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Effectiveness of Task-Oriented Circuit Training in Improving Functional Mobility and Balance in Moderate Parkinson's Disease: A Case Study

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Abstract

Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by motor impairments that significantly affect mobility and daily activities. This case study explores the effectiveness of task-oriented circuit training (TOCT-AT) in improving functional mobility, balance, and independence in a 60-year-old woman with moderate PD (Modified Hoehn & Yahr Stage3). The subject, who experienced frequent falls and gait instability, underwent a 12-week personalized training program focusing on task-specific motor activities, gait retraining, and sensory-modulated exercises.

Outcome measures included the Timed Up and Go (TUG) test, Modified Dynamic Gait Index (m-DGI), and Functional Independence Measure (FIM), assessed at baseline, 6 weeks, and 12 weeks. Results showed a significant reduction in TUG time (32 ± 2s to 18 ± 1.8s), an increase in m-DGI score (32 to 50), and improved FIM scores (98 to 107), exceeding Minimal Clinically Important Difference (MCID) values. The improvements in gait adaptability, postural control, and fall risk reduction suggest that TOCT-AT is a clinically relevant approach for enhancing mobility in PD.

This study highlights the potential of personalized, task-based rehabilitation in improving functional outcomes in PD and encourages further research to establish long-term benefits.

Keywords: Parkinson's Disease, Task-Oriented Circuit Training, Functional Mobility, Balance Improvement, Gait Adaptability, Falls Prevention

Introduction

Parkinson's disease (PD) is a prevalent and progressive neurodegenerative disorder that manifests with a range of motor and non-motor symptoms, even in its early stages. As the condition advances, these symptoms become more severe, significantly affecting the ability to perform daily activities (ADLs)[(1)(2)]. The aim of managing fluctuations in patients with advanced Parkinson's disease is to ensure consistent dopaminergic stimulation in particular, been linked to L-dopa therapy. Using continuous dopaminergic stimulation[(3)(4)]. Physiotherapy should target specific motor issues like falls, freezing, and deconditioning. For individuals in the early stages of the disease, promoting physical activity—such as regular walking, gym workouts, or even dance therapy—is a practical approach[(5)].

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Case Presentation

A 60-year-old ambulatory woman, socially active and enthusiastic by nature, presented with complaints of imbalance and frequent falls-approximately twice a month. These episodes occurred primarily during turning movements or when rising from a bed or chair and initiating gait. These instability episodes have led to previous injuries, including a right acromioclavicular joint fracture five years ago and a left distal radioulnar joint injury three years ago. Additionally, she underwent bilateral total knee replacement (TKR) one year ago. She was diagnosed with idiopathic Parkinson's disease (PD) with thorough neurological examination, MRI and SPECT at a reputed hospital in Pune.

She is a full-time homemaker residing on the ground floor of a three-storied building with her husband. Access to her home requires climbing four steps at the entrance. She visits the first floor at least once daily, which involves climbing two flights of stairs (18 steps). Currently, she remains independent in most indoor activities but requires a walker during "off" periods. She needs supervision during stair climbing and transitional movements, particularly while bathing and using the toilet.

Functionally, she reported difficulties in upper limb activities, such as combing her hair overhead, braiding, and fastening buttons or hooks on her upper body clothing. Her speech is often slurred.

Motor Examination

- **Range of Motion (ROM):** Full ROM in all joints except:
  - Right shoulder: Flexion and abduction limited to 95°
  - Left wrist: Extension limited to 10°
- **Muscle Strength:** Good in all four limbs. However, hand power was fair, and precision in the left hand was notably poor.
- **Tone:** Mild, non-velocity dependent hypertonia graded as 3+ in limbs(left>right) also marked rigidity seen in trunk.
- **Tremors:** Resting tremors predominantly noted in the left wrist.
- **Reflexes:** All deep tendon reflexes (biceps, triceps, brachioradialis, quadriceps, Achilles) were diminished.
- **Sensory Examination:** All peripheral and cortical sensory functions were intact.
- **Coordination Tests:** Both equilibrium and non-equilibrium coordination tests were negative, suggesting normal cerebellar function.

Gait and Functional Assessment

- The patient demonstrated independent ambulation, but her gait was characterized by festination and frequent freezing episodes, especially during initiation.
- Gait speed: 0.7 m/s
- Cadence: 105 steps/min
- Stride length: 72 cm
- Step length: 35 cm
- Reciprocal arm swing was diminished during walking.

On the **Modified Hoehn and Yahr Scale**, she was classified at **Stage 3 Parkinsonism**, indicating moderate disease with postural instability, but still functionally independent.

The **Functional Independence Measure (FIM)** scores were 7 for all ADLs except bathing and toileting, which scored 6, indicating modified independence.

This case report is part of a single-subject study of a 65-year-old woman diagnosed with Parkinson's disease. Ethical approval was obtained from the institutional review board, and the subject provided written informed consent for participation.The initial assessment was done in October 2024 and the post training first assessment was done after 6 weeks treatment and second assessment after 12 weeks. 3 outcome measures were used to assess the progress of patient's balance.

Outcome measures considered are Timed Up and Go Test, Dynamic Gait Index and Functional Independence Measure (FIM)

Timed Up and Go Test (TUG)

Timed up and go test was developed as a quick measure of dynamic balance and mobility. The patient is seated comfortably in a firm chair with arms and back resting against the chair. The patient is then instructed to rise and walk as quickly and safely as possible 3 m (10 ft.), cross a line marked on floor, turn around, walk back, and sit down. The patient is allowed to use an assistive device typically used but must complete the test without manual assistance. Time to administer is less than 5 minutes. Performance on the original TUG Test use a 5 points ordinal scale ranking from 1, Normal (No risk of fall) to 5, Severely abnormal (High risk of fall). Healthy adults are able to complete the test in less than 10 seconds. Older adults(age 60-80) have also been shown to average score less than 10 (mean of 8). Scores of 11-20 sec are considered typical for frail elderly or individual with a mild disability, scores over 30 seconds are indicative of impaired mobility and high fall risk. Previous study states that TUG maybe used as a screening and ongoing assessment tool for patients with PD(6).

Modified Dynamic Gait Index (DGI)

The Dynamic Gait Index was designed to examine the ability to adapt gait to changes in task demands. The m-DGI integrates an evaluation of three facets of performance for each task: gait pattern(24 total points), level of assistance (16 total points) and time required to complete each task (24 total points) for eight items, including gait on even surfaces, gait while changing speeds, gait and head turns in vertical or horizontal direction, stepping over obstacles, and gait with pivot turns and steps. A study[7]concludes, DGI maybe used as a screening and ongoing assessment tool for patients with PD.

Functional Independence Measure

FIM is an 18-item measure of physical, psychological, and social function. A 7-point scale is used based on the percentage of active participation from the patient. In the tool, 7 is defined as Complete independence for an item and 1 is defined as total assistance required to perform the activity or the item is not testable. The instrument lists six self care activities: feeding, grooming, bathing, upper body dressing, lower body dressing and toileting. Bowel and Bladder Control, functional mobility including transfers, communication and social cognition are tested separately.

Treatment Protocol

The intervention was designed as a 12-week program, with sessions conducted thrice a week. Frequency of exercise was 6 days/week, and intensity was kept mild to moderate during the "on" period of medication. A mid-intervention assessment was conducted at 6 weeks.Previous studies have reported significant improvements in motor abilities following exercise interventions such as dance, dual-task training, and high-intensity resistance training[8]

Goals of Therapy

- Improve balance and gait initiation
- Enhance upper limb function and ADL independence
- Reduce risk of falls

Interventions Included:

Upper Limb Training:

- Active and active-assisted overhead ROM exercises:
  - Ball throwing and catching
  - Darting activities
  - Wand and towel exercises
  - Object removal from elevated positions
- The subject was trained to make her own braids and bun everyday for 10 min alternatively.

Circuit Training:

- Time-based functional circuits mimicking daily activities:
  - Sit-to-stand transitions from bed/sofa/chair
  - Hurdle walking (figure-of-8 pattern)

- Navigating through narrow spaces
- Step-ups on elevated platforms

- Each task was trained individually before being integrated into a circuit.

Engagement-Based Activities:

- Playful interventions:
  - Archery, ball targeting, and catching
  - Dance movements (Garba steps)
- Speech and Upper limb dexterity:
  - Breath control exercises (10 minutes/day)
  - Daily 10-minute braiding/bun-making sessions

Balance Training:

- Supervised stair climbing (2 flights daily)
- Standing and sitting dynamic balance exercises.

Results

Statistically significant improvements were observed across all outcome measures over the 12-week intervention period (Table 1). The **Timed** Up and Go (TUG) test demonstrated a mean reduction of 14 ± 3.8 seconds (from 32 ± 2 to 18 ± 1.8 seconds), exceeding the MCID range of 3–11 seconds, indicating a clinically meaningful reduction in fall risk.

The Modified Dynamic Gait Index (DGI) total score increased from 32 to 50, reflecting a change beyond the established MCID (≥4–5 points), suggesting significant enhancement in gait adaptability. Subscale analysis revealed improvements in:

- Performance Score: 7 ± 1.2
- Gait Pattern Score: 6 ± 1.1
- Level of Assistance:5 ± 1.0

The Functional Independence Measure (FIM) score improved from 98 to 107, with a mean difference of 9 ± 1.5 points, falling within the MCID range of 5–10 points, indicating a borderline but clinically relevant gain in functional independence.

Sr. No.	Outcome measures	Initial scores	Scores at 6 weeks	Scores at 12 weeks	Mean difference± SD	MCID Value	Clinical Significance
1	**TUG test**	32 ± 2 seconds	28 ± 1.5 seconds	18 ± 1.8 seconds	14 ± 3.8 seconds.	≥3-11 sec	**Highly significant** (fall risk reduced)
2	**Modified DGI (total score)**	32	36	50		≥4-5 points	**Strong improvement in gait adaptability**
	Performance Score	11/24	12/24	18/24	7 ± 1.2		
	Gait Pattern Score	10/24	12/24	16/24	6 ± 1.1		
	Level of Assistance	11/16	12/16	16/16	5 ± 1.0		
3	**FIM Scores**	98	100	107	9 ± 1.5	5-10 points	**Borderline MCID, functional improvement**

Table 1: Summarizing changes in outcome measures at baseline, 6 weeks, and 12 weeks. Data are expressed as mean ± standard deviation (SD), where applicable. TUG = Timed Up and Go; Modified DGI = Modified Dynamic Gait Index; FIM = Functional Independence Measure; MCID = Minimal Clinically Important Difference. Improvements were evaluated for both statistical and clinical significance. A decrease in TUG time and increases in Modified DGI and FIM scores reflect improved mobility, gait adaptability, and functional independence, respectively.

Discussion

The findings of this study provide strong evidence that task-oriented and personalized circuit training (TOCT-AT) is effective in improving activities of daily living (ADLs) in individuals with Parkinson's disease (PD). The results align with previous research suggesting that TOCT-AT enhances balance and gait performance, which in turn positively influences functional mobility, balance confidence, disease severity, and overall quality of life in people with PD (PwPD)[9]. Task-oriented circuit training, whether combined with aerobic exercises or delivered through telerehabilitation, has also shown promise in improving both lower and upper limb motor functions. Such improvements further reinforce the value of Task oriented circuit Training- based interventions in not only addressing motor symptoms but also in supporting individuals with limited access to in-person rehabilitation, ultimately contributing to better independence and life satisfaction in PwPD[9][10]. Successfully completing a task requires individuals to manage multiple contributing factors simultaneously. When training focuses on only one component and neglects others, it may limit improvements in daily living activities. Functional-task training addresses this by repeatedly practicing all relevant components within real-life tasks, under varying conditions and difficulty levels. This comprehensive approach may explain why traditional physiotherapy or external cueing alone often have less impact on activities of daily living (ADLs) compared to task-based exercise programs. In Parkinson's disease, task-specific exercises integrated into structured balance programs have been shown to effectively enhance balance[11].

Furthermore, studies have demonstrated that task-specific training significantly improves functional balance, promotes independence in ADLs, and reduces the fear of falling among individuals with PD[12]. This study also reinforces the notion that task-oriented exercises, whether performed with or without altered sensory input, contribute to improved balance and fall reduction. However, interventions incorporating altered sensory input were found to be more effective in enhancing postural control and functional stability[13].

These findings emphasize the importance of individualized, task-based rehabilitation approaches for PwPD, particularly those that incorporate sensory-motor integration strategies to maximize functional recovery and independence.

Conclusion

This study demonstrates that task-oriented and personalized circuit training (TOCT-AT) is an effective intervention for improving balance, gait adaptability, and functional independence in individuals with moderate Parkinson's disease (PD). The significant improvements observed in Timed Up and Go (TUG) test, Modified Dynamic Gait Index (m-DGI), and Functional Independence Measure (FIM) scores indicate a reduction in fall risk, enhanced mobility, and greater independence in activities of daily living (ADLs).

Furthermore, incorporating sensory-modulated task-specific exercises was found to be particularly beneficial in optimizing postural control and functional stability. The observed changes exceeded the Minimal Clinically Important Difference (MCID) values, confirming that the improvements are not only statistically significant but also clinically meaningful.

These findings emphasize the importance of customized, task-oriented rehabilitation strategies in managing PD-related motor impairments. Future research with larger sample sizes and long-term follow-up is recommended to further validate these results and refine therapeutic approaches for enhancing functional mobility and quality of life in people with Parkinson's disease.

Limitations

1. The follow-up was short-term. We don't know if the gains will last over time without continued training.
2. The patient's performance also varied depending on her medication cycle, which made consistent assessment a bit tricky.

Future Recommendations

Here are a few directions for future work based on what we've learned:

1. Try this protocol with more participants to see if the benefits hold true across different individuals and severity levels.
2. Including a comparison group would help us better understand how effective this approach really is.
3. Longer follow-up periods could show us whether the progress is sustainable.

Ethical Clearance: Taken from Tilak Maharashtra Vidyapeeth Research & Ethics Committee for Bio-Medical Research, September 2024, Reference No. 221/ICE/PHYSIO 2024

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Effectiveness of Modified Constraint-Induced Movement Therapy in Restoring Fine Motor Function of The Upper Limb in MCA Post-Stroke Patients: A Prospective Case Study

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Abstract

Background: Stroke, or cerebral vascular accident, occurs due to insufficient blood flow to the brain, causing cell death and impairing motor functions. Middle cerebral artery (MCA) stroke often leads to upper limb dysfunction, severely affecting daily activities. Modified Constraint-Induced Movement Therapy (mCIMT) is a rehabilitation method that restricts the unaffected arm, encourages repetitive task practice, and promotes neuroplasticity to enhance motor recovery. This case report examines the effectiveness of mCIMT in improving fine motor function in a 70-year-old male patient with right-sided hemiparesis following an MCA stroke.

Methods: The patient, with a history of diabetes, hypertension, ischemic heart disease, recent COVID-19 symptoms, and a prior left-sided cerebral vascular accident (CVA), demonstrated grade 2 spasticity and a score of 44 on the Fugl-Meyer Assessment for the upper limb. The patient also exhibited some degree of wrist and finger movement, specifically 25 degrees of wrist extension and 10 degrees of finger flexion. His performance on the Wolf Motor Function Test (WMFT) revealed severe functional deficits: tasks took 100-120 seconds to complete, with Functional Ability Scale (FAS) scores ranging from 1 to 2.5. Over 10 weeks, the patient underwent mCIMT at a tertiary care hospital, involving 45-minute sessions four times a week, and wore a restrictive mitten on the unaffected arm for at least three hours daily at home.

Results: Post-treatment evaluations revealed significant improvements. The Fugl-Meyer Assessment score increased from 44 to 58, indicating enhanced motor function and coordination. In the WMFT, the average completion time for timed tasks decreased from 100-120 seconds to 70-90 seconds per task, and the FAS scores improved from 1-2.5 to 3-4. The total time for completing 15 timed tasks was reduced from approximately 1500-1800 seconds to 1050-1350 seconds, and the total FAS score for 17 tasks increased from around 25-42 to 51-68.

Conclusion: The mCIMT intervention lead to considerable improvements in fine motor function and overall upper limb performance in this MCA post-stroke patient. The therapy resulted in faster task completion, improved movement quality, and enhanced independence in daily activities. These findings underscore the efficacy of mCIMT in rehabilitating upper limb function and highlight its potential as a valuable intervention for stroke patients with MCA involvement.

Keywords: Fine motor skills, Constraint-Induced Movement Therapy, Stroke, Middle Cerebral Artery, Motor Assessment

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Introduction

Stroke is a significant global health problem that causes disability and mortality on a large scale. It is characterized as a sudden neurological impairment resulting from localized injury to the central nervous system (CNS) due to vascular factors such as cerebral infarction, intracerebral hemorrhage (ICH), and subarachnoid hemorrhage[1,2]. The World Health Organization (WHO) reports that stroke ranks third globally in terms of disability-adjusted life years (DALY) and is the second most frequent reason for mortality. An estimated 13.7 million occurrences of stroke occur worldwide each year, and the condition is thought to be the cause of 5.5 million stroke-related deaths[3,4,5].

In India, the prevalence of stroke is estimated to be 119–145 per 100,000 population, making it a leading cause of long-term disability. The rising incidence is attributed to factors such as an aging population, changes in lifestyle, and increased prevalence of risk factors like high blood pressure and diabetes. Middle cerebral artery (MCA) strokes are particularly common and significantly impair upper limb motor functions, leading to reduced quality of life and a high degree of functional dependence. This growing burden highlights the importance of effective rehabilitation strategies in the Indian context[6].

The middle cerebral artery (MCA), which supplies segments M1 through M4 to the brain's internal capsule, basal ganglia, and lateral surface, frequently contributes to strokes. The basal ganglia, which are crucial to emotions and motor control, are supplied by the M1 section. The insula, parietal lobe, inferolateral frontal lobe, and superior temporal lobe are all supplied by the M2 segment. The opercular segment (M3) includes the temporal, parietal, and frontal lobes. Finally, M4, or the cortical segment, is made from smaller branches that enter the cerebral cortex and carry blood to specific regions of the brain[7].

Patients affected by MCA involvement experience more severe upper limb impairments. During the early stage of a stroke, around 60–80% of sufferers experience motor difficulties affecting either their upper or lower extremities. However, only 20% of those with severe paretic strokes regain normal upper limb function, compared to 80% of those with milder strokes. This upper limb dysfunction not only affects basic motor skills necessary for daily tasks like walking, balance, and self-defense reflexes but also leads to deficits in fine motor abilities. Due to its impairment of fundamental tasks of daily living (ADLs) including eating, washing, writing, walking, and manipulating items, this dysfunction severely reduces the quality of life (QoL) and limits the capacity of stroke patients to live freely in society. Hands and arms are required for a variety of tasks at work. With a wide range of physical intervention techniques available, the aim of therapeutic training is to assist patients in using their affected side and performing motor skills voluntarily[8].

Modified Constraint-Induced Movement Therapy (mCIMT) is a vital treatment for recovering upper limb function after a stroke[9,10]. Modified CIMT improves upper limb function by limiting the less damaged side. The injured upper limb receives rigorous, repetitive exercise, typically over ten workdays. Additionally, a "transfer package" ensures that improved upper limb use is incorporated into daily tasks. By intentionally limiting the use of the upper limb that is not impaired, the technique encourages the user to strengthen and use the side that is more affected[11,12]. Modified CIMT has a major influence on upper limb motor control and daily activity function when compared to standard therapy. Evidence points to its effectiveness in encouraging upper extremity (UE) usage and functional recovery following a stroke, which is similar to that of CIMT. Notably, mCIMT improves UE function and utilization while performing better than standard care regimens in chronic stroke victims. In mCIMT, the shorter duration of therapeutic treatment might improve manageability.

The Fugl-Meyer Assessment (FMA) is considered a valuable tool to evaluate motor function for people with post-stroke hemiparesis, especially the FMA for Upper Extremity (FMA-UE). Its high psychometric qualities include validity, responsiveness, and reliability. Each item in the FMA-UE indicates a motion, from proximal to distal joints, that is critical

for motor function in hemiparesis after a stroke. Determining the level of difficulty for each task on the FMA-UE is essential for accurately diagnosing upper extremity paresis and appropriately guiding rehabilitation procedures. Clinicians often use the FMA-UE to assess impairment before intervention and during follow-up sessions. The FMA-UE scale ranges from 0-66 points, with greater scores indicating better motor function. Besides evaluating the impairment itself, it is crucial to have a precise and sensitive assessment of functional activities to gauge the effectiveness of interventional therapy in enhancing upper extremity weakness[13].

The Wolf Motor Function Test (WMFT) is a reliable and frequently used evaluation tool for assessing functional capability in the upper limbs. It includes two strength tests and a set of fifteen functional tasks that start with basic motions at closer joints and advance to more intricate actions at farther joints. Each of these 15 tasks needs to be finished within a time limit of 120 seconds. The evaluation also provides sub-scores indicating the movement quality during these tasks. Studies have validated the reliability and accuracy of the WMFT in gauging upper limb function[14].

This case report investigates the effectiveness of Modified Constraint-Induced Movement Therapy (mCIMT) in restoring fine motor function of the upper limb in a 70-year-old male patient with right-sided hemiparesis following a stroke in the middle cerebral artery (MCA). The patient's condition was compounded by a history of diabetes, hypertension, ischemic heart disease, and recent COVID-19 symptoms. He had also experienced a prior left-sided cerebral vascular accident (CVA), which exacerbated his functional difficulties, particularly affecting his dominant hand.

MATERIALS AND METHODS

Ethics and Consent

The study was approved by the Institutional Scientific Review Board on human subjects (Approval Number: 01/024/2023/ISRB/PGSR/SCPT). The study's purpose and procedures were explained to the subject, who provided written informed consent to participate in the study and for the case report to be published. The patient's anonymity was maintained throughout the study.

Patient Information and Clinical History

The subject was a 70-year-old male with a history of right-sided hemiparesis following an ischemic stroke in the middle cerebral artery (MCA) territory. The patient had co-morbidities including diabetes mellitus, hypertension, and ischemic heart disease. He also experienced recent COVID-19 symptoms and had previously suffered a left-sided cerebral vascular accident (CVA), which further impaired his functional abilities, particularly affecting his dominant hand.

Clinical Findings at Baseline

Upon initial evaluation, the patient presented with the following clinical features:

- Spasticity: Grade 2 spasticity on the Modified Ashworth Scale (MAS).
- Motor Function: Fugl-Meyer Assessment for the Upper Limb (FMA-UE) score of 44, indicating moderate impairment.
- Range of Motion (ROM): Limited active wrist extension (25 degrees) and finger flexion (10 degrees).
- Functional Performance: Severe functional deficits on the Wolf Motor Function Test (WMFT):
    - Task Completion Times: Tasks took 100–120 seconds on average.
    - Functional Ability Scale (FAS): Scores ranged from 1 to 2.5, reflecting significant dependence.
    - Total WMFT Time: Approximately 1500–1800 seconds for 15 timed tasks.
    - Total FAS Score: Approximately 25–42 out of 75 for 17 tasks.

Diagnosis

The patient was diagnosed with right-sided hemiparesis resulting from an MCA ischemic stroke,

based on clinical presentation, neuroimaging reports (CT/MRI findings confirming infarction in the MCA territory), and medical history. His condition was further compounded by co-morbidities, which were being managed medically.

Therapeutic Intervention

The patient participated in a 10-week Modified Constraint-Induced Movement Therapy (mCIMT) program conducted at a tertiary care hospital. The intervention was structured as follows:

Figure 1: Small object manipulation(Coins)

Figure 2: Book page turning

- **Constraint Protocol:**
  - The unaffected arm was constrained during therapy sessions.
  - A restrictive mitten was worn on the unaffected arm for a minimum of three hours daily at home.
- Therapy Sessions:
  - Conducted four times a week for 45 minutes each.
  - The therapy focused on nine task-specific upper limb functional exercises, including:
    1. Peg transferring
    2. Ball grasping and releasing
    3. Spoon feeding
    4. Block stacking
    5. Clothing fastening
    6. Pouring liquid
    7. Small object manipulation
    8. Book page turning
    9. Scissor cutting
  - Repetitions, task performance, and adherence were carefully monitored and documented[15].

Follow-Up and Outcome Measurements

The patient was evaluated at baseline, midtreatment (week 5), and posttreatment (week 10) using the following measures:

- Spasticity: MAS scores were re-evaluated to track changes in muscle tone.
- Motor Function: FMA-UE scores improved from 44 at baseline to 58 post-treatment, indicating enhanced coordination and motor function.
- **Functional Performance:**
  - Task Completion Times (WMFT): Decreased from 100–120 seconds per task at baseline to 70–90 seconds post-treatment.
  - FAS Scores (WMFT): Improved from 1–2.5 at baseline to 3–4 post-treatment, demonstrating better movement quality and independence.
  - Total WMFT Time: Reduced from 1500–1800 seconds to 1050–1350 seconds.

- Total FAS Score: Increased from 25–42 at baseline to 51–68 post-treatment.

Adherence and Compliance

The patient adhered to the protocol, consistently wearing the restrictive mitten and participating in all therapy sessions. The home-based constraint duration was also documented to ensure compliance.

Follow-Up Observations

A follow-up assessment conducted one month after the completion of therapy showed sustained improvements in upper limb function and independence in activities of daily living (ADLs). The patient reported increased confidence in performing tasks such as eating, dressing, and object manipulation.

Statistical Methods

As this is a single case report, no statistical analysis was performed. Changes in motor function, spasticity, and functional performance were assessed descriptively using pre- and post-intervention values.

Results

Following the 10-week mCIMT program, the 70-year-old male patient showed significant improvements. The Fugl-Meyer Assessment score increased from 44 to 58, indicating enhanced motor function. In the Wolf Motor Function Test, average task completion time decreased from 100-120 seconds to 70-90 seconds, and Functional Ability Scale scores improved from 1-2.5 to 3-4. The total time for 15 timed tasks reduced from 1500-1800 seconds to 1050-1350 seconds, while the total FAS score increased from 25-42 to 51-68. These results demonstrate substantial gains in motor coordination, movement quality, and independence.

Discussion

The findings of this case study underscore the effectiveness of Modified Constraint-Induced Movement Therapy (mCIMT) in improving fine motor function in a 70-year-old male patient with right-sided hemiparesis following a Middle Cerebral Artery (MCA) stroke. This case study highlights significant improvements in motor function, task performance, and independence after undergoing mCIMT, which restricted the unaffected arm and focused on intensive, task-specific training for the affected arm. The positive results observed in this patient support the potential of mCIMT as a promising rehabilitation strategy for stroke survivors, particularly those with significant upper limb impairments following MCA strokes.

The therapy approach utilized in this case study adhered to the core principles of mCIMT, which involves the use of a restrictive mitten to prevent the unaffected limb from being used during daily activities, encouraging the use of the affected arm. The patient engaged in 45-minute therapy sessions four times per week for 10 weeks, focusing on specific motor tasks that aimed to enhance functional movement and neuroplasticity. The primary assessment tools used in this study—Fugl-Meyer Assessment for Upper Limb (FMA-UE) and the Wolf Motor Function Test (WMFT)—demonstrated significant improvement in motor function, with the FMA-UE score increasing from 44 to 58, indicating better motor coordination and functional ability. Similarly, the WMFT results showed reduced task completion times, further supporting the positive impact of mCIMT on task performance and motor function.

These findings are consistent with previous research, such as that by **Raj Kumar Yadav et al.** and **Alana Fleet et al.**, who demonstrated the positive effects of mCIMT in improving upper limb motor function in stroke patients. The improvements observed in this study are in line with the evidence suggesting that mCIMT, by restricting the unaffected limb and focusing on the affected limb's intensive use, promotes neuroplasticity and facilitates motor relearning. This approach is particularly beneficial for patients with MCA stroke, where the upper limb deficits can be severe due to the specific brain regions affected, particularly in terms of fine motor skills and dexterity. The case study highlights the value of mCIMT as a targeted, individualized intervention

for stroke survivors, where motor function improvements are crucial for improving the patient's ability to perform daily activities independently[16].

The improvements in task performance, such as the reduction in the time required for completing tasks in the WMFT and the increase in Functional Ability Scale (FAS) scores, further underscore the effectiveness of mCIMT. These objective measures of motor recovery demonstrate that the therapy was successful in enhancing the patient's ability to use the affected upper limb for functional tasks, such as grasping, lifting, and manipulating objects. As noted by **Hijikata et al.**, the FMA-UE and WMFT are reliable tools for assessing upper extremity motor recovery, especially in stroke survivors with significant motor impairments, and they provided a comprehensive assessment of the patient's progress in this study[17].

Additionally, it is important to recognize that while mCIMT has demonstrated significant benefits in improving motor function in this case study, the intensive nature of the therapy requires high levels of patient motivation and adherence. In this case, the patient's compliance with wearing the restrictive mitten for three hours daily and attending therapy sessions was essential for achieving the observed improvements. This emphasizes the importance of patient motivation and behavioral support in ensuring the success of mCIMT, as also noted by **Timea M. Hodics et al.**, who highlighted the challenges of maintaining patient engagement in rehabilitation protocols[18].

In light of the promising results seen in this case, further research is needed to explore the long-term benefits of mCIMT and to evaluate its effectiveness in larger populations of MCA stroke survivors. Future studies could explore the integration of mCIMT with other rehabilitation technologies, such as robotic-assisted therapy and virtual reality rehabilitation, which have shown potential in improving motor recovery and enhancing patient engagement. While mCIMT has proven effective in this case study, combining it with emerging rehabilitation techniques could provide a more comprehensive approach to stroke recovery, addressing both the motor and motivational aspects of rehabilitation.

In conclusion, this case study supports the effectiveness of mCIMT in improving fine motor function, motor coordination, and task performance in MCA stroke patients. The improvements seen in the FMA-UE, WMFT, and FAS scores highlight the potential of mCIMT as a valuable intervention for enhancing upper limb function and promoting independence in daily activities. Given the promising results observed in this case, mCIMT stands out as an effective rehabilitation approach for individuals post-MCA stroke, and future research should further investigate its integration with other innovative rehabilitation methods to enhance motor recovery and overall rehabilitation outcomes.

Limitations and Recommendations

Despite the promising results, this case report has several limitations. The study's single-case design limits the generalizability of the findings to a broader population. The absence of a control group or comparison with other rehabilitation methods further constrains the ability to draw definitive conclusions about the relative effectiveness of mCIMT compared to other interventions.Furthermore, the short study period might not adequately account for the sustainability and long-term impacts of the noted improvements.

