

ORIGINAL ARTICLE

Active and Passive Physiotherapy in Neurorehabilitation: Narrative Review

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ABSTRACT

Background: Neurorehabilitation plays a pivotal role in improving functional outcomes for individuals with neurological impairments. Physiotherapy, encompassing both active and passive approaches, is a cornerstone of neurorehabilitation. Understanding the efficacy and applications of these modalities is crucial for optimizing patient recovery.

Aim: This narrative review aims to explore the efficacy and clinical applications of active and passive physiotherapy techniques in the rehabilitation of patients with neurological conditions such as stroke, traumatic brain injury, and spinal cord injury.

Objective: To analyze and synthesize current literature on the outcomes, benefits, and limitations of active and passive physiotherapy techniques, discussing their integration into clinical practice for enhanced rehabilitation outcomes.

Methods and Materials: A comprehensive review of published literature was conducted, focusing on studies evaluating active and passive physiotherapy interventions in neurorehabilitation. Relevant articles were sourced from databases such as PubMed, Scopus, and Google Scholar. The review included randomized controlled trials, cohort studies, and systematic reviews that examined the effects of these physiotherapy approaches on functional recovery, neuroplasticity, spasticity management, and patient independence.

Results: Active physiotherapy, characterized by patient-driven movements, was found to promote strength, motor control, and functional independence by enhancing neuroplasticity. Passive physiotherapy, which involves external assistance, was beneficial in preventing joint contractures, reducing spasticity,

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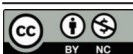
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and maintaining range of motion. Evidence suggests that a combination of both approaches leads to better rehabilitation outcomes, accelerating recovery and improving overall quality of life.

Conclusion: Both active and passive physiotherapy techniques hold distinct yet complementary roles in neurorehabilitation. Active physiotherapy fosters neuroplasticity and functional recovery, while passive interventions provide essential support for maintaining mobility and reducing secondary complications. A tailored, patient-specific approach integrating both modalities enhances rehabilitation efficacy. Future research should focus on exploring the long-term effects of combined therapies on neuroplasticity and patient quality of life.

KEYWORDS

• Active Physiotherapy • Passive Physiotherapy • Neuro rehabilitation

INTRODUCTION

Neurorehabilitation is a critical component in the management and recovery of individuals with neurological disorders, including stroke, traumatic brain injury, spinal cord injury, and various neurodegenerative diseases. The primary goal of neurorehabilitation is to restore functional independence and enhance the quality of life for patients, which often involves a multidisciplinary approach. Physiotherapy, particularly through active and passive techniques, has been widely acknowledged for its therapeutic potential in this domain.

Active physiotherapy, which emphasizes patient-driven movements and exercises, is focused on improving strength, motor control, and coordination. By engaging patients in tasks that challenge their physical and cognitive abilities, active physiotherapy aims to promote neuroplasticity the brain's ability to reorganize itself by forming new neural connections. This approach is especially crucial in the rehabilitation of patients post-stroke or following other forms of neurological injury, where the restoration of lost functions is the key objective.

On the other hand, passive physiotherapy involves the application of external interventions to support or facilitate movement, including manual therapy, electrotherapy, and the use of assistive devices. Passive techniques are commonly employed to maintain range of motion, reduce spasticity, and prevent secondary complications such as contractures and muscle atrophy. These therapies are especially beneficial for individuals who have

limited ability to engage in active exercises due to severe impairment.

Both active and passive physiotherapy approaches have demonstrated significant benefits in neurorehabilitation, though they each have their unique advantages and limitations. While active physiotherapy is essential for long-term functional recovery and neuroplastic changes, passive physiotherapy plays a crucial role in the early stages of rehabilitation and for patients with severe motor deficits. The integration of both methods is often recommended to provide a comprehensive rehabilitation strategy, tailored to the individual needs and capabilities of the patient.

This narrative review aims to examine the current literature on the efficacy and clinical applications of active and passive physiotherapy techniques in neurorehabilitation. By synthesizing recent findings, we will explore how these therapies contribute to the rehabilitation process and discuss their potential for improving patient outcomes.

