



A critical review of exercise therapy in neurological physiotherapy: Therapeutic applications and clinical outcomes

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Abstract

Exercise therapy is an important part of neurological physiotherapy and is widely used to improve physical and functional abilities in people with neurological disorders. Conditions such as stroke, spinal cord injury, multiple sclerosis, Parkinson's disease, and traumatic brain injury may result in muscle weakness, impaired motor control, poor balance, reduced coordination, abnormal gait, and difficulty performing daily activities. Structured therapeutic activities can address these limitations when they are selected according to the patient's clinical condition, functional capacity, and rehabilitation goals. This critical review examines the therapeutic applications of exercise therapy in neurological physiotherapy and its effects on major clinical and functional outcomes. It considers strengthening, aerobic conditioning, balance and coordination training, task-specific practice, gait rehabilitation, flexibility activities, and repetitive functional movements. Appropriate therapeutic programmes may improve muscle performance, mobility, walking ability, postural control, endurance, and independence in daily activities. However, treatment responses can differ depending on the neurological condition, severity of impairment, training intensity, frequency, duration, and patient adherence. The review further emphasises individualised programme planning, gradual progression, safety precautions, and regular assessment of functional changes. Overall, exercise therapy has a valuable role in neurological rehabilitation, although further well-designed studies are needed to establish optimal training strategies for different neurological conditions and patient populations.

Keywords: Exercise therapy, neurological physiotherapy, neuro-rehabilitation, functional outcomes, motor recovery

Introduction

Neurological disorders frequently result in persistent physical and functional limitations that can affect a person's independence and daily life. Conditions such as stroke, spinal cord injury, Parkinson's disease, multiple sclerosis, traumatic brain injury, and cerebral palsy may interfere with muscle performance, voluntary movement, postural control, coordination, walking, and physical endurance [1]. These difficulties can make routine activities such as standing, walking, transferring, climbing stairs, and self-care more challenging. They may also reduce an individual's involvement in social, family, educational, and occupational activities. Therefore, neurological physiotherapy focuses not only on managing physical impairments but also on restoring functional capacity, promoting independence, and supporting participation and quality of life.

The global requirement for rehabilitation is considerable. *The World Health Organization (WHO)* reports that approximately 2.4 billion people worldwide have a health condition for which rehabilitation may be beneficial. In response to this growing need, WHO has promoted the integration of rehabilitation into health systems through its Rehabilitation 2030 initiative. Rehabilitation is increasingly recognised as an essential health service rather than an optional component of care [2]. In 2023, the World Health Assembly adopted Resolution WHA76.6, which further emphasised the need to strengthen rehabilitation within health systems and improve access to appropriate rehabilitation services [3].

Therapeutic exercise forms an important part of neurological physiotherapy because it provides a structured method for addressing movement and functional limitations. Depending on individual needs, physiotherapists may incorporate resistance and strengthening activities, aerobic conditioning, balance practice, coordination training, flexibility work, gait rehabilitation, and task-oriented functional activities. Selection of these approaches generally follows a clinical assessment of strength, movement quality, balance, mobility, endurance, functional limitations, and potential safety risks [4]. The practical aim is to improve physical capacity in ways that support meaningful activities, including walking, transfers, standing, reaching, stair negotiation, and activities of daily living.

The role of rehabilitation in neurological care is also supported by international health guidance. WHO's Package of Interventions for Rehabilitation: Module 3—Neurological Conditions outlines evidence-informed rehabilitation interventions for several neurological conditions, including stroke, Parkinson's disease, traumatic brain injury, spinal cord injury, cerebral palsy, and dementia. Such guidance can assist healthcare systems in identifying appropriate rehabilitation interventions, workforce requirements, equipment, and service needs, particularly in settings where rehabilitation resources are limited [5].

In India, rehabilitation has also been incorporated into national health initiatives. *The National Programme for Prevention and Control of Non-Communicable Diseases (NP-NCD)* addresses prevention, early identification,

management, referral, and strengthening of healthcare services for major non-communicable diseases, including stroke. National stroke-management guidance also recognises physiotherapy and rehabilitation as important elements of comprehensive care. Practical rehabilitation components include mobility training, gait and balance activities, functional practice, and preparation for continued care after discharge^[6].

