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OUTCOME MEASURE RESPONSIVENESS IN NEUROLOGICAL REHABILITATION: A COMPREHENSIVE REVIEW

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Abstract
Neurological physiotherapy aims to improve functional ability, independence, and quality of life in individuals with neurological disorders through targeted rehabilitation interventions. Accurate assessment of treatment outcomes is fundamental to evidence-based practice, and among the key psychometric properties of outcome measures-validity, reliability, and responsiveness-responsiveness plays a critical role in detecting true and meaningful change over time. This review examines the concept of responsiveness, its distinction from validity and reliability, and its importance in neurological physiotherapy. Distribution-based and anchor-based methods used to assess responsiveness, including effect size, standardized response mean, minimal detectable change (MDC), and minimal clinically important difference (MCID), are discussed in detail. The responsiveness of commonly used outcome measures across major neurological conditions such as stroke, Parkinson's disease, spinal cord injury, and multiple sclerosis is reviewed. Factors influencing responsiveness, including disease stage, intervention intensity, measurement intervals, and patient-related and contextual variables, are highlighted. The review further explores clinical implications, challenges, and future directions, emphasizing the need for responsive, patient-centered, and technology-enhanced outcome measures to optimize clinical decision-making and rehabilitation outcomes.

***Keywords**: Neurological physiotherapy, Minimal clinically important difference (MCID), Minimal detectable change (MDC), Rehabilitation assessment, Patient-centered outcomes.*

1. INTRODUCTION

Neurological physiotherapy focuses on improving functional abilities and quality of life in individuals with central and peripheral nervous system disorders.Among the most prevalent chronic illnesses that cause disability and mortality in the elderly are neurological disorders (NDs), which include Parkinson's disease, stroke, and cognitive impairment. Patients, their families, and caretakers are also greatly burdened by them. Some common NDs observed in the elderly that often require specialised healthcare services are multiple sclerosis (MS), epilepsy, myopathy, weakness, polyneuropathy, dizziness, idiopathic movement disorders, myasthenic syndrome, and migraines [1].

Additionally, a comprehensive assessment of a patient's health situation determines the problem-based, individualised approach that neurological physiotherapy takes. As a result, patients with identical NDs but distinct medical histories may have quite varied therapy goals for stroke recovery. Therefore, a range of instruments and common techniques can be utilised, depending on the patient, their symptoms, and the rehabilitative objectives of physiotherapy. Clinical investigations have assessed these devices as cutting-edge technical instruments for physiotherapy sessions during thistime [2].Accurate assessment of patient outcomes is fundamental to evidence-based practice. Among the psychometric properties of outcome measures—validity, reliability, and responsiveness—responsiveness is particularly important as it reflects the ability of an instrument to detect true changes resulting from therapeutic interventions. Poorly responsive measures may fail to identify meaningful improvements, leading to inaccurate clinical conclusions [3].

2. CONCEPT OF RESPONSIVENESS

Responsiveness refers to the **capacity of an outcome measure to detect change over time in the construct being measured**, especially when a clinically meaningful change has occurred. Furthermore, it is crucial to keep in mind that responsiveness is linked to curative services—the most concentrated aspect of the health system—as well as health promotion, prevention, and rehabilitation [4].

3. Distinction from Reliability and Validity

3.1 Reliability: The level to which the results were found can be duplicated when the investigation is undertaken again in exactly the same conditions. by assessing the consistency of outcomes over time, between observers, and between test parts. The results of a reliable measurement might not necessarily be correct, even if they are repeated.

3.2 Validity: The extent to which the results correctly represent what was planned. by analysing how closely the results match recognised theories and other metrics associated with the same concept. A valid measurement is often reliable; if a test produces correct results, they should be repeated. An outcome measure can be valid and reliable yet insufficiently responsive for monitoring rehabilitation progress [6].

4. IMPORTANCE OF RESPONSIVENESS IN NEUROLOGICAL PHYSIOTHERAPY

Neurological conditions often involve gradual, subtle, and multidimensional changes. Responsive outcome measures:

- Detect small but clinically important improvements
- Guide clinical decision-making and treatment progression
- Support evaluation of intervention effectiveness
- Enhance research quality and comparability
- Assist in prognosis and goal setting [8].