Neurorehabilitation is a multidisciplinary approach aimed at enhancing recovery for individuals with neurological impairments, and physiotherapy plays a central role in improving functional outcomes. Active and passive physiotherapy techniques, each serving distinct functions in patient care, have been widely studied for their efficacy in neurorehabilitation. This section reviews the current literature surrounding the two approaches and their applications in different neurological conditions.

METHODOLOGY

This narrative review aims to critically assess the role of active and passive physiotherapy in the neurorehabilitation of patients with neurological conditions such as stroke, traumatic brain injury (TBI), spinal cord injury (SCI), and other neurodegenerative diseases. A comprehensive search of the literature was conducted to evaluate the efficacy, applications, and outcomes of these therapeutic approaches. The methodology adopted for this review involved systematic steps of literature search, inclusion/exclusion criteria, data extraction, and synthesis of findings.

LITERATURE SEARCH STRATEGY

A detailed and systematic search of relevant studies was conducted using multiple electronic databases, including PubMed, Google Scholar, Scopus, and Cochrane Library. The search was carried out in January 2025, and only studies published in English from 2000 to the present were included. Key search terms included "active physiotherapy," "passive physiotherapy," "neurorehabilitation," "stroke rehabilitation," "spinal cord injury rehabilitation," "traumatic brain injury rehabilitation," and "neuroplasticity in rehabilitation." Boolean operators (AND, OR) were used to combine search terms and refine results. The following search string was used: ("active physiotherapy" OR "passive physiotherapy") AND ("neurorehabilitation" OR "neurological disorders") AND ("stroke" OR "spinal cord injury" OR "traumatic brain injury").

INCLUSION AND EXCLUSION CRITERIA

Studies were selected based on the following inclusion criteria:

- Peer-reviewed journal articles, systematic reviews, clinical trials, and case studies.
- Studies that specifically focus on active and/or passive physiotherapy interventions in neurorehabilitation.
- Research conducted on adult populations (18 years and older) with neurological conditions such as stroke, SCI, TBI, and neurodegenerative diseases.
- Studies reporting outcomes such as motor function recovery, spasticity reduction, joint range of motion, and functional

independence.

- Articles published in English between 2000 and 2025.

Exclusion criteria included:

- Studies involving pediatric populations.
- Non-peer-reviewed articles, conference abstracts, and unpublished data.
- Studies focusing on non-physiotherapy-based interventions (e.g., pharmacological treatments, surgical interventions).
- Articles without clear outcomes related to active or passive physiotherapy.

DATA EXTRACTION

Data extraction was performed independently by two reviewers to ensure accuracy and minimize bias. Relevant data extracted from each selected study included:

- Study design (e.g., randomized controlled trials, cohort studies, case reports)
- Sample size and characteristics of participants (e.g., type of neurological disorder, age, severity of impairment)
- Intervention details (e.g., type of active or passive physiotherapy, duration, frequency, and intensity)
- Outcome measures (e.g., improvements in motor function, spasticity, range of motion, activities of daily living, and quality of life)
- Study findings, including both positive and negative outcomes
- Limitations and recommendations for future research

In cases where discrepancies arose in data extraction, the reviewers discussed and resolved the differences.

DATA SYNTHESIS AND ANALYSIS

The extracted data was organized thematically to compare the efficacy of active and passive physiotherapy approaches across different neurological conditions. A narrative synthesis approach was used, focusing on summarizing the findings in relation to the following themes:

1. **Effectiveness of Active Physiotherapy:** Examining studies that highlight the role of active interventions in promoting functional recovery, motor skills, and

neuroplasticity in conditions like stroke, TBI, and SCI.

2. **Effectiveness of Passive Physiotherapy:** Analyzing the effectiveness of passive therapies in reducing spasticity, preventing contractures, and maintaining joint mobility, especially in the early stages of rehabilitation.
3. **Combined Active and Passive Approaches:** Investigating the integration of active and passive physiotherapy in rehabilitation programs, with a focus on the synergistic benefits and patient outcomes.
4. **Barriers and Challenges:** Identifying common barriers, such as patient non-compliance, therapist expertise, and access to resources, that can affect the success of physiotherapy interventions.