Future studies should address these limitations by employing larger sample sizes and randomized controlled trial designs to validate the efficacy of mCIMT across diverse stroke populations. Additionally, incorporating a comparison group receiving alternative or standard rehabilitation methods would provide a clearer understanding of mCIMT's relative benefits. Long-term follow-up studies are also recommended to assess the durability of motor function improvements and the impact on overall quality of life.

Conclusion

This case report demonstrates the effectiveness of Modified Constraint-Induced Movement Therapy (mCIMT) in significantly enhancing fine motor function of the upper limb in a 70-year-old male with right-sided hemiparesis from an MCA stroke. Despite severe initial impairments, mCIMT led to substantial improvements in Fugl-Meyer Assessment (FMA) scores and reductions in Wolf Motor Function Test (WMFT) completion times, indicating enhanced motor function and coordination. These findings underscore mCIMT's potential as a targeted, intensive rehabilitation strategy for stroke patients, highlighting the need for larger studies to validate its effectiveness and explore long-term benefits.

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Scapular Pull up – The Assessment and Management of Unilateral Interscapular Pain with Functional Scoliosis in An Olympic Weightlifter – A Case Study

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Abstract

Introduction: Interscapular pain is a familiar condition in athletes with overhead load activity. The usual location of pain is along the medial border of the scapula close to the midline. Functional scoliosis is a type of scoliosis with temporary curvature of the spine which is reversible in nature and absence of rotation of the vertebrae. This case studies the scapular pull up exercise as assessment to view compensations and treatment variation to solve the root cause of unilateral interscapular pain.

Method: The pronated grip hanging scapular pull up exercise was performed by the athlete which showed overactivity of the retractors and depressors of scapula with curvature of spine appearing at thoracolumbar level, convexity on same side. As a treatment plan for functional scoliosis and overactivity the same exercise was performed but with lateral flexion of spine towards the same side of convexity. The exercise was performed for 10 repetitions of 4 sets for 2 sessions across 2 days for a total of 4 sessions of treatment.

Results: Numerical pain rating scale was taken pre and post treatment at rest, in movements and training overhead at same weights. Post treatment there was clinically significant reduction in pain and the scapular pull up lateral trunk bending exercise changed the temporary curvature of spine (functional scoliosis) to normal on observation.

Conclusion: This single case study shows an important assessment exercise to find the compensation, the root cause and the treatment exercise for unilateral interscapular pain with functional scoliosis in overhead training athlete.

Keywords: *Interscapular pain, scapular pull up, functional scoliosis.*

Introduction

Interscapular pain is a common condition caused by cervical disc herniation, upper thoracic facet joint problems, low cervical spondylosis and myofascial pain syndrome.[1] Overactivity of scapular retractors and depressors namely rhomboids, middle and lower trapezius leading to muscular trigger points is one of the major cause for unilateral interscapular pain.[2] There is also a non specific diagnostic cause for this condition.[2]Pain intensity is higher in movements of shoulder flexion, adduction and side lying on affected side.[3]

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Functional scoliosis is a form of scoliosis that is marked by a temporary curvature of the spine, which does not involve the rotation of the vertebrae. This type of scoliosis most of the times is due to asymmetrical loading with altered mechanical forces acting on spine and usually reversible in nature with targeted exercise protocol.[4]

Weightlifting is one of the Olympic sports. Olympic weightlifting has 2 major lifts that is snatch and clean and jerk. Both of these techniques require tremendous amount of symmetry in overhead positions. The sport demands various attributes such as strength, balance, speed, coordination and technical skill.[5]

Pull ups in pronated forearm from the hang position is one of the upper extremity pulling strength test in athletes.[6] Scapular pull up is the initial active phase of pull up in which there is scapular retraction and depression from full hang position to initial active hang engaging the scapular muscles. In this position we can observe the recruitment of the upper back muscles. In this active position we can also observe the difference in recruitment, any compensations and deviations in the spine.

Numerical pain rating scale (NPRS) is one of the easy understandable methods to assess pain levels in numeric value. This scale also provides the difference in score to clinical importance and it also predicts disability.[7]

This brainstorm development of different assessment led to finding the root cause and the single exercise that reduced the pain at rest, active movements and overhead weight training. Also the scapular pull up lateral trunk bending exercise showed change of functional scoliosis to normal.

There is scarcity of literature about unilateral interscapular pain especially in athletes. A literature gap is evident about assessment and cause of interscapular pain in Olympic weightlifters and overhead weight training athletes. So a strong need arises to find the cause of unilateral interscapular pain, especially in Olympic weightlifters.

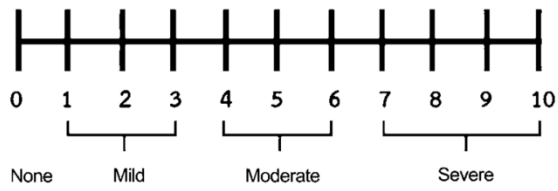
Case Description

A 19 year old elite weightlifter presented with pain in the upper back region on the right side. The pain gradually increased with his overhead training of snatch and clean and jerk at 70-80 percent of his training load. This also created the discomfort in overhead lifts and also the feeling of not stable in overhead lifts. The week of gradual increase of pain also had incomplete or failed lifts in training. He continued the release with this tennis ball on his own along the medial border of the scapula on the right side which reduced the pain minimally but the pain reappeared in training, post training, lying down on same side. This cycle of events occurred for a week. He presented himself to the physiotherapist and the assessment was done.

Assessment

PAIN

Numerical Pain Rating Scale



1. Pain at rest along the lower medial border of the scapula on the right side – NPRS – 6.
2. Pain at same site in right shoulder flexion and adduction movement – NPRS – 7.
3. Pain in overhead training snatch and clean and jerk – NPRS – 8.

The NPRS scale was shown and explained to the athlete about the scoring. The athlete mentioned the number accordingly.

In standing position there was no deviation of the spine. In Bar clean position also there was no deviation of spine (Figure 1).

There was tightness and overactivity of the scapular retractors and depressors namely the middle trapezius, lower trapezius and rhomboids (Figure 2). To confirm the overactivity the athlete was told to

perform a scapular pull up which clearly showed the overactive medial scapular muscles with deviation of the spine at thoracolumbar level (Figure 2). There was also no leg length discrepancy.

(Figure 1)

(Figure 2)

Methods:

After the assessment the athlete was told to perform the pronated scapular pull up with lateral flexion of trunk to the right side (lower limbs pointing to lower right diagonal) (Figure 3).

This exercise was performed for 4 sets of 10 repetitions, 2 sessions a day across 2 days without any rest day in between for a total of 4 sessions.

Outcome measures: NPRS was taken pre treatment and post treatment at rest, active movements of shoulder flexion and adduction, overhead training of snatch and clean and jerk at same weights.

The same scapular pull up exercise test was done to see the muscular recruitment difference and spine deviation changes through observational analysis (video and images) (Figure 4).

(Figure 3)

(Figure 4)

Results

There was significant lower rating of pain level on NPRS after 4 sessions of treatment (Table 1). The pre and post scapular pull up exercise test shows equal recruitment of medial scapular muscles and corrected deviation of spine at thoarcolumbar region (Figure 5).

Table 1. Pre and Post NPRS scores at rest, in movements and post training.

NPRS	At Rest	In Movements	Post Training
Pre	6	7	8
Post	0	1	1

(Figure 5)

Discussion

Interscapular pain is common presentation of pain along the medial border of the scapula, although there are various causes but mostly it is due to myofascial pain or trigger point in the muscle due to overactivity. The roll and pinch test elicits pain on the area of feeling of tightness which is along the medial border of scapula (interscapular point).[1] The elite weightlifter has immense demand of overhead shoulder stability and the scapular muscles play a key role in Olympic weightlifting techniques.

Functional scoliosis is a type of scoliosis which has a nature of reversibility of the temporary curvature of the spine. This postural deformity is caused by asymmetrical loading, difference in biomechanical forces side to side and gravitational forces that act along the spinal column.[8] In Olympic weightlifting techniques, the snatch and clean and jerk have overhead finish phase where the demand of symmetry and forces acting along the spinal column is crucial for balance to complete the lifts with massive weight.

Pull up exercise is one of the most practiced exercises for athletes as well as in general to gain upper limb and back strength. According to the literature of the regard of this case study the initial phase of pull up has activation of middle trapezius, lower trapezius and rhomboids whereas at the full phase there is more activation of latissimus dorsi and external oblique.[9, 10] Pronated wide grip pull up exercise has a lot of stability demand on the retractors and depressors of the scapula.

Numerical pain rating scale is 11 point pain rating scale ranging from 0 – 10 with 0 depicting no pain and 10 depicting worst imaginable pain. This scale has shown to have concurrent validity and validity for pain intensity measure. The use of this scale is feasible, easily understandable and shows good responsiveness to measure pain intensity in clinical and research settings. A minimum of 2 point change on NPRS represents a clinically meaningful change.[11]

The scapular pull up exercise is an initiation active phase of the pull up where the scapular retractors and depressors are active and enhances scapular movement control. In this particular case study this was used as an assessment to see the overactivity of the medial scapular muscle group and during this exercise test there was a curvature of the spine seen at thoracolumbar level. The tennis ball release was done by self which did not give any change to the athlete. The scapular pull up through brainstorm was done to see the difference of muscle engagement of medial

scapular group. The right side through observation showed clear overactivity at lower medial scapular group (Figure 2).

Latissimus dorsi is fan shaped muscle covering a significant portion of the back. It has widespread attachments with the origins from the iliac crest, thoracolumbar aponeurosis, spinous processes of T7 – L5, inferior angle of the scapula and the fibers wind around the teres major muscle and inserts as a tendon on the floor of bicipital groove of the humerus.[12]

The overactivity of the right lower medial scapular group could be because of the reduced shared activity of the latissimus dorsi at the scapula as one of its functions is to retract and depress the scapula. This assumption is based on the compensation that occurred at its spinal level where the weakness of latissimus dorsi shows deviation of spine. This has been assumed as the root cause of unilateral interscapular pain.

As a treatment protocol the same exercise of scapular pull up with the lateral bending of the trunk with both lower limbs to right lower diagonal position was administered for 10 repetitions of 4 sets, 2 sessions a day across 2 days for a total of 4 sessions. This exercise was done to enhance the recruitment of the latissimus dorsi. The insertion component of the latissimus dorsi is fixed and only the origin component of the muscle is concentrically working.

The pain reduction post treatment may be due to

1. Post isometric relaxation.

   This is one type of muscle energy technique in which there is brief period of submaximal isometric contraction of a muscle against a counter force which results in decrease in muscle tone of same single or group muscle isometrically worked. This works on the principle of autogenic inhibition where the Golgi tendon organ (GTO), the musculotendinous proprioceptor is activated responding by reflex inhibition.[13] In this case the isometric contraction is for the scapular retractors and depressors and the counterforce is the body weight.

2. Exercise Induced Hypoalgesia (EIH).

   The theory behind relief of pain by exercise can be considered as EIH (exercise induced hypoalgesia), which states that there is release of endogenous opioids and serotoninat various sites like central, spinal and peripheral levels which helps in modulating the pain. The other mechanism of exercise which helps in relieving the pain maybe by release of cannabinoid receptors in brain and spinal cord. There will be release of chemicals such as N-arachidonylethanolamine, endocannabinoids and 2-archidonoylglycerol which will help in controlling CNS by activating cannabinoid receptors, which will further produce anti nociception. These two theories are proved to cause pain modulation by release of endogenous opioid peptides and endocannabinoids which will increase the circulation post exercise and produceanalgesia.[14]

3. Effective shared muscle activity for scapular control.

   The scapular pull up lateral trunk bending to right exercise could have increased the recruitment of latissimus dorsi as the action of latissimus dorsi at the scapular level is the retract and depress the scapula. The muscle assists in holding the scapula against the thorax during upper limb movements. The attachment of the muscle to the inferior angle of the scapula allows this. The lateral trunk bending could have massively increased the recruitment because the large area of attachments produces lateral flexion of the trunk.

The change in the curvature compensation of the spine at the thoracolumbar level could be due to the gain in the strength and neuromuscular control of the latissimus dorsi. According to the literature the peak activation during the pull up are maximum for latissimus dorsi and external oblique muscles.[15] Another study showed that ipsilateral lateral flexion has increase in activation of latissimus dorsi muscle.[16]

This exercise could be termed by the principle of reverses of muscle action or reversal of insertion action

to origin action of the muscle where the insertion component of the muscle is fixed which in this case is the maintained position of the scapular pull up and the origin action of the muscle is targeted with lateral trunk bending to the right. So this way of fixing the insertion and movement at origin attachment is assumed to have corrected the temporary curvature (functional scoliosis).

Conclusion

The scapular pull up exercise could be used as an aseessment for unilateral interscapular pain to observe difference in recruitment and compensations that can lead to the root cause of the overactivity of medial scapular muscle group. The scapular pull up with lateral trunk bending exercise showed change the temporary curvature of spine to normal on observation. There was clinical significant change in pain at rest, in movements and in training rated on NPRS after 4 sessions of treatment. On observation there is also equal recruitment of medial scapular muscle groups on both sides.

Scapular pull up exercise could be used as an assessment for unilateral interscapular pain and the scapular pull up lateral trunk bending exercise could be used as a therapeutic exercise for functional scoliosis.

Implications

1. The assessment with scapular pull up in athletes may give an indication of cause of unilateral interscapular pain and the compensations.
2. Overactivity of the particular medial scapular group of muscles and the inadequate shared muscle activity can be judged.
3. This study motivates to find a functional assessment pattern.
4. The study implies on specific exercise targets in athletes, different attachment action of muscles which can be studied for different conditions.
5. The reduction in pain in unilateral interscapular pain emphasizes the importance of having equal recruitment of muscles for similar action.

Limitations

1. Unifactorial pain scale.
2. Functional scoliosis measured is by observation.
3. No objective measure for muscle recruitments involved.
4. This assessment was possible because of the strength of upper body that athlete possesses.
5. Single case.

Future scope

1. Multifactorial pain scale can be used.
2. Objective measures (cobb's angle) could be used to see definite changes of spine.
3. EMG analysis can be done as objective measurement for overactivity of muscles and for the muscles that are assumed to have changed the functional scoliosis to normal.
4. Case series or RCT can be done to see the effectiveness. Control group or comparative studies can be done further.
5. Comparison between origin action and insertion action could be done to see the recruitment levels through EMG studies.
6. For non sportspersons or with less upper body strength a variation of scapular pull up sitting on Swiss ball and lateral trunk bending can be an alternative for functional scoliosis. A study could be done with EMG analysis of back and core muscles.

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Assessing Disaster Preparedness, Knowledge among Physiotherapists and Nurses in India: A Systematic Review

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Abstract

Objective: The concept of preparedness, defined as a pre-planned system involving organized healthcare professionals, is crucial for effectively responding to disasters. Disasters result in substantial losses across all sectors, and those affected can benefit significantly from coordinated healthcare efforts. According to the findings of the current review, the expertise and roles of nurses and physiotherapists are often undervalued, and there is a notable lack of knowledge about disaster preparedness among these professionals. This systematic review aims to assess the level of disaster preparedness knowledge among nurses and physiotherapists in India, with the goal of identifying existing gaps and weaknesses in their readiness for disaster response.

Methods: The review methodology followed a systematic screening and selection process, as illustrated in the PRISMA flow diagram. Initially, 104 records were identified through database searches. After removing five duplicate entries, 99 records remained for screening based on their titles and abstracts. Of these, 75 studies were excluded for being irrelevant or not meeting the inclusion criteria. The remaining 24 full-text articles were assessed for eligibility. Following a critical evaluation, nine articles were excluded, and 15 studies that met all the predefined criteria were included in the final review.

Results: According to the current review, nurses and physiotherapists in India demonstrate a significant lack of awareness regarding their roles beyond treating injuries and providing first aid. Their involvement in disaster preparedness and response remains limited, particularly when compared to global standards. Although the COVID-19 pandemic highlighted the critical importance of these professionals in emergency planning and response, their engagement in pre-planned disaster management strategies in India continues to be insufficient. This reflects a broader issue of limited role clarity and professional development among nurses and physiotherapists in the country.

Conclusion: The insights gathered from this review can contribute to assessing the current levels of disaster preparedness knowledge among physiotherapists and nurses.

Keywords: Disaster preparedness,knowledge, awareness physiotherapists,nurses.

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Introduction

Disasters refer to unexpected incidents that may occur over a short period of time and result in causing a lot of calamity, loss and pain to people[1]. These incidents may be natural disasters such as earthquakes and floods or created by a human being such as a pandemic and industrial accidents. Rising levels and incidents of disasters around the globe have raised considerable concerns on the importance of good preparedness measures against such calamities. The United Nations Office for Disaster Risk Reduction (UNISDR) argues that preparedness entails the knowledge and capabilities established by governments, organizations as well as individuals to overcome, expect, and recover when hazardous events happen[2]. Disaster preparedness refers to the broad approach undertaken by taking several steps beforehand so that the communities are in a position to manage such disasters in a manner that impacts less on them[3].

The significance of disaster preparedness cannot be overestimated because it significantly helps to minimize the risks, mitigate the effects and provide a quick and efficient response to the disasters[4]. In the National Disaster Management Act (2016) of India, it is highlighted that disaster preparedness steps focus on reducing the impact of the debacle or its consequences and developing a disaster by using hazard location and setting it apart[2]. During disasters, especially the hospitals are more vulnerable, because they have to offer critical care to the patients but at the same time have to deal with the influx of casualties. Lack of proper preparation might result in extensive interference of healthcare services, higher death rate, and a long-term impact on the health of the concerned groups. The disaster management cycle according to the National Disaster Management Plan (NDMP) entails a number of processes, which are pre disaster preparation, mitigation, response, recovery and reconstruction after the disaster[2]. All the phases need the concerted efforts of different stakeholders i.e., the healthcare professionals in order to provide a holistic approach to reducing disaster risk. The top strategies in disaster preparedness are to design an emergency plan, improve the communication system, and carry out training and awareness programs and averting an outbreak of infectious diseases[2]. These are crucial steps towards the reduction of risks and making the communities more capable of facing the disasters and recovering successfully. Nurses are the key players in disaster preparedness and response among healthcare professionals. Being the largest healthcare providers, nurses tend to be at the center stage of emergency care, especially in delivering live-saving mechanisms, triage, and psychological assistance to the victims of the disaster when it occurs[5]. Their tasks are not restricted to providing immediate medical assistance, they are also involved in surveillance, controlling infections, and addressing the community in order to avoid the development of secondary health crises[6]. Nevertheless, their importance notwithstanding, a high number of nurses do not receive adequate disaster training in their academic training or practice, and this may prevent the nurses to respond effectively when there is an emergency[7]. The COVID-19 pandemic highlighted the crucial role of nurses in the situation of managing the public health crisis because they had a responsibility to treat people, to monitor their vital statistics, to safeguard sanitary regulations, and to make sure that patients and medical personnel remain safe[8].

In a similar way, physiotherapists have also proved crucial players in disaster recovery especially in aspects of rehabilitation and long-term recovery. They are equally competent in mobility restoration, pain control, and pulmonary care, much needed by patients incurring deaths in disasters[9]. Physiotherapists help in wound management, respiratory therapy, exercise interventions and rehabilitation of amputation and spinal cord ailment patients, which makes sure that the survivors do regain functioning as well as quality of life[10]. The role of physiotherapists in disaster response is under-appreciated, yet there is a necessity in terms of incorporating the rehabilitation services more in disaster preparedness plans[11]. Physiotherapists contributed during the COVID-19 pandemic by treating patients with breathing difficulties, offering tele-rehabilitation, and ensuring that their patients would remain physically active to counter the harmful consequences of the extended home-confinement[12-13]. The evolving nature of

disasters necessitates continuous improvements in preparedness strategies, with a strong emphasis on interdisciplinary collaboration. Nurses and physiotherapists must be actively involved in disaster planning, training, and simulation exercises to enhance their readiness for future emergencies[3,10]. Strengthening their roles in disaster response not only improves patient outcomes but also builds resilient healthcare systems capable of withstanding crises.

Aim and Objectives

This study focuses on systematic review to assess disaster preparedness knowledge awareness among physiotherapists and nurses in India. Further to understand the loop holes of disaster preparedness level of physiotherapists and nurses. It will be suggesting the help in measuring of improvement in the disaster preparedness knowledge level of physiotherapists and nurses in emergency situations.

Research Gap

Many researches have checked out the role of nurses in India in disaster preparedness however, not much of the research is done on the role of physiotherapist in disaster preparedness in India. furtherPhysiotherapist and nurses both contribute concerned in training affected person, dressing wounds, imparting assistive devices, applying braces, additionally involved in more conventional roles mobilizing patients, also offer emergency treatment for injured people. Physiotherapist and nurses must not underestimate their contribution in the stages of a disaster response

Methodology

Search strategy

The review conducted was by using standardized PRISMA guidelines. The keywords used in this search were "Disaster preparedness,knowledge, awareness physiotherapists,nurses. Disaster Preparedness* OR Emergency Preparedness* AND (Knowledge* OR Awareness*) AND (Physiotherapists* OR Physical Therapists*) AND Nurses* AND India* AND Systematic Review*. One can resort to the usage of such a string in academic databases such as PubMed, Scopus, or Google Scholar in order to narrow down the search to focus on pertinent studies. The researcher conducted a revised search approach that included allied health professionals' physiotherapists and nurses. Electronic database like ScienceDirect, PubMed, Google Scholar, ResearchGate were searched. Search strategies are listed in **Table 1.** The search included published evidence and 'grey' research literature; duplicate articles were crossed out before quality screening. The PRISMA flowchart of methodological search is listed in **Figure 1**.

Table 1. Inclusion and exclusion criteria

Title	Year	Population	Type of Study
Inclusion	2013-2023	• Allied health professionals especially nurses and physiotherapists. Language English and full text article.	Observational studies Review Questionnaire based study
Exclusion	Articles before 2013	non-English language\ abstracts. Paramedics, surgeon and other health care professionals	Case studies Group discussion Conference proceeding

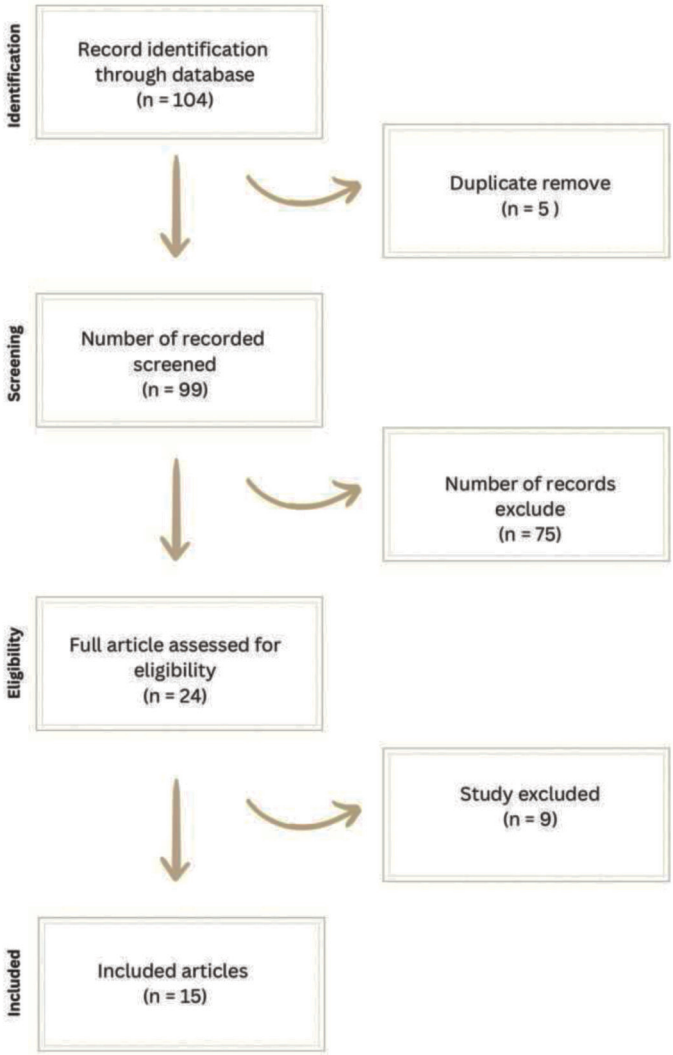

Figure 1: PRISMA flowchart

Results

Post screening, fifteen articles met the eligibility criteria. Six of these studies concentrated on physiotherapists and nine on nurses. In determining the degree of disaster preparedness knowledge, they possess on the topic of interest, the findings revealed the existence of mixed levels of awareness in both groups.

Particularly, two studies conducted on physiotherapists indicated good level of knowledge, none pointed at moderate knowledge level and four indicated the low level of knowledge. In the case of nurses, similarly, two studies found the good disaster preparedness knowledge, two studies found moderate disaster preparedness knowledge and five studies found the lack of disaster preparedness knowledge. This may be summarily stated as, there were five studies of lack to good disaster preparedness knowledge among the physiotherapists, but in the case of nurses, the ratios were 5:2:2 respectively in favor of lack, moderate and good disaster preparedness knowledge. In general, the findings show that both physiotherapists and nurses have little knowledge in the studies involved as listed in **Table 2** and listed in **Figure 2**.

Table 2. Knowledge Findings of Nurses and Physiotherapists from Literature of included articles (n=15)

S. No	Author	Year	Search Engine	Study Design	Population	Findings	Knowledge Level Identified
1	Michel D. Landry et.al	2015	Google Scholar	Descriptive Study	Physio-therapists	Reducing the effect of natural disaster on existing population of people with disability and effective in minimizing the effect of long-term disabilities.	Lack of response and preparedness
2	Gladston. S Nayak. Ret.al	2017	Google Scholar	Descriptive and convenience sampling facing	Nurses	The study reported low disaster pre-paredness among the Indonesian nurses especially response skills and evaluation skills. Most people are not confident and clear about their roles during disasters in spite of training that may have taken place. They must have ongoing education and simulation-training, which is acutely required.	Low level of practical knowledge
3	Rehana Shabbir Et Al et.al	2017	Research Gate	Quantitative, descriptive and cross sectional	Nurses	The authors of the study found that a good proportion of nurses (65.4%) possessed the knowledge on disaster management and emergency preparation. Nevertheless, their implementation was very low, whereby 83.3 percent had poor practices in the hospitals. The need of enhanced training, revised disaster plans and frequent drills to fill the knowledge-practice gap is urgently felt.	Good knowledge and poor practice of disaster preparedness.

Continue....

4	Navjot Trevediet.al	2018	Google Scholar	Descriptive study.	Physio-therapists	The research establishes that physiotherapists can play an influential yet under-represented part in disaster management during response and recovery processes. They take part in acute care and rehabilitation but in an informal and vague way.	Good knowledge and practice of disaster preparedness
5	Khan. S et.al	2017	Google Scholar	Descriptive and cross-sectional research study	Nurses and nursing supervisors	Current knowledge of disaster preparedness among nurses.	Minimum knowledge and good practice
6	Manal Ai Harthiet.al	2020	Pubmed	Scoping review	Nurses	Challenging facing nursing that obstructed them from achieving effective disaster management and based on current gap in literature and lack of survey of evidence related to barriers.	Inadequate level of preparedness and lack of research
7	Mousavi. Get.al	2019	Pubmed	Systemic review	Physio-therapists	The systematic review point out that physical rehabilitation services are also delayed, uncoordinated, and inadequate, particularly in the early stages of the disaster. Although they play a crucial role in discouraging long-term disability, such services are not well incorporated in disaster health systems.	The study indicated a need for improved training and preparedness in disaster response.

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8	Zaworaski K et.al	2022	Google scholar	Questionnaire qualitative study	All age group patients, nurses and physical therapist	The preference of participants as to the type of physical activity undertaken changes as well	Lack of knowledge
9	Randy S. Wax et.al	2019	Science Direct	Descriptive Study	Physio-therapists, physicians, pharmacist, social worker.	To identify potential flaws in the current disaster plan through frequent disaster exercise.	Lack of knowledge of disaster preparedness
10	Kosar Yousefi et.al	2019	Pub Med	Systematic review.	Nurses	Moderate level of knowledge and performance and good attitude association with preparedness in disaster	Moderate knowledge, attitude and performance
11	Chidiebele P Ojukwe et.al	2021	Pubmed	Cross Sectional Descriptive	Physio-therapists	Trained physiotherapists have moderate knowledge regarding the role of physiotherapists at various stages of disaster management	Lack of knowledge, practice and perceived barriers in disaster management.
12	Kirsty Wittmeier et.al	2020	Pubmed	Systemic Review	Physical therapist and health workers	Current COVID-19 pandemic will help physiotherapist enhance their role in treating patients in physical therapy and rehabilitation setting	Lack of planning and response during COVID -19
13	Islam Azizpour et.al	2022	Google Scholar	Descriptive Cross Sectional	Nurses	Hospital and pro-fessional organizations understand the impor-tance of knowledge and provide pre-paredness training program.	Lack of disaster preparedness knowledge

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14	Nahomi Ezhilarasi et.al	2018	Google Scholar	Quantitative study	Nurses	The educational interventional programs was effective in terms of improving the knowledge of the nursing personnel regarding the role of nurses during disaster in terms of preparedness, mitigation, response and recovery phase.	Lack of Knowledge
15	Sadighe Sadat Tabatabaei et.al	2020	Research Gate	Cross sectional and descriptive, analytical study	Nurses	Increase their level of knowledge and performance for being prepared in critical situation and increasing therequality	Increase level of knowledge and performance

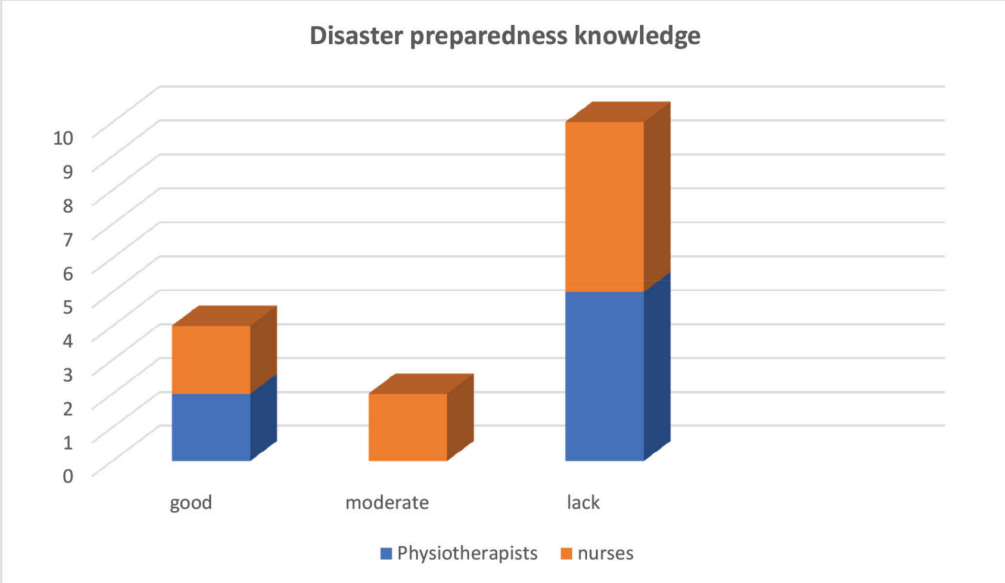

Figure 2: The level of disaster preparedness among physiotherapists and nurses as per the literature.