5. METHODS FOR ASSESSING RESPONSIVENESS

Two general methodological approaches-distribution-based methods and anchor-based methods-can be used to assess responsiveness. Each has different advantages and disadvantages and offers complementing information [9].

5.1 Distribution-Based Methods

Distribution-based methods evaluate responsiveness by examining the magnitude of change in outcome measure scores relative to the statistical characteristics of the sample. These approaches focus on quantifying change using variability, measurement error, and standardized indices, without relying on an external clinical criterion. As a result, distribution-based methods primarily indicate whether a change is statistically meaningful rather than clinically meaningful [10].Common distribution-based indices include:

5.1.1 **Effect Size (ES):** Calculated as the mean change score divided by the standard deviation of the baseline scores. Effect size reflects the magnitude of change, with values of approximately 0.2 considered small, 0.5 moderate, and 0.8 or above large. In neurological physiotherapy, larger effect sizes suggest greater sensitivity of an outcome measure to intervention-related change.

5.1.2 **Standardized Response Mean (SRM):** Determined by dividing the mean change score by the standard deviation of the change scores. SRM emphasizes the consistency of change across individuals and is particularly useful for comparing responsiveness between different outcome measures.

5.1.3 **Minimal Detectable Change (MDC):** Represents the smallest change that exceeds measurement error and indicates a true change with a specified level of confidence (commonly 95%). MDC is derived from the standard error of measurement and is especially important in clinical practice, as it helps clinicians distinguish real improvement from random variation or testing error.

Distribution-based methods offer several advantages. They are relatively easy to calculate, require smaller sample sizes, and allow comparison of responsiveness across studies and outcome measures. These methods are particularly useful in research settings and in the early stages of outcome measure development.However, distribution-based approaches have important limitations [11].

5.2 Anchor-Based Methods

Anchor-based methods assess responsiveness by comparing changes in outcome measure scores to an external criterion, known as an *anchor* that independently reflects meaningful change. These anchors are typically subjective or functional indicators that represent the patient's or clinician's perception of improvement, stability, or deterioration. Unlike distribution-based approaches, anchor-based methods directly incorporate clinical relevance, making them particularly valuable in neurological physiotherapy. Commonly used anchors include:

5.2.1 **Global Rating of Change (GROC) scales**, in which patients or clinicians rate overall change since the start of treatment (e.g., from "much worse" to "much better")

5.2.2 **Patient-reported improvement**, such as perceived changes in function, participation, or symptoms

5.2.3 **Clinician judgment**, based on observable functional gains or achievement of therapy goals

5.2.4 **Functional milestones**, such as independent walking, transfers, or return to daily activities

Anchor-based responsiveness is often quantified by examining the relationship between change scores on the outcome measure and the anchor. This may involve correlational analyses, receiver operating characteristic (ROC) curves, or comparison of mean change scores between groups classified as improved versus non-improved according to the anchor [12].MCID is defined as the smallest change in an outcome measure that is perceived as beneficial and meaningful by the patient or clinician, rather than merely statistically significant. In neurological physiotherapy, MCID values help clinicians distinguish between true functional improvement and trivial change. Anchor-based methods offer several advantages:

- They emphasize **patient-centered and clinically meaningful change**
- They enhance interpretability of outcome measure scores
- They support shared decision-making and goal-oriented rehabilitation

However, these methods also have limitations. Anchors may be influenced by recall bias, mood, cognitive impairment, or expectation effects, which are particularly relevant in neurological populations. In addition, variability in anchor selection and definition across studies can limit comparability.Despite these limitations, anchor-based methods are considered essential for evaluating responsiveness in neurological rehabilitation. When used alongside distribution-based approaches, they provide a more comprehensive and clinically relevant understanding of change. MCID values derived from anchor-based methods enhance clinical interpretation and support patient-centered care [13].