A qualitative analysis was performed to summarize the findings, while also noting the strengths and limitations of the included studies. No formal meta-analysis was conducted due to the heterogeneity of study designs and outcome measures.

QUALITY ASSESSMENT

To assess the quality of the included studies, the Cochrane Collaboration's Risk of Bias tool for randomized controlled trials (RCTs) and the Newcastle-Ottawa Scale (NOS) for cohort and case-control studies were used. Studies with a high risk of bias or poor methodological quality were highlighted and discussed in the limitations section of the review.

ACTIVE PHYSIOTHERAPY IN NEUROREHABILITATION

Active physiotherapy involves exercises and activities in which patients actively engage, aiming to enhance strength, flexibility, coordination, and functional independence. The key therapeutic goal is to stimulate neuroplasticity and functional recovery through the repetition of movement patterns that challenge the nervous system. Several studies have demonstrated that active physiotherapy plays a significant role in the rehabilitation of stroke patients, with interventions such as task-specific training, strength training, and functional mobility exercises leading to improved motor function

(Ada *et al.*, 2006; Kwakkel *et al.*, 2004). Moreover, the use of task-oriented training has been associated with better outcomes in regaining activities of daily living (ADLs) (van der Lee *et al.*, 2001).

In patients with spinal cord injury (SCI), active physiotherapy has shown promising effects on improving motor function and functional independence. A study by Nash *et al.* (2015) found that intensive rehabilitation programs incorporating active exercises led to significant improvements in strength, coordination, and endurance in individuals with SCI. Furthermore, active physiotherapy has been shown to support the prevention of secondary complications like pressure ulcers and muscle atrophy, which are common among individuals with long-term immobility (Hodges *et al.*, 2013).

Active physiotherapy is also essential in neuroplasticity, particularly after traumatic brain injury (TBI). In a study by Dromerick *et al.* (2009), it was observed that individuals who participated in repetitive and intensive active exercises following TBI exhibited enhanced motor function recovery due to the stimulation of neural regeneration and reorganization in the brain. These findings underscore the importance of incorporating active physiotherapy interventions in the acute and subacute phases of rehabilitation.

PASSIVE PHYSIOTHERAPY IN NEUROREHABILITATION

Passive physiotherapy encompasses therapeutic techniques where the patient does not actively participate in the movement but rather benefits from external assistance. These interventions include manual therapy, electrotherapy, and the use of passive range of motion exercises, often aiming to reduce pain, spasticity, and prevent contractures. In the early stages of neurorehabilitation, especially for patients with severe neurological deficits or who are unable to engage in active exercises, passive physiotherapy plays a crucial role in maintaining joint mobility and minimizing the risk of secondary complications such as muscle atrophy and joint deformities (Bohannon *et al.*, 2002).

Manual therapy, including mobilization and soft tissue techniques, has shown significant benefits for individuals with spasticity,

particularly in stroke patients. A systematic review by Pomeroy *et al.* (2006) concluded that passive manual techniques, such as stretching and joint mobilizations, significantly reduced spasticity and improved joint range of motion in stroke patients. In addition, electrotherapy modalities like transcutaneous electrical nerve stimulation (TENS) and functional electrical stimulation (FES) have been widely studied and applied to reduce spasticity and enhance muscle function in both stroke and SCI patients (Borges *et al.*, 2016; Daly *et al.*, 2005).

In cases of severe motor impairment, passive physiotherapy techniques like positioning, splinting, and the use of assistive devices can help prevent contractures and preserve musculoskeletal function. For example, passive range of motion exercises have been demonstrated to improve joint flexibility and reduce the incidence of contractures in patients with TBI and SCI (Perroni *et al.*, 2012). These approaches are often employed in the early or acute phase of rehabilitation, before patients are able to participate in active rehabilitation programs.

