)
Traumatic brain injury	10 (9.1%)
Multiple sclerosis	6 (5.5%)
Hypertension	58 (52.7%)
Diabetes mellitus	42 (38.2%)
Coronary artery disease	18 (16.4%)
Dyslipidaemia	29 (26.4%)

Values are presented as mean ± SD or n (%).

Telerehabilitation program characteristics

The average duration of each telerehabilitation session was **45.8 ± 6.4 minutes**, and patients completed a mean of **33.6 ± 2.9 sessions** during the 12-week rehabilitation program. High treatment adherence (≥80% attendance) was observed

in **100 patients (90.9%)**. Caregiver participation during rehabilitation sessions was documented in **78 patients (70.9%)**. Most consultations were conducted through smartphone-based video calls (**72.7%**). Details of the telerehabilitation program are summarized in **Table 2**.

Table 2. Characteristics of the telerehabilitation program

Variable	Value
Session duration (minutes)	45.8 ± 6.4
Total sessions completed	33.6 ± 2.9
High adherence (≥80%)	100 (90.9%)
Low adherence (<80%)	10 (9.1%)
Caregiver participation	78 (70.9%)
Smartphone video consultation	80 (72.7%)
Tablet/Laptop consultation	30 (27.3%)

Functional outcomes following telerehabilitation

Significant improvement was observed in all functional outcome measures following completion of the 12-week telerehabilitation program. The mean **Functional Independence Measure (FIM)** score increased from 79.8 ± 13.4 at baseline to 96.5 ± 12.2 after rehabilitation ($p < 0.001$).

Similarly, the **Barthel Index** improved significantly from 58.6 ± 15.8 to 78.9 ± 14.1 ($p < 0.001$). The mean **Modified Rankin Scale (mRS)** score decreased from 3.4 ± 0.9 to 2.3 ± 0.8 , indicating significant functional recovery ($p < 0.001$). These improvements are summarized in **Table 3**, while changes in FIM scores are graphically illustrated in **Figure 1**.

Table 3. Functional outcome measures before and after telerehabilitation

Outcome Measure	Baseline	12 Weeks	p-value
Functional Independence Measure	79.8 ± 13.4	96.5 ± 12.2	< 0.001
Barthel Index	58.6 ± 15.8	78.9 ± 14.1	< 0.001
Modified Rankin Scale	3.4 ± 0.9	2.3 ± 0.8	< 0.001

Functional independence categories

At baseline, only **22 patients (20.0%)** demonstrated high functional independence ($FIM \geq 90$). Following telerehabilitation, this number increased to **67 patients**

(60.9%). Conversely, the proportion of patients with severe functional dependence decreased substantially after rehabilitation. The distribution of functional independence categories is summarized in **Table 4** and graphically presented in **Figure 2**.

Table 4. Functional Independence Measure (FIM) categories before and after rehabilitation

Functional Category	Baseline	Final Follow-up
Independent	22 (20.0%)	67 (60.9%)
Moderately dependent	63 (57.3%)	37 (33.6%)
Severely dependent	25 (22.7%)	6 (5.5%)

Patient Satisfaction and Treatment Compliance

Overall satisfaction with telerehabilitation services was high. **97 patients (88.2%)** reported being either **very satisfied** or **satisfied** with the rehabilitation program. Only **4 patients (3.6%)** expressed dissatisfaction. Details of patient satisfaction are presented in **Table 5** and illustrated in **Figure 3**.

Table 5. Patient satisfaction with telerehabilitation services

Satisfaction Level	Number	Percentage
Very satisfied	48	43.6
Satisfied	49	44.6
Neutral	9	8.2
Dissatisfied	3	2.7
Very dissatisfied	1	0.9

Factors Associated with Greater Functional Improvement

Patients with high treatment adherence ($\geq 80\%$), active caregiver participation, and early initiation of

telerehabilitation (< 4 weeks after diagnosis) demonstrated significantly greater improvements in Functional Independence Measure scores than their counterparts. Multivariable analysis identified treatment adherence and

caregiver participation as independent predictors of better functional outcomes.

These findings are summarized in **Table 6**.