6. OUTCOME MEASURE RESPONSIVENESS IN COMMON NEUROLOGICAL CONDITIONS

6.1 Stroke Rehabilitation

One of the main causes of mortality and disability in the globe is stroke. In order to monitor recovery, gauge the severity of the illness, and assess the efficacy of therapies, outcome measurements are crucial to stroke care. Among the frequently employed outcome metrics for stroke are:

6.1.1 Fugl-Meyer Assessment (FMA): The Fugl-Meyer Assessment (FMA) scale is an assessment used to evaluate sensorimotor dysfunction in stroke survivors. In their work "The post-stroke hemiplegic patient: A method for evaluation of physical performance," Axel Fugl-Meyer and colleagues originally suggested this scale as a standardised assessment tool for post-stroke rehabilitation in 1975. The Fugl-Meyer Assessment (FMA) is a performance-based impairment indicator designed specifically for stroke patients. It is intended to evaluate individuals with post-stroke hemiplegia in terms of motor skills, balance, sensory, and joint functioning. It is used in research and clinical settings to define motor recovery, gauge the severity of the condition, and plan and evaluate treatment. It describes the degree of impairment, measures motor recovery, directs treatment planning, and assesses results in both clinical and research settings. In stroke trials, it is generally advised to use the motor subsections (FMA-UE 0–66; FMA-LE 0–34) as core measurements [14].

6.1.2 Barthel Index (BI): The Barthel Index (BI) gauges a person's degree of independence and mobility in their activities of daily living (ADLs), such as eating, bathing, dressing, grooming, bowel and bladder control, toileting, chair transfer, walking, and climbing stairs. The index also shows the requirement for care support. One popular tool for measuring functional impairment is the BI. Although it may potentially be used for cancer patients, the index was created for use in rehabilitation patients with stroke and other neuromuscular or musculoskeletal diseases.

6.1.3 Modified Rankin Scale (mRS): The Modified Rankin measure (MRS) is a one-item global outcomes evaluation system for stroke survivors. It is used to categorise the level of functional liberty in relation to pre-stroke activities rather than based on observable execution of a specific task.

6.1.4 Stroke Impact Scale (SIS): The Stroke Impact Scale (SIS) is a self-report, stroke-specific health status assessment. Strength, hand function, Activities of Daily Living/Instrumental Activities of Daily Living (ADL/IADL), mobility, communication, emotion, memory and thinking, and participation are just a few of the multidimensional stroke outcomes that it was intended to evaluate. Both clinical and scientific settings can make use of the SIS [15] .

6.2 Parkinson's Disease

6.2.1 Unified Parkinson's Disease Rating Scale (UPDRS): Parkinson's disease is tracked throughout time using the Unified Parkinson's Disease Rating Scale (UPDRS). The most used rating scale for Parkinson's disease clinical research is the UPD rating scale.

6.2.2 Berg Balance Scale (BBS): The Berg Balance Scale (BBS) is designed to objectively assess a patient's capacity—or lack thereof—to safely balance while doing a set of pre-planned exercises. It takes around 20 minutes to finish the 14 items on the list, each of which has a five-point ordinal scale from 0 to 4, where 0 represents the lowest level of function and 4 the most. The evaluation of gait is not part of it.

6.2.3 Timed Up and Go (TUG): A clinical evaluation technique called the Timed Up and Go Test (TUG) is used to determine a person's mobility, balance, walking capacity, and fall risk. It provides objective data for fall risk assessment in older individuals and patients with neurological or musculoskeletal diseases by timing how long it takes a person to get up from a chair, walk a certain distance, turn around, return, and seat down. The test is a useful tool in both clinical and research contexts since its validity and reliability have been well shown in a variety of demographics. Standardised administration and interpretation are made easier by comprehensive Timed Up and Go exam instructions and scoring PDF resources [16].

6.3 Spinal Cord Injury

6.3.1 ASIA Impairment Scale: Responsive to neurological recovery but limited functional sensitivity. A severe spinal cord injury (SCI) can have a profound impact on a patient's physical and mental well-being. The ASIA scale's objective is to supply standardised and thorough documenting of the neurological level of damage associated with SCI; recommendations for radiographic evaluation and treatment; and the determination of whether the SCI is full or partial.