Despite its broad application, therapeutic exercise should not be prescribed as a uniform programme for all neurological patients. Treatment requirements can differ according to the diagnosis, severity of impairment, stage of recovery, fatigue, cardiovascular tolerance, sensory or cognitive problems, associated health conditions, motivation, adherence, and available clinical resources. Effective practice therefore requires careful assessment, patient-specific planning, appropriate progression, safety monitoring, and regular evaluation of functional responses. Physiotherapists must select a level of challenge that is sufficient to promote improvement while remaining appropriate for the individual's tolerance and clinical safety. Against this background, the present critical review examines the therapeutic applications of exercise therapy in neurological physiotherapy and their clinical outcomes. It reviews commonly used approaches across major neurological conditions and critically considers their effects on strength, balance, gait, mobility, endurance, functional independence, and quality of life. The review also addresses practical considerations, limitations in the existing evidence, and research gaps, with particular emphasis on the need for individualised and evidence-informed rehabilitation practice.

Therapeutic Applications of Exercise Therapy in Neurological Physiotherapy

Exercise therapy is an important part of neurological physiotherapy. Many neurological conditions can cause muscle weakness, poor movement control, balance problems, stiffness, walking difficulties, fatigue, and reduced independence. Physiotherapy uses planned physical activities to address these problems and help patients perform daily tasks more easily. The choice of activity depends on the person's neurological condition, level of disability, physical capacity, treatment goals, and ability to tolerate the programme. Regular assessment is important so that the programme can be changed as the patient's condition improves.

Strength and Resistance Training

Muscle weakness is frequently seen in people recovering from stroke, spinal cord injury, multiple sclerosis, Parkinson's disease, and other neurological conditions. Strength training can help patients develop better muscle force and improve their ability to perform functional movements. Depending on individual needs, physiotherapists may use active movements, resistance bands, body-weight activities, free weights, or other forms of resistance.

Strengthening is more useful when it is linked to everyday activities. For example, lower-limb strengthening can be combined with sit-to-stand practice, transfers, stair climbing, or walking. The level of resistance should be increased gradually while observing fatigue, pain, movement quality, and the patient's overall response^[7].

Aerobic and Endurance Training

People with neurological disorders may have reduced physical fitness because of limited mobility, inactivity, weakness, or prolonged illness. Aerobic activities can help improve endurance and make physical activities easier to perform. Depending on the patient's ability, options may include walking, treadmill training, stationary cycling, or other appropriate cardiovascular activities. The amount and intensity of training should be decided individually. Before starting, the physiotherapist should consider the patient's mobility, cardiovascular fitness, fatigue, medication, and other health problems^[8]. Training may begin with short periods of activity and gradually increase as the patient becomes more comfortable and capable.

Balance and Postural Control Training

Problems with balance are common in many neurological conditions and can increase the risk of falls. Patients may have difficulty maintaining stability while standing, reaching, turning, walking, or changing position. Balance training aims to improve the ability to control the body during both stationary and moving activities.

Common activities include weight shifting, reaching, stepping, turning, standing balance, and changing from sitting to standing^[9]. The difficulty can be increased gradually by changing the position, movement, or environment. Patients with a high risk of falling should receive appropriate support and supervision during these activities.

Coordination and Motor Control Training

Neurological damage can affect the timing, accuracy, and smoothness of voluntary movements. As a result, patients may find it difficult to control their arms, legs, or whole-body movements. Coordination and motor-control activities are used to improve the accuracy and purposeful performance of movement^[10].

These activities may include controlled limb movements, reaching for targets, bilateral movements, and coordinated movements of the upper and lower limbs. Physiotherapists may also provide visual, verbal, or tactile feedback to help patients understand and improve their movement. The focus should be on performing movements correctly and in a meaningful way.