Discussion

A substantial lack of evidence on disaster preparedness among physiotherapists and nurses in India is eminent based on this systematic review. Literature have found low awareness, training, and participation in disaster management protocols, even for the essential services such as immediate care and triage, rehabilitation, and long-term recovery, which had to be considered in light of the vital parts played by them during calamities[14,15,16]. Among the 15 studies selected, most of them indicated inadequate

levels of preparedness, with each of the groups of professionals having poor to mediocre levels of knowledge, and therefore being in dire need of interventions.Due to the lack of preparedness, formal education, and research on disaster nursing, the mentioned factors limit the effectiveness of nurses in their response to the emergency when they act as the first responders. Likewise, physiotherapists who play an important role in respiratory therapy, mobility training, and rehabilitation are also underrepresented in the disaster response system, even though they are instrumental during a recovery process[17,18]. These gaps need specialized training, policy support and inclusion of such professionals into the operating disaster regimes. The insufficiency of the disaster training preparedness in educational programs has a considerable effect on the preparedness of specialists ready to deal with actual emergencies. This knowledge-practice gap is enhanced by a low level of access to simulation-based training, cross-disciplinary drills, and educator facilitation, which is essential in narrowing the knowledge-practice gap[19,20]. To enhance efficacy of emergency response, disaster preparedness education should be integrated into the context- and skills-based learning. The next couple of sections discuss the current condition of the disaster preparedness training and what that signifies[21,22]. Disaster management modules have proved to be important in the training of physiotherapists and nurses to improve on the response of healthcare during organizational emergencies. This must involve life-long training and participation at policy level so as to be prepared and effectively respond. They ought to concentrate on mutual emergency planning that requires the participation of all stakeholders in the healthcare system[23]. The future research is expected to determine the effectiveness of these interventions, maintenance of performance, and knowledge retention in the long-run. The given approach can be justified with references to numerous researches on the critical role of special training and multidisciplinary interaction in dealing with the issues of a disaster[24,25].The results emphasize the need to identify and enhance the roles of physiotherapists and nurses in the disaster management systems so that the healthcare response to the crises is efficient and resilient.

Conclusion

This systematic review reveals the known knowledge gap in disaster preparedness knowledge of physiotherapists and nurses in India. The results show that although these two professional categories are needed in the process of emergency response and post-disaster recovery, their actual state of knowledge and preparedness is insufficient. This gap provides a significant obstacle to the effective response to disasters and makes it clear that the systematic evidence-based training is needed. Practical readiness should be improved through a combination of integration of disaster preparedness in the curricula of physiotherapists and nurses, engagement in continuous professional development and interdisciplinary simulations. Besides, these healthcare professionals should be empowered by having their roles at the policy level recognized, and they should be supported at the institutional level, to enable them to be effective at both the pre-disaster and post-disaster stages. Ensuring capacity building initiatives in the future by way of education, research and incorporating both physiotherapists and nurses in a nation and institutional-level disaster management plans must be given a priority. Empowering their roles will not only enhance the work in the emergency care sector but also help to establish a more sustainable healthcare system that would be able to respond successfully to any new potential crisis.

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The Effectiveness of Myofascial Release Therapy in Improving Myofascial Pain Syndrome – A Review of Literature

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Abstract

Objective: To methodically review the randomized controlled studies to assess Myofascial Release Therapy's impact on myofascial pain syndrome.

Methodology: The articles were collected by search engines including the Physiotherapy Evidence Database (PEDro), ResearchGate, PubMed, Scopus, and Google Scholar. Using the phrases and MFR methods, 15 articles were chosen. The information was tallied based on the kind of study, the number of participants, the illness being treated, the course of treatment, the end measures, and the outcomes of the study.

Result: The result of this review implies that Myofascial Release (MFR) is effective in improving myofascial pain.

Conclusion: According to this study, different responses were generated by the findings of MFR techniques. These conflicting results emphasize the need for additional research. This may help with the development of protocols that will enhance interpretations and the need for evidence-based information, as well as the application of MFR in randomized controlled trials (RCTs).

Keywords: Myofascial Release, Pain, Trigger point release, Randomized Controlled Trials

Introduction

There are few precise trigger locations for MPS, a disorder that produces musculoskeletal pain.[1] An assessment and history are essential in diagnosing MPS. Myofascial discomfort and dysfunction are frequently caused by direct or indirect trauma, spine disease, cumulative and repetitive strain exposure, postural dysfunction, and physical deconditioning.[2] One of the many manual treatment approaches for

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treating MPS is MFR therapy, which has gained a lot of traction in recent years. In the late 1980s, MFR was first used in a course at Michigan State University.[3] Since the term "myofascial release" is broad and encompasses many different therapies, it's important to specify which specific treatment is being employed. The form of MFR of interest in this study is a graded stretch to soft tissue in which the therapist determines the stretch's direction, force, and duration based only on feedback from the recipient's body to address particular soft tissue constraints. Orthopedic issues are commonly treated with this kind of MFR.[4] It's also important to remember that both the patient and the practitioner must provide feedback for myofascial release to be effective. Other types of MFR include trigger-point therapy and active therapies, where the patient contracts their muscles to relax. Fascia is a type of connective tissue composed of three layers: the deep layer, the layer of potential space, and the surface layer.The fibers of fascia travel in several directions, allowing it to move and change in unison with the surrounding tissues.[5] Therefore, pain, tightness, and restriction in one part of the body may be caused by straining the fascia in another. Similar like pulling plastic wrap across a dish, as one side is pulled tight, the other side becomes even more rigid. The experienced pain deviates from the typical patterns of transferred pain. Because of the fascia's dynamic nature, myofascial soreness can be difficult to diagnose, but once it is, manual therapy techniques like MFR are commonly employed to treat it. Participants may display a "jump sign" through vocal or facial cues when trigger sites are compressed during palpation.

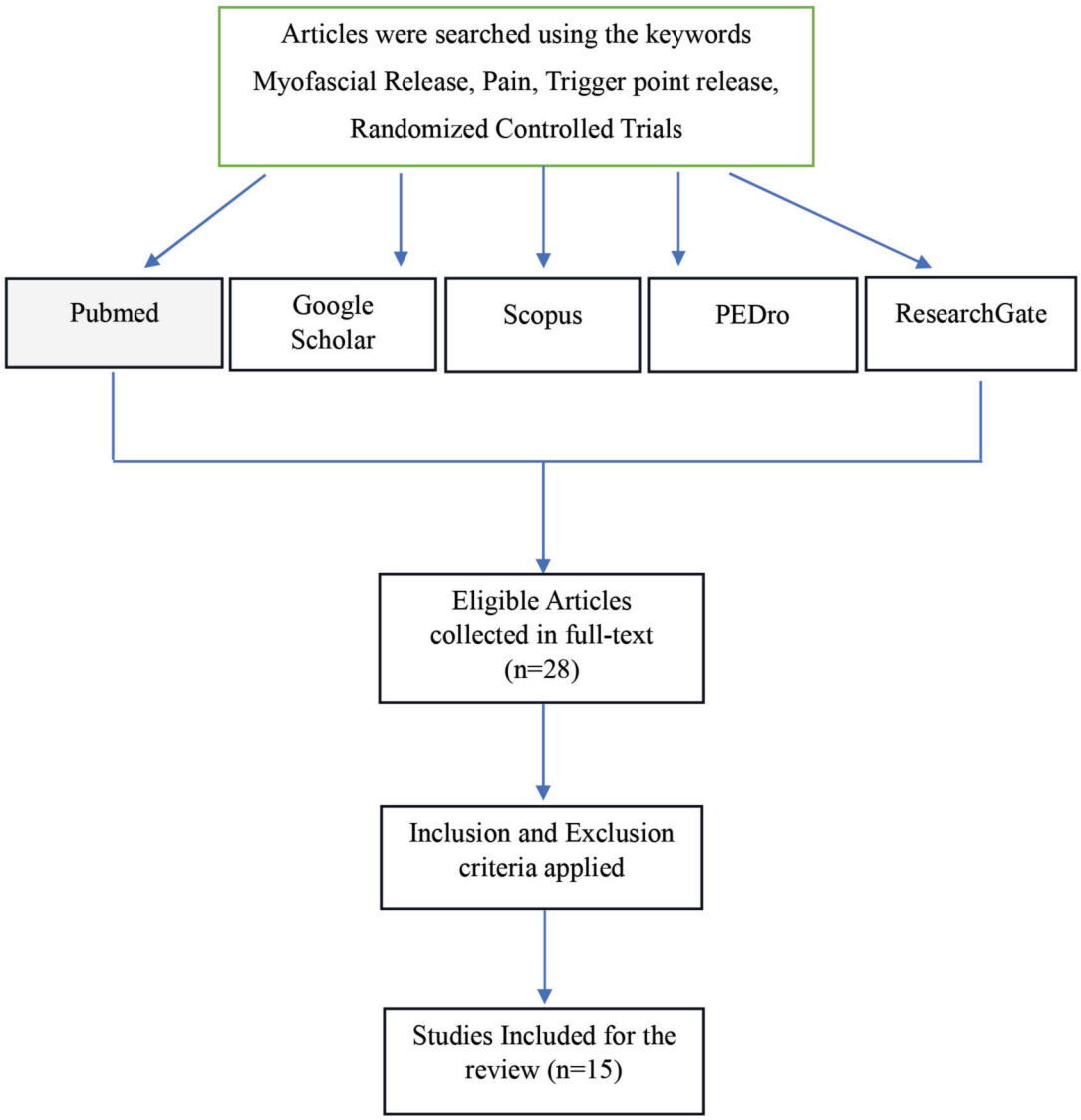
The musculoskeletal system is a sophisticated network of interrelated tissues that work together to efficiently facilitate movement. Muscular function is hindered when the muscles and fascia sustain microtrauma. These fascia-developing Myofascial Trigger Points can result in decreased strength, decreased range of motion, and changes in neuromuscular properties. Because its fibers can flow in many different directions, the fascia can shift and change in response to the surrounding tissues. The thickening of connective tissues brought on by overuse alters the ground material and the structure of the collagen fibers in muscles. Depending on how they are used, MFR techniques can be classified as either direct or indirect. In the direct MFR approach, the practitioner releases the trigger point by stretching the fascia with the elbow or another tool. The indirect MFR technique involves gently stretching the body with minimal force while moving the hand in the direction of the fascial constriction. This approach is sometimes referred to as the passive MFR technique since the patient remains passive during treatment and minimal pressure is applied to the tissue. Myofascial manipulation often results in an immediate relaxation of tissue beneath the operating hand. Historically, this remarkable characteristic has been ascribed to the connective tissue's mechanical characteristics. However, the fascia is richly innervated with mechanoreceptors that respond to physical pressure.In addition to altering local tissue viscosity, stimulation of these sensory receptors has been shown to reduce sympathetic tone. Moreover, fascia contains smooth muscle cells that seem to be involved in active fascial contractility. After releasing the tissue barriers in one area, the practitioner moves on to the next and holds it in place. The tissue becomes pliable after a few releases. When myofascial tissue lengthens again, strain on the wounded tissues is reduced and joint mobility and alignment are restored. It may be difficult to identify trigger point discomfort since the fascia plays a dynamic role and does not follow a single pattern of pain.[6]

The superficial fascia often allows mobility between the integument and underlying structures, as well as transporting blood vessels and nerves to and from the skin.[7] Some authors contend that the treatment cannot be substantiated by evidence because its results are arbitrary. Although numerous manual ways were once described using the same logic, it is now acknowledged that these techniques are part of evidence-based research.The process of

myofascial discharge is creative. Much depends on the therapist's innate skills and experience. The first step is to confirm that the condition is indeed musculoskeletal in origin. This is not always easy since movement and posture might be disrupted by non-musculoskeletal reasons.[8] Thus, the main objective of this review study was to gather evidence in favor of MFR and evaluate its effectiveness as a treatment approach for myofascial pain issues.

Materials and Methodology

Search Methodology: From 2010 to 2023, online search engines PubMed, Google Scholar, PEDro, Scopus, and the ResearchGate database were used to collect journals. Initially, a total of 28 articles were found based on the inclusion criteria.The articles were collected in full text, out of which 15 were selected for review [Fig-1-Flow Chart of the study].



Inclusion Criteria: Studies that are published in English language only, published between the years 2010-2023, Studies that include direct or indirect MFR techniques, published in peer-reviewed journals, Studies that are free of cost, contain both genders and only Randomized Controlled Trials (RCTs).

Exclusion criteria: Studies that are non-English and published before 2010; Case Studies; studies that do

not have accurate outcomes; non-RCTs; preceding papers, conferences, and articles without available full text.

Review of Literature

An RCT with 113 patients with chronic low back pain (CLBP) and a PEDro score of 7 out of 10 was carried out by Oẓóg et al. in 2023. They found that a single MFR treatment in the thoracolumbar fascia (TLF) did not immediately affect postural stability in the experimental group of CLBP patients. Additionally, after a month, postural stability did not improve in comparison to the pre-treatment data. The experimental group's postural equilibrium parameter values did not significantly change from those of the control group one month after the intervention.[9] Another RCT by Oẓóg et al., 2021, found that after receiving a single MFR therapy, a group of patients with CLBP experienced an immediate decrease in the activity of the erector spinae and multifidus muscles in the lumbodorsal spine region at rest (PEDro score of 7). Comparing the outcomes with those of the control group demonstrates that the effects are stronger for the multifidus muscle.[10] According to a Paulo et al., 2021 RCT with a 7 PEDro score, a single treatment of the thoracolumbar myofascial release technique was not enough to reduce pain and disability in those with CLBP. Further investigation into the combination of myofascial mobilization and longer-term therapy is required.[11] According to a randomized controlled trial (RCT) by Sabake et al. (2020), the proposed protocol, which comprised three sessions of myofascial techniques, helped the subjects with LBP experience a month-long reduction in pain intensity, a decrease in the degree of lumbar disability, enhanced spine mobility, and improved posterior chain flexibility. The PEDro scale gave the study a score of six out of ten.[12] The myofascial release method was found to significantly reduce pain and impairment in individuals with lower back pain when compared to the sham group, according to an RCT done on 36 patients by Arguisuelas et al. in 2019. This study has a PEDro score of 9 out of 10.[13] According to the findings of another RCT by Kisilewicz et al. (2018), active myofascial trigger points with ischemic compression reduce stiffness in the upper half of the trapezius muscle after just one treatment session.[14] In an RCT with 54 patients with CLBP who had a PEDro score of 9 out of 10, Arguisuelas et al. (2017) discovered that Myofascial Release Therapy significantly reduced both pain and disability.[15] In their RCT, Gutiérrez-Rojas C et al. (2015) reported that while the extensor muscle strength of each group remained unchanged, the pressure pain threshold (PPT) immediately improved. This study's main drawbacks were its small sample size and absence of follow-up.[16] Ravish et al. (2014) also noted that both groups' functional limits, range of motion, and discomfort levels were significantly improved. Positional Release Therapy (PRT) with LASER has not shown as much improvement as MRT with LASER when comparing the subjects in the two groups.[17] Chaudhary et al. (2013) reported that MFR plus exercises improved pressure pain threshold, opposite side cervical side flexion range of motion, and pain relief in patients with upper trapezitis more effectively than cold packs plus exercises or exercises alone because of the stretching effect on the muscle. The study's quality suffered and conclusive results about the effects of MFR could not be obtained due to the small sample size and absence of follow-up measurements.[18] Ajimsha et al. (2012) conducted another RCT with 68 computer professionals and discovered that the MFR they examined was more effective in treating Lateral Epicondylitis (LE) than a control intervention that used sham ultrasound therapy. There was randomization and a further evaluation after the PEDro score of six out of ten. Additionally, a control group was included in this single-blinded study. MFR is an effective treatment option for LE, as this study showed.[19] To determine whether MFR and heat packs could both improve range of motion, Kain J et al. (2011) performed a randomized controlled trial (RCT) on 31 randomly selected participants from a convenience sample. The sample size was small, and blinding was not used. The study's quality was insufficient because the treatment was only given once and there was no follow-up measurement. They claimed that throughout a larger range of motion, MFR was shown to be equally effective as hot packs.[20]

In treating patients with plantar heel pain, an RCT by Renan-Ordine et al. (2011) found that combining Trigger Point manual treatment with a self-stretching regimen yielded superior short-term outcomes than a self-stretching program alone.[21] According to Tozzy P et al. (2011), MFTs appear to be a useful method for improving or even regaining normal tissue mobility and function as well as lowering pain perception.[22] In the short- to medium-term management of chronic Temporomandibular Disorder (TMD), another study by Kalamir A. et al. (2010) showed that intraoral myofascial therapy (IMT), either alone or in combination with self-care, may be beneficial.[23]

Result Tables

Table 1. List of studies that are included in the review with their results.

Sl No.	Author Names	Study type	Sample Size	Intervention	Outcome measures	Results
1	Oz˙óg et al., 2023 (PEDro Score – 7)	RCT	113	MFR intervention	Posturography	After a month, postural stability did not improve in comparison to the pre-treatment data.
2	Oz˙óg et al., 2021 (PEDro Score – 7)	RCT	113	MFR intervention	Surface electromyography (sEMG)	After a single MFR treatment in the EG, the ES and MF muscles in the lumbar posterior spine area immediately displayed decreased activity when at rest.
3	Paulo et al., 2021 (PEDro Score – 7)	RCT	41	MFR intervention	Numerical pain rating scale (NPRS), pressure pain threshold (PPT), and Oswestry Disability Index (ODI)	One thoracolumbar MFR experiment proved insufficient to reduce pain intensity and disability in patients with CLBP.
4	Sakabe et al., 2020 (PEDro Score – 6)	RCT	60	MFR intervention	Visual Analogue Scale (VAS), ODI, Fingertip to Floor test (FTF), Sit and Reach Test, Measurement of lateral spine inclinations	The MFR regimen improved mobility and decreased the degree of lumbar dysfunction and pain severity in participants with CLBP, according to the findings of the Sit and Reach and FTF tests.
5	Arguisuelas et al., 2019 (PEDro Score – 9)	RCT	36	MFR intervention	Mc.Gill Pain Questionnaire (SF-MPQ), Roland-Morris Questionnaire (RMQ), sEMG	MFR also showed a significant reduction in pain severity and disability as compared to the Control Group.

Continue....

6	Kisilewicz A et al.,2018 (PEDro Score – 6)	RCT	12	Compression trigger point therapy	Myoton PRO device	After just one session, the stiffness went down.
7	Arguisuelas et al., 2017et al., 2019 (PEDro Score – 9)	RCT	54	MFR intervention	SF-MPQ, VAS, RMQ, Fear Avoidance Belief Questionnaire (FABQ)	Although there were minor but statistically significant differences in pain and impairment, the study concluded that it is still unclear if this improvement is statistically significant.
8	GutiérrezRojas C et al.,2015 (PEDro Score – 9)	RCT	30	Ice Therapy, MFR, Ice and MFR combined	PPT, Pressure Pain Perception (PPP), Strength of flexor and extensor of forearm	MFR and Ice together show better development in PPT.
9	RavishVN et al.,2014 (PEDro Score – 5)	RCT	60	MFR, PRT with LASER therapy	VAS, Cervical ROM (CROM), Neck disability index (NDI)	Laser-assisted MFR demonstrated greater improvement.
10	Chaudhary ES et al.,2013(PEDro Score – 5)	RCT	45	MFR, Cold pack, and exercises	VAS, PPT, ROM	Exercise and MFR showed greater improvements.
11	Ajimsha et al.,2012 et al., 2019 (PEDro Score – 6)	RCT	68	MFR, and Sham US	Patient-Rated Tennis Elbow Evaluation (PRTEE)	MFR is effective in pain reduction.
12	Kain J et al.,2011 (PEDro Score – 5)	RCT	31	Indirect MFR	PROM	MFR is effective in increasing ROM.
13	Renan-Ordine et al.,2011 (PEDro Score – 6)	RCT	60	Self-Stretching and MFR	Quality of life SF-36 questionnaire, PPT	MFR is better than Stretching group.
14	Tozzy P et al.,2011 (PEDro Score – 6)	RCT	120	MFR interventions	Dynamic Ultrasound (US)	The MFR group showed improvement in pain reduction in Neck Pain & Low Back Pain.

Continue....

15	Kalamir A. et al.,2010 (PEDro Score – 8)	RCT	30	MFR, MFR with exercises and self-care	11-point self-reported graded chronic pain scale, ROM by vernier calipers	MFR alone or with self-care is more beneficial but to maximize the effectiveness, a well-designed RCT would be ideal.

Discussion

Fifteen articles, all RCTs, were considered in this review. Only RCTs were used for the study since they offer the strongest degree of evidence.The following are a few of the particular situations mentioned: The sample size estimation methods used in the two studies were not described.[10,12] The research methodology was not reported in certain papers.[9,10] Three trials did a significant amount of research without blinding the evaluator,[9,10,12] and no study blinded the therapist performing the MFR process.[9,10,11,12] This may result in bias. In the Arguisuelas et al. study, there were no appreciable differences in the SF-MPQ scores across the groups after therapy. In contrast to the CG15, the results of the 12-week follow-up showed a statistically significant decrease in the EG's pain level (measured by the SF-MPQ). A control group was absent from several of them. Although evidence is required to support its efficacy, MFR cures many illnesses.[14,16,17,18] As a result, further research can be based on the experimental results presented in this paper. These studies clearly show that the results are not consistent. While some studies showed that MFR was better than other treatment approaches, most showed that other approaches were as effective in treating that condition. MFR has been used in several studies as part of combination therapy, which amplifies the advantages of physiotherapy and different manual therapy methods. These guidelines hinder objectively evaluating the therapy's components and deter-mining the most effective interventions, even though they aim to provide comprehensive physiotherapy and include useful explanations. The findings indicate that a series of MFR treatments can improve range of motion, reduce functional impairment and fear-avoidance attitudes, change the way paraspinal muscles contract, and dramatically reduce the level of pain experienced by people with CLBP. To avoid oversimplifying the benefits of MFR based on scant or contradictory data, the few qualifying trials with limitations should be carefully interpreted.

Conclusion

The range of RCTs under consideration suggests that MFR is a promising treatment for musculoskeletal conditions and pain. The production of higher-quality evidence to improve the therapeutic practice of therapists utilizing MFR techniques will require future research that emphasizes safety and technical approaches, uses more rigorous procedures, and adheres to uniform protocols. The suggestions made in this analysis will help to improve the quality of results and prove that MFR is a truly effective treatment for myofascial pain.

Limitations

The study has several limitations, such as the fact that only English-language publications were evaluated because of financial and comprehension constraints. Even with a comprehensive search of all published RCTs, some relevant studies might have been overlooked. The majority of the studies had tiny sample sizes which may be challenging to identify significant differences across interventions due to random variation in the outcomes.

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Conflict of Interest: There is no conflict of interest.

Funding: Self-funded study.

Ethical Clearance: Not applicable.

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Effectiveness of Intensive Motor Learning Approaches for Stroke: A Systematic Review of Randomized Controlled Trials"

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Abstract

Background: Stroke is a major contributor to long-term disability worldwide, presenting significant obstacles to motor function, coordination, and independence. Rehabilitation approaches to those deficits include intensive motor learning strategies aimed at promoting neuroplasticity that will lead to functional recovery. This systematic review examined the effectiveness of different motor learning-based interventions in stroke rehabilitation, including, but not limited to, constraint-induced movement therapy (CIMT), task-specific training (TST), robotics-assisted therapy, virtual reality interventions, and Hand-Arm Bimanual Intensive Therapy Including Lower Extremities (HABIT-ILE).

Methods: A systematic search on PubMed, the Cochrane Library, and Google Scholar identified studies published in the last decade that examined intensive motor learning interventions with respect to stroke rehabilitation. The search yielded 4871 studies, leading to the final selection of ten studies that met strong inclusion criteria. To promote methodological rigor, the PRISMA framework was used. Primary outcome measures were motor function improvements, neuroplasticity changes, and functional independence levels.

Results: The results show HABIT-ILE, TST and virtual reality-based interventions displayed significant and long-lasting improvements in motor function, coordination, and independence. CIMT needs more research and while it has promise, we do not know how it will compare long-term and the evidence is mixed regarding its effectiveness in reducing disability levels. Robotics-assisted therapy improves motor learning and strength, but there are still challenges in applying these improvements to activities of daily living (ADLs).

Conclusion: It is essential to incorporate various intensive motor learning strategies instead of depending only on traditional therapy to maximize stroke rehabilitation. Interventions such as HABIT-ILE and task-specific training show great promise, and new technologies like virtual reality and robotics provide extra advantages. Nonetheless, more research is necessary to improve intervention protocols, create standardized outcome measures, and design personalized rehabilitation strategies to enhance motor recovery for stroke survivors.

Categories: Physical Medicine & Rehabilitation, Therapeutics, Motor Learning, Neurorehabilitation

Keywords: Stroke rehabilitation, motor learning, neuroplasticity, constraint-induced movement therapy (CIMT), hand-arm bimanual intensive therapy (HABIT-ILE)

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Introduction

Stroke remains a major contributor to long-term disability worldwide, with its incidence continuing to rise. It significantly impacts functional independence, limiting daily activities and reducing overall quality of life for affected individuals.[1] It remains a major global health challenge, imposing a substantial burden on mortality and disability rates. Its incidence has increased significantly, rising from 1.1 million cases per year in 2000 to an estimated 1.5 million cases annually by 2025. In the United States alone, stroke risk has grown by 25% since 2010, with projections indicating that more than 4 million people may be affected by 2030. Given its rising prevalence and serious health implications around the world, continued research into effective prevention and management strategies is essential.[2]

Stroke is a neurological condition resulting from an acute focal injury to the central nervous system (CNS) due to a vascular event. It is the third leading cause of mortality in Western countries and a primary contributor to long-term disability. Globally, stroke affects approximately 15 million individuals annually, with an estimated 5 million fatalities and an additional 5 million experiencing permanent disability.[4]

Currently there are limited standardized, intensive efficacious protocols for optimizing motor recovery from stroke rehabilitation. Intensive motor learning approaches have shown promise to improve recovery by enhancing neuroplasticity and functional outcomes; however, this clinical utilization is limited by heterogeneous protocols, inconsistent outcome measures, and a lack of high-quality randomized controlled studies. Additionally, there are no standardized long-term follow-ups, limiting conclusions on sustained efficacy. In this review, we have tried to address these issues by critically reviewing the efficacy of intensive motor learning approaches, and their clinical relevance, as a starting point for evidence-based rehabilitation interventions along with the most effective approach for future research and clinical application.

Methods

Eligibility Criteria and Reporting Protocols

Articles were selected based on defined inclusion and exclusion criteria. Inclusion criteria comprised studies published in the past 10 years, in English, involving stroke patients undergoing rehabilitation. Eligible studies included randomized controlled trials (RCTs), meta-analyses of RCT's of physiotherapy interventions such as task-specific training, robot-assisted therapy, constraint-induced movement therapy (CIMT), HABIT-ILE and virtual reality-based therapy. Primary outcomes included motor function recovery, functional independence, and neuroplasticity-related changes. Psychological outcomes (e.g., self-efficacy, quality of life) were also considered.Exclusion criteria involved non-English studies, non-human trials, inaccessible full texts, studies unrelated to the review objective, insufficient intervention description, pharmacological or surgical studies lacking a motor learning component, and studies with unreliable outcome measures.

This review followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.The central research question was: Do intensive interventions in motor learning have a significant effect in stroke rehabilitation, and what techniques are considered to be most effective?

Research Strategy and Screening

To synthesize current evidence on the effectiveness of intensive motor learning strategies for stroke rehabilitation, a systematic search was conducted across PubMed, the Cochrane Library, and Google Scholar for studies published between 2015 and January 2025. Where possible, searches were restricted to randomized controlled trials (RCTs) and systematic review and meta-analyses of RCTs. Only English-language, full-text, freely accessible articles were included. Key search terms included stroke rehabilitation, task-specifictraining, constraint-induced movement therapy (CIMT), and Hand-Arm Bimanual Intensive Therapy Including Lower Extremities (HABIT-ILE), incorporating

Medical Subject Headings (MeSH) and Descriptors for Science and Health. Boolean operators "AND" and "OR" were applied, particularly in Cochrane searches. Data extraction included authorship, publication year, study location, participant demographics, and assessment parameters. All selected articles were independently reviewed by multiple investigators. The study design and systematic review framework were verified for methodological rigor.

Data Extraction

Data were extracted from each included study regarding the rationale for topic selection, formulation of the research question, inclusion and exclusion criteria, author details, publication information, sample size (total and per group), intervention intensity and duration for experimental groups, and primary outcome measures. Aims, interventions, outcomes, results, and conclusions were systematically presented. Each study was critically appraised using the PEDro quality assessment scale. The following criteria were evaluated: (a) eligibility criteria specified (not scored), (b) random allocation, (c) concealed allocation, (d) baseline comparability, (e) participant blinding, (f) therapist blinding, (g) assessor blinding for at least one primary outcome, (h) primary outcome data for >85% of participants, (i) intention-to-treat analysis, (j) appropriate statistical reporting, and (k) between-group comparisons with variability estimates. Each fulfilled criterion received a score of 1, yielding a maximum score of 10 (see Table 1).