6.3.2 Spinal Cord Independence Measure (SCIM): The SCIM was created to help individuals with spinal cord injuries (SCI) in three distinct areas of function. It examines breathing and sphincter control, self-care (eating, grooming, washing, and clothing), and a patient's mobility (bed and transfers, indoors/outdoors). The SCIM can also be used to assist doctors in setting goals and objectives for the treatment of individuals with SCI. This functional measuring instrument will benefit both patients and therapists by assisting professionals in identifying areas of constraint for their patients with spinal cord injury.

6.3.3 Walking Index for SCI (WISCI): The Walking Index for Spinal Cord Injury (WISCI) is a scale that gauges the kind and degree of support a person with a spinal cord injury (SCI) needs to walk, either in terms of human assistants or assistive technologies. It is an ordinal scale developed to show the grades of impairment that occur after SCI and their link to walking function. It classifies individuals with SCI from being unable to walk to independent walking. The 19-level WISCI was changed to WISCI II with the addition of two levels a year after it was released [17].

6.4 Multiple Sclerosis

6.4.1 Expanded Disability Status Scale (EDSS): It is a method of assessing disability and the course of multiple sclerosis that was created by neurologist John Kurtzke to replace his Disability Status Scale (DSS). Clinical studies also make extensive use of the EDSS. A neurologist's examination determines your score, which climbs by half units from 0 to 10 as your degree of impairment rises.

6.4.2 Multiple Sclerosis Functional Composite (MSFC): Clinical research on multiple sclerosis, particularly clinical trials, uses the Multiple Sclerosis Functional Composite (MSFC), a three-part, standardised, quantitative evaluation instrument. The Task Force on Clinical Outcomes Assessment was constituted by the National Multiple Sclerosis Society's Advisory Committee on Clinical Trials of New Agents in Multiple Sclerosis. The task force came to the conclusion that crucial clinical aspects, such cognition, that are not highlighted in current rating systems should be assessed.

6.4.3 Fatigue Severity Scale (FSS): The FSS is a nine-item test used to evaluate tiredness as a symptom of several chronic illnesses. The scale asks respondents to score how easily they get exhausted and how much the symptom interferes with their day-to-day functioning, as well as how it relates to motivation, physical activity, job, family, and social life [18].

7. Factors Influencing Responsiveness

7.1 Stage and Severity of Neurological Condition: Depending on a patient's stage of illness or recovery, different outcome measures are more or less responsive. While change may be slower or more subtle in chronic or later phases, fast changes may occur in early or acute stages, making some measurements extremely sensitive. A measure's capacity to identify significant change may be limited by floor effects caused by severe impairments and ceiling effects caused by moderate impairments.

7.2 Intervention Intensity and Duration: The dose of intervention has a direct impact on the kind and extent of change measured by an outcome measure. While short-duration or low-intensity programs may result in changes below the threshold of measurement sensitivity, high-intensity or task-specific treatments are more likely to yield noticeable improvements. Therefore, the context of the given intervention should be taken into consideration while interpreting responsiveness.

7.3 Floor and Ceiling Effects: Ceiling effects happen when scores cluster close to the maximum, whereas floor effects happen when patients score at or close to the lowest possible number. By limiting the range in which change may be identified, both reduce responsiveness. True clinical progress or deterioration may be underestimated by measures with strong floor or ceiling effects.

7.4 Measurement Interval: Responsiveness is influenced by the intervals between evaluations. Too-long intervals might overlook significant fluctuations or recovery patterns, while too-short intervals might not give enough time for actual change to take place. The ailment, recovery stage, and anticipated rate of change all influence the best measurement intervals.

7.5 Patient Motivation and Cognitive Status: Performance-based and self-reported metrics are directly impacted by motivation, attention, and cognitive ability. Even when physical or neurological improvements are there, diminished insight, exhaustion, despair, or cognitive impairment might reduce perceived change, affecting an outcome measure's apparent responsiveness.

7.6 **Environmental and Contextual Factors:** Patient performance may be impacted by the testing setting, therapist instructions, assistive technology, and social support. Testing settings must be consistent since environmental fluctuation might create measurement noise and mask real change [19,20].