Gait and Task-Specific Training

Walking problems are a major concern for many people undergoing neurological rehabilitation. Gait training may include over ground walking, treadmill practice, supported walking, stepping activities, turning, changes in walking speed, and negotiating simple obstacles. The selected approach should match the patient's walking ability and safety needs.

Task-specific practice is particularly useful because it allows patients to practise activities that are directly relevant to everyday life^[11]. Examples include getting up from a chair, walking between different areas, turning, climbing stairs, or stepping over obstacles. Repeated practice of meaningful tasks can help improve confidence, movement efficiency, and functional performance.

Flexibility and Range-of-Motion Activities

Limited joint movement may develop because of weakness, increased muscle tone, prolonged inactivity, pain, or

abnormal movement patterns. Maintaining available joint movement is therefore important for positioning, mobility, and functional activities^[12].

Physiotherapists may use active movements, assisted movements, gentle stretching, positioning, and functional mobility activities according to the patient's needs. Extra care is required when the patient has pain, joint instability, reduced sensation, or increased muscle tone. Movements should be performed safely and comfortably rather than using unnecessary force.

Repetitive and Functional Movement Practice

Repeated practice is an important part of neurological rehabilitation. Patients may need to perform a movement several times before they become more confident and efficient in carrying out a functional task. Practice may

include reaching, grasping, stepping, standing, transfers, walking, and other goal-directed activities.

Repetition is most meaningful when it is connected to the patient's daily needs. Instead of practising isolated movements without a clear purpose, physiotherapists can include them within functional activities. The level of difficulty can then be increased gradually as the patient's performance improves^[13].

Individualisation and Progression

There is no single programme that is suitable for every person with a neurological disorder. Two patients with the same diagnosis may have very different levels of weakness, balance, coordination, mobility, fatigue, and functional ability^[14]. For this reason, treatment should be individually planned and regularly reviewed.

Application across Major Neurological Conditions

Neurological condition	Main impairments	Common exercise / physiotherapy approaches	Key precautions
Stroke	Muscle weakness, altered muscle tone, poor balance, impaired coordination, abnormal gait, reduced endurance	Strengthening, balance training, gait practice, task-specific training, aerobic conditioning, sit-to-stand and transfer practice	Monitor fatigue, blood pressure and cardiovascular tolerance; reduce fall risk; consider cognitive and communication difficulties
Spinal cord injury	Paralysis or weakness, sensory loss, impaired trunk control, reduced mobility, muscle stiffness	Strengthening of available muscles, flexibility work, transfer training, standing practice, wheelchair skills, supported gait training where appropriate	Monitor skin integrity and pressure areas; watch for autonomic dysreflexia, orthostatic symptoms, excessive fatigue, and joint stress
Parkinson's disease	Bradykinesia, rigidity, tremor, reduced step length, freezing, postural instability, difficulty turning	Large-amplitude movements, strengthening, balance training, gait and stepping practice, turning exercises, aerobic conditioning	Consider medication timing, freezing episodes, fall risk, fatigue, and postural instability; provide appropriate support during challenging tasks
Multiple sclerosis	Fatigue, weakness, impaired balance, sensory changes, stiffness, reduced endurance	Strengthening, aerobic activities, balance training, flexibility, gait practice, functional mobility, energy-conservation strategies	Avoid excessive fatigue; consider heat sensitivity, fluctuating symptoms, balance problems, and individual exercise tolerance
Traumatic brain injury	Weakness, impaired balance, poor coordination, altered gait, reduced endurance, cognitive and behavioural difficulties	Strengthening, balance and postural training, gait rehabilitation, coordination activities, functional task practice	Use clear instructions and supervision when needed; monitor fatigue, cognition, behaviour, balance, and safety awareness
Cerebral palsy	Abnormal muscle tone, weakness, restricted movement, impaired balance, coordination problems, gait difficulties	Strengthening, stretching, balance activities, postural training, gait practice, functional and play-based activities	Avoid excessive fatigue and forceful movements; consider joint range, abnormal tone, pain, growth-related changes, and individual developmental needs

Clinical Outcomes, Evidence and Critical Analysis

Neurological physiotherapy aims not only to improve body functions but also to help patients perform everyday activities more safely and independently. The success of rehabilitation can therefore be seen through changes in strength, balance, walking ability, coordination, endurance, mobility, and functional independence. Rehabilitation approaches recommended by the World Health Organization for neurological conditions provide a broader framework for improving activity and participation in people with neurological disabilities.