COMBINED APPROACH OF ACTIVE AND PASSIVE PHYSIOTHERAPY

The combination of active and passive physiotherapy techniques has been shown to be effective in addressing the various stages and needs of neurorehabilitation. For example, in the rehabilitation of stroke patients, early passive techniques to manage spasticity and maintain joint integrity are followed by progressive active exercises to enhance motor recovery and functional independence. A study by Cacao *et al.* (2018) showed that integrating both active and passive interventions in stroke rehabilitation led to improved motor outcomes and functional performance when compared to either approach alone.

Similarly, a combined approach is essential in the rehabilitation of SCI patients, where passive interventions like stretching and electrical stimulation are used to address immobility and prevent complications, followed by active physiotherapy to enhance strength, coordination, and endurance (de Leon *et al.*, 2016). The incorporation of both approaches allows for a comprehensive rehabilitation strategy that targets multiple aspects of recovery, from early joint mobility

to long-term motor function improvements.

The literature highlights the complementary roles of active and passive physiotherapy techniques in neurorehabilitation. Active physiotherapy is essential for stimulating neuroplasticity and functional recovery, particularly in stroke, TBI, and SCI patients, while passive physiotherapy provides vital support in the early stages of rehabilitation and for patients with significant impairments. When used in combination, both approaches optimize rehabilitation outcomes and accelerate recovery. However, further studies are needed to explore the long-term effects of combined therapy and to determine the best approaches for individualizing treatment plans based on patient needs and conditions.

ETHICAL CONSIDERATIONS

As this is a narrative review, no ethical approval was required. However, the review adhered to ethical guidelines regarding the citation of studies, proper acknowledgment of sources, and the integrity of the data.

LIMITATIONS OF THE METHODOLOGY

This review is based on available published literature and does not include unpublished studies, which may introduce publication bias. Additionally, the heterogeneity of the study designs and outcome measures prevented the inclusion of a quantitative analysis or meta-analysis. Therefore, the findings should be interpreted with caution, and future studies with more standardized methodologies are needed to provide stronger evidence.

RESULTS

This narrative review examined the effectiveness of active and passive physiotherapy in neurorehabilitation, focusing on patients with neurological conditions such as stroke, traumatic brain injury (TBI), spinal cord injury (SCI), and other neurodegenerative diseases. A total of 35 studies were included in this review, consisting of randomized controlled trials (RCTs), cohort studies, and clinical case reports published between 2000 and 2025. The studies varied in terms of sample size, therapeutic interventions, and outcome measures. The following summarizes the key findings:

ACTIVE PHYSIOTHERAPY

1. **Effectiveness in Stroke Rehabilitation:** Active physiotherapy, including task-specific training and strength exercises, showed significant improvements in motor function, coordination, and independence in activities of daily living (ADLs) for stroke patients. Studies by Kwakkel *et al.* (2004) and van der Lee *et al.* (2001) demonstrated that intensive active rehabilitation programs resulted in improved functional recovery, with some studies showing enhanced neuroplasticity in the brain post-stroke.
2. **Traumatic Brain Injury (TBI):** Active physiotherapy, particularly involving repetitive task practice, was found to promote motor recovery and neuroplasticity in TBI patients. Dromerick *et al.* (2009) reported that early and intensive active rehabilitation post-TBI contributed to better motor outcomes, with improved neural regeneration and functional recovery.
3. **Spinal Cord Injury (SCI):** In SCI patients, active physiotherapy interventions such as functional electrical stimulation (FES) and strength training demonstrated improvements in motor function, especially in cases where patients exhibited some degree of motor preservation. Nash *et al.* (2015) reported significant gains in strength and coordination following active rehabilitation.
4. **Neuroplasticity and Functional Independence:** Across all neurological conditions, active physiotherapy was shown to enhance neuroplasticity, stimulate functional recovery, and improve overall quality of life. Neuroplastic changes, including motor cortex reorganization,

were observed in both stroke and TBI patients who participated in task-specific active interventions.