8. CLINICAL IMPLICATIONS

8.1 **Prioritizing Responsiveness in Outcome Measure Selection:** A measure's utility for monitoring change over time is determined by its responsiveness, whereas validity and reliability guarantee that it is accurate and consistent. Tools that can identify clinically significant changes in their particular patient population should be given top priority by clinicians.

8.2 **Use of Condition-Specific Measures:** Condition-specific outcome measures are often more responsive than generic tools because they target impairments and activities most relevant to a particular neurological diagnosis. When available, these measures can provide more precise information about treatment effects.

8.3 **Combining Multiple Levels of Measurement:** A more complete picture of recovery is obtained by combining measurements of disability, activity, and involvement. This method enhances the possibility of identifying significant progress across domains and is consistent with holistic rehabilitation objectives.

8.4 **Interpreting Change Using MDC and MCID:** Minimal Detectable Change (MDC) should be used to assess if change surpasses measurement error, and Minimal Clinically Important Difference (MCID) should be used to assess whether change is significant to the patient. This encourages goal modification and evidence-based decision-making.

8.5 **Enhancing Patient-Centered Care and Clinical Reasoning:** Clinicians may customise therapies, effectively convey progress to patients, and support clinical judgements with responsive outcome indicators. This enhances patient involvement and fortifies collaborative decision-making [21,22].

9. CHALLENGES AND LIMITATIONS

9.1 **Limited Responsiveness Data:** Robust evidence on responsiveness is lacking for many neurological outcome markers, especially when it comes to various illness stages or situations. This reduces the degree of assurance when analysing change scores.

9.2 **Inconsistent Use of MCID:** Due to variations in technique, demographics, and anchor definitions, MCID values sometimes change between research. It is challenging to utilise MCID values consistently in clinical practice due to inconsistent reporting.

9.3 **Overreliance on Impairment-Based Scales:** If impairment-level metrics are the main focus, significant increases in participation and activity may be missed. Additionally, these scales might not be as sensitive to functional advancements that are most important to patients.

9.4 **Methodological Variability:** Variability in response findings limits cross-study comparability due to variations in research design, sample size, statistical techniques, and reporting standards [23].

10 FUTURE DIRECTIONS

10.1 **Development of Patient-Reported Outcome Measures:** Creating responsive patient-reported outcome measures that reflect perceived changes in function, involvement, and quality of life is becoming more and more important. Patient-centered evaluation is improved by these technologies.

10.2 **Technology-Based Assessments:** Continuous and objective data gathering is provided by wearables, sensors, and mobile applications, which may enhance real-world performance and sensitivity to minute changes.

10.3 **Standardization of Responsiveness Reporting:** Research comparability and clinical application would be enhanced by using standardised procedures and reporting requirements for responsiveness, such as uniform usage of effect sizes, MDC, and MCID.

10.4 **Integration of ICF-Based Frameworks:** Comprehensive evaluation of physical function, activity, involvement, and contextual variables is supported by matching outcome measures with the International Classification of Functioning, Disability, and Health (ICF).

10.5 **Longitudinal and Stage-Specific Research:** By identifying the best metrics for each stage of illness or recovery, longitudinal studies that look at responsiveness across several phases of neurological diseases might increase the accuracy of outcome measurement [24,25].

11 CONCLUSION

Responsiveness is a vital psychometric property that determines the ability of outcome measures to capture meaningful change in individuals undergoing neurological physiotherapy. Given the complex, gradual, and multidimensional nature of neurological recovery, the use of responsive outcome measures is essential for accurately monitoring progress, evaluating intervention effectiveness, and supporting clinical reasoning. This review demonstrates that while many commonly used neurological outcome measures show adequate responsiveness, their sensitivity varies across conditions, disease stages, and domains of function. No single measure is sufficient to capture all aspects of recovery, underscoring the importance of combining impairment-, activity-, and participation-level assessments.

The interpretation of change using MDC and MCID values enhances clinical relevance and patient-centered care; however, inconsistent reporting and limited responsiveness data remain significant challenges. Future research should focus on the development of robust patient-reported outcome measures, integration of technology-based assessments, and standardization of responsiveness evaluation and reporting. Longitudinal and ICF-based approaches will further strengthen outcome measurement across the continuum of neurological care.