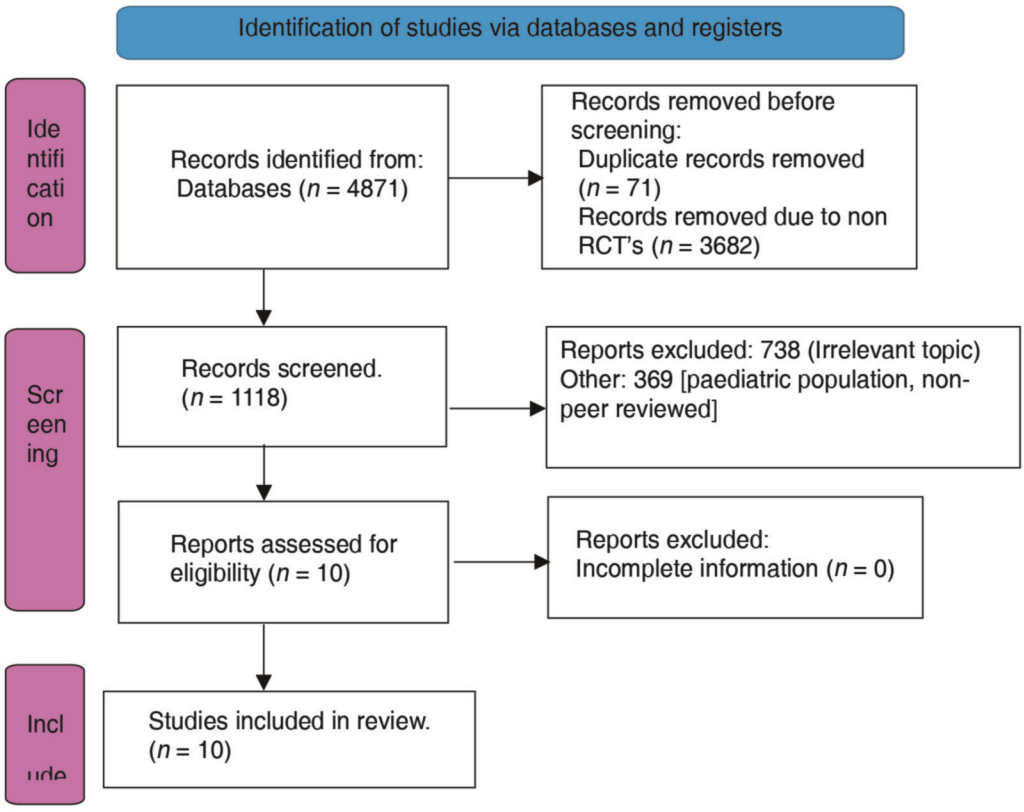

Figure 1: PRISMA Chart

Table 1. Methodological Quality assessment of included studies for review via PEDro scale.

Author\year	A	B	C	D	E	F	G	H	I	J	K	Total
Liu G et al. (2022)	1	1	0	1	0	0	0	1	1	0	1	5
Corbetta D et al. (2015)	1	1	1	1	0	0	1	1	1	1	1	8
Kim et al. (2021)	1	1	0	1	0	0	1	1	0	1	1	6
Reddy et al. (2022)	1	1	0	1	0	0	1	1	1	1	1	7
Ebner-Karestinos, et al. (2023)	1	1	1	1	0	0	1	1	1	1	1	8
Abdollahi et al. (2018)	1	1	0	1	1	0	1	1	0	1	1	7
Tedla et al. (2022)	1	1	0	1	0	0	1	1	0	1	1	6
French et al. (2016)	1	1	1	1	0	0	1	1	1	1	1	8
Alsubiheen et al. (2022)	1	1	1	1	0	0	1	1	0	1	1	7
Chengpeng et al.	1	1	1	1	1	0	1	1	1	1	1	9

Task-specific training [TST], Constraint-Induced Movement Therapy (CIMT), Hand-Arm Bimanual Intensive Therapy Including Lower Extremities (HABIT-ILE), Repetitive task Training [RTT], Robotic-assisted motor training. Virtual reality-based motor training

Table 2. Literature Matrix

Sr. No	Author	Study Type	Study Sample	Intervention	Results	Conclusion	Analysis
1.	Liu G, Cai H, Leelayuwat N (2022)	RCT	Stroke patients with hemiplegia	Rehabilitation robotic bed under machine learning combined with intensive motor training	Significant improvement in motor function recovery compared to conventional therapy	Machine learning-assisted robotic rehabilitation can enhance motor recovery in stroke patients	The research underlines the adoption of intensive motor learning in technology-enabled rehabilitation and focuses on machine learning to optimize stroke recovery.

Continue....

2	Corbetta D, Sirtori V, Castellini G, Moja L, Gatti R (2015)	Systematic Review	42 studies, 1453 stroke patients	CIMT for upper extremities in stroke patients	Limited improvements in motor impairment and function, but no significant reduction in disability	CIMT may improve motor function but does not convincingly reduce disability in stroke patients	Indicates that while CIMT is an intensive motor learning approach, its effectiveness in reducing disability remains uncertain, necessitating further investigation.
3	Kim K-H, Jang S-H (2021)	RCT	37 stroke patients, divided into three groups	TST combined with Cognitive Sensorimotor Exercise (CSE)	Significant improvements in proprioception, spasticity, and gait speed, especially in the experimental group	TST combined with CSE enhances proprioception and gait function in stroke patients better than conventional therapy	It recommends that while CIMT is a intensive motor learning approach, its effectiveness in lessening disability is not yet clear and more studies are needed to arrive at final conclusions.
4	Reddy RS, Gular K, Dixit S, et al. (2022)	Systematic Review & Meta-Analysis	10 studies, 329 stroke patients	CIMT for lower extremities	No significant improvements in gait speed and balance compared to control	CIMT for lower limbs may not significantly enhance ambulation, requiring further study on its effectiveness	It proves that intensive motor learning via task-specific practice and cognitive sensorimotor training produces favourable rehabilitation outcomes in patients with stroke.

Continue....

5	Ebner-Karestinos D, Gathy E, Carton de Tournai A, et al. (2023)	RCT	48 chronic stroke patients	HABIT-ILE	Improved motor function and bimanual coordination compared to conventional therapy	HABIT-ILE is an effective intensive motor learning approach for stroke patients targeting both upper and lower extremities	It highlights the effectiveness of whole-body motor learning, emphasizing goal-directed and task-specific training using HABIT-ILE in stroke rehabilitation.
6	Abdollahi F, Corrigan M, Lazzaro EDC, Kenyon RV, Patton JL (2018)	RCT	26 chronic stroke patients	Error-Augmented Bimanual Therapy (EABT) using robotic feedback and self-rehabilitation system	Modest gains in motor function, with significant improvement detected after removing an outlier	Error augmentation in bimanual training may enhance motor recovery, but further studies are needed to confirm clinical significance	This research introduces robotic-assisted error augmentation as an encouraging intensive motor learning strategy, especially for self-rehabilitation.
7	Tedla JS, Gular K, Reddy RS, et al. (2022)	Systematic Review & Meta-Analysis	8 RCTs, 208 stroke patients	CIMT for balance and functional mobility	Significant improvement in balance (effect size 0.51, p=0.01) but no significant improvement in functional mobility (effect size -4.18, p=0.16)	CIMT is effective in improving balance in stroke patients, but its impact on functional mobility remains uncertain	Supports CIMT for balance improvement but underscores the need for further research on its impact on functional mobility.
8	French B, Thomas LH, Coupe J, et al. (2016)	Systematic Review	33 trials, 1853 stroke patients	RTT for improving functional ability	Low- to moderate-quality evidence supporting RTT for improving upper/lower limb function, but benefits diminish after six months	RTT can enhance motor function post-stroke, but long-term benefits are unclear	This emphasizes the value of task-specific intensive motor learning but calls for further study of duration and intensity.

Continue....

9	Alsubiheen AM, Choi W, Yu W, Lee H (2022)	RCT	33 chronic stroke patients	Task-Oriented Activities of Daily Living (T-ADL) training vs. conventional occupational therapy	T-ADL improved upper limb function and manual dexterity significantly, but ADL and QoL improvements were similar in both groups	T-ADL training is effective in improving upper limb function and dexterity but does not significantly outperform conventional therapy in ADL and QoL improvements	Supports the use of task-oriented training in stroke rehabilitation but recommends its combination with other methods for more general functional gains.
10	Chengpeng Hu, Chun Hang Eden Ti, et al.	Pilot RCT	18 chronic stroke survivors	HD-tDCS targeting individual motor hotspot with EMG-driven robotic hand training	HDtDCS-group showed significant improvement in FMAUE scores and MASf scores compared to Sham-group	Personalized HD-tDCS enhances brain activation in motor-related regions and improves motor recovery	The study highlights the benefits of combining HD-tDCS with EMG-controlled robotic training, supporting intensive motor learning by enhancing neuroplasticity, hand dexterity, and grip strength post-stroke.

Results

Selection of Studies

The initial search yielded 4871 records. After screening titles and abstracts, 3682 non-RCTs and 71 duplicates were excluded. Full-text screening was performed on 1118 articles, of which 738 were excluded due to non-intensive motor training protocols, different populations, or non-RCT designs. Ten studies met the eligibility criteria and were included in the final analysis [Table 1].

Summary of Identified Studies

Of the 4871 studies screened, 10 experimental studies were included in the data extraction process. These were conducted in China, the USA, Taiwan, India, Turkey, Belgium, and Brazil—countries actively contributing to stroke rehabilitation research. The included studies also incorporated robot-assisted and virtual reality-based interventions.

Risk of Bias

When the concealed allocations were employed, there was nearly never any bias in the process of

creating the randomly allocated item sequences. Due to the participants' and professionals' blinding of items, there was a considerable possibility of bias. This occurs because of the public availability of important study methodologies and findings.

The risk of bias was evaluated using the RoB 2.0 tool and visualized with the Risk of Bias Visualization (RobVis) tool. Each study was independently assessed as shown in figure 2 and 3.

Main Findings

The study reported that CIMT moderately improved upper limb function, though its long-term impact on disability remains unclear. Despite its frequent use, CIMT lacks consistent evidence when compared to other intensive motor training techniques. In contrast, task-specific training (TST) with cognitive-sensorimotor components significantly enhanced proprioception and gait. Robotics-assisted therapy promoted motor recovery via error augmentation and feedback-based learning. Virtual reality interventions enhanced patient engagement and improved functional outcomes, whereas HABIT-ILE demonstrated high efficacy by targeting motor control recovery in both the upper and lower limbs.

Table 3. Study assessment criteria

Author/ Year	Type of study	Place	Demographic details	Assessment
Liu et al., 2022	Randomized Controlled Trial (RCT)	Ganzhou Hospital, China	80 stroke patients (40 per group), Mean Age: 48.52 ± 11.46 years, 38 males, 42 females, Course of disease <6 months	Fugl-Meyer Assessment of Lower Extremity (FMA-LE), Rivermead Mobility Index (RMI), Modified Barthel Index (MBI)
Corbetta et al., 2015	Systematic Review and meta-analysis	Multicenter (42 RCTs across USA, Europe, Asia)	42 studies, 1453 stroke patients, Mean Age: 37–87 years, 64% male, Various global locations	Fugl-Meyer Assessment (FMA), Wolf Motor Function Test (WMFT), Motor Activity Log (MAL), Nine-Hole Peg Test (9HPT), Stroke Impact Scale (SIS)
Kim & Jang, 2021	Randomized Controlled Trial (RCT)	Bundang Jesaeng Hospital, Gyeonggi-do, South Korea	37 stroke patients (13 in Experimental I, 12 in Experimental II, 12 in Control Group); Mean age: 50.23 ± 14.89 years	Electro-goniometer (Proprioception), Composite Spasticity Score (CSS), MyotonPRO (Muscle Tone), 10-Meter Walk Test (10MWT)
Ebner-Karestinos D et al., 2023	Randomized Controlled Trial (RCT)	Belgium (UCLouvain, CHU UCL Namur, Saint-Luc University Hospital)	48 adults with chronic stroke (≥40 years old), able to walk independently, functional upper limb movement	Ad-AHA Stroke, Fugl-Meyer UE, Box and Block Test, Wolf Motor Function Test, 6MWT, ACTIVLIM-Stroke, ABILHAND, SIS, COPM, neuroimaging

Continue....

Abdollahi et al., 2018	Double-Blinded Randomized Controlled Trial (RCT)	University of Illinois at Chicago, Rehabilitation Institute of Chicago, USA	26 chronic stroke patients (Age: 26–77, Mean: 53.86 years, 8 Female), hemiparetic arm function recovery	Fugl-Meyer Assessment (UE), Wolf Motor Function Test, Motor Activity Log (Quantity & Quality), Box and Blocks Test, Intrinsic Motivation Inventory
Tedla et al., 2022	Systematic Review & Meta-Analysis	Brazil	208 stroke patients (127 males, 81 females), Mean Age: 59.3 ± 8.6 years, Height: 1.69 ± 0.08 m, Mass: 74.2 ± 10.3 kg	Berg Balance Scale (BBS), Timed Up and Go Test (TUG), Functional Reach Test (FRT), Trunk Impairment Scale (TIS), Limits of Stability (LOS)
French B et al., 2016	Systematic Review & Meta-Analysis	Cochrane Collaboration	33 trials, 1853 stroke patients, Mixed age groups, Mean Age: ~59 years (range: 26–85), Height & Mass not consistently reported	Arm Function, Hand Function, Walking Distance, Functional Ambulation, Lower Limb Functional Measures (6MWT, TUG, BBS, FIM, SIS, ARAT, Box & Blocks, etc.)
Alsubiheen et al., 2022	Randomized Controlled Trial (RCT)	Saudi Arabia & South Korea (King Saud University, Gachon University, Eulji University)	30 chronic stroke patients (15 per group), Mean Age: 54.4 ± 12.7 (T-ADL group), 59.8 ± 8.3 (OT group), BMI: 22.9 ± 1.8 (T-ADL), 23.4 ± 2.6 (OT)	Manual Function Test (MFT), Box and Block Test (BBT), Grip Strength Test, Modified Barthel Index (K-MBI), Stroke-Specific Quality of Life (SS-QoL)
Hu et al., 2024	Pilot Randomized Controlled Trial (RCT)	Hong Kong	19 chronic stroke patients (HDtDCS-group: n=9, Sham-group: n=10), Mean Age: 56.0 ± 9.7 years (HDtDCS), 62.1 ± 10.8 years (Sham), No height/mass data	Fugl-Meyer Assessment UE (FMAUE), Modified Ashworth Scale (MAS), Action Research Arm Test (ARAT), fMRI, EEG-EMG, EMG assessments

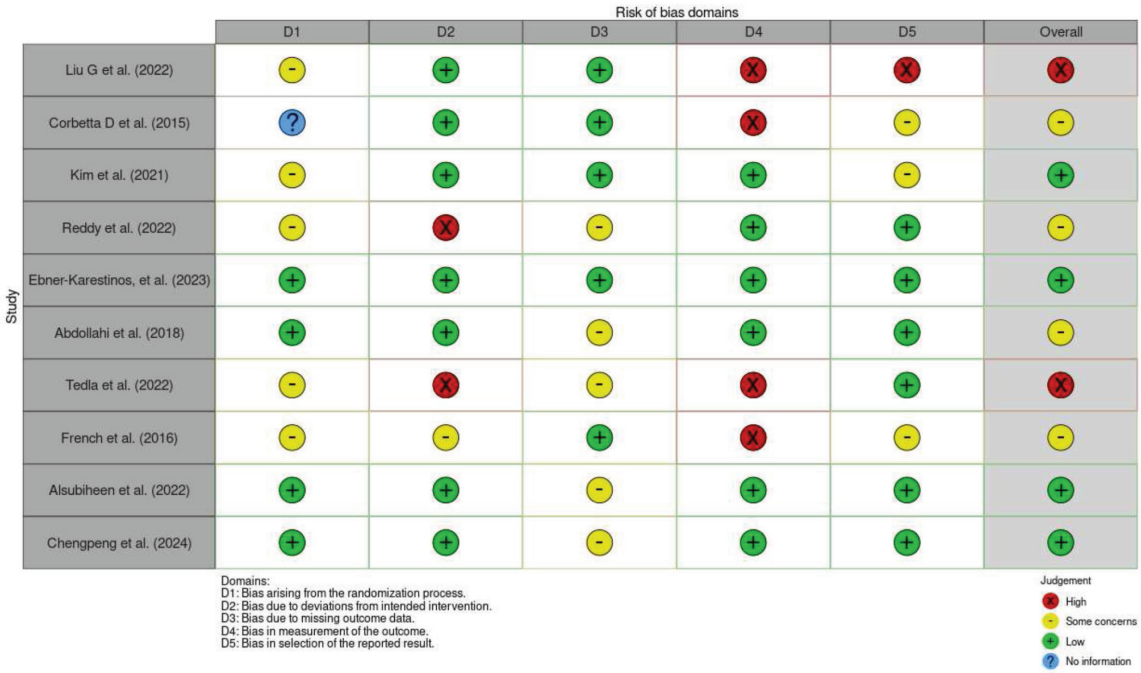

Figure 2: Risk of bias assessment

It appears to be Further high-quality research with larger samples focused on other instead of CIMT to evaluate a successful intensive technique for motor recovery in patients with stroke to confirm these results.

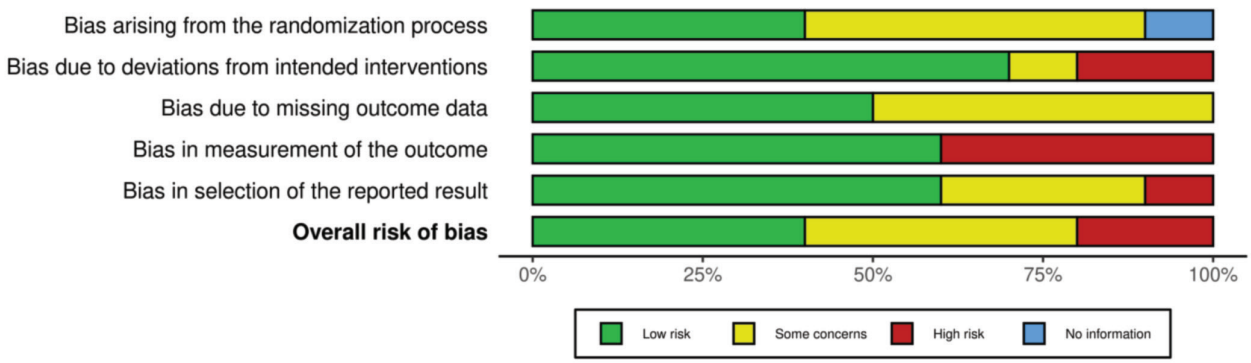

Figure 3: Risk of bias summary of included articles for review

Discussion

This systematic review highlights the effectiveness of intensive motor learning strategies in stroke rehabilitation. These methods promote neuroplasticity through repetitive, task-specific training and sensorimotor integration, leading to notable improvements in motor function and independence. Constraint-Induced Movement Therapy (CIMT) has demonstrated positive short-term effects by restricting the unaffected limb and promoting use of the affected one; however, its long-term functional benefits remain uncertain, with some studies reporting limited transfer to daily activities.[16] Task-Specific Training (TST), focused on functional task repetition, consistently improves

motor outcomes, particularly when combined with cognitive and sensorimotor tasks.[18,19]

Technology-assisted interventions, including robotics and virtual reality (VR), offer promising enhancements. Robotics delivers high-intensity and interactive movement training, improving upper limb strength, though its translation to activities of daily living (ADL) is still limited.[17] VR promotes engagement and motivation, aiding motor learning and recovery, but its long-term efficacy and standardization require further exploration.[18]

Hand-Arm Bimanual Intensive Therapy Including Lower Extremities (HABIT-ILE) improves both upper and lower limb coordination, balance, and mobility. Early findings suggest strong outcomes in independence and quality of life.[20] Despite these advancements, factors such as individual patient differences, the chronicity of the stroke, and adherence to rehabilitation programs play a crucial role in recovery outcomes. Future studies should focus on hybrid models that merge various motor learning strategies, combining HABIT-ILE, robotics, and virtual reality to develop personalized rehabilitation plans for the best possible stroke recovery

Study Limitations

The exclusion of non-English studies may have introduced language bias, potentially overlooking relevant data. Limited availability of high-quality RCTs weakened the evidence base. Heterogeneity in intervention protocols, outcome measures, participant profiles, stroke severity, and rehabilitation settings hinders comparability and generalizability. Despite a comprehensive search strategy, some pertinent studies may have been missed. Furthermore, the lack of standardized long-term follow-up limits conclusions on the sustained efficacy of intensive motor learning interventions

Conclusion

The systematic review demonstrated the benefits of employing intensive motor learning approaches in stroke rehabilitation. It was emphasized that CIMT, task-focused training, robotics-assisted rehabilitation, HABIT-ILE and virtual interventions can be effective at improving motor recovery through neuroplasticity. More research on CIMT is warranted as the evidence regarding its effectiveness is unclear, also HABITILE, Task specific approach and newer approaches such as Virtual or augmented reality applies promise in results although more research is warranted to optimize the interventions protocols, determine industry standard measures of outcomes, and consider personalized clinical interventions for stroke rehabilitation outcomes. Further high-quality research is still required to confirm these results, especially RCTs.

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Conflicts of Interest: There are no conflicts of interest.

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Cracking the Coccyx Code: A State-of-the-Art Review on Physical Therapy for Coccydynia

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Abstract

Background: Coccydynia, or tailbone pain, is a debilitating musculoskeletal condition affecting the coccygeal region, limiting daily activities like sitting and transitional movements. Despite its significant impact, it is often underdiagnosed or mismanaged, progressing to chronic symptoms. Common causes include trauma, prolonged sitting, childbirth-induced pelvic floor dysfunction, microtrauma, and idiopathic factors. In recent years, conservative approaches—particularly physiotherapy—have gained prominence for symptom relief and functional restoration.

Objective: To review and synthesize current evidence on the efficacy of physiotherapy interventions in the conservative management of coccydynia and identify research gaps to inform future clinical guidelines.

Methods: A comprehensive search of relevant randomized controlled trials (RCTs) was conducted in PubMed/MEDLINE, EMBASE, CINAHL, Scopus, Web of Science, Cochrane Central Register of Controlled Trials (CENTRAL), and Physiotherapy Evidence Database (PEDro) using terms like "Coccydynia," "Manual Therapy," and "Pelvic Floor Rehabilitation". Outcomes of interest included pain, function, mobility, and patient satisfaction. Due to the heterogeneity of the included studies, a narrative synthesis was performed. " Studies from 1990 to 2025 evaluating non-invasive physiotherapy in adults with acute or chronic coccydynia were included. Exclusions were studies focusing solely on surgical or pharmacological treatments.

Results: Manual therapy techniques, especially internal and external coccygeal mobilizations, improved mobility and reduced pain. Pelvic floor re-education, biofeedback, McKenzie approach and muscle energy techniques (METs) were effective in addressing dysfunction. Postural retraining, ergonomic correction, and core stabilization exercises offered sustained relief. Electrotherapy, including TENS and ultrasound, provided adjunctive benefits. Limitations included lack of standardized protocols and long-term data.

Conclusion: Physiotherapy plays a critical role in conservative coccydynia management. Multimodal, individualized plans integrating manual therapy, pelvic floor rehab, and education are most effective. However, further high-quality trials and standardized protocols are essential for improving care quality.

Keywords: Coccydynia, Physical Therapy, Manual Therapy, Pelvic Floor Dysfunction, Muscle Energy Technique, Non-Surgical Management

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Introduction

Coccydynia, or coccygeal pain, refers to discomfort localized in the region of the coccyx—the terminal segment of the vertebral column. Although relatively uncommon, it can significantly impair an individual's quality of life, particularly during prolonged sitting, transitional movements, or activities that impose direct pressure on the tailbone. Epidemiological data suggest a prevalence of approximately 1–3%, with a higher incidence among women due to anatomical and obstetric factors[1]. Despite this, the condition is frequently underdiagnosedand remains poorly understood, leading to delays in diagnosis and suboptimal management[2,8].

The coccyx, though vestigial, plays a functional role by supporting body weight in the seated position and serving as an anchorage for muscles and ligaments associated with the pelvic floor[2]. Coccydynia can be attributed to multiple etiologies, including direct trauma (e.g., falls), repetitive microtrauma, childbirth-related injuries, anatomical anomalies, and idiopathic factors[3]. Traumatic causes—such as childbirth, falling directly onto the buttocks, or sustained pressure from hard surfaces—are among the most common and may lead to subluxation, dislocation, or coccygeal fractures, thereby inciting inflammation and local irritation[4].However, pain may also arise in the absence of overt trauma, often due to pelvic floor dysfunction, prolonged postural strain, or psychosocial influences[5]. Psychosocial factors such as chronic stress, anxiety, depression, and somatization have been shown to amplify pain perception, reduce pain thresholds, and influence pain chronicity in musculoskeletal conditions. Patients with persistent coccydynia may develop a heightened fear of movement (kinesiophobia), social withdrawal, or catastrophizing behavior, all of which can worsen pain and functional limitations. In such cases, addressing emotional well-being becomes an integral part of a comprehensive management plan. In some individuals, abnormal coccygeal mobility, exacerbated by poor biomechanics or sustained pressure, contributes to the onset of pain[6].

Historically, management of coccydynia has centered on pharmacological interventions, including nonsteroidal anti-inflammatory drugs (NSAIDs) and corticosteroid injections. In refractory cases, surgical interventions such as coccygectomy have been employed[7].

Physical therapy has emerged as a pivotal component in the conservative management of coccydynia, offering a multi-dimensional approach aimed at alleviating pain, improving function, and restoring musculoskeletal balance. Among these interventions, manual therapy plays a particularly prominent role. Techniques such as internal and external coccygeal mobilization aim to restore normal joint alignment and mobility while reducing myofascial tension[9]. Complementary methods—including myofascial release, McKenzie approach trigger point therapy, and muscle energy techniques (MET)—target associated musculature such as the gluteals, pelvic floor, and lumbopelvic stabilizers, thereby enhancing pelvic alignment and functional capacity[10].

A multimodal treatment approach, integrating manual therapy with pelvic floor rehabilitation, ergonomic modifications, and tailored exercise regimens, has shown promising outcomes. For instance, pelvic floor therapy is used to address neuromuscular dysfunctions—such as muscle tightness, trigger points, or impaired coordination—that often coexist with coccygeal pain. Additionally, ergonomic interventions, like pressure-relieving cushions or modified seating, help reduce mechanical stress on the coccyx, especially during prolonged sitting, thereby minimizing pain and preventing symptom aggravation[11,12].

Nevertheless, the management of coccydynia remains complex due to the heterogeneity of its etiology and individual variability in treatment response. A standardized protocol for physiotherapeutic intervention is currently lacking, and much of the existing literature is derived from small-scale studies, anecdotal evidence, and expert consensus[13]. There is an urgent need for high-quality randomized controlled trials to validate the efficacy of conservative treatments and establish evidence-based guidelines[14].

This state-of-the-art review aims to comprehensively evaluate current physical therapy

interventions for coccydynia. It emphasizes the role of manual therapy—particularly coccygeal mobilization,McKenzie and MET—while also exploring adjunctive approaches such as pelvic floor rehabilitation and corrective exercise. Furthermore, the review highlights clinical challenges and identifies future research directions to optimize treatment strategies and improve patient outcomes.

Literature Review

The therapeutic management of coccydynia using physical therapy has gained momentum over the past two decades, with an increasing number of studies highlighting the efficacy of conservative interventions. The focus has largely shifted from pharmacological and surgical strategies to non-invasive options such as manual therapy, pelvic floor rehabilitation, exercise therapy, and ergonomic modifications.

1. Manual Therapy

Manual therapy, particularly coccygeal mobilization, has been widely investigated. Wray et al. (1991)[4]conducted one of the earliest studies exploring intrarectal manipulation of the coccyx and reported significant pain relief in 25 out of 30 patients over a 12-week period. Similarly, Maigne et al. (2000)[1] differentiated between post-traumatic and idiopathic coccydynia and demonstrated that manipulation under anesthesia was more effective for traumatic cases (success rate of 85%).

Muscle energy techniques (MET), which combine active muscle contractions with therapist-applied counterforce, have shown promising results in addressing coccygeal dysfunctions. In a randomized controlled trial by Senthil Kumar et al. (2018)[15], MET significantly improved coccygeal alignment and reduced pain scores by 50% after four weeks of intervention.

Manual Therapy: When and for Whom?

Manual therapy—mainly coccygeal mobilization—appears most effective in patients with *post-traumatic coccydynia*, especially those with coccygeal subluxation or malalignment following falls or childbirth. Khatri et al. (2017)[14]reported significant pain relief and functional improvement in such cases, suggesting that mechanical correction of coccygeal dysfunction may underlie these outcomes. Conversely, idiopathic cases, where no identifiable mechanical fault exists, show less consistent results. For these patients, manual therapy may require adjunctive strategies, such as pelvic floor therapy or cognitive reassurance. Therefore, patient selection based on etiology is crucial to maximizing the benefits of manual therapy.

2. Pelvic Floor Rehabilitation

Pelvic floor dysfunction has been increasingly implicated in idiopathic cases of coccydynia. A study by Furtado et al. (2017)[16] showed that patients who underwent pelvic floor muscle retraining combined with coccygeal mobilization reported a 60% greater reduction in pain compared to mobilization alone. Interventions typically involved biofeedback, Kegel exercises, and transvaginal/perineal manual therapy techniques.

Pelvic Floor Rehabilitation: Gender and Childbirth Context

Pelvic floor dysfunction is a common contributor to coccydynia, especially in females post-childbirth, due to perineal trauma, ligamentous laxity, and neuromuscular disruption. Studies such as Cumming (2025)[22] and Furtado et al. (2017)[16] suggest that pelvic floor therapy — including biofeedback, manual internal release, and Kegel retraining — provides significant benefit in these cases. Men with idiopathic coccydynia may also benefit, but the therapeutic effect is typically stronger and faster in postnatal women, who often present with clearer patterns of pelvic floor weakening[16]. These findings emphasize the importance of a gender-sensitive and history-informed physiotherapy assessment in chronic coccygeal pain.

3. Exercise Therapy and Postural Correction

Targeted exercise therapy focusing on lumbar and pelvic stabilization has also been investigated. In a cohort study by Jha et al. (2019)[17], patients receiving core stabilization and posture correction exercises showed improved sitting tolerance and significant functional outcomes compared to those treated with analgesics alone.

McKenzie Therapy vs Core Stabilization

Both McKenzie therapy and core stabilization exercises aim to address *lumbo-pelvic biomechanics*, but their mechanisms differ. McKenzie therapy uses directional preference movements (often extension) to centralize and reduce pain, while core stabilization focuses on improving muscular support and pelvic alignment. Naqvi et al. (2020)[20]demonstrated that McKenzie therapy led to more rapid reductions in pain and disability compared to conventional physiotherapy, particularly in patients with postural dysfunctions. In contrast, Lee et al. (2019)[21]found that core stabilization produced better long-term improvements in sitting tolerance and functional independence. Thus, especially when combined.