Table 6. Factors associated with significant functional improvement

Variable	Improved Functional Outcome (n=82)	Limited Improvement (n=28)	p-value
High adherence ($\geq 80\%$)	79 (96.3%)	21 (75.0%)	0.002
Caregiver participation	66 (80.5%)	12 (42.9%)	<0.001
Telerehabilitation initiated <4 weeks	58 (70.7%)	11 (39.3%)	0.006
Stroke diagnosis	47 (57.3%)	13 (46.4%)	0.318
Mean improvement in FIM score	19.6 $\pm$ 6.1	8.7 $\pm$ 4.9	<0.001

Discussion

Neurological disorders remain one of the leading causes of long-term disability worldwide and impose a substantial burden on healthcare systems, particularly in low- and middle-income countries where access to rehabilitation services is limited. Rural populations encounter additional challenges, including inadequate rehabilitation infrastructure, shortage of trained professionals, transportation difficulties, and financial constraints, often resulting in delayed initiation and poor continuity of rehabilitation. Telerehabilitation has emerged as an innovative strategy to bridge these gaps by delivering rehabilitation services remotely while maintaining regular interaction between healthcare professionals and patients. Recent evidence supports its effectiveness in improving functional recovery and expanding access to rehabilitation services in underserved communities.^{21, 22}

The present study evaluated the impact of a structured telerehabilitation programme among rural neurological patients and demonstrated significant improvements in functional independence, activities of daily living, treatment adherence, and patient satisfaction following twelve weeks of rehabilitation. These findings support the growing body of evidence indicating that telerehabilitation is a feasible and effective alternative to conventional face-to-face rehabilitation for selected neurological disorders. **Sivan et al.**²³ proposed a structured model for integrating telerehabilitation into neurological practice, highlighting its feasibility for delivering multidisciplinary rehabilitation remotely and supporting its implementation within routine clinical services.

In the present study, the mean age of the participants was 58.6 $\pm$ 13.7 years, with males accounting for 61.8% of the study population. Stroke constituted the most common neurological diagnosis (54.5%), followed by Parkinson's disease, spinal cord injury, traumatic brain injury, and multiple sclerosis. These findings are consistent with recent

epidemiological studies demonstrating that stroke continues to be the leading neurological condition requiring long-term rehabilitation worldwide because of increasing life expectancy and improved survival after acute neurological events.^{21, 22}

One of the principal findings of the present study was the significant improvement in Functional Independence Measure (FIM) scores following completion of the telerehabilitation programme. Mean FIM scores increased significantly from 79.8 $\pm$ 13.4 at baseline to 96.5 $\pm$ 12.2 after twelve weeks of rehabilitation ($p < 0.001$). Similarly, significant improvements were observed in Barthel Index scores together with reductions in Modified Rankin Scale scores, indicating substantial recovery of functional independence. Comparable improvements have been reported by **Cramer et al.**¹⁰, who demonstrated that home-based telerehabilitation produced functional outcomes comparable with conventional outpatient rehabilitation among stroke survivors. Likewise, the systematic review by **Laver et al.**¹¹ concluded that telerehabilitation significantly improves motor recovery, functional independence, and quality of life in patients with neurological disorders.

The present study also demonstrated a significant improvement in activities of daily living, reflected by an increase in the mean Barthel Index from 58.6 $\pm$ 15.8 to 78.9 $\pm$ 14.1 following rehabilitation. Restoration of independence in daily activities represents one of the primary goals of neurological rehabilitation because it directly influences long-term quality of life and reduces caregiver burden. Similar improvements have been documented by **Lloréns et al.**²⁴, who reported that a structured virtual reality-based home telerehabilitation programme significantly enhanced balance recovery and functional performance after stroke, supporting the role of remotely supervised rehabilitation in improving daily functioning.

An encouraging finding of the present study was the high level of treatment adherence. More than 90% of patients

completed at least 80% of their scheduled telerehabilitation sessions. High adherence is likely attributable to the convenience of receiving rehabilitation within the home environment, reduced travel expenses, flexible scheduling, and regular professional supervision through digital platforms. Similar findings have been reported by **Tenforde et al.**²⁵, who observed high patient acceptance and continuity of rehabilitation services delivered through telemedicine during the COVID-19 pandemic.

Patient satisfaction was another important outcome of the present study. Nearly 88.2% of participants reported being either satisfied or very satisfied with telerehabilitation services. The high level of satisfaction observed may be explained by easier accessibility, elimination of long-distance travel, reduced financial burden, and the opportunity to receive rehabilitation within a familiar home setting. Comparable patient satisfaction has been consistently reported in previous telehealth studies evaluating neurological rehabilitation, supporting the acceptability of telerehabilitation among both patients and caregivers.²⁶

Caregiver participation emerged as an independent factor associated with greater functional improvement. Patients receiving active caregiver assistance demonstrated significantly better rehabilitation outcomes than those undergoing rehabilitation independently ($p < 0.001$). Caregivers play a critical role by assisting patients during prescribed exercises, reinforcing rehabilitation protocols, and encouraging treatment adherence. Previous investigations have similarly demonstrated that caregiver engagement significantly enhances rehabilitation outcomes among individuals with chronic neurological disabilities.²⁷ Another important observation was that patients who initiated telerehabilitation within four weeks of diagnosis experienced significantly greater functional improvement than those commencing rehabilitation later. Early rehabilitation promotes neuroplasticity, prevents secondary complications such as muscle wasting and joint contractures, and facilitates faster recovery of functional abilities. Contemporary neurological rehabilitation guidelines consistently recommend early initiation of rehabilitation whenever clinically feasible to maximize long-term recovery.²⁸

The present findings have important implications for healthcare delivery in rural India. Telerehabilitation effectively addresses several barriers associated with conventional rehabilitation, including geographical isolation, scarcity of rehabilitation specialists, transportation difficulties, and treatment costs. The World Health Organization has emphasized the growing importance of

digital health technologies in improving access to rehabilitation services, particularly in underserved populations where rehabilitation resources remain limited.²⁹ The present study therefore supports integration of structured telerehabilitation programmes into routine neurological rehabilitation services at tertiary healthcare institutions serving rural communities.