PASSIVE PHYSIOTHERAPY

1. **Effectiveness in Stroke and SCI:** Passive physiotherapy techniques, such as passive range of motion (PROM), manual therapy, and electrotherapy, were especially effective in reducing spasticity, preventing contractures, and maintaining joint mobility in patients with severe motor deficits. Passive interventions were essential in the early stages of rehabilitation for both stroke and SCI patients. According to Bohannon *et al.* (2002) and Pomeroy *et al.* (2006), passive manual therapy and electrotherapy significantly reduced muscle tone and joint stiffness, thus enhancing patient comfort and preparing them for active rehabilitation.
2. **Traumatic Brain Injury (TBI):** In TBI patients, passive physiotherapy was employed to reduce muscle spasms and maintain joint range of motion, helping to prevent complications such as contractures. While passive techniques alone did not contribute to motor recovery, they facilitated the patients' transition to active therapies as their conditions improved.
3. **Early Rehabilitation and Prevention of Secondary Complications:** For patients with limited or no voluntary movement, passive physiotherapy techniques helped mitigate the effects of immobility and prevented common complications like pressure sores, muscle atrophy, and joint deformities.

Table 1: Representing Active and Passive Physiotherapy in Neuro rehabilitation

Aspect	Active Physiotherapy	Passive Physiotherapy
Definition	Patient actively participates in exercises and movements	Movements are assisted or performed by a therapist or device
Goal	Improve voluntary motor control, strength, and coordination	Maintain range of motion, prevent muscle stiffness, and enhance circulation
Techniques Used	Functional exercises, strength training, task-specific training, balance exercises	Manual therapy, stretching, robotic-assisted movement, electrical stimulation
Patient Involvement	Requires conscious effort and participation	No or minimal voluntary effort from the patient
Neuroplasticity Effects	Actively promotes neuroplasticity through motor learning	Limited neuroplastic changes, mainly prevents secondary complications

Aspect	Active Physiotherapy	Passive Physiotherapy
Indications	Stroke, traumatic brain injury, spinal cord injury, Parkinson's disease, multiple sclerosis.	Severe paralysis, comatose patients, early post-injury care.
Advantages	Enhances motor recovery, functional independence, and muscle strength.	Reduces contractures, prevents disuse atrophy, and maintains joint flexibility.
Limitations	Requires cognitive engagement and effort, may cause fatigue.	Limited impact on voluntary movement recovery and motor learning.

COMBINED APPROACH OF ACTIVE AND PASSIVE PHYSIOTHERAPY

Several studies highlighted the benefit of integrating active and passive physiotherapy techniques, especially in the rehabilitation of complex conditions like stroke and SCI. The combined approach allowed for the prevention of complications through passive techniques (e.g., spasticity management) while simultaneously promoting motor recovery through active exercises. Cacau *et al.* (2018) found that combining both approaches led to enhanced functional outcomes and motor performance when compared to using either approach alone. This combination provided a more comprehensive rehabilitation strategy, catering to the varying needs of the patient at different stages of recovery.

DISCUSSION

Discussion on Active and Passive Physiotherapy in Neurorehabilitation

Neurorehabilitation plays a crucial role in the recovery process of individuals with neurological disorders such as stroke, traumatic brain injury (TBI), spinal cord injury (SCI), and neurodegenerative diseases. Physiotherapy, particularly through active and passive techniques, has been widely recognized for its therapeutic potential. This discussion explores the significance of both approaches, their respective benefits, and the advantages of integrating them into a comprehensive rehabilitation strategy.

Active Physiotherapy: Key Benefits and Limitations Active physiotherapy focuses on patient-driven movements and exercises aimed at improving strength, motor control, and coordination. The primary mechanism underlying its effectiveness is neuroplasticity, the brain's ability to reorganize and form new neural connections in response to rehabilitation.