4. Multimodal Therapy

Recent studies underscore the need for a multimodal approach. For instance, a clinical trial by Reddy et al. (2020)[18]incorporated manual therapy, postural training, and ergonomic cushions in 40 patients and demonstrated a 70% improvement in Visual Analog Scale (VAS) scores at 8 weeks, compared to 40% in those receiving single-modality care.

Summary of key studies on Physical Therapy Interventions for Coccydynia

Author (Year)	Intervention	Sample Size	Duration	Outcomes Measured	Key Findings
Wray et al. (1991) [4]	Intrarectal coccygeal manipulation	30	12 weeks	Pain relief, sitting tolerance	83% showed significant pain reduction
Maigne et al. (2000) [1]	Mobilization under anesthesia	51	6 weeks	Functional disability, pain scores	More effective in traumatic cases (85% success rate)
Senthil Kumar et al. (2018) [15]	Muscle energy techniques	45	4 weeks	Coccygeal alignment, VAS	50% reduction in pain scores
Furtado et al. (2017) [16]	Pelvic floor rehab + mobilization	28	8 weeks	Pelvic floor tone, VAS	Combined therapy superior to mobilization alone ($p< 0.05$)
Jha et al. (2019) [17]	Core stabilization exercises	33	6 weeks	Posture, VAS, Oswestry Index	Improved function and pain relief
Reddy et al. (2020) [18]	Multimodal physical therapy	40	8 weeks	VAS, SF-36, sitting duration	70% symptom improvement in multimodal group
Khatri et al. (2017) [14]	Coccygeal manipulation	36	4 weeks	Pain scores, functional outcomes	Improved pain and function
Patel et al. (2024) [19]	Manual therapy + exercise	50	8 weeks	Pain relief, functional improvement	Greater benefits than exercise alone
Naqvi et al. (2020) [20]	McKenzie therapy vs conventional	30	4 weeks	VAS, Oswestry Disability Index	McKenzie group had superior pain and function outcomes
Cumming (2025) [22]	Pelvic floor physical therapy	Case series	4–6 weeks	Pain reduction, function	Noted clinical improvements in pain and function

Materials and Methods

A comprehensive narrative literature search was conducted to identify relevant studies, clinical guidelines, and expert consensus articles related to non-invasive physical therapy interventions for coccydynia. Electronic databases including *PubMed, Scopus, ScienceDirect, and Google Scholar* were searched for English-language articles published between 1990-2025. Keywords and Medical Subject Headings (MeSH) used in various combinations included: "*physical therapy*", "*physiotherapy*", "*manual therapy*", "*pelvic floor rehabilitation*", "*exercise therapy*", "*coccydynia*", and "*non-invasive treatment*".

Priority was given to *high-quality randomized controlled trials (RCTs), systematic reviews, and well-documented case series.* However, relevant observational studies, clinical commentaries, and expert opinions were also considered to provide a holistic understanding. Articles were selected based on their relevance to the topic, scientific rigor, and contribution to current clinical practice. The final selection represents a curated synthesis of contemporary evidence and expert consensus that reflects current trends, debates, and gaps in the field.

Inclusion Criteria

- Articles in English.
- Studies involving human subjects diagnosed with coccydynia.
- Interventions focusing on physical therapy modalities.
- Study designs including RCTs, cohort studies, case series, and controlled clinical trials.

Exclusion Criteria

- Studies focused solely on surgical or pharmacologic interventions.
- Reviews lacking clinical data or methodological clarity.
- Animal studies or non-peer-reviewed reports.
- Data were extracted on study design, sample size, intervention types, outcome measures, and key findings. Methodological quality was rated using the PEDro scale. Thematic synthesis was used to interpret findings across diverse methodologies.

Results and Discussion

Results

The reviewed literature collectively reinforces the role of *physical therapy as a primary intervention* in the conservative management of coccydynia. Across various study designs—including randomized controlled trials, case series, and cohort studies—non-invasive physiotherapy techniques consistently yielded improvements in pain, mobility, and functional capacity.

1. Manual Therapy

Manual therapy, especially coccygeal mobilization (both intrarectal and external), has demonstrated notable outcomes. Wray et al.[4]reported significant pain relief in 83% of patients receiving intrarectal coccygeal manipulation over 12 weeks. Similarly, Maigne et al.[1] found that mobilization under anesthesia resulted in an 85% success rate among patients with traumatic coccydynia. Khatri et al.[14] and Anderson et al.[10] further supported these findings, showing functional improvement and pain reduction in patients treated with mobilization techniques.

2. Muscle Energy Techniques (MET)

MET, targeting coccygeal malalignment through isometric contractions, showed statistically significant improvements. Senthil Kumar et al.[15] found a 50% reduction in pain scores (VAS) and better coccygeal positioning after four weeks of MET. These outcomes were particularly evident in patients with musculoskeletal contributors to coccyx pain.

3. Pelvic Floor Rehabilitation

In cases with idiopathic coccydynia—especially postpartum females—pelvic floor dysfunction emerged as a key contributor. Furtado et al. [16]observed a 60% greater reduction in pain when pelvic floor

muscle reeducation was combined with coccygeal mobilization, compared to mobilization alone. Cumming[22] echoed these findings in a case series, noting notable improvements with biofeedback and perineal release techniques in women with childbirth-related coccydynia.

4. Exercise Therapy and Postural Correction

Exercise therapy aimed at lumbopelvic stabilization produced both symptomatic and functional benefits. Jha et al. [17] reported improved sitting tolerance and reduced Oswestry Disability Index (ODI) scores with core stabilization programs. In comparative studies, Naqvi et al. [20] showed that McKenzie therapy outperformed conventional physiotherapy in reducing pain and disability, while Lee et al. [21]found that core stabilization yielded more sustainable functional outcomes.

5. Multimodal Interventions

Evidence supports combining therapies for synergistic benefit. In a controlled trial, Reddy et al. [18] demonstrated a 70% improvement in VAS scores among patients receiving a multimodal regimen (manual therapy + exercise + ergonomic supports), compared to 40% in single-modality groups. Similarly, Patel et al. [19]concluded that combining manual therapy with therapeutic exercises was significantly more effective than exercise alone.

Discussion

The findings from this review reflect a paradigm shift in the management of coccydynia—from predominantly pharmacological and surgical strategies toward more *holistic, conservative approaches*. A growing body of evidence supports physical therapy as a safe, non-invasive, and effective modality for managing coccygeal pain, particularly when individualized to patient presentation and underlying etiology.

Manual Therapy: Best Suited for Mechanical Dysfunction

Manual therapy appears to be particularly effective in cases of *mechanical dysfunction* of the coccyx, especially when the etiology is *post-traumatic,* such as from falls or childbirth. Studies by Maigne et al. [1] and Wray et al. [4] demonstrated significant improvements in pain and function following coccygeal mobilization techniques, with success rates exceeding 80% in trauma-related cases. Similarly, Khatri et al. [14]and Anderson et al. [10] highlighted that precise mobilization techniques can restore alignment and alleviate symptoms in patients with coccygeal malposition or hypermobility. These findings reinforce the importance of accurate diagnosis and patient selection, as idiopathic cases may not respond as predictably to mobilization alone.

Pelvic Floor Rehabilitation: Crucial in Idiopathic and Postnatal Coccydynia

Pelvic floor rehabilitation has emerged as a *critical adjunct* in managing *idiopathic or postnatal coccydynia,* particularly among women. Dysfunction of pelvic floor muscles—resulting from childbirth, trauma, or neuromuscular imbalance—can contribute to coccygeal pain even in the absence of direct injury. In this context, techniques such as *myofascial release, biofeedback, and neuromuscular re-education* are essential. Furtado et al. [16] showed significantly greater pain reduction when pelvic floor therapy was combined with mobilization. Cumming [22] further emphasized the effectiveness of internal release and re-education in postpartum women. These results suggest that gender-specific, history-informed physiotherapy may be particularly beneficial in chronic idiopathic cases.

Exercise and Ergonomics: Long-Term Functional Gains

Targeted exercise therapy, particularly *core stabilization and postural correction,* plays a vital role in reducing mechanical stress on the coccyx. These interventions promote *lumbopelvic stability,* correct biomechanical alignment, and improve functional tolerance. Jha et al. [17] reported significant improvement in sitting duration and reduced disability following core strengthening. When compared to conventional physiotherapy, *McKenzie therapy* showed faster pain relief *(Naqvi et al. [20])*, while *core stabilization* offered better long-term outcomes (Lee et al. [21]).

Ergonomic strategies, such as the use of *wedge cushions or donut pillows,* help redistribute pressure and prevent aggravation during seated activities. These adaptations are often included in multimodal rehabilitation protocols, which have shown the most consistent improvements in both pain and function.

Multimodal Interventions: Synergistic Benefits

The complex origins of coccydynia—spanning biomechanical, muscular, and postural factors—warrant a multimodal treatment approach. Studies by Reddy et al. [18] and Patel et al. [19] highlight that combining manual therapy, exercise, and ergonomic strategies leads to greater symptom relief and functional improvement than isolated therapies, reinforcing the effectiveness of integrated care.

Limitations of Current Evidence

- Despite encouraging findings, this review also highlights key limitations in the current literature:
- Many studies are *small-scale* and lack *control groups.*
- Intervention protocols vary widely, limiting *comparability.*
- There is a *lack of standardized outcome measures*, such as uniform use of VAS, ODI, or SF-36, across studies.
- *Long-term follow-up data* are scarce, making it difficult to assess recurrence or durability of treatment effects.

Conclusion

Coccydynia remains a complex and often misunderstood condition with a significant impact on the quality of life of affected individuals. The current review highlights that physical therapy offers a promising, non-invasive, and patient-centered approach to managing coccygeal pain. Techniques such as manual therapy, muscle energy techniques, pelvic floor rehabilitation, ergonomic modifications, and therapeutic exercise demonstrate measurable benefits in pain reduction, mobility restoration, and functional improvement.

Manual therapy, particularly coccygeal mobilization, is effective in cases with identifiable biomechanical dysfunction, while pelvic floor rehabilitation plays a critical role in addressing idiopathic or childbirth-related cases. A multimodal treatment approach—tailored to the patient's specific presentation and underlying etiology—shows the most consistent results and aligns well with the biopsychosocial model of care. Psychosocial factors like somatization, anxiety, depression, and chronic stress have been found to heighten pain sensitivity, reduce pain tolerance, and contribute to the development of chronic musculoskeletal pain. In individuals with persistent coccydynia, this may manifest as fear of movement (kinesiophobia), social withdrawal, or an exaggerated focus on pain (catastrophizing), all of which can intensify symptoms and limit function. Therefore, addressing psychological health is an essential part of comprehensive treatment planning. Despite these encouraging findings, the literature suffers from certain limitations, including small sample sizes, heterogeneity in treatment protocols, lack of standardized outcome measures, and insufficient long-term follow-up. These limitations make it difficult to establish universally accepted clinical guidelines. Moreover, the interplay between anatomical, neuromuscular, and psychosocial factors in chronic coccydynia remains underexplored.

Future Directions

- **Large-Scale Randomized Controlled Trials (RCTs):** There is a need for well-designed RCTs to validate the effectiveness of various physical therapy interventions and identify the most efficient combinations of treatments.
- **Standardization of Protocols:** Development and validation of standardized physiotherapy protocols and outcome measures will enhance comparability across studies and clinical settings.

- **Long-Term Follow-Up Studies:** Research focusing on the long-term effects of conservative management strategies is critical to understand recurrence rates and sustained benefits.
- **Mechanistic Research:** Investigating the neuromuscular and fascial connections influencing coccygeal mechanics may yield new insights into both diagnosis and treatment.
- **Integrative Models of Care:** Exploring interdisciplinary approaches that incorporate psychological and behavioral therapies alongside physiotherapy could improve outcomes for patients with chronic or idiopathic coccydynia.

In conclusion, physical therapy holds a pivotal role in the modern conservative management of coccydynia. With further research, refined techniques, and a more nuanced understanding of the condition's etiology, physiotherapists can significantly improve the prognosis for patients suffering from coccyx pain

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The Role of Physiotherapy in Chikungunya: A Comprehensive Analysis

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Abstract

Chikungunya fever (CHIKV) is a viral infection transmitted primarily by Aedes aegypti and Aedes albopictus mosquitoes. While the benefits of physiotherapy in managing musculoskeletal disorders are well-established, its role in post-chikungunya arthralgia remains underexplored. This review aims to evaluate the effectiveness of diverse physio therapeutic interventions and analyse their outcomes over varying timeframes. A thorough literature search was performed using databases such as PubMed and Google Scholar. The findings highlight that interventions like electrotherapy, kinesiotherapy, and manual therapy effectively alleviate pain, improve functional capacity, and enhance range of motion (ROM) in individuals with musculoskeletal issues. Evidence suggests that well-structured therapeutic protocols significantly reduce pain, restore ROM, and improve functional performance. Additionally, the frequency and timing of these interventions appear to influence their therapeutic efficacy, offering valuable guidance for patients and healthcare practitioners alike.

Keywords: Chikungunya, arthralgia, physiotherapy, physiotherapy management post chikungunya arthralgia.

Introduction

Chikungunya fever is a viral disease caused by the chikungunya virus (CHIKV), transmitted by the bite of infected Aedes aegypti and Aedes albopictus mosquitoes [1].

The term "chikungunya" originates from the Makonde language, spoken in various of eastern Africa, and translates to "one who bends over." This refers to the bent parts posture that patients often adopt due to severe joint pain during the illness. [2]

It has become a global concern and has been designated as a priority by the scientific leadership group of the Global Virus Network.[3] In India, approximately 15% of clinically suspected cases are confirmed, with a recent study from 2019 reporting a laboratory confirmation rate of 14.9% among suspected cases. Globally, determining an exact percentage remains challenging due to variations in reporting practices.[10]

Symptomatic infection from the virus is typically characterized by a sudden high fever, often exceeding 39 °C, along with headache, chills, conjunctivitis, rash, muscle pain, and severe symptoms. Clinical presentations of chikungunya may vary in different geographical regions around the world. In some regions, an incidence as high as 80% has also been reported.[5] In the post-viral or chronic phase, joint pain becomes a predominant symptom.[6] Chikungunya is characterised by a high morbidity rate, primarily due

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to severe and prolonged joint pain. This significantly reduces both quality of life and productivity.[7]

In this context, physical rehabilitation is essential for maintaining functionality in patients during the chronic phase of the disease. It aids in cellular healing processes, enhances joint lubrication, and restores normal joint mechanics by preventing tissue adhesions. Physiotherapy has an added advantage as it is a drug-free alternative for managing pain related to joints, tendons, and nerves. [8]

Although the clinical benefits of physiotherapy are well-documented, its impact on post chikungunya arthralgia remains underexplored. To address this gap, the present article systematically reviews the effectiveness of various physiotherapeutic interventions, emphasizing their outcomes at different time intervals. By correlating the frequency and timing of interventions with their therapeutic results, this study aims to provide valuable insights into optimizing physiotherapy for managing post-chikungunya arthralgia.

Materials and Methods

A comprehensive search for studies was conducted using the Google and PubMed electronic databases. The following keywords were used: "Chikungunya, treatment, arthralgia, physiotherapy treatment, post-Chikungunya treatment," as available in MeSH (Medical Subjects Headings) terms. The inclusion criteria for study selection were Quasi-experimental, case reports, peer-reviewed articles, and randomized controlled trials (RCTs). Exclusion criteria included consensus statements from medical societies, expert opinions, and articles with restricted access.

Initially, a total of 200 articles were found. After removing duplicates, 68 articles remained. Applying the exclusion criteria reduced this number to 25. Of these, 10 articles with full PDFs were thoroughly reviewed, and ultimately, 9 articles were selected for the final review. Titles and abstracts of all identified articles were reviewed, with no restrictions on population groups. In cases where reading the abstract alone was insufficient to determine eligibility based on the inclusion criteria, the full text of the article was reviewed to make a final decision on inclusion.

The data extracted from various articles were categorized based on the duration of the intervention (e.g., 2 weeks, 3 weeks, 4 weeks, and 12 weeks). Additionally, the physiotherapy techniques applied to different joints and their outcomes at various time intervals were systematically tabulated and analyzed (Table 1).

Limitations

The patients of varying ages, genders, and health backgrounds. For instance, some patients were older adults with pre-existing conditions, while others were younger and generally healthy. this diversity might affect responses to exercise, and our review did not account for pre-existing health status or age, which limits our findings., hence the data cannot be directly extrapolated and should be used with caution.

Result

2 weeks

Two studies conducted by Tenorio et al., (2020)[11] and Almeida et al., (2021)[12] utilized electro thermotherapy, kinesiotherapy and manual therapy for chikungunya patients at a rate of one session per week for 14 and 10 sessions respectively. Both studies showed a reduction in pain. They also reported improvements in functional capacity and range of motion (ROM). In a case report by Ribeiro et al., 2016[13] the electrotherapy combination including ultrasound, infrared laser and Tens burst were given 10 sessions of similar outcome came there the study showed an improvement in quality of life is seen after intervention and also functional activity increased.

In case of Silva et al., 2020[14] the effect was traced even in molecular level where 12 training sessions of 40 minutes of physiotherapy. Maximum shows improvement of lipid peroxidation, protein oxidation and non-enzymatic antioxidant system.

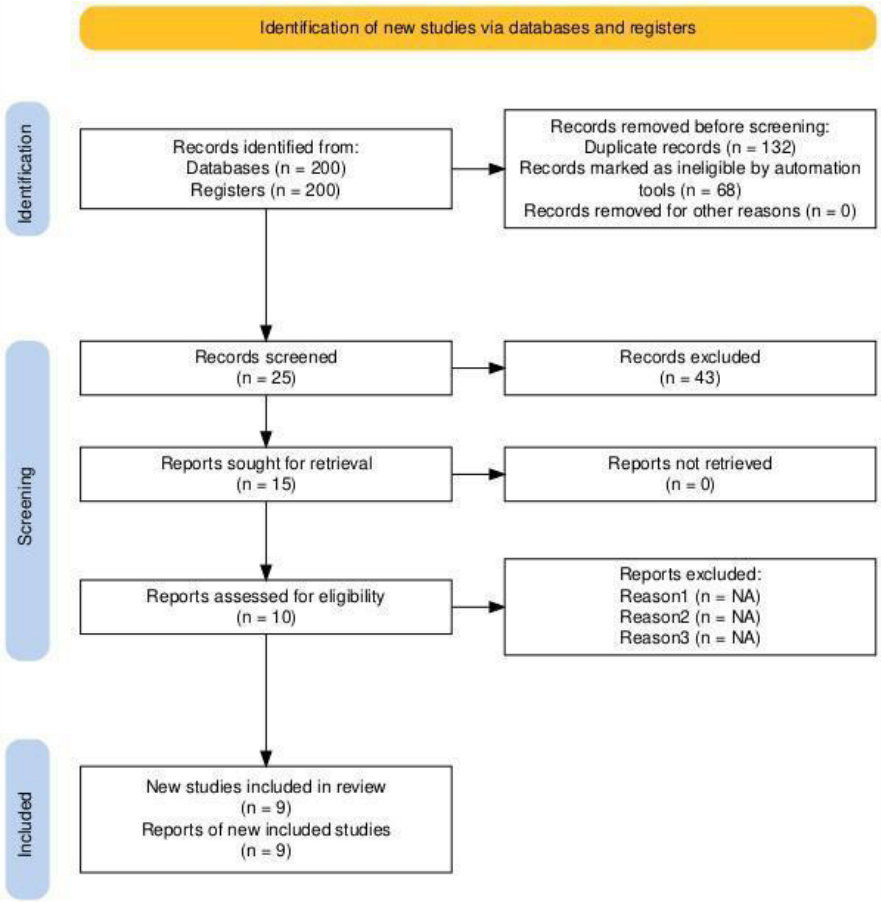

Figure 1: Prism flowchart for a comprehensive analysis

From the above studies, it is seen that there is an effect of physiotherapy even with a 2week intervention. Collectively, these findings underscore the importance of integrating physiotherapy into chikungunya management protocols to optimize patient recovery, enhance functional outcomes, and improve overall quality of life.

3 weeks

The study by Rahman et al.,2017[3] involved a group of patients with post-chikungunya joint pain. Three patients experienced lower back and knee pain, three patients had pain in the lower back and ankle, and four patients reported neck and shoulder pain. A treatment of electrotherapy and exercise therapy, was given over six sessions, twice a week. The mean pre-treatment pain score of 6.70 cm was reduced significantly to 5.40 cm post-treatment. The details of the different interventions used in different joints are given in the table (Table 1).

4 weeks

In a Case report by Oliveira et al., 2017[15] and Silva et al., 2017[15], a 4-week musculoskeletal rehabilitation program based solely on kinesiotherapy (therapeutic exercises and manual therapy) was implemented. The study found that kinesiotherapy alone was effective in increasing muscle strength, enhancing range of motion (ROM), reducing oedema, and improving functional capacity, as well as decreasing pain levels.

12 weeks

— In a study by Oliveira et al., (2019)[16], patients were divided into two groups.(Group 1) consisted of 22 patients who participated in a Pilates-based

exercise intervention lasting 50 minutes per session, conducted twice-weekly for 12 weeks. (Group 2) included 20 patients who received no intervention, with only follow-up assessments. The outcomes observed in Group 1 included:

- A reduction in pain (p<0.001), as measured by the Visual Analogue Scale (VAS).
- Improvement in quality of life, assessed using the SF-36 instrument.
- Enhanced range of motion (ROM) and flexibility, measured through goniometry and flexibility testing.

— In a study by Neumann et al. (2021)[17], patients were divided into two groups. The outcomes observed in Group 1 included of 15 patients who participated in a 50-minute resistance exercise session, held twice-weekly over a 12-week period. Group 2, with 16 patients, received no intervention and attended follow-up sessions only in addition PGIC also increased, reduction in pain, measured by the Visual Analogue Scale (VAS).

- Improved quality of life(p=<0.01; d=0.38), assessed using the SF-36 instrument.
- Enhanced functional capacity.
- Increased patient satisfaction with treatment, measured by the Patient Global Impression of Change (PGIC) instrument.

— In the case study by de Oliveira.,2020[7] of a 47-year-old woman underwent a 12-week program of exercise therapy and electrotherapy, comprising 24 sessions, significant improvements were observed. This treatment enhanced her quality of life, reduced pain and nerve irritation, increased strength and flexibility, and supported her return to social and professional activities. Additionally, the resistance exercise group demonstrated a significant reduction in pain intensity, with values changing from (p = 0.04; d = 0.39) to (p = 0.01; d = 0.38), indicating a decrease in pain following the intervention.

Table 1. Details of the included studies according to author, year,sample size, country, study type, time and interventions.

Author (year)	Population or sample	Country	Study type	Time	Intervention
Oliveira et al. ; 2017 [15]	A female of 35 years	Brazil	Case report	4 weeks	Weeks 1-2: For the UL, interventions included 1) 1) radio carpal traction (40–60 repetitions / minute), 2) myofascial release of wrist muscles(3 minutes each region), 3) low grade (1 and 2)joint mobilization for wrist, 4) passive stretching for wrist flexion and extension (60 oscillations/minute + 1minute of stretching), 5)and cryotherapy in painful areas (20 min 3 times per day). The patient was positioned in supine (SP) or supine with 90° elbow flexion as required.

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					For LL, treatment comprised 1) Femorotibial traction (60 repetitions per minute), 2) knee mobilization at grade 1 and 2 (40–60 oscillations / minute), 3) ankle pumps, 4) and passive stretching of the triceps surae(1minute). The patient was positioned sitting or supine, depending on the activity. Weeks 3-4: The focus shifted to active and strengthening exercises. For the UL, exercises included 1)bilateral wrist movements with a stick(2 ×/12 repeats), 2)strengthening with light weights, 1 kg (2 ×/12repeats), 3)and isometric grip exercises with visual feedback(2×/10 repetitions with 3-5seconds). For LL, activities included 1) assisted triple flexion using a Swiss ball, 2) quadriceps strengthening with weighted shin pads(2×/12repetitions), 3) and straight leg raises. Positions were adjusted to optimize each exercise's effectiveness, with the patient in supine or sitting as indicated.
Ribeiro et al., ;2016 [13]	A 57yrs female	Brazil	Case report	2 weeks	Session 1: continuous US with f= 1 MHz, I = 1w/cm square for 6 min on shoulder and 4 min on elbows, + IR laser with 4J and 3sec / point have 5point / joint Session 2 :reperforming a total of 20j and 12sec per joint and finalizing with tens burst with the pulse width of 250microsec and f=2hz modulated by 150Hz, 20 min on each of the 4 joints.

Continue....

Rahman et al., ; 2017 [3]	10 participants	Bangladesh		3 weeks	Week 1: 1) Patients received ice compression for 10 minutes every 2–3 hours to alleviate joint swelling, as needed. 2) Active-assisted range-of-motion exercises were conducted within pain-free limits, alongside nonweight-bearing exercises for the lower limb joints. 3) Patients performed these activities 3–4 times per week, depending on their tolerance and symptoms. Week 2: Depending on patient's tolerance level, pulley-assisted exercises, isometric exercises, and close kinetic chain exercises using the patient's own body weight. These activities were adjusted to patient tolerance levels. Week 3: Patients continued with mild aerobic exercises and stretching routines. A home exercise routine of 20 min /session twice daily active exercises for both upper and lower limbs, low-impact aerobic activities like walking for 5 minutes at a comfortable pace, and static stretching of major muscle groups with 10-second holds.
Neuman et., Al ; 2021 [17]	(Aged 56+/-10yrs) Total 31	Brazil	RCT Resistanc e exercise group (n=15) Control group (n=16)	12 weeks	Resistance exercise group did a resistance program using elastic bands, completing 24 sessions in total. Control group symptoms monitored through regular phone check-ins.

Continue....

Oliveira et al., 2019[16]	51 Participants	Brazil	RCT Group 1(n=26) Group 2 (n=25) (After 12 weeks, 4 participants in the Pilates group and 5 in the control group were lost to follow-up)	12 weeks	Group 1 (n=22) : Pilates exercise sessions of 50minute duration, 2 sessions/ week for 12 weeks Group 2(n=20) : no intervention, follow up onl
de Oliveira., 2020[7]	47yr women	Brazil	Case report	12 weeks	Sessions 1-4: Upper and lower limb passive mobilization and passive stretching. Pain relief was achieved with TENS (10 Hz, 200 ms, 20 minutes) and continuous ultrasound (0.3 W/cm², 1 MHz, 3 minutes). Sessions 5-8: 1) Warm water immersion (10 minutes) with water exercises. 2) Active and passive stretching for upper and lower limb flexors 3) light intensity (30% 1RM). Sessions 9-12: 1) stationary cycling (10 minutes) and stretching of major muscle groups using contract-relax methods. 2) Joint mobilization 3) Lower limb strengthening progressed to light intensity (40% 1RM), and ultrasound treatment was increased to 0.7 W/cm². Sessions 13-16: 1) treadmill walking (10 minutes at 2.5-3.5 km/h) 2) Strengthening of wrist and shoulder extensors and flexors progressed with dumbbells (3×8 reps)

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					3) TENS and ultrasound were discontinued. Sessions 17-20: 1) increased resistance on the exercise bike or treadmill. 2) Upper and lower limb stretching on a Swiss ball, core strengthening, and proprioceptive and aerobic training were introduced, with strengthening intensity raised to 40-60% of 1RM.
Tenoria et al. 202011	2 participants	Brazil	Case report	2 weeks	14 sessions, protocol : electro thermotherapy, kinesiotherapy and manual therapy
Almeida et al. ,202112	21 Participants	Brazil	Quasi-experimental	2 weeks	10 sessions, protocol : mobilizations joints, stretching, exercises resumen aerobic, active assisted, active free and resource electrothermotherapeutics.

Discussion

The demand for treatment research for chikungunya virus (CHIKV) remains high due to the significant psychosocial and economic impacts caused by its high morbidity rates, affecting the health and well-being of individuals and populations globally. it is having a severe impact in number of working days lost, particularly in low-resource regions where the virus is most prevalent. Although advanced research is being carried to explore advancements in CHI KV treatment and the challenges encountered in studying this complex virus. [9]. However, it is not economically possible for the low resource regions to fund their process. Hence, utilizing alternative solutions like physiotherapy which can be drug free and equally efficacious solutions has to be systematically explored and streamlined for clinical use.

Hence, this article aimed to identify the specific criteria like frequency of the session's nature of the exercise and its outcome is specific intervals of time.

It was found that the use of therapeutic interventions, including electrotherapy, kinesio-therapy, and manual therapy, yielded positive results across various studies in managing pain, improving functional capacity, and enhancing range of motion (ROM) in patients with musculoskeletal and post-chikungunya joint pain. Studies such as those by Tenorio et al., (2020)[11] and Almeida et al., [12] demonstrated the effectiveness of electro thermotherapy, kinesiotherapy, and manual therapy, with patients showing reductions in pain and improvements in functional capacity and ROM after 10–14 sessions over two weeks. Similarly,from Ribeiro et al., 2016[13] case study observed that a 10-session electrotherapy regimen utilizing ultrasound, IR laser, and TENS bursts improved quality of life and functional activity levels. Additionally, Silva et al., 2020[14] study indicated that exercise therapy, when applied over a molecular level-focused approach, contributed to biochemical improvements, including enhanced lipid peroxidation, protein oxidation, and the non-enzymatic antioxidant system.

Conclusion

Across all studies, a consistent outcome was the effectiveness of structured therapeutic programs in managing pain, increasing functional capacity, and enhancing quality of life in patients

with musculoskeletal conditions. Short-term interventions (2–4 weeks) utilizing electrotherapy, kinesiotherapy, and manual therapy proved beneficial in improving ROM, reducing pain, and enhancing basic functional outcomes. Meanwhile, long-term programs (12 weeks) involving Pilates and resistance training provided more sustained improvements in pain levels, ROM, muscle strength, flexibility, and patient satisfaction, which are crucial for reintegration into social and professional activities. These findings collectively emphasize the importance of personalized, targeted therapeutic approaches that consider both the physical and psychosocial dimensions of recovery, leading to comprehensive benefits for patients with joint pain and other musculoskeletal issues.

Exercise Regimens: The study categorized patients into groups based on the type of exercise regimen they followed. Some patients engaged in low-impact exercises like walking and stretching, while others participated in more intensive activities such as resistance training and aerobic workouts.