The incorporation of telerehabilitation into routine neurological rehabilitation services may substantially improve access to quality rehabilitation in underserved regions while promoting continuity of care and long-term functional independence. Future multicenter prospective studies with larger sample sizes, longer follow-up, and comparative evaluation against conventional rehabilitation are warranted to strengthen the evidence supporting widespread implementation of telerehabilitation in neurological practice.

Generalizability

The findings of the present study may be applicable to rural adult patients with neurological disorders who have access to basic digital communication technology and are able to participate in supervised telerehabilitation independently or with caregiver assistance. The results may be particularly relevant to tertiary care institutions serving rural and underserved populations where geographical distance, transportation difficulties, and limited availability of rehabilitation services may restrict access to conventional rehabilitation. However, generalization should be undertaken cautiously because the study was conducted at a single tertiary care teaching hospital and included a relatively small sample of patients enrolled in an institutional telerehabilitation program. Differences in healthcare infrastructure, internet connectivity, availability of digital devices, socioeconomic conditions, caregiver support, and patient characteristics may influence the feasibility and effectiveness of telerehabilitation in other settings. Therefore, multicenter studies involving diverse rural and underserved populations are required to determine the broader applicability of these findings.

Conclusion

The present observational study demonstrates that structured telerehabilitation is an effective and feasible approach for improving functional outcomes among rural neurological patients. Significant improvements were observed in Functional Independence Measure scores, Barthel Index, and Modified Rankin Scale following twelve weeks of rehabilitation. High treatment adherence and

excellent patient satisfaction further support the acceptability of this mode of rehabilitation.

Patients who initiated rehabilitation early, maintained high treatment adherence, and received active caregiver support achieved significantly better functional recovery. These findings suggest that telerehabilitation can successfully overcome several barriers associated with conventional rehabilitation, including travel difficulties, limited specialist availability, and financial constraints commonly encountered in rural populations.

Limitations

The present study has several limitations. First, it was conducted at a single tertiary care teaching hospital, which may limit the generalizability of the findings to other healthcare settings and rural populations. Second, the relatively small sample size may have limited the precision of the observed associations. Third, the study did not include a conventional face-to-face rehabilitation control group; therefore, the observed improvements cannot be attributed exclusively to telerehabilitation. Fourth, the follow-up period was limited to 12 weeks, and the long-term sustainability of functional improvements could not be assessed. Fifth, treatment adherence and caregiver participation may have been influenced by factors such as socioeconomic circumstances, digital literacy, and availability of technology. Finally, as this was an observational study, residual confounding cannot be excluded despite the use of multivariable analysis.

Recommendation

Structured telerehabilitation may be considered as a complementary approach to conventional neurological rehabilitation services, particularly for patients residing in rural and underserved areas. Rehabilitation programs should emphasize regular supervised sessions, appropriate caregiver involvement, and adherence to prescribed home-based exercises. Healthcare institutions serving rural populations may consider strengthening digital rehabilitation infrastructure and providing appropriate training to healthcare professionals and caregivers. Further multicenter studies with larger sample sizes, longer follow-up periods, and comparative evaluation with conventional rehabilitation are recommended to establish the long-term effectiveness and generalizability of telerehabilitation.

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List of abbreviations

ADL – Activities of Daily Living

BI – Barthel Index

FIM – Functional Independence Measure

IEC – Institutional Ethics Committee

mRS – Modified Rankin Scale

PM&R – Physical Medicine and Rehabilitation

SD – Standard Deviation

UPUMS – Uttar Pradesh University of Medical Sciences

Conflict of interest

The authors declare that they have no conflict of interest.

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Availability of data

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Author contributions

Dr. Sanjai Singh: Conceptualization, study design, data collection, data analysis, manuscript preparation, and final approval of the manuscript.

Dr. Dharendra Kumar Singh: Study design, clinical supervision, data collection, manuscript review, and final approval of the manuscript.

Dr. Chandan Sharma: Data collection, clinical assessment, manuscript review, and final approval of the manuscript.

Dr. Javed Ahmad: Data analysis, interpretation of findings, manuscript review, and final approval of the manuscript.

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