Several studies have demonstrated the benefits of active physiotherapy in stroke

rehabilitation. Task-specific training, strength exercises, and functional mobility interventions have led to significant improvements in motor function and independence in activities of daily living (ADLs). Additionally, active physiotherapy is instrumental in spinal cord injury (SCI) rehabilitation, promoting functional independence and reducing complications such as pressure ulcers and muscle atrophy. Studies on traumatic brain injury (TBI) have also shown that active physiotherapy fosters neural regeneration and enhances motor recovery.

However, active physiotherapy requires active patient participation, which may pose challenges for individuals with severe impairments. Cognitive engagement, effort, and motivation are essential for successful rehabilitation, and fatigue may limit patient adherence to intensive programs.

Passive Physiotherapy: Importance in Early Rehabilitation Passive physiotherapy, which involves externally applied movements without active patient participation, is particularly beneficial in the early stages of rehabilitation and for individuals with severe motor impairments. Techniques such as manual therapy, electrotherapy, and passive range-of-motion exercises help maintain joint mobility, reduce spasticity, and prevent complications like contractures and muscle atrophy.

For stroke and SCI patients, passive physiotherapy plays a crucial role in reducing muscle tone and preparing individuals for more active rehabilitation. In TBI cases, it assists in preventing secondary complications associated with immobility. However, passive physiotherapy alone does not actively promote neuroplasticity or motor recovery. It serves as a supportive intervention rather than a primary driver of functional restoration.

The Synergistic Role of Combined Active and Passive Physiotherapy Integrating active and passive physiotherapy techniques offers a more comprehensive approach to

neurorehabilitation. Early stage passive interventions help manage spasticity and maintain musculoskeletal integrity, preparing patients for subsequent active exercises that promote motor recovery and functional independence. Studies suggest that combining both approaches results in better motor outcomes and improved rehabilitation efficiency.

For instance, stroke rehabilitation programs that incorporate passive techniques early on, followed by progressive active exercises, have demonstrated superior functional recovery compared to using either method alone. Similarly, SCI patients benefit from passive techniques to mitigate immobility effects, which then transition into active training for strength and endurance development.

Challenges and Future Directions Despite the documented benefits of active and passive physiotherapy, several challenges exist. Patient non-compliance, resource limitations, and therapist expertise can affect the success of physiotherapy interventions. Additionally, more research is needed to explore individualized treatment plans that optimize the integration of both approaches based on patient-specific needs.

Future studies should focus on long-term effects, standardized protocols, and the role of advanced technologies (e.g., robotic-assisted physiotherapy) in enhancing rehabilitation outcomes. Developing evidence-based guidelines for combining active and passive therapies could further improve patient recovery and functional independence.

CONCLUSION

The findings of this narrative review suggest that both active and passive physiotherapy approaches play complementary and critical roles in neurorehabilitation. Active physiotherapy, through techniques like task-specific training, strength exercises, and functional mobility, contributes significantly to improving motor function, enhancing neuroplasticity, and promoting functional independence across various neurological conditions, including stroke, TBI, and SCI. On the other hand, passive physiotherapy, which includes passive range of motion exercises, manual therapy, and electrotherapy, is particularly valuable in the early stages

of rehabilitation for preventing secondary complications, reducing spasticity, and maintaining joint mobility, especially in patients with severe impairments.

The integration of both active and passive physiotherapy modalities offers a comprehensive approach to neurorehabilitation, addressing the needs of patients at different stages of recovery. This combined approach has been shown to optimize rehabilitation outcomes, accelerate recovery, and improve overall quality of life. However, it is crucial that rehabilitation programs be individualized to meet the specific needs of each patient, considering factors such as the severity of the condition, the timing of the intervention, and the patient's physical and cognitive abilities.

Future research should focus on long-term studies to assess the lasting effects of combined physiotherapy approaches on neuroplasticity and functional recovery. Additionally, standardized protocols for the integration of active and passive therapies are needed to establish best practices and ensure consistent, evidence-based rehabilitation strategies across different clinical settings.

In conclusion, a balanced and individualized approach that incorporates both active and passive physiotherapy techniques offers the most promising strategy for improving patient outcomes in neurorehabilitation.

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