Recovery Outcomes: The table shows the recovery rates for each group. Patients who followed low-impact exercises reported a gradual improvement in joint mobility and pain reduction. For example, those in the walking group experienced a 30% improvement in their symptoms over four weeks. In contrast, patients who engaged in more intensive regimens showed quicker recovery times, with some reporting a 50% improvement in just three weeks.

The data suggests that while all exercise regimens contributed positively to recovery, the intensity, and type of exercise played a significant role. Low-impact exercises were beneficial for older patients or those with severe symptoms, while younger patients or those with milder symptoms thrived on more vigorous activities.

In summary, the data illustrates how different exercise regimens can significantly impact recovery from chikungunya, providing valuable insights for both patients and healthcare professionals.

Strengths and Limitations of The Study

This study has several notable strengths and limitations. One key limitation is the wide age range of participants across the included studies, spanning from 18 to 75 years. Due to the limited availability of experimental or intervention-based studies, conducting a subgroup analysis was not feasible, preventing a comparison of outcomes between specific age groups, such as adults and the elderly. Another limitation pertains to the risk of bias assessment, as nearly half of the included studies scored between 45.4 and 63.3, indicating moderate to high risk of bias.

On the other hand, a significant strength of this study is that it represents the first systematic review to comprehensively examine the role of musculoskeletal rehabilitation in addressing sequelae following Chikungunya fever. It also provides detailed insights into the types of interventions used, the outcomes measured, and the effects observed. This unique focus contributes valuable knowledge to the field.

Future Research Recommendations

In this context, the study highlights the need for further research on this topic to underscore the significance of rehabilitative approaches employed by physiotherapy and related disciplines in managing musculoskeletal complications following Chikungunya fever. Additionally, it emphasizes the importance of advancing efforts toward early and precise diagnosis of Chikungunya, as its signs and symptoms often overlap with those of other conditions, such as rheumatoid arthritis. This diagnostic challenge can complicate the treatment of post-Chikungunya sequelae and warrants greater exploratory attention.

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Various Valid and Reliable Scales used in Covid19 Assessment -A Narrative Review

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Abstract

Background: Coronavirus Disease 2019 (COVID-19), caused by the SARS-CoV-2 virus, emerged in late 2019 and was declared a pandemic by the World Health Organization (WHO) on March 11, 2020. The virus causes symptoms ranging from mild respiratory issues to severe pneumonia and organ failure, with critical cases often requiring hospitalization and mechanical ventilation. Beyond physical health, COVID-19 has profoundly affected psychological, social, and economic well-being, leading to anxiety, stress, depression, and daily life disruptions.

Materials and Methods: Literature related to COVID-19 was reviewed from sources such as PubMed, Scopus, and PEDro to assess the efficacy of various scales measuring health aspects like anxiety, depression, and stress.

Results: Nine studies were included, demonstrating the effectiveness of various scales in physiotherapy assessment for COVID-19 patients. The Fatigue Severity Scale showed good test-retest reliability in assessing physical activity levels. The Hospital Anxiety and Depression Scale demonstrated strong construct validity and reliability, effectively evaluating anxiety and depression levels. The COVID-19 Anxiety Scale proved reliable and valid, successfully distinguishing individuals with dysfunctional anxiety from those without. The COVID-19 Stress Scale exhibited positive psychometric properties, effectively measuring anxiety levels. The Post-COVID-19 Functional Status Scale was effective in tracking symptom progression and its impact on patients' functional status. The Burnout Scale for COVID-19 indicated higher degrees of burnout or stress with higher scores, while the Coronavirus Stress Measure was a reliable tool for assessing stress and burnout related to COVID-19. Additionally, the COVID-19 Stigma Scale proved effective in evaluating stigma among healthcare providers, showing good reliability across various contexts.

Conclusion: All nine scales demonstrated strong validity and reliability, proving effective in physiotherapy assessments during the COVID-19 pandemic. Their consistent performance supports their clinical utility for accurate patient evaluation.

Keywords: COVID-19; Scales; Functional Status; Pandemic; SARS-CoV-2

Introduction

CORONAVIRUS DISEASE 2019 (COVID 19) The broad family of viruses known as coronaviruses (CoV) is responsible for a variety of illnesses, from the common cold to more serious illnesses. A common virus known as a coronavirus can infect the nose, sinuses, or upper throat. Most coronaviruses do not pose a threat. Following an epidemic in China in December 2019, the World Health Organization recognised SARS-CoV-2(severe acute respiratory syndrome) as a novel coronavirus in the early

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months of 2020. The epidemic spread fast around the globe. One of seven coronavirus types, SARS-CoV-2 is responsible for serious illnesses such Middle East respiratory syndrome (MERS) and sudden acute respiratory syndrome (SARS) [1]

Pandemic: The coronavirus disease of 2019 (COVID-19) has been classified as a pandemic by the World Health Organization (WHO). To stop the virus from spreading further, a concerted international effort is required. "Occurring over a vast geographic area and impacting an extraordinarily high proportion of the population" is how a pandemic is described. The H1N1 flu pandemic in 2009 was the most recent pandemic to be reported globally. [2]

Coronavirus 2 causing severe acute respiratory syndrome is the virus that causes COVID-19 (SARS-CoV-2). While coronaviruses can infect both humans and animals, they are only known to cause respiratory diseases in humans. The COVID-19 virus has a large number of genetic variants. The spread of the virus, the severity of an infection, and the protection you get from past infections, immunizations, or therapies can all be impacted by variations.[3]

Direct transmission of COVID-19 between individuals is possible via respiratory droplets. Aerosols (droplets small enough to float in the air) released when an infected person coughs or sneezes can also expose you to the virus. These aerosols stay in the atmosphere for a very long time.

Global population psychological health was impacted by COVID-19. According to studies, the COVID-19 pandemic had distinct effects on people around the world. Evidence connected mental stress to emergencies, lockdowns, and quarantines, when people in threatening situations lost the ability to forecast and manage their lives. According to a systematic review including 398,771 participants, the prevalence of psychological distress, depression, and anxiety during the COVID19 pandemic was 50%, 27%, and 28%, respectively. It has been found that middle-aged mothers and single women who are also single have higher rates of psychological discomfort. Numerous detrimental psychological impacts of quarantine, such as stress, anxiety, frustration, despair, insomnia, and rage problems, were identified in a recent evaluation of the COVID-19-related lockdown they continued after the quarantine.[4]

Clinical Manifestations

Patients infected with the disease present with a variety of symptoms, including severe sickness, mild to moderate pneumonia, and hypoxia necessitating hospitalisation (leading to invasive mechanical ventilation, multiorgan dysfunction and possibly death). from epidemiological data.[5,6]

Management

Physiotherapy Treatment

When COVID 19 is in the acute phase, mobilising secretions and reducing the effort required for breathing are the major objectives of respiratory physiotherapy. Positioning, autogenic drainage, deep breathing exercises, breath stacking, the active cycle of breathing, mobilisation, and manual treatments (such percussion, vibrations, assisted cough) are only a few of the approaches that can be used as interventions. Any stage of the disease can be treated with these procedures if it is suitable and safe to do so.[9,10,11]

Methods: Literature related to COVID-19 was reviewed from sources such as PubMed, Scopus, and PEDro to assess the efficacy of various scales measuring health aspects like functional status, anxiety, depression, and stress.

Search terms: COVID-19 OR SARS-CoV-2 OR Coronavirus AND Scales

CIVID-19 OR Coronavirus pandemic AND anxiety OR depression scale OR stress

Inclusion Criteria

1. Age 18 and above
2. Able to read and understand the scale
3. Patients affected by the pandemic
4. informed consent
5. Technological access

Exclusion Criteria

1. Inability to understand the language
2. pre-existing condition
3. no informed consent

Literature Review

1. Fatigue Severity Scale(Fss)

The Fatigue Severity Scale (FSS), consisting of nine items, evaluates the intensity of fatigue and its impact on a patient's daily activities and lifestyle across various medical conditions. Originally designed for individuals with systemic lupus erythematosus and Multiple Sclerosis, it is now applicable to a broader population, including those suffering from COVID-19, fibromyalgia, multiple sclerosis, Parkinson's disease, and arthritis. This self-report scale (see Annexure 1) measures the severity of fatigue and its effects on different activities, with responses scored from 1 to 7, where 7 indicates strong agreement. The total score ranges from a minimum of nine to a maximum of 63, with higher scores reflecting more severe fatigue and greater interference with daily activities. The scale is user-friendly, typically requiring about eight minutes to complete. The reliability of the scale is supported by an Intraclass Correlation Coefficient (ICC) ranging from 0.80 to 0.89 and a Cronbach's alpha of 0.88. This study employed the Arabic version of the scale, which has been validated and shown to possess good reliability at 0.80. This scale shows better prognostic results when patients feel fatigue due to disease The psychometric properties of the Arabic translation of the Fatigue Severity Scale indicate acceptable test-retest reliability (r=0.84). Furthermore, there is a significant correlation between the concurrent validity of the Fatigue Severity Scale and the scores obtained from the visual analogue scale[12]

2. Hospital Anxiety and Depression Scale (Hads)

The Hospital Anxiety and Depression Scale (HADS) is a tool designed to check for the presence and seriousness of mild anxiety, depression, and mood issues. It is provided as a simple questionnaire that assists individuals to evaluate the simultaneous presence and intensity of anxiety and depression, with each having a separate score. (Annexure 2). It is utilized to assess the internal consistency, reliability, and construct validity of the Hospital Anxiety and Depression Scale as a patient-reported outcome measure for understanding the emotional impact of SARS-CoV-2 on hospitalized COVID-19 survivors dealing with long COVID. The connections between the two subscales ranged from 0.40 to 0.74. Cronbach's alpha varied from 0.67 to 0.90 for HADS-D and from 0.68 to 0.93 for HADS-A. The sensitivity and specificity of both HADS-A and HADS-D were both 0.80, which were very similar to the sensitivity and specificity of the General Health Questionnaire (GHQ). The HADS and several other common questionnaires showed correlations between 0.49 and 0.83. This questionnaire has been recognized for use in many languages, countries, and situations, including community and general practice settings. It is useful for making an initial diagnosis and tracking the development (or disappearance) of psychological symptoms. This indicates that the Hospital Anxiety Depression scales for measuring anxiety and depressive symptoms generally have acceptable psychometric quality to be used for evaluating psychological and emotional stress in COVID-19 survivors experiencing long COVID.[13,14]

3. Covid19 Anxiety Scale(Cas)

During the COVID-19 pandemic, the severe anxiety associated with the risk of developing the disease or the nearing nature of death itself may be increased. Considering how the pandemic has affected the anxiety levels of the people, a metric, i.e., the COVID-19 Anxiety Scale, can precisely assess the fluctuation of anxiety levels caused by COVID-19. Researchers have not sufficiently examined the coronavirus pandemic's effects on people's mental health. The Coronavirus Anxiety Scale (Annexure 3), a rapid mental health screener used to identify probable occurrences of dysfunctional anxiety connected to the COVID-19 crisis, was developed and evaluated. The study was done on 775 persons showed high internal consistency with Cronbach's alpha values ranging from 0.86 to 0.89, and it shows

good convergent validity. Also, this scale successfully distinguishes between individuals who have dysfunctional anxiety and those who do not with 90 % sensitivity and 85 % scale specificity. Increasing coronavirus anxiety scores have been related to higher coronavirus diagnoses, impairments, alcohol/ drug usage, inadequate religious coping, severe depression, and suicidal thoughts. These findings affirm the Coronavirus Anxiety Scale's validity and reliability as a tool for clinical research and practice.[15]

4. Covid 19 Stress Scale(Css) or Pandemic Related Perceived Stress Scale (Pss)

The COVID-19 Stress Scales is used to analyse its psychometric properties. Participants had to complete a socio-demographic survey as well as the Coronavirus Stress Scale and Perceived Stress Scale. People who provided their consent forms in the questionnaire they got via email, Facebook, or WhatsApp were given the modified Perceived Stress Scale-10 connected to COVID-19. A study was done to determine reliability on 406 individuals; 61.8 % of them were women, 90.6 % are degree holders, and 44.1% are healthcare workers, among whom observed scores ranged from 0 to 36; 58 persons obtained scores of 25 or above. The Perceived Stress Scale-10 (Annexure 4) had shown good internal reliability, and Cronbach's alpha values were within normal levels. When determining if the items grouped a latent component and the number of factors, internal consistency was computed using Cronbach's alpha value, showing a 0.84 coefficient and the Exploratory Factor Analysis. It is also crucial to assess the Perceived Stress Scale performance because this scale also helps in identifying distress levels that can inform prevention and early intervention strategies to mitigate long-term health impacts.[16]

5. Stress And Anxiety To Viral Epidemics-6(Save) Scale

In order to measure healthcare workers' anxiety behaviours to the viral pandemic, this survey evaluated the accuracy and effectiveness of the Stress and Anxiety to Viral Epidemics-6 items scale, which is frequently used to assess the general population. An online survey conducted among a total of 135 healthcare professionals. Psychiatric symptoms were assessed using the Stress Anxiety to Viral Epidemics-6, Goldberg Anxiety and Depression Scale, and Pittsburgh Sleep Quality Index, and participants' sociodemographic details were obtained. The scales validity was evaluated using the confirmatory factor analysis. Based on the outcomes of the parallel analysis, the Stress Anxiety to Viral Epidemics-6 single-structure model was chosen. The Stress Anxiety to Viral Epidemics -6 scale was useful in assessing the level of anxiety that the viral epidemic had on healthcare professionals. Strong internal reliability and good validity were found between the Stress Anxiety to Viral Epidemics-6 and the Goldberg depression and anxiety scores. Compared to other rating scales now in use, the SAVE-6 scale was shown to be valid and reliable (Cronbach's alpha = 0.815). The GAD-7 score of 5 suggests mild generalized anxiety, and the optimal cut-off point was found to be > 15 (sensitivity = 0.70, specificity = 0.60).[17]

The Stress and Anxiety to Viral Epidemics-9 Items (SAVE-9) scale used to assess how the pandemic affected healthcare workers' reactions to work-related stress and anxiety. Additionally, its suitability for a specific group of people, such as cancer patients 20, public servants 21 or medical students 20, was investigated. Different countries may have different pandemic situations, language environments, or healthcare systems. According to the study, participants were categorised as having anxiety or depression, respectively.[17]

6. Post Covid 19 Functional Status Scale(Pcfs)

A simple tool to track the progression of symptoms and their effects on patients' functional status – specifically, a scale that can measure the impact of the disease beyond binary outcomes like mortality – is essential. COVID-19 is expected to have a significant effect on individuals with mild illness manifestations' physical, cognitive, mental, and social health status. It was done to identify patients who are experiencing a sluggish or partialy, which would help to guide

the careful use of healthcare resources and would also simplify research activities, given the enormous numbers of COVID-19 survivors who need follow-up. The development of this scale helped in the assessment of the same among the covid-19 patients.

A study was done on finding out the reliability and validity of the post-COVID functional scale for assessing functional activities in individuals post-COVID-19. The results of this study's test-retest analysis revealed a strong positive correlation between the PCFS test and retest scores, which showed 0.54. The PCFS is a valid tool for evaluating the functional constraints of individuals who have recovered from COVID-19, as demonstrated by its good correlation with r value = 0.837. When the same people were assessed twice, their scores stayed the same, suggesting that the PCFS may be used to accurately track changes in functional status over time. [18]

It addresses the whole range of functional outcomes and concentrates on both restrictions on routine activities and tasks and changes in way of life throughout the six scale grades (annexure 6). This scale showed good face validity, construct validity and concurrent validity. Notably, the scale is intended to be used as a revealed effect measure to assess the long-term effects of COVID-19 on functional status rather than to replace existing pertinent instruments for assessing quality of life, fatigue, or dyspnoea in the acute phase.

7. Burnout Scale for Covid 19

COVID-19 Burnout Scale (COVID-19-BS) (Annexure 7) to evaluate burnout related to COVID-19. The strong internal consistency reliability was obtained value ranged from 0.75 to 0.92. This analysis revealed that COVID-19 stress predicted both COVID-19 burnout and resilience. COVID-19 burnout was predicted by resilience. Resilience played a role in mediating the connection between COVID-19 stress and burnout. The results further clarify how resilience plays a part in the link between stress and burnout in respect to COVID-19.

Three components were identified through both exploratory and confirmatory factor analysis for the COVID-19-BS: physical fatigue, emotional exhaustion, and exhaustion from COVID-19-related measures. The COVID-19-BS and the three variables had Cronbach's alpha coefficients that ranged from 0.860 to 0.921. The p-value for the Bartlett test was less than 0.001, and the Kaiser-Meyer-Olkin value was 0.945. High concurrent validity was shown by a substantial beneficial association between the three components and anxiety and depression. The intraclass correlation coefficients ranged from 0.888 to 0.997, while Cohen's kappa ranged from 0.848 to 0.957. **S**o, this scale can improve patient care, reduce medical errors and improve patient outcomes. Burnout also leads to chronic physical health problems, leading to cardiovascular disease or decreased immunity. By taking this measure, the health professionals will know about the condition and treat accordingly.[19]

8. Coronavirus Stress Measure (Csm)

The COVID-19-related stress is assessed using 5 items in the coronavirus stress measure (CSM). Each item is scored on a Likert scale of 0 (never) to 4 (very much so) (very often). The total score can range from 0 to 20, and higher scores on the total CSM indicate greater stress associated to COVID-19. The total score can be computed by reverse scoring two items and then adding all five items. [Cronbach's alpha for this study was 0.71].[20]

In order to quantify stress and burnout related to COVID-19, this survey validated the Coronavirus Stress Measure (CSM) and the COVID-19 Burnout Scale (COVID-19-BS). 431 young individuals, 72.6 % female made up the participants. A one-factor solution was confirmed by confirmatory factor analysis for the COVID-19-Burnout Scale and the Coronavirus Stress Measure. High internal consistency dependability was present in both scales. Depression, anxiety, and stress were all positively correlated with coronavirus stress, while resilience was negatively correlated with each of these factors. Beyond resilience, age, and gender, greater levels of sadness, anxiety, and stress were associated with COVID-19 burnout and coronavirus stress. Findings indicate that the COVID-19-Burnout Scale and Coronavirus Stress

Measure in Polish are reliable tools for measuring stress and burnout in relation to COVID-19. Findings also indicate that problems with mental health may be persistently increased by the coronavirus stress and COVID-19 exhaustion experienced during the pandemic's later stages. [21]

9. Covid 19 Stigma Scale

COVID 19 Stigma scale or SARS stigma scale was developed using the Berger HIV scale for use as a COVID-19 stigma measure and its psychometric properties were evaluated. There is a lack of a standardized and specific measure for assessing coronavirus disease 2019 (COVID-19) stigma among healthcare practitioners. Therefore, COVID 19 stigma scale is used. In an online questionnaire, 509 physicians were participated in the study, half of the sample was subjected to exploratory factor analysis. On the other half, structural equation modelling was used to perform confirmatory factor analysis on the resulting model. Cronbach's alpha was used to assess scale reliability and internal consistency (Cronbach's α was 0.909). Regression models were used to analyse the relationship between the modified COVID-19 stigma scale and significant variables, and convergent construct validity was evaluated. In group of physicians, the COVID 19 stigma scale showed strong internal consistency and construct validity. The scale is suitable for use by researchers and practitioners due to its adequate psychometric qualities.[22]

Discussion

This review examines various scales used to measure anxiety, depression, fatigue, stress, functional activity, and exhaustion in post-COVID-19 patients and healthcare workers. Due to the lack of confirmed reliability and validity for many scales, only those with established psychometric properties were included. The primary goal was to evaluate and assess the psychometric properties of COVID-19-related scales, providing a simple yet effective method to measure mental health outcomes.

Among the scales reviewed, the Fatigue Severity Scale, Hospital Anxiety and Depression Scale, and COVID-19 Burnout Scale demonstrated strong reliability and validity compared to others. These tools are critical for identifying individuals—both patients and healthcare workers—at high risk of experiencing stress, anxiety, and depression, particularly in response to the widespread psychological impacts of the pandemic. The review highlighted how perceived psycho-physical health issues, including changes in daily life, academic stress, and isolation, significantly affected mental well-being.

Furthermore, the reduction in physical activity during COVID-19-induced quarantines was linked to decreased functional health. Some scales effectively detected disease-related fatigue, supporting the need for targeted interventions. The review also identified a strong association between COVID-19 stigma and factors such as younger age, lower professional qualifications, and employment in COVID-19 isolation facilities, particularly among physicians. This underscores the importance of specific scales to evaluate the psychological burden of stigma and its effects on healthcare workers. Overall, this review offers researchers and practitioners a concise, valid, and reliable framework to assess mental health challenges related to COVID-19.

Conclusion

In this study, we conclude that the outcome measures listed out for the assessment of covid 19 patients in different domains and aspects, provided us with knowledge about the reliability, validity and the effective use of the scales in the studies to be conducted.

Clinical and Research Implications

Clinical and research implications of numerous functional scales available, only fatigue severity scale, covid 19 burnout scale, hospital anxiety depression scale, COVID 19 stigma scale have shown great reliability and validity in patients, health care workers. Some scales in the review have some limitations i.e., online questionnaire, participation due to difficulty in understanding questionnaire, illiteracy so patients couldn't be able to fill the form. The virus spread so quickly that it left people isolated

and unable to interact. Apart from the mentioned scales, rest of the available scales need more study in respect to its validity and reliability.

Implications on health care professionals- Healthcare professionals (HCPs) experienced an unprecedented strain due to the COVID-19 pandemic, which had an impact on their mental, emotional, and physical health. Effectively identifying and addressing these impacts is significantly impacted by the use of validated evaluation instruments.

1. Early Mental Health Issue Identification Measures including the COVID-19 Anxiety Scale (CAS), SAVE-6, and Hospital Anxiety and despair Scale (HADS) allow health care professionals to quickly assess their levels of stress, anxiety, and despair. Early identification enables prompt intervention, halting the development of long-term mental health issues or exhaustion.
2. Monitoring and Preventing Burnout
   Frontline workers should pay special attention to the COVID-19 Burnout Scale (COVID-19-BS), which assesses procedural burnout, emotional depletion, and physical fatigue. Hospital administrators can create plans to lessen workloads, enhance shift rotations, and offer psychological support with the aid of ongoing monitoring.
3. Healthcare Error Prevention
   Healthcare mistakes are directly associated with mental exhaustion and burnout. Proactive steps to lower errors, increase patient safety, and raise the standard of care are made possible by the use of fatigue and burnout evaluation tools.
4. Stigma and Isolation Management
   Measures such as the COVID-19 Stigma Scale are useful for evaluating the social stigma that health care professionals, particularly those employed in isolation units, must contend with. Understanding the discomfort associated with stigma can help organizations develop peer support initiatives and anti-stigma efforts both inside and outside of healthcare settings.
5. Support for Post-COVID Recovery Scales:
   healthcare professionals who have contracted COVID-19 can benefit from further rehabilitation and reintegration through the use of scales like the Post-COVID Functional Status Scale (PCFS) and FSS. These resources support return-to-work programs and aid in recovery monitoring.

Limitation

1. Limited Diversity in the Population
   Numerous studies that were examined were carried out on particular populations, such as hospitalized patients, university students, or healthcare workers. This limited the findings' applicability to the general public, particularly in rural or low-income areas.
2. Dependence on Self-Reported Information
   Self-reported questionnaires, which are prone to answer bias, recollection bias, and social desirability bias, provide the basis for the majority of the scales examined. Due to cultural or personal variables, participants may overreport or underreport their symptoms.
3. Cultural and Linguistic Barriers
   Several instruments still need cross-cultural validation, despite the fact that certain scales have been translated into other languages. The reliability of ratings across different locations may be impacted by cultural differences in how mental health symptoms are interpreted.
4. Problems with Digital Accessibility
   Because of the pandemic's social distancing requirements, many studies collected data using online surveys. People with poor internet access or digital literacy, such as elderly folks, the illiterate, or members of socioeconomically disadvantaged groups, are not included in this method.

Ethical Clearance: Since this is a narrative review, the ethical clearance is not needed.

Conflict of Interest: Nil

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Impact of Smartphone Apps in Caregiver Training for Rehabilitation of Individuals with Parkinson's Disease – A Systematic Review

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Abstract

Background: Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by motor impairments such as bradykinesia, rigidity, tremor, and postural instability, as well as non-motor dysfunctions. These impairments significantly affect daily activities and quality of life, necessitating caregiver assistance in rehabilitation. Smartphone-based interventions have been explored as a means to enhance caregiver competence and facilitate PD rehabilitation.

Objective: This systematic review examines the effectiveness of smartphone-based interventions in improving caregiver training for PD rehabilitation.

Methods: A comprehensive search was conducted across Google Scholar, PubMed andCochrane Library for studies published in English. Eligible studies included randomized controlled trials (RCTs), systematic reviews and experimental studies assessing smartphone-based caregiver training interventions for PD rehabilitation. A total of 15 studies met the inclusion criteria.

Results: Findings indicate that interactive educational content, real-time monitoring and telemedicine support significantly enhance caregiver competence and patient rehabilitation. Key effective features include:Personalized feedback, Remote expert consultation and Gamification elements. However, challenges such as technology accessibility, digital literacy barriers and the lack of standardized outcome measures limit widespread adoption.

Conclusion: Smartphone-based interventions show promise in enhancing caregiver training and improving patient care in PD rehabilitation. Further research is needed to optimize usability, address technological limitations and promote equitable access to maximize their effectiveness in PD management.

Categories: Parkinson's Disease (PD), Neurology and Neurorehabilitation, Mobile health (mHealth), Telemedicine and Assistive technology, Healthcare innovation and technology Adoption

Keywords: Parkinson's disease, smartphone applications, caregiver training, rehabilitation technology, telemedicine.

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Introduction

Parkinson's Disease (PD) is a progressive neurodegenerative disorder that presents a significant global healthcare challenge due to its increasing prevalence and substantial impact on patient well-being. It is characterized by motor symptoms such as bradykinesia, resting tremor, muscular rigidity, and postural instability, as well as a range of non-motor symptoms that collectively lead to functional impairment and reduced quality of life.[1]According to the World Health Organization (WHO), the global burden of neurological disorders, including PD, has been steadily rising, particularly among aging populations, necessitating urgent interventions to improve disease management.[2] Beyond its direct impact on patients, PD imposes considerable psychosocial and economic burdens on families and healthcare systems worldwide.[3]

As the disease progresses, caregiversplay a crucial role in assisting with daily activities, medication adherence, and rehabilitation exercises. However, caregivers frequently face challenges in managing PD's variable symptoms, evolving patient needs, and complex therapeutic schedules. Studies highlight that adequate caregiver education and training significantly influence both patient outcomes and caregiver well-being.[4] Traditional in-person training methods, however, are often limited by logistical constraints, resource shortages, and disparities in access to specialized expertise.

Recent advancements in digital health technologies, particularly smartphone applications, offer a potential solution to bridge the gaps in caregiver training. These applications serve as interactive platforms for PD education, real-time symptom monitoring, and teleconsultation. Some apps leverage sensor-based data collection (e.g., accelerometers and gyroscopes) to track motor symptoms such as tremor intensity and gait abnormalities, enabling early detection of symptom progression and timely intervention.[5] Additionally, telemedicine features allow caregivers to consult movement disorder specialists, physiotherapists, and allied health professionals, which is particularly beneficial in rural and underserved areas where in-person consultations are limited.[6]

Many smartphone applications also integrate structured educational modules, covering topics such as neuropathology, pharmacological treatments, and home-based rehabilitation techniques. These modules help demystify complex aspects of PD care, empowering caregivers with practical knowledge and confidence to handle daily caregiving responsibilities. Furthermore, gamification strategies, including interactive quizzes, progress tracking, and reward-based incentives, enhance caregiver engagement and adherence to training programs.[7]

Given the potential of smartphone-based interventions in enhancing caregiver training and improving patient care, this study seeks to systematically evaluate their effectiveness.

Methodology

Search Strategy

A comprehensive literature search was conducted across the following electronic databases: PubMed, Cochrane Library and Google Scholar. The search included studies published in English and focused on smartphone-based interventions for caregiver training in Parkinson's Disease (PD) rehabilitation. The following keywords and Medical Subject Headings (MeSH) terms were used in various combinations: Parkinson's Disease, Smartphone applications, Mobile health (mHealth), Caregiver training, Rehabilitation technology, Digital health interventions, Caregiver support, Telemedicine, Self-management, Technology adoption in healthcare, Remote monitoring and Digital therapeutics.Boolean operators (AND, OR) were applied to refine search results and exclude irrelevant studies.

Eligibility Criteria

The selection process of studies for this review was specified by predetermined inclusion and exclusion criteria to guarantee a methodological rigor and relevance of studies included. Included were articles focused on the smartphone-based

interventions for caregiver training rehabilitation in Parkinson's disease that were published between 2015 and 2025. Studies investigating digital health strategies aimed at improving caregiver competence, remote symptom monitoring, and rehabilitation in management of PD were included. The only eligible studies included randomized controlled trials, systematic reviews and experimental studies that assessed the efficacy of such interventions to improve caregiver proficiency, patient rehabilitation outcomes and reduce caregiver burden. In addition, full-text studies published in peer-reviewed journals in English were part of the inclusion criteria. Studies published before 2015, those without English language versions, full text, or that did not involve human participants were excluded from the survey. Exclusion criteria also covered studies solely focusing on pharmacological intervention, unrelated neurological or musculoskeletal disorders, or that did not provide a clear methodology and standardized outcome assessments.

The search initially yielded 25 relevant articles across databases, with the following distribution: PubMed - 8 articles, Google Scholar - 12 articles and Cochrane Library - 5 articles. After screening titles and abstracts, 18 studies met the inclusion criteria and were selected for full-text review. Three articles were excluded due to non-compliance with eligibility criteria. Three studies **(**Articles 1, 4, and 5**)** were initially included but later excluded after failing to meet the inclusion criteria upon detailed review. The final datasetcomprised 15 studies that passed the quality assessment.To ensure the reliability of findings, a risk of bias assessment was conducted using standardized tool, which was RoB 2 (Revised Cochrane Risk of Bias Tool) for Randomized Controlled Trials (RCTs).

Results

Figure 1: represent a PRISMA flow diagram showing the selection process for studies included in this study.