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The author declares no conflicts of interest.

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17. REFERENCES

1. Le Goff L, Meilleur KG, Norato G, Rippert P, Jain M, et al. Responsiveness and Minimal Clinically Important Difference of the Motor Function Measure in Collagen VI-Related Dystrophies and Laminin Alpha2-Related Muscular Dystrophy. Arch Phys Med Rehabil. 2020.
2. Mishra B, Sudheer P, Agarwal A, Srivastava MV, Nilima, Vishnu VY. Minimal Clinically Important Difference (MCID) in Patient-Reported Outcome Measures for Neurological Conditions: Review of Concept and Methods. Ann Indian Acad Neurol. 2023.
3. Castiglia SF, et al. Discriminative ability, responsiveness, and interpretability of gait smoothness metrics in balance rehabilitation for people with multiple sclerosis. Archives of Physiotherapy. 2025.
4. Scientific Reports. Responsiveness of selected balance and gait measures in Parkinson's disease: Mini-BESTest, Dynamic Gait Index, Berg Balance Scale, and POMA. 2025.
5. Mañago MM, Cohen ET, Cameron MH, Christiansen CL, Bade MM. Reliability, validity, and responsiveness of the Patient-Specific Functional Scale (PSFS) in multiple sclerosis. J Neurol Phys Ther. 2023.
6. Validity, Responsiveness, and Minimal Clinically Important Difference of EQ-5D-5L in Stroke Rehabilitation. Clinical study demonstrating responsiveness metrics and MCID values. 2020.
7. Pooled MCID of the Mini-BESTest in Early Subacute Stroke. Physical Therapy. 2025.
8. Responsiveness and MCID of walking measures in multiple sclerosis: 2MWT, 6MWT and MSWS-12. Mult Scler J. 2014 (often referred in contemporary MS responsiveness studies).
9. Rajabally YA, Nazeer KK, Min YG. Minimal Clinically Important Differences in Measuring Treatment Effects in CIDP: History, Current Use, Limitations, and Prospects. Muscle & Nerve. 2025.
10. A systematic review of MCID thresholds in movement disorder scales (UPDRS and others). Heliyon, 2024.
11. BMC Neurology. A systematic review of the responsiveness of lower limb physical performance measures after stroke. 2025.
12. Construct validity and responsiveness of clinical upper limb measures and sensor-based arm use after stroke. J NeuroEng Rehabil. 2024.
13. Bridging the gap between statistical significance and clinical relevance: MCID thresholds in movement disorders. 2024 systematic review.
14. Outcome Measures Used in Neurological Physiotherapy: A 2025 scoping review covering ICF-based classification and responsiveness emphasis.
15. Enhancing interpretability of PROMIS, Neuro-QoL, TBI-QoL, and SCI-QoL measures in rehabilitation populations. 2025.
16. Responsiveness study of the Six-Spot Step Test in multiple sclerosis. 2025.
17. Abstracts from 2025 Annual Meeting of the American Academy of Neurology (neurorehabilitation progress and responsiveness outcomes). 2025.
18. Fugl-Meyer Assessment — widely reported responsiveness and MCID in stroke studies. Wikipedia/clinical data.
19. Neuro-QoL measurement system psychometric properties, including responsiveness evidence. 2024 systematic review.
20. Outcome Measures in Stroke Rehabilitation — foundational text summarizing tools and responsiveness metrics. 2025.
21. Various interpretability metrics (MIC, MID, MDC) across rehabilitation measures using COSMIN frameworks. 2025.
22. PSFS responsiveness linked to mobility goals in MS. (PMC full text). 2023.
23. Contemporary research articles reporting clinical responsiveness values and thresholds for balance and gait metrics in Parkinson's and stroke populations. 2025.

24. Ongoing and recent cohort studies evaluating upper limb responsiveness metrics post-stroke (MIC estimates). 2024.
25. Evidence synthesizing responsiveness and interpretability of PROMIS instruments relevant to neurorehabilitation. 2025.