Clinical Outcomes

Clinical outcomes help the physiotherapist determine whether a rehabilitation programme is producing useful changes. Assessment should include both physical performance and the patient's ability to manage daily activities.

Important outcomes include

Muscle strength: Improvement may allow a patient to stand from a chair, move the affected limb, climb stairs, or complete transfers with less assistance.

Balance and postural control: Progress can be observed when the patient stands, reaches for an object, changes direction, or moves from sitting to standing without losing stability.

Walking and mobility: Walking speed, distance, step pattern, turning, transfers, and movement in different environments can be assessed.

Endurance: Improvement is reflected when a patient can walk or remain physically active for longer without becoming excessively tired.

Coordination: Better timing, accuracy, and control of movement may make activities such as reaching, stepping, grasping, and walking easier.

Functional independence: A reduction in the amount of assistance required for dressing, bathing, toileting, transfers, and household mobility indicates meaningful progress.

Participation and quality of life: Improved physical ability may help patients return to family responsibilities, education, work, social activities, and community life. Outcome assessment should always be connected with the patient's goals. For example, an improvement in lower-limb strength is clinically meaningful when it enables a patient to stand independently, transfer from bed to chair, or walk safely to the bathroom.

Evidence Supporting Exercise-Based Rehabilitation

Research supports the use of structured physical rehabilitation for many neurological conditions. Different approaches, including strengthening, aerobic conditioning, balance activities, gait training, flexibility work, and functional practice, may be used according to the patient's needs. However, the same treatment plan cannot be applied to every patient because neurological impairments differ considerably.

For example, after stroke, treatment may initially focus on supported standing, weight shifting, sit-to-stand practice, and short-distance walking. As control improves, the therapist can increase walking distance, resistance, speed, or task complexity. In Parkinson's disease, treatment may include larger movement patterns, stepping practice, turning, balance activities, and walking exercises. For people with multiple sclerosis, strengthening and endurance activities may be useful, but the programme should also include appropriate rest periods and strategies for managing fatigue.

Regular physical activity may provide benefits beyond improving movement. It can contribute to better cardiovascular fitness, mobility, physical capacity, and independence. Some studies have also reported possible benefits in areas such as cognition and psychological well-being. However, research findings are not always identical because studies differ in patient characteristics, intervention methods, treatment duration, outcome measures, and follow-up periods. Therefore, evidence should be interpreted carefully and applied according to the individual clinical situation rather than treating research findings as a fixed treatment protocol.

Critical Analysis of Clinical Effectiveness

The response to neurological rehabilitation varies from one person to another. Factors such as the severity and duration of the condition, age, sensory impairment, muscle weakness, balance problems, cognitive status, fatigue, and other health conditions can influence recovery. Consequently, a treatment programme should be individually planned and regularly reviewed.

One important consideration is the training dose. The physiotherapist has to determine an appropriate level of activity, including intensity, duration, frequency, and progression. Insufficient activity may provide limited benefit, whereas excessive training can cause fatigue, pain, dizziness, poor movement control, or increased risk of falling.

For example, a patient with poor standing balance may initially practise weight shifting while holding a stable

surface. When this becomes easier, reaching activities can be introduced, followed by stepping, turning, and walking with reduced support. Such gradual progression provides an appropriate challenge while maintaining safety.

Adherence is another important factor affecting treatment results. Patients may not follow rehabilitation programmes consistently because of fatigue, transportation difficulties, financial limitations, lack of family support, cognitive difficulties, or limited access to physiotherapy services. Simple home exercises, understandable instructions, family involvement, and regular follow-up can improve participation.