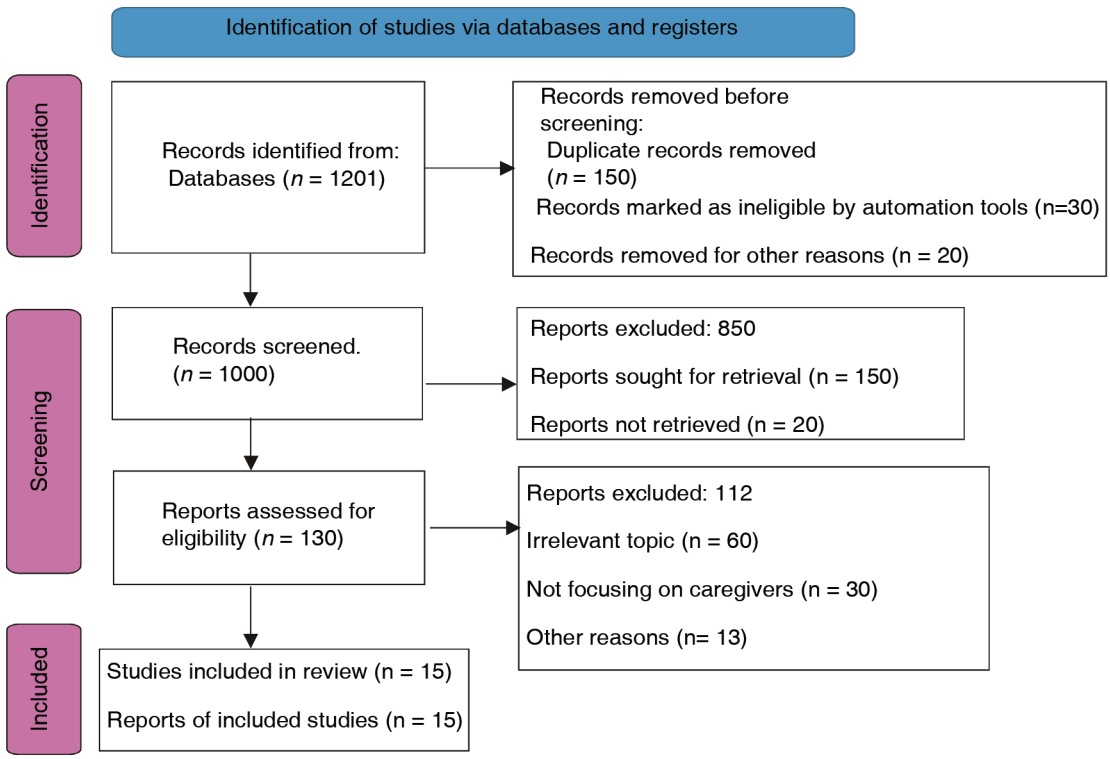

Figure 1: PRISMA Flowchart

Table 1. LITERATURE MATRIX

Sr. No	Author	Study Type	Study Sample	Intervention	Result	Conclusion	Analysis
1.	Pieter Ginis, Alice Nieuwboer, et al. (2016)8	Pilot Randomized Controlled Trial (RCT)	40 individuals with Parkinson's disease	Compared home-based gait training using the CuPiD system (smartphone-based biofeedback) vs. personalized gait advice	Both groups improved gait speed; CuPiD group showed significantly better balance and maintained quality of life at follow-up	CuPiD was feasible, well-accepted, and effective for home-based gait training, though not significantly superior to conventional training	Supports the feasibility and effectiveness of smartphone-based interventions for Parkinson's disease management. The user-friendly nature of CuPiD suggests that smartphone apps could also be effective for caregiver training, improving their ability to assist patients and manage symptoms at home.
2.	Marc Codina Barberà (2024)9	Quantitative Study (Technological Development and Validation Study)	Wearable sensor data from MIoT platform users	Developed a gait analysis and balance assessment platform using AI and machine learning to analyze mobility data	The platform improved medical diagnostics and demonstrated cost-effectiveness in healthcare applications	Demonstrated the feasibility of wearable sensor technology for gait and balance assessment, with potential savings for healthcare systems	Supports the integration of smartphone-based health interventions. The study highlights how MIoT platforms improve mobility assessment, which can be adapted to caregiver training apps for Parkinson's patients to enhance home-based care and rehabilitation.
3.	Elina Kuosmanen et al. (2020)10	Quasi-Experimental Study	11 participants with Parkinson's disease	Used the STOP smartphone app to monitor hand tremor and assess medication effectiveness	Significant correlation between the Tremor Intensity Parameter (TIP) and UPDRS II tremor scores; medication intake led to observable changes in accelerometer data	Demonstrates the feasibility of smartphone-based monitoring for assessing Parkinson's tremors and medication effectiveness	Supports the use of smartphone-based interventions for Parkinson's care, reinforcing the potential of a caregiver training app for remote symptom assessment

Continue....

4.	Matthew Fuller-Tyszkiewicz et al. (2020)11	Randomized Controlled Trial (RCT)	183 caregivers of individuals with physical or mental disabilities	Evaluated the StressLess app, a 5-week self-guided intervention based on cognitive-behavioral therapy (CBT) for stress reduction	The intervention group showed significant reductions in stress and depression, with sustained improvements in emotional well-being, optimism, self-esteem, and social support over 3-4 months	Demonstrates that mHealth psychological interventions can effectively reduce caregiver stress and improve well-being	Supports the feasibility of smartphone-based interventions for caregivers, reinforcing the potential app for stress management
5.	Alice Khachian, Kosar Zeighami, Tahereh Alsadat Khoubbin Khoshnazar, Hamid Haghani (2023)12	Quasi-Experimental Study	77 patients with Parkinson's disease	Developed and tested the "ParkinSeven" mobile app for self-management education; patients received training and used the app for 12 weeks	Significant improvement in quality of life scores over time ($P < 0.001$)	Self-management education via mobile apps is effective in improving the quality of life of Parkinson's patients and should be integrated into clinical practice	Reinforces the potential of smartphone-based caregiver training apps for Parkinson's disease by demonstrating the effectiveness of digital self-management interventions
6.	Yusun Park RN, PhD a, Sung Reul Kim RN et al (2022)13	RCT	20 Parkinsons disease patients	Developed and tested a mobile health intervention based on the IMB (Information-Motivation-Behavioral) model	After 16 weeks, self-efficacy and non-motor symptom scores in the intervention group significantly improved compared to the control group. However, no significant differences were observed in motor symptoms, self-management, and quality of life	The mobile health intervention for self-management is effective in improving self-efficacy and non-motor symptoms in people with Parkinson's disease	Supports the use of smartphone-based interventions for Parkinson's care, reinforcing the potential of a caregiver training app for symptom monitoring and management

Continue....

7.	Fatih Özden (2023)14	Systematic review and meta-analysis	Various mHealth studies on Parkinson's disease	Evaluated different mobile health (mHealth) interventions for self-management in Parkinson's patients	mHealth interventions improve symptom tracking, medication adherence, and quality of life, but usability and long-term engagement remain challenges	Mobile health solutions can enhance self-management in Parkinson's disease, supporting their integration into healthcare strategies	Supports the role of smartphone-based interventions for Parkinson's caregivers, reinforcing their potential in training and remote disease management
8.	(2025)15	Experimental study - Feasibility Study	50 caregivers and patients	Mobile speech therapy app for PD patients	Reduced caregiver burden and improved communication in patients	Apps can enhance caregiver support but need larger RCT validation	Limited sample size; results may not generalize to all caregivers.
9.	Lee et al. (2022)16	Meta-Analysis	20 studies (RCTs & case studies)	Self-care apps for caregivers and patients	Improved caregiver satisfaction and patient engagement	Self-care apps are beneficial, but intervention standardization is required	Studies vary in methodology, making direct comparisons difficult.
10.	Zhang et al. (2021)17	Meta-Analysis	12 studies	Family-centered mobile interventions that guide caregivers in patient monitoring and exercise routines	Caregivers reported feeling more engaged in PD management, leading to better symptom tracking	Mobile interventions improve Parkinson's disease caregiving at home, offering a structured way to train caregivers	The study suggests positive outcomes, but integration with healthcare professionals is necessary to ensure accurate monitoring and guidance.
11.	Avanzino et al. (2023)18	Experimental study - Feasibility Study	30 PD patients and their caregivers	Parkinson Rehab® app for home-based exercises, requiring caregivers to assist patients	High caregiver involvement, better patient adherence, and increased engagement in therapy	Mobile rehab apps provide a practical solution for Parkinson's rehabilitation but require further RCT validation	The study is limited by the lack of a control group and needs longer-term assessments of patient outcomes and caregiver fatigue.

Continue....

12.	Sin et al. (2022)19	Systematic Review & Meta-Analysis	10 studies (RCTs)	Online caregiver training and mobile support apps that provide educational content, symptom management tips, and stress-reduction strategies	Reduced caregiver stress and improved ability to manage PD symptoms	Internet-based caregiver training is beneficial but must be made more accessible for those with low digital literacy	Lack of standardization in online training content and delivery may impact effectiveness; further studies should focus on personalization and accessibility.
13.	Chen et al. (2020)20	Systematic Review & Meta-Analysis	18 studies	Smartphone-based telehealth interventions that connect caregivers to remote specialists for training and support	Increased knowledge retention and improved symptom monitoring	Telehealth apps effectively support caregivers by providing structured training and real-time feedback	Internet connectivity and technology literacy remain barriers to widespread adoption; further studies should explore hybrid models combining in-person and digital training.
14.	Ferré-Grau et al. (2021)21	RCT	100 non-professional caregivers	A mobile app-based mental health support program to help caregivers manage stress while assisting PD patients.	Caregivers experienced reduced emotional distress, higher confidence, and improved coping skills.	Mobile-based psychological support can enhance caregiver resilience, but requires personalization.	The study did not measure long-term retention of benefits; follow-up studies should assess lasting psychological impact.
15.	Ma et al. (2021)22		RCT	Tai Chi and stretching exercises delivered via a smartphone app, with caregivers assisting in sessions.	Patients gained better flexibility, and caregivers became more involved in exercise routines.	Movement-based mHealth interventions improve caregiver engagement, but usability challenges remain.	Older caregivers struggled with app navigation, suggesting a need for simplified UI.

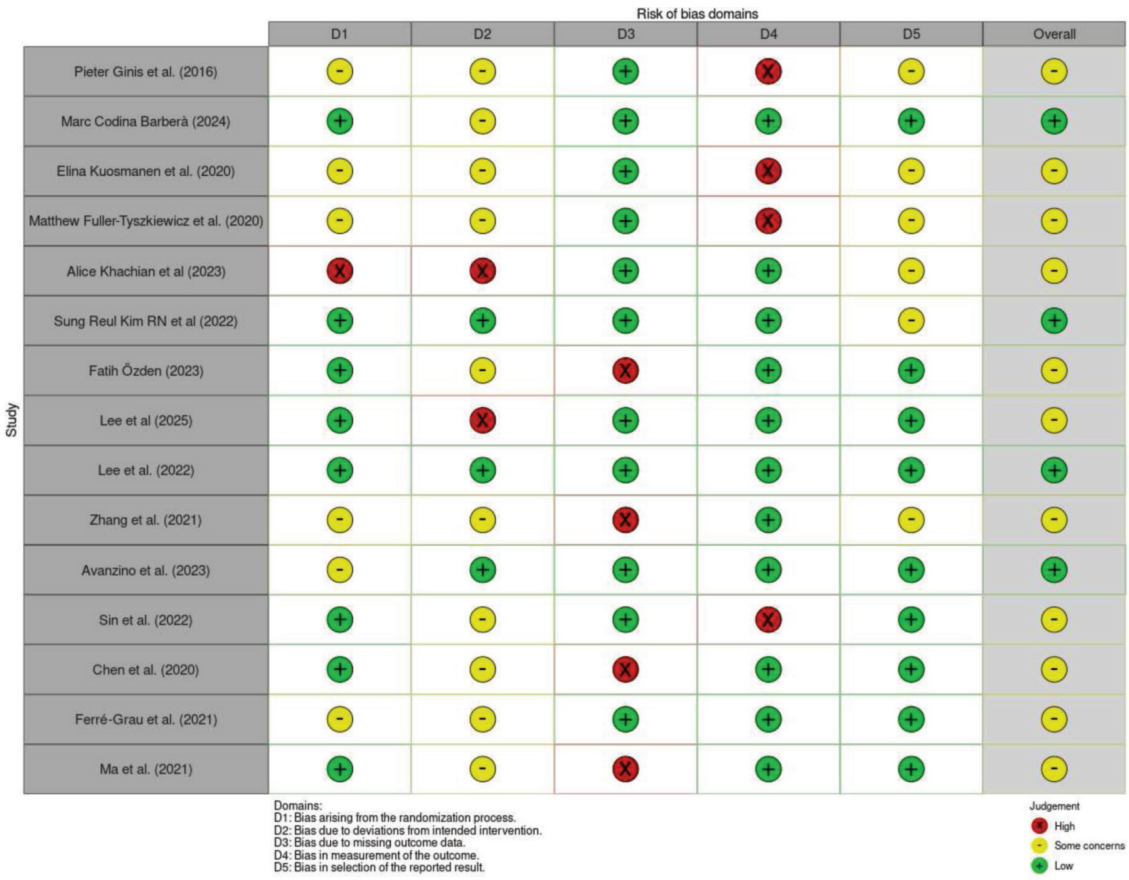

Figure 2: Risk of Bias visual representation using RoB2

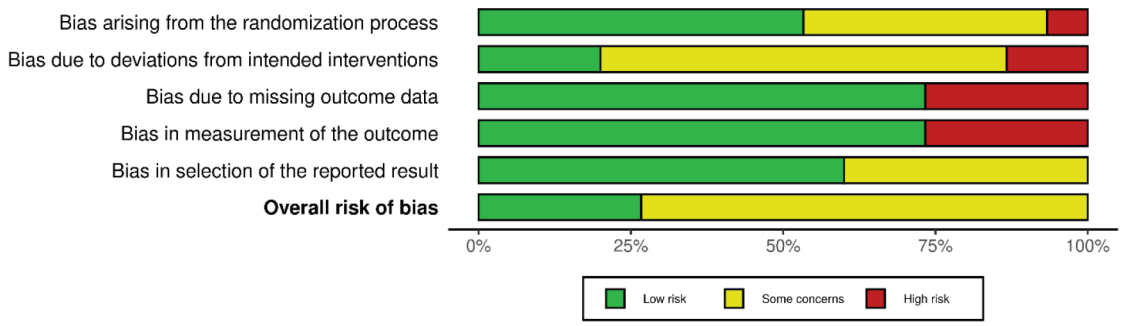

Figure 3: Risk of Bias summary of included articles for review

Discussion

Effectiveness of Smartphone Applications

Multiple studies have demonstrated that mobile application-based rehabilitation can enhance the quality of life for individuals with Parkinson's Disease (PD). Özden and Sarı (2023) found that while app-based interventions did not significantly outperform standard rehabilitation methods in terms of balance improvement or disease severity measures, they played a crucial role in boosting patient adherence and engagement with therapeutic exercises.[14] This suggests that smartphone applications should not be seen as a replacement for conventional rehabilitation

but rather as a complementary tool that reinforces existing treatment strategies.However, the long-term effectiveness of these digital interventions remains unclear. Many studies have focused on short-term adherence, but whether caregivers and patients continue using these apps beyond initial engagement is uncertain. Further research is needed to assess sustained behavioral changes and clinical outcomes over extended periods.

Usability and Feasibility

The practicality of smartphone applications for PD rehabilitation has been a key area of study. De Biase et al. (2023) conducted a large-scale feasibility study involving 900 PD patients in Armenia and reported high satisfaction rates and ease of use for a customized mobile-based home rehabilitation program.[23] These findings highlight the potential for mobile health (mHealth) solutions to support remote rehabilitation and reduce dependency on in-person therapy. However, usability concerns persist. Some studies indicate that older adults with PD may struggle with digital literacy and app navigation, which could limit the effectiveness of these tools. Accessibility features such as voice commands, simplified interfaces, and caregiver-assisted navigation could help mitigate these challenges.

Role in Caregiver Training

The role of smartphone applications in caregiver training for PD rehabilitation remains underexplored. Although Cano-de-la-Cuerda et al. (2017) identified multiple mobile applications for PD management, they reported a lack of high-quality evidence supporting their effectiveness in caregiver education.[24] This gap in the literature underscores the need for more targeted research focusing on the educational impact of mobile apps on caregiver competency, how these apps affect caregiver stress, burden and mental well-being and the integration of interactive features, gamification and expert consultation to enhance engagement.Future studies should prioritize randomized controlled trials (RCTs) to establish the clinical efficacy of digital caregiver training interventions.

Safety Considerations

Safety remains a critical aspect in the development of digital health applications for PD management. De Biase et al. (2023) reported no adverse events associated with mobile-based rehabilitation programs, suggesting that well-designed application interfaces can support safe home-based care.[23] However, existing studies often lack comprehensive safety assessments, particularly concerning with fall risks associated with unsupervised exercise sessions, data security and privacy concerns when storing sensitive patient and caregiver information and technical malfunctions that may disrupt symptom tracking and rehabilitation. Future research should establish standardized safety guidelines for app development, risk mitigation, and emergency support mechanisms to ensure reliable and secure digital health interventions.

Limitations and Future Directions

Despite the promise of smartphone-based interventions in PD rehabilitation and caregiver training, several limitations must be acknowledged: 1) Quality of Evidence – Many existing studies rely on small sample sizes, lack longitudinal follow-ups and use subjective self-reported measures rather than objective clinical outcomes. 2) Digital Divide – Accessibility challenges due to technological literacy, affordability and internet connectivity could limit adoption, especially in low-resource settings. 3) Comparison with Standard Treatments – While mobile apps offer convenience and engagement, they have not consistently demonstrated superiority over traditional in-person rehabilitation and caregiver education programs. A balanced approach integrating both digital and conventional methods may be optimal. 4) Sustainability and Long-Term Adherence – While initial engagement rates are promising, it is unclear whether caregivers and patients continue using these applications long-term. More studies are needed to explore user retention, motivation strategies, and barriers to sustained use.

Conclusion

Smartphone-based interventions hold significant potential in enhancing rehabilitation and caregiver support for Parkinson's Disease (PD). Existing research indicates that mobile applications can improve patient adherence and engagement, but their effectiveness in caregiver training remains underexplored. While some apps offer educational resources and remote monitoring features, there is limited high-quality evidence validating their direct impact on caregiver competency and patient outcomes. To integrate these technologies into real-world healthcare systems, it is crucial to establish clear implementation strategies. Mobile applications could serve as supplementary tools alongside conventional rehabilitation programs, offering on-demand training, symptom tracking, and remote consultation features. However, for widespread adoption, standardization, regulatory approvals, and clinician integration must be prioritized.

Future research should focus on developing and validating caregiver-specific applications through rigorous clinical trials. Establishing standardized safety and usability guidelines will be essential to ensure that these tools are effective, accessible and seamlessly integrated into healthcare frameworks. As technology continues to evolve, mobile applications have the potential to revolutionize caregiver training, ultimately improving the quality of life for individuals living with PD and their caregivers.

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Ethical Clearance: This research did not require an ethics clearance, as this work did not use data collected from human participants.

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Prevalence of Low back pain in Physiotherapists among Emirates Health Services: A cross-sectional Study

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Abstract

Low back pain (LBP) is a prevalent issue among physiotherapists, with nearly 80% experiencing it during their careers. Key risk factors include prolonged standing, patient lifting, repetitive movements, and poor ergonomic practices. LBP affects physiotherapists' health, job performance, and job satisfaction and leads to increased sick leave and attrition rates.

This study aims to explore the prevalence, risk factors, and impact of Low Back Pain on physiotherapists in the United Arab Emirates (UAE), focusing on male and female physiotherapists aged 30 to 50 years. The Oswestry Low Back Pain Disability Questionnaire was used to assess functional disability related to Low Back Pain. The study lasted 6 months.62.3% of participants experienced mild Low Back Pain while performing work tasks, with 14.3% reporting severe pain during weightlifting. Low Back Pain is identified as the most common work-related health issue among physiotherapists, leading to reduced work productivity, absenteeism, and lower health-related quality of life.

Female physiotherapists are more susceptible to musculoskeletal disorders due to their body composition. The study recommends improving head, neck, and trunk posture; adopting correct manual handling techniques; using self-protection strategies; managing stress; and reducing prolonged sitting. Policymakers should implement programs to reduce the clinical and economic burden of Low Back Pain on healthcare professionals.

Key words: Chronic Low back pain, Emirates Health Services, Low back pain, Physiotherapist, United Arab Emirates.

Introduction

Low back pain (LBP) is prevalent among physiotherapists due to their physically demanding work, prolonged standing, lifting patients, repetitive movements, and poor ergonomics. The prevalence varies by region and working conditions.

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LBP is a prevalent issue among physiotherapists, with nearly 80% experiencing it during their careers[1]. In 2020, LBP affected 619 million people worldwide, and this number is projected to rise to 843 million by 2050[2].

70% of healthcare professionals suffer from LBP, 57.2% were working with a risky posture. around 40.63% of individuals without LBP, were using risky postures during working. LBP prevalence of dentists and nurses were higher compared to other groups[3].

Low back pain significantly impacts physiotherapists' work performance, job satisfaction, and overall well-being, leading to increased sick leave and turnover in the profession.

Rationale & Background Information

A study of 500 US physical therapists revealed that 83% experienced work-related low back pain, particularly in acute care and rehabilitation settings. The most common causes of injury were lifting with sudden maximal effort and bending and twisting[4].

This study aims to address the lack of data on low back pain (LBP) among physiotherapists in the UAE, particularly within Emirates Health Services. It seeks to gather information on LBP prevalence among physiotherapists to fill data gaps, reduce work-related LBP, minimize sick leave, and enhance both the quality of life and work performance of physiotherapists in the UAE through effective rehabilitation strategies.

A study in Edmonton, Canada, surveyed 462 physical therapists to determine the prevalence of work-related low back pain. Over half (55.4%) of those with LBP showed little or no disability[5].

A study was conducted in Riyadh, Saudi Arabia, to understand the prevalence of work-related LBP among physical therapists. A self-administered online questionnaire was sent to 600 members of the Saudi Physical Therapy Association. Among the respondents, 89.65% reported LBP after starting their practice, while 35.6% reported it at the survey's time[6].

Excessive strain from occupational activities significantly impacts the intensity and frequency of spinal pain episodes. Nurses and physiotherapists primarily suffer from LBP, with Visual Analog Scale pain scores higher in nurses[7].

Under the topic of prevalence of work-related musculoskeletal disorders among physiotherapists in Sabah.70% responses were collected back and injuries mostly have been occurred in low back region (44%). They concluded that there is high prevalence of work-related musculoskeletal disorders in physiotherapists[8].

The study involved 120 physiotherapy and medical students, divided into 2nd, 3rd, and 4th year groups. Physiotherapy students reported a higher prevalence of lower back pain compared to medical students in all measures[9].

Physiotherapists, following nurses, are among the healthcare workers most affected by low back pain. Female physiotherapists are particularly susceptible. Their smaller body frame can be a disadvantage when lifting or transferring patients and equipment, putting extra strain on the spine and increasing the risk of musculoskeletal disorders[10].

A significant link between the implementation of incorrect manual handling techniques and musculoskeletal disorders, predominantly the lower back and lumbar discs[11].

The lower back was the most commonly affected body part at 70% (n =63). Previous studies in Africa and other regions findings are similar with these, have found the lower back to be the most commonly affected anatomical area among individuals. Physical therapists that ranging between 45% and 79.6%. 41% Physical therapists reported that the low back injury was the injury that had the greatest impact on their career[12].

In 2023, Antoine Fourré et al. conducted an online study with 527 physiotherapists to assess their knowledge, attitudes, and beliefs regarding guideline-adherent approaches to LBP. The study found that only 38% were familiar with LBP management guidelines, and 63% gave recommendations

inconsistent with them. Additionally, only half recognized signs of specific LBP[13].

Vanina Nicol et al. conducted a narrative review of international guidelines for diagnosing and treating non-specific chronic low back pain (cLBP). The review of eight guidelines, including the 2021 French guidelines, suggests assessing "yellow," "blue," and "black flags" to stratify chronicity and disability risk, emphasizing non-pharmacological treatments like exercise and education. Pharmacological treatments are considered for specific cases[14].

Bareza Reszaei conducted a systematic review and meta-analysis to assess the prevalence and risk factors of LBP among healthcare personnel. The review found a lifetime LBP prevalence of 54.8%, with age, gender, BMI, lack of physical activity, occupational factors, body position, stress, and stress as the strongest risk factors.[15].

Amanda et al. conducted a survey to assess physiotherapy practices for managing chronic LBP in the Eastern Health Regional Health Authority, Newfoundland and Labrador. Of the 76 respondents (84% response rate), 74% treated LBP regularly, with most having over 10 years of experience. Common treatments included self-management advice, home exercises, and supervised exercise. However, many lacked confidence in using cognitive-behavioral techniques. The study found that while most LBP management aligned with guidelines, broader adoption of a biopsychosocial approach would require further training and support[16].

Statement of the Problem

- Back discomfort has led to 13.7% of therapists stopping their work due to its severity.
- Occupational activities that cause excessive strain on the spine significantly increase the intensity and frequency of spinal pain episodes.
- In 2017, low back pain affected approximately 7.5% of the global population, or 577.0 million people[17].

Study Design

This multi-institutional descriptive cross-sectional study surveyed physiotherapists from Emirates Health Services (EHS) across several UAE emirates, including Dubai, Sharjah, Ajman, Umm al Quwain, Ras al Khaimah, and Fujairah. The focus was on male and female physiotherapists aged 30 to 50, as those under 30 are less likely to experience low back pain (LBP), while those over 50 are more prone to it. The Oswestry Low Back Pain Disability Questionnaire was used to assess the disability related to LBP among the participants.

No follow up was required as it was a single point observation study

Inclusion Criteria

- Physiotherapists within the age group of 30 to 50 years working in Emirates Health Services.

Exclusion Criteria

- Pregnancy / six months post-delivery.
- History of low back surgeries.
- Pre-existing renal disease.
- Pre-existing gynaecological issues.
- Suffering from chronic life-threatening diseases.
- Psychological disorder.
- Physiotherapists who were not willing to provide informed consent.

Sample Size

Sample Size: 77

Population group includes both male and female physiotherapists between the ages between 30 to 50 years working in Emirates health services as voluntary participation. (n=114). Informed consent was provided by 96. After the survey only 77 fulfilled the inclusion criteria. The technique used was non-probability convenient sampling technique.

Ethical Consideration

Ethical clearance was obtained from Research ethics Committee, Ministry of Health and Prevention, United Arab Emirates.

The survey was conducted with strict confidentiality, ensuring that only the researchers and statisticians had access to participant's information. Participants provided data anonymously, without disclosing any personal identification details.

Data Collection

By sending questionnaire link through EHS Data HUB. - https://survey.ehs.gov.ae/en/surveys/1/WdGg6

Dissemination of Results

The study aimed to gather data on the prevalence of low back pain among physiotherapists working in EHS. The goal is for future research based on this study's findings to fill existing data gaps, leading to the implementation of effective rehabilitation measures. These measures would help reduce work hours lost due to LBP and improve the quality of life for physiotherapists in EHS, UAE.

Results

Staff feedback about the presence of back or leg pain and its effect on ability to manage in everyday life (n-77) (Tab. 1).

Table 1. Participants response for Oswestry Low back pain questionnaire.

Feedback about the presence of back or leg pain and its effect on ability to manage in everyday life (n-77)		**No.**	**%**
Section 1 – Pain intensity	I have no pain at the moment	40	51.9
	The pain is very mild at the moment	21	27.3
	The pain is moderate at the moment	15	19.5
	The pain is very severe at the moment	1	1.3
Section 2 – Personal care (washing, dressing etc)	I can look after myself normally without causing extra pain	67	87.0
	I can look after myself normally but it causes extra pain	5	6.5
	It is painful to look after myself and I am slow and careful	3	3.9
	I need some help but manage most of my personal care	2	2.6
Section 3 – Lifting	I can lift heavy weights without extra pain	39	50.6
	I can lift heavy weights but it gives extra pain	22	28.6
	Pain prevents me from lifting heavy weights off the floor, if conveniently placed	5	6.5
	Pain prevents me from lifting heavy weights, but I can manage light to medium weights	6	7.8
	I can lift very light weights	5	6.5
Section 4 – Walking	Pain does not prevent me walking any distance	66	85.7
	Pain prevents me from walking more than 2 kilometers	8	10.4
	Pain prevents me from walking more than 1 kilometer	2	2.6
	I can only walk using a stick or crutches	1	1.3
Section 5 – Sitting	I can sit in any chair as long as I like	50	64.9
	I can only sit in my favorite chair as long as I like	11	14.3
	Pain prevents me sitting more than one hour	14	18.2
	Pain prevents me from sitting more than 30 minutes	2	2.6

Continue....

Section 6 – Standing	I can stand as long as I want without extra pain	46	59.7
	I can stand as long as I want but it gives me extra pain	22	28.6
	Pain prevents me from standing for more than 1 hour	8	10.4
	Pain prevents me from standing for more than 10 minutes	1	1.3
Section 7 – Sleeping	My sleep is never disturbed by pain	58	75.3
	My sleep is occasionally disturbed by pain	16	20.8
	Because of pain I have less than 6 hours sleep	3	3.9
Section 8 – Sex life (if applicable)	My sex life is normal and causes no extra pain	62	86.1
	My sex life is normal but causes some extra pain	10	13.9
Section 9 – Social life	My social life is normal and gives me no extra pain	61	79.2
	My social life is normal but increases the degree of pain	10	13.0
	Pain has no significant effect on my social life apart from limiting my more energetic interests eg: sport	5	6.5
	Pain has restricted my social life and I do not go out as often	1	1.3
Section 10 – Travelling	I can travel anywhere without pain	56	72.7
	I can travel anywhere but it gives me extra pain	18	23.4
	Pain is bad but I manage journeys over two hours	3	3.9

Results - this questionnaire consists of ten domains, and 87 % of the participants reported that I can look after myself without causing extra pain

Overall Pain Disability

The distribution of pain levels among the physiotherapists showed that no staff experienced severe pain disability. However, 25% reported experiencing no pain, 62% had mild pain, and 13% experienced moderate pain. (Fig. 1).

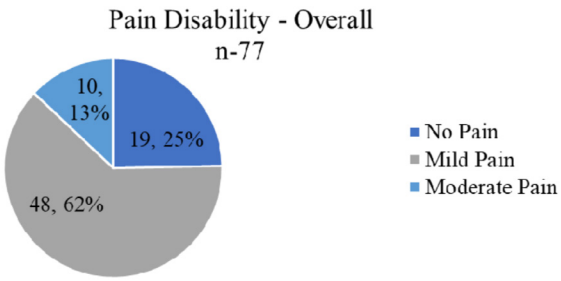

Figure 1: Overall Pain disability

Overall, the results suggest that most individuals can manage their daily lives with minimal pain, but a small group experiencing moderate to severe pain faces significant disruptions in their physical abilities and social interactions. (Tab. 2).

Table 2. Showing variation of pain in participants, Less pain Vs Severe pain

Components	**Less Pain**		**Severe Pain causing disabilities**	
	Staff count	**%**	**Staff count**	**%**
1 – Pain intensity	76	98.7	1	1.3
2 – Personal care (washing, dressing etc)	75	97.4	2	2.6

Continue....

3 – Lifting	66	85.7	11	14.3
4 – Walking	76	98.7	1	1.3
5 – Sitting	75	97.4	2	2.6
6 – Standing	76	98.7	1	1.3
7 – Sleeping	77	100		
8 – Sex life (if applicable)	72	93.5		
9 – Social life	76	98.7	1	1.3
10 – Travelling	77	100		

The study found that the average total pain score among physiotherapists in EHS was observed as 2 (median), with minimum score of 0 (no pain disability) and maximum 19 (moderate).

In summary, the distribution of pain levels among physiotherapists indicates a positive trend, with no severe pain reported. However, 62% of the workforce experiences mild pain, and 13% report moderate pain. These findings highlight the need for targeted interventions, such as ergonomic assessments, education on posture and body mechanics, and tailored rehabilitation programs. By creating a pain-free work environment and implementing proactive measures to support physiotherapists' well-being, the organization can foster a healthier, more resilient workforce, which would, in turn, enhance the quality of patient care delivery.

As the study does not incorporated participant characteristics such as age, gender, nationality, or other variables, it is not possible to identify the factors associated with pain disability.

Discussion

This multi-institutional cross-sectional study, conducted among 96 physiotherapists in Emirates Health Services using the Oswestry LBP disability questionnaire, found that 62.3% of participants reported experiencing mild pain while working. Additionally, 14.3% reported severe pain while lifting weight. The study highlights considerable variability in the pain experienced by the participants.

Low back pain (LBP) is the most commonly reported work-related health issue among healthcare professionals, particularly physiotherapists. Those with chronic LBP experience poorer physical function, greater limitations in daily tasks and social activities, increased depressive symptoms, and a lower health-related quality of life. LBP also impacts work and productivity, often leading to reduced working hours or absenteeism. However, there have been only a few studies assessing the work-related issues of physiotherapists in the UAE. This study could provide valuable insights into the challenges faced by physiotherapists in the region.

Our study finding shows that 62.3% had lower back pain which corresponds to the study done in university students where 43.4% of students have a minimal intensity pain and 20% has high intensity pain[18]. However, our results do not correspond to the study done US, which reports 83% experienced work-related low back pain during patient treatment[19].

Our study recommends correcting head-neck and trunk postures to reduce low back pain, as suggested in ergonomic studies. There is a significant association between improper manual handling techniques and musculoskeletal disorders, especially affecting the lower back and lumbar discs. Musculoskeletal disorders are major causes of long-term pain and physical disability, affecting millions worldwide. Literature reviews also suggest that physiotherapists should enhance their knowledge of self-protection strategies to minimize work-related musculoskeletal disorders. Maintaining proper body posture at work, managing stress, and reducing prolonged sitting are essential practices to follow.

Previous studies show that Physiotherapists reported that the low back injury was the injury that had had the greatest impact on their career[20]. This may lead to economic burden and frequency hospital visits, absence from work among physiotherapist.

The urgent need is to implement targeted interventions that promote non-pharmacological treatments, such as exercise therapy, physical activity, physiotherapy, and education, as recommended by guidelines. These interventions could help reduce

the burden of low back pain (LBP) and improve the quality of life for physiotherapists. LBP is an increasing concern among healthcare professionals, and policymakers must establish effective programs to reduce both the clinical and economic burden associated with LBP. Such efforts will ultimately improve health outcomes for individuals and the broader population.

Conclusion

In conclusion, this multi-institutional study highlights the significant prevalence of lower back pain (LBP) among physiotherapists in the UAE, with 62.3% reporting mild pain during work and a considerable number experiencing severe pain while lifting weights. The findings emphasize that LBP is a common work-related health issue among healthcare professionals, especially physiotherapists, leading to impaired physical function, reduced productivity, and potential long-term health consequences. The study stresses the importance of raising awareness about self-protection strategies, proper posture, and ergonomic practices to reduce the risk of musculoskeletal disorders. Given the considerable impact on both career and health, targeted interventions such as exercise therapy and education are crucial to addressing the growing burden of LBP. Policymakers must prioritize preventive measures and strengthen workplace health programs to reduce the clinical and economic burden of LBP, ultimately improving the well-being of physiotherapists and healthcare professionals overall.

Ethical Approval: was issued by Ministry of Health and Prevention Research Ethics committee Approval Reference No: MOHAP/DXB-REC/S.O. O /No. 122 / 2023, Dated 17/10/2023.

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Effect of Bosu Ball and Pilates Exercises on Core Stabilization among University Cricket Players: An Experimental Study

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Abstract

Background: Cricket players must practice core stabilization to maintain their balance and stability. Cricket performance relies heavily on balance, making it crucial to design programs that assess, maintain, and enhance these skills. Despite the emphasis on core stability in cricket, limited research explores the comparative effectiveness of different exercise interventions, such as Bosu ball and Pilates workouts, on improving balance and core endurance among athletes. Exercise on unstable surfaces, such as the Bosu ball (both sides up), activates core muscles, while Pilates enhances posture, core strength, balance, and peripheral mobility. Therefore, this study aimed to evaluate the effects of Bosu ball and Pilates exercises on core stability among university cricket players.

Methods: In this experimental study, 36 collegiate cricket players participated and were randomly allocated into two groups: Bosu ball and Pilates exercises. Participants' dynamic balance was assessed using the Y Balance Test, static balance using the Flamingo Balance Test, and core endurance using the McGill Core Endurance Test. Evaluations were conducted before and after a six-week intervention period for both groups.

Results: Bosu ball exercises were found to be statistically significant ($p < 0.01$) and more effective than Pilates in improving core stabilization among university cricket players.

Conclusion: Both interventions showed improvement in core stability and balance of university cricket players. However, Bosu ball exercises were slightly more effective in enhancing static and dynamic balance compared to Pilates.

Keywords: Bosu Ball, Pilates Exercise, Core stabilization, Cricketers, Static and Dynamic Balance

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Introduction

There are three primary forms for cricket, a sport that is very popular all over the world: Test matches, One-Day Internationals (ODIs), and Twenty20 matches. ODIs are shorter, with fifty overs each side; T20, the newest format, only has twenty overs per side; and Test matches are the longest, with up to five days and 90 overs per day [1]. The danger of injury increases as players' physical demands rise, especially because cricket requires a variety of physical responsibilities including hitting, bowling, and fielding. While lower limb injuries affect 25–30% of cricket players, back and trunk problems affect 14–18% of them. According to research, bowling is the main cause of these injuries, with 38% of bowlers in elementary schools and 65.7% of bowlers in provinces reporting a substantial prevalence of back injuries [2].

Often referred to as the "power-house" of the body, the core is made up of the hip, low back, and abdominal muscles and is essential for stability. The core links the upper and lower extremities by joining the thorax and lumbopelvic area [3]. The paraspinals, gluteals, diaphragm, pelvic floor, hip girdle musculature, and abdominal muscles are all part of the lumbopelvic area. When it comes to producing force and power during lower extremity motions and trunk stability, the hip muscles are very crucial. The gluteal muscles are in charge of keeping the trunk in place over a planted leg during exercises like sprinting or throwing [4]. The body is stabilized by muscles such as the rectus abdominus, external oblique, latissimus dorsi, gluteus maximus, hamstrings, and rectus femoris, as well as deeper muscles like the transverse abdominus, internal oblique, quadratus lumborum, and psoas major [5].

Strong core stability is connected to improved balance, whereas weak core muscles are frequently linked to bad posture and lower body ailments [6]. Cricket players frequently get lower back ailments, such as musculoligamentous strains and stress fractures. Energy transmission can be disrupted by a weak core, which can impair athletic performance and raise the risk of injury in undeveloped muscle groups [7]. For cricket players, strengthening the core is crucial since it lowers the chance of lower back and lower limb problems [8]. To improve performance and reduce the chance of injury, cricket beginners in particular should concentrate on building strong core muscles. Prioritizing core strength reduces the risk of injury, particularly over time, for elite cricket players [9].

Balance, which is the capacity to maintain the body's center of gravity within the base of support without falling, is a crucial component of stability. Balance can be classified as either dynamic or static. While dynamic balance entails the ability to move without losing stability, static balance refers to the capability to maintain equilibrium without moving [10]. The body's center of gravity should be above the base of support for optimal performance. Therapeutic rehabilitation frequently uses the Y-Balance Test (Lower Quarter), a functional performance test, to evaluate dynamic balance. Additionally, it can assist in identifying athletes who are susceptible to injury, enabling therapists to suggest regimens to avoid injuries [11]. The Y-Balance Test is a useful tool for evaluating sports balance and identifying deficits that might result in injury because of its increased dependability compared to other balance tests [12].

Pilates is a mind-body training regimen that prioritizes flexibility, posture, balance, and core strength. It was created by German personal trainer Joseph Pilates at the beginning of the 20th century. The six major tenets of the Pilates technique are: breathing (coordinating breathing with movement), precision (ensuring accuracy), control (controlling posture), centering (concentrating on the core), and flow (creating seamless transitions between movements) [13]. Pilates improves neuromuscular coordination, balance, and coordination, all of which help athletes perform better and sustain fewer injuries. In order to increase endurance, strength, flexibility, and coordination, the exercises activate different skeletal muscles through a variety of starting postures and multidirectional motions [14]. Because of this, Pilates is good for mental clarity, general physical fitness, and preventing injuries, especially among athletes [15].

David Weck's BOSU ball is another well-liked item for enhancing stability and balance. Like a half-cut Swiss ball, the BOSU ball is made out of an inflating rubber bladder and a solid plastic base [16]. It is referred to as the "both sides up balance trainer." By putting an unstable surface on firm ground, it challenges balance and increases stability in both upright and horizontal postures. It is frequently combined with traditional bodyweight exercises and free weight training. Enhancing strength, balance, coordination, flexibility, and endurance, the BOSU ball is a useful tool for enhancing sports performance [17].

Core stability refers to the ability of the core muscles to support the body and enable effective energy transfer during physical activities. Enhancing core stability is crucial for both improving athletic performance and preventing injuries [18]. Various tests are used to assess core stability, including the plank test, unilateral hip bridge endurance test, flexor and extensor endurance tests, side bridge test, and Sahrmann core stability test. Among these, the flexor endurance test (0.93), extensor endurance test (0.97), and side bridge test (0.91) have the highest reliability [19]. Strong core stability plays a vital role in the coordination between the upper and lower limbs, particularly in sports like cricket, where bowling requires precise coordination of both upper and lower body movements [20].

McGill's trunk endurance test is often used to assess trunk muscle strength and endurance, focusing on the flexors, extensors, and lateral muscles. Pilates exercises are often incorporated into training programs to strengthen these core muscles. Core muscle endurance is essential for sustaining force transmission during physical activities such as sprinting, agility, kicking, and throwing. Throughout a cricket match, trunk muscle endurance helps maintain core stability and allows for sustained athletic performance [21]. However, despite the importance of core muscles, many athletes fail to prioritize core strengthening exercises in their training routines, leading to increased risk of lower back and limb injuries. The connection between athletic performance, injury risk, and balance highlights the importance of incorporating core stability exercises into training programs, especially for cricket players. While balance and core stability are critical for cricket performance, there is a lack of evidence comparing the efficacy of different exercise modalities tailored for this population. The study addresses this gap by investigating the effectiveness of Bosu ball and Pilates exercises, providing evidence-based recommendations for trainers and athletes to optimize core stability and balance training in cricket players.

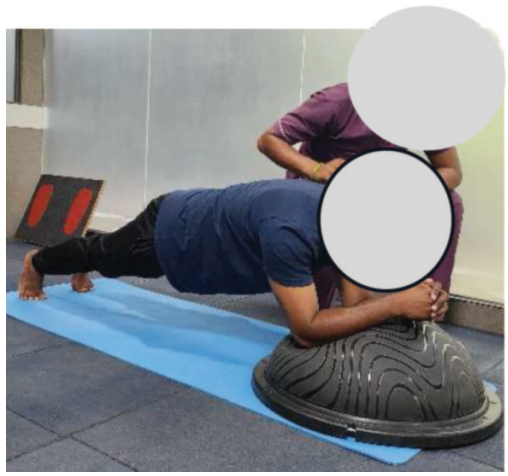
Material and Methods

The study tested aspiring university cricketers at Saveetha College of Engineering and Physical Education in Chennai. In the age group of Eighteen to twenty-five years old, Male college cricket players are included in this study. The players who practicing cricket for at least two years were include. A history of serious hip, knee, ankle, or back injuries; being an uncooperative player; being unwilling to participate; having a history of mental, neurological, cardiovascular, or pulmonary problems; or having previously had hip or back joint surgery were all criteria for exclusion from this study. The Y Balance Test assesses dynamic balance by evaluating stability during multi-directional reaching, making it relevant for cricket players who require dynamic movements like running, lunging, and reaching. The Flamingo Balance Test measures static balance through single-leg stance assessment, crucial for batting, bowling, and fielding, where stability is essential. The McGill Core Endurance Test evaluates core muscle endurance, vital for stability, posture, and efficient energy transfer during cricket activities, ensuring sustained performance in matches and training. These measures were chosen for their reliability, validity, and relevance to the physical demands of cricket. Pre-test evaluations carried out before the six-week intervention and post-test evaluation assessments conducted after the six-week training session.

Out of 45 players evaluated, 36 satisfied the requirements of the present study and were randomly assigned to two groups: Group A (n = 18) for Bosu Ball exercises and Group B (n = 18) for Pilates exercises. The sample size was determined

based on power analysis, which was conducted to ensure sufficient statistical power (80%) to detect meaningful differences between the two groups. With an alpha level of 0.05, the minimum sample size of 18 participants per group was chosen to balance statistical reliability with practical feasibility, allowing for robust results while considering participant availability. This sample size was adequate for assessing the impact of both interventions on core stability and balance. Both groups followed a five-day-a-week exercise schedule for six weeks. Bosu ball exercises included planks, crunches, cross-sit-ups, one-leg bridging, and sit-ups,

Bosu sit-ups



Bosu ball plank

Bosu ball cross sit-ups

Bosu ball crunches

Figure 1: Bosu ball exercises

While the Pilates group performed planks, side planks, reverse planks, pelvic bridges, pelvic bridge with straight leg raise, and Hundreds [1]

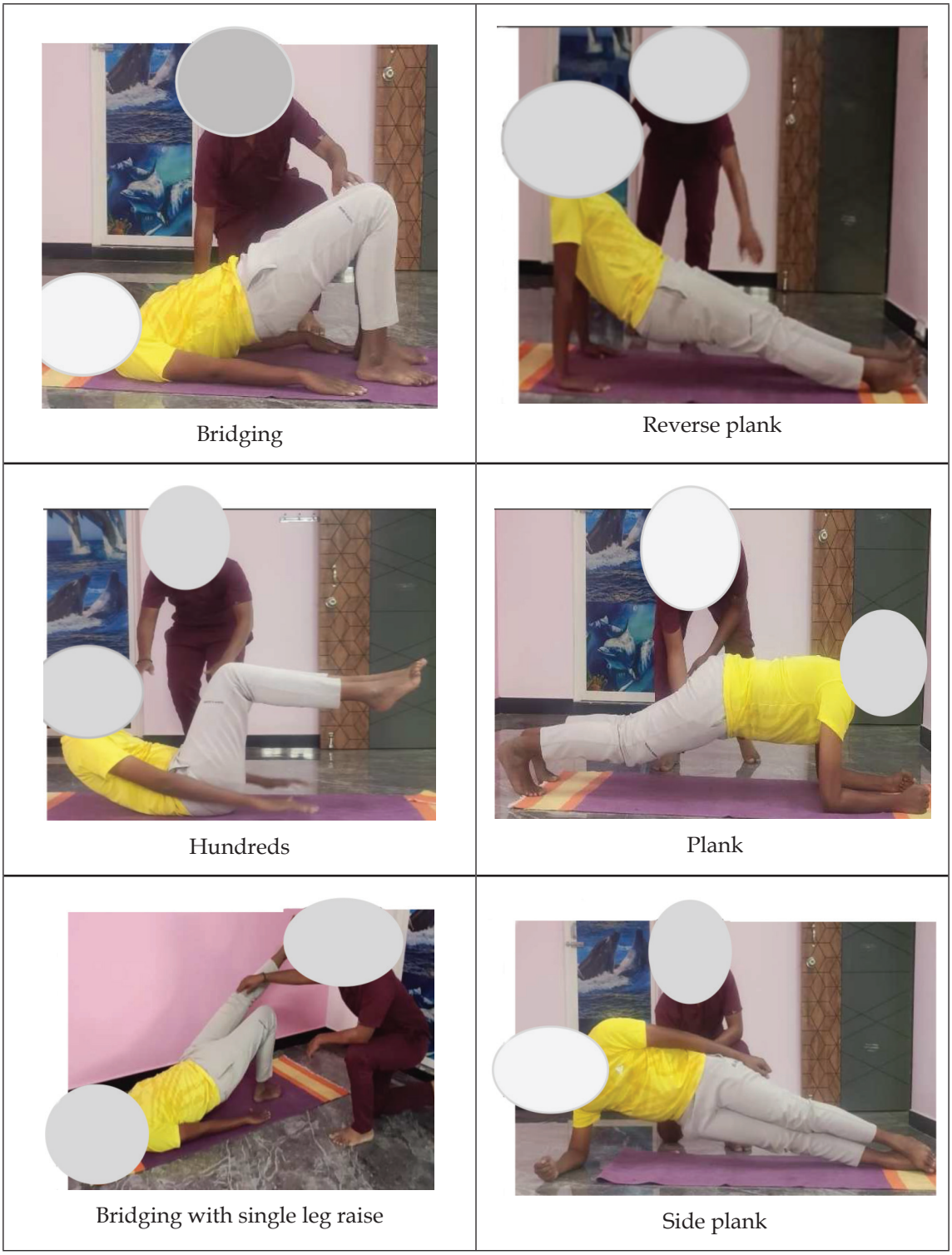


Figure 2: Pilates Exercises

Each workout consisted of 10 repetitions with a 10-second break, and both groups completed a 10-minute warm-up and cool-down. After six weeks, pre- and post-test results were statistically analysed.

Results

Quantitative analysis of participant data highlighted pre-test and post-test outcomes using descriptive statistics as shown in Table 1. The Flamingo Balance Test, Y Balance Test, and McGill Core Endurance Test assessed the effects of Bosu Ball and Pilates interventions. Within-group differences were analyzed with paired t-tests, and between-group post-test comparisons were evaluated with unpaired t-tests.With a pre-test mean of 8.06 (SD = 1.35) and a post-test mean of 5.72 (SD = 1.23), Group A (Bosu Ball) demonstrated a significantly significant improvement ($t = 16.66$, $p<0.0001$) on the right leg Flamingo balancing test. With a pre-test mean of 8.28 (SD = 1.27), and a post-test mean of 6.72 (SD = 1.02), Group B (Pilates) likewise showed a substantial improvement ($t = 7.15$, $p<0.0001$). Comparisons between the post-tests were significant ($t = 2.66$, $p<0.01$). Group B made considerable development ($t = 6.64$, $p<0.0001$) and Group A made significant progress ($t = 14.44$, $p<0.0001$) for the left leg, with significant post-test differences ($t = 2.49$, $p<0.01$).

Table 1. Pre and post-test values of Bosu group and Pilates within the groups.

OUTCOME	GROUPS	PRE TEST	POST TEST	T VALUE	P VALUE
Flamingo balance test (RT)	Bosu group	8.06±1.35	5.72±1.23	16.66	0.0001
	Pilates group	8.28±1.27	6.72±1.02	7.15	0.0001
Flamingo balance test (LT)	Bosu group	8.17±1.20	5.89±0.90	14.44	0.0001
	Pilates group	8.11±1.13	6.67±0.97	6.64	0.0001
Y balance (RT)	Bosu group	90.44±1.29	93.26±1.45	8.06	0.001
	Pilates group	90.74±1.32	92.30±0.91	5.38	0.001
Y balance (LT)	Bosu group	91.01±1.19	94.12±1.18	10.03	0.001
	Pilates group	90.75±1.20	93.22±1.08	8.52	0.001
MC gill core endurance test (Extensor endurance test)	Bosu group	72.72±1.18	76.62±1.21	12.58	0.0001
	Pilates group	72.96±1.0	75.09±2.19	4.47	0.0003
MC gill core endurance test (Flexor endurance test)	Bosu group	70.11±1.53	74.08±1.57	9.93	0.0001
	Pilates group	70.16±1.40	72.91±1.23	8.09	0.0001
MC gill core endurance test (side bridge test RT)	Bosu group	43.94±1.61	48.49±2.94	8.26	0.0001
	Pilates group	43.54±1.57	46.55±1.28	16.74	0.0001
MC gill core endurance test (side bridge test LT)	Bosu group	42.86±1.42	46.79±1.40	10.92	0.0001
	Pilates group	42.90±1.10	45.86±0.80	11.84	0.0001

The pre-test mean for the right leg Y balance test was 90.44 (SD = 1.29), and the post-test mean was 93.26 (SD = 1.45), indicating a substantial improvement (t = 8.06, p<0.001) for Group A. The pre-test mean for Group B was 90.74 (SD = 1.32) and the post-test mean was 92.30 (SD = 0.91), indicating further improvement (t = 5.38, p<0.001). Significant post-test comparisons were found (t = 1.65, p<0.01). With notable post-test differences (t = 2.49, p<0.01), Group A (t = 10.03) and Group B (t = 8.52) shown improvement for the left leg.

On the left side bridge test, Group A's pre-test mean was 42.86 (SD = 1.42) and post-test mean was 46.79 (SD = 1.40), indicating a substantial improvement (t = 10.92, p<0.0001). Pre-test mean = 42.90 (SD = 1.10) and post-test mean = 45.86 (SD = 0.80) showed improvement in Group B as well (t = 11.84, p<0.0003). Differences were significant after the test (t = 2.44, p<0.01). Group B had noteworthy development (t = 16.74, p<0.0001), whereas Group A exhibited considerable improvement (t = 8.26, p<0.0001) on the right side. There were also significant post-test differences (t = 2.55, p<0.01) as shown in Table 2.

Table 2. Post-test values of Bosu group and Pilates between the groups

OUTCOME	GROUPS	POST TEST	T VALUE	P VALUE
Flamingo balance test (RT)	Bosu group	5.72±1.23	2.66	0.01
	Pilates group	6.72±1.02		
Flamingo balance test (LT)	Bosu group	5.89±0.90	2.49	0.01
	Pilates group	6.67±0.97		
Y balance (RT)	Bosu group	93.26±1.45	1.65	0.01
	Pilates group	92.30±0.91		
Y balance (LT)	Bosu group	94.12±1.18	2.49	0.01
	Pilates group	93.22±1.08		
MC gill (Extensor endurance test)	Bosu group	76.62±1.21	2.47	0.01
	Pilates group	75.09±2.19		
MC gill (Flexor endurance test)	Bosu group	74.08±1.57	2.58	0.01
	Pilates group	72.91±1.23		
MC gill (side bridge test RT)	Bosu group	48.49±2.94	2.55	0.01
	Pilates group	46.55±1.28		
MC gill (side bridge test LT)	Bosu group	46.79±1.40	2.44	0.01
	Pilates group	45.86±0.80		

Discussion

The results of this study show the benefits of Pilates and Bosu ball exercises for strengthening the core stabilization of cricket players. Our findings are consistent with earlier studies showing the advantages of Pilates and Bosu ball workouts for improving athletes' core stability and balance in a variety of sports.

Yash Vijay Sawant et al. (2022) and Sawant et al. (2020) shown that Bosu ball workouts improve core stability in cricket players, which is consistent with our findings. Constant neuromuscular changes are required due to the unstable surface, which probably explains the training group's small advantage and larger long-term gains in core stability [16,17].

Varsha Panchal et al. (2022) showed that Pilates improves core strength, which improves cricket play, and our results support their findings. In order to target deep stabilizing muscles, Pilates emphasizes exact alignment and regulated movements [1]. Likewise, Kamatchi et al. (2020) emphasized how well Pilates works to strengthen the core [3]. In addition, highlighted that Swiss ball exercises develop core strength, which is essential for enhancing athletic performance, more effectively than floor workouts [2].

Our results are consistent Jibi Paul et al. (2023), with those, who found that Pilates exercises improved cricket players' trunk muscular endurance more than floor exercises did [14,22]. Halil Tanir et al. (2018) and Gulbin RudarliNalcakan et al. Furthermore, study showed that balance training improves both static and dynamic balance abilities, which is consistent with our findings on the advantages of Pilates and balance-focused workouts for cricket players [10].

In research conducted in 2020 by Ankita Mane and AmrutkuvarRayjade twenty-four players were split into two groups at random: BOSU Ball and Swiss Ball. The study sought to ascertain whether ball enhances core strength, specifically for postmenopausal women who have insufficient core muscles and pelvic floor dysfunction. The results showed that the Swiss Ball group did not improve core strength as much as the BOSU Ball group did[18].

Our study goes one step further by showing that through Pilates and BOSU ball workouts, collegiate cricket players may increase their static and dynamic balance, improving stability and lowering their risk of injury during crucial movements.

Conclusion

Both the intervention shows improvement in core stability and Balance where Bosu ball was slightly effective than Pilates. For the best possible performance and injury prevention in cricket, both exercises provide efficient methods for improving balance and core stability. Cricket players may improve their general health and fitness by adding these activities into their regular training methods, which will ultimately improve their lifespans and on-field performance. The very small sample size and the brief six-week intervention period are two important study limitations. In order to fill in these gaps and provide more light on the long -term impacts of Pilates and Bosu ball exercises on cricket players core stabilization, Female cricket players should incorporate in future studies, where this study limits only male players.

Source of Funding: This study was conducted with self-funding.

Conflicts of Interest: Nil.

Ethical Clearance: Thestudy was approved by the Institutional Scientific Review Board on human subjects (Approval Number: 01/033/2023/ISRB/PGSR/SCPT).

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Development and Validation of Questionnaire assessing Knowledge, Attitude and Practice about Neuro-Physiotherapy among Healthcare Students and Professionals

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Abstract

Background: Neuro-physiotherapy plays a crucial role in the rehabilitation of individuals with neurological disorders, aiming to optimize functional abilities and enhance quality of life. This study outlines the development and validation of a comprehensive questionnaire designed to assess knowledge, attitude and practice by recognizing the importance of understanding the current landscape of neuro-physiotherapy with healthcare education and practice.

Method: A self-constructed questionnaire assessing the knowledge, attitude, and practice of neurophysiotherapy treatment among health care students and professionals was developed, followed by content validation by an expert panel. Content Validity Index was used to validate the questionnaire domains. Pilot testing was conducted on 25 students and 25 professionals, in which the developed questionnaire was administered. The validity and reliability of the questionnaire were analyzed using the Item-Total Correlation and Cronbach's alpha, respectively.

Results: The computed content validity index of the questionnaire was 0.9. The reliability of the questionnaire for students and professionals was found to be 0.915 and 0.949, respectively, and the item total correlation with respect to all domains was recorded to be greater than 0.30, which is the standard for validation in both students and professionals.

Conclusion: The developed questionnaire achieved a statistically satisfactory content validity and is suitable for assessing knowledge, attitude and practice about neurophysiotherapy treatment among the healthcare students and professionals.

Key Words: Neurological Physiotherapy; Neurorehabilitation; Healthcare; Survey; Rehabilitation

Introduction

Physiotherapy is one of the earliest specialties in the medical field that focuses on the patient's comprehensive rehabilitation.[1] Injuries and illness have increased over decades. As members of the healthcare team, physical therapists are crucial in minimizing hospital stays, promoting more efficient healing, and facilitating rehabilitation for improving the quality of life.[2] The profession of physiotherapy has also developed and grown from its general

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applications to specialized field of physiotherapy that provides services to healthcare facilities.[2,3] Neuro-physiotherapy is one of the mainstream physiotherapy branches with tremendous potential and prospect. "Neuro-physiotherapy", also referred to as "neurological physiotherapy" is a type of rehabilitation used to treat the functional, physical, emotional and cognitive issues caused due to neurological illness.[4]

Neuro-physiotherapy differs from traditional physiotherapy as it takes advanatage of the phenomenon known as neuroplasticity. Neuro-plasticity is the brain's and neural structures' capacity to reorganize themselves in response to disruption, which can aid in a wide range in the restoration of function.[5]

The impact of neurological illnesses on global health is significant.[6] Neurological conditions are a leading cause of death and morbidity globally, according to the Global Burden of Diseases, Injuries and Risk Factors survey.[7] Individuals who suffer from these conditions can have a devastating impact on their lives as well as those of their family and friends.[8] Dysfunction of neural system may cause a variety of physical, emotional and cognitive symptoms and these may have an effect on the quality of their lives.[9] To prevent and treat motor dysfunction and its consequences, as well as to promote functional independence, intensive neuro-physiotherapy treatment is essential.[10]

Due to aging and population growth, neurological disorders are expected to become more common in India and around the world.[11]For patients to receive optimal treatment, there must be interdisciplinary collaboration between all the medical sciences.[12] To do this, team members who are capable of providing patient care must be acknowledge, respected and understood for their abilities and skills.[2]

Following a review of literature, it has been found that people identify orthopaedics and sports as key areas of specialty in physiotherapy.[2,12,13] There is limited knowledge about neuro-physiotherapy among other health care professionals, which may impede the effective and prompt referral of the patients. This may also interfere in delivering goal-oriented treatment due to lack of collaborative approach. As a result, many neurological patients do not have access to specialists for neurophysiotherapy treatment.

Thus, there is a need for collaboration in neuro-physiotherapy treatment among health personnel from various professional backgrounds, as interdisciplinary team is capable of meeting the demands of patients with neurological conditions.[14] As a result, the present study focuses on to develop a questionnaire to assess health care students and professionals' knowledge, attitude and practice related to neuro-physiotherapy treatment.

Methodology

Institutional Ethical Board approved this study and the study was carried out in two phase. The first phase included the development and the content validation of the questionnaire (KAPA-NPTHCSP) and the second phase included assessment of validity of the developed questionnaire.

Phase I

Development of Questionnaire: This