Limitations of Current Evidence

Although research provides strong support for rehabilitation, several limitations should be considered. Studies may include different numbers of participants and use different treatment durations, exercise intensities, assessment tools, and patient populations. These differences make it difficult to apply the findings of one study directly to every neurological patient.

Another important issue is the difference between improvement in the clinic and improvement in everyday life. A patient may perform better during a walking test in a controlled environment but still experience difficulty walking outdoors, using stairs, moving over uneven surfaces, or completing household activities.

For this reason, clinical assessment should not depend only on numerical scores. Standardised tools such as the 10-Meter Walk Test, 6-Minute Walk Test, Berg Balance Scale, Timed Up and Go, Fugl-Meyer Assessment, Spinal Cord Independence Measure, MDS-UPDRS, and Gross Motor Function Measure can provide objective information. These measures can be repeated at different stages of rehabilitation to identify changes over time. At the same time, therapists should observe practical activities such as transfers, walking, reaching, stair climbing, dressing, and other tasks that are important to the individual patient.

Clinical Interpretation

The available evidence indicates that structured physical rehabilitation is a major component of neurological physiotherapy. It should not be viewed as a single exercise or isolated treatment. Instead, different methods can be combined according to the patient's impairments and functional goals. These may include strengthening, aerobic conditioning, balance training, gait practice, flexibility activities, coordination training, and task-specific practice.

Regular reassessment is essential. The physiotherapist should monitor changes in strength, walking, balance, endurance, fatigue, pain, movement quality, cardiovascular tolerance, safety, and independence in daily activities. Based on these findings, the treatment programme can be progressed, reduced, or modified.

The ultimate purpose of rehabilitation is not simply to improve performance during a therapy session. The more important goal is to help the patient move safely, perform daily activities with greater independence, and participate more actively in normal life. Therefore, treatment should gradually connect therapeutic activities with real-life tasks whenever possible.

Conclusion

Exercise therapy plays a major role in neurological physiotherapy by helping individuals improve their physical abilities, movement, mobility, and independence. Neurological disorders such as stroke, spinal cord injury,

Parkinson's disease, multiple sclerosis, traumatic brain injury, and cerebral palsy can affect muscle performance, balance, coordination, walking, endurance, and the ability to carry out routine activities. A properly planned rehabilitation programme can address these difficulties through strengthening activities, aerobic conditioning, balance practice, flexibility exercises, coordination training, gait rehabilitation, and functional task practice.

The review shows that the benefits of therapeutic exercise are not limited to changes in muscle strength or individual body functions. When treatment is selected according to the patient's condition and gradually progressed, it can improve walking ability, postural stability, endurance, transfers, functional mobility, and independence. Clinical tools such as the 10-Meter Walk Test, 6-Minute Walk Test, Berg Balance Scale, Timed Up and Go, Fugl-Meyer Assessment, and condition-specific assessment scales can help physiotherapists measure progress and determine whether treatment is producing meaningful changes.

At the same time, the response to rehabilitation varies between individuals. The severity and type of neurological impairment, fatigue, sensory changes, cognitive difficulties, other health conditions, physical capacity, and personal goals may all influence treatment outcomes. For this reason, rehabilitation should be designed around the individual rather than following one standard programme. Careful exercise selection, appropriate training intensity, gradual progression, safety precautions, patient participation, and regular reassessment are important for achieving better results.

From a practical clinical perspective, rehabilitation becomes more effective when therapeutic activities are connected with the patient's everyday needs. Treatment should gradually progress from basic movements to functional tasks such as standing, transferring, walking, climbing stairs, reaching, and performing household or community activities. The main objective is therefore not simply to improve performance during physiotherapy sessions, but to help the person move safely, function more independently, and participate more actively in daily life. In conclusion, exercise therapy provides a practical and evidence-based approach to neurological rehabilitation. Its effectiveness is greatest when the programme is individualised, goal-directed, progressive, and regularly evaluated using appropriate clinical outcome measures. Future research should focus on determining suitable training intensity and duration, long-term treatment effects, home-based rehabilitation, strategies for improving adherence, and condition-specific approaches that can produce meaningful improvements in functional independence and quality of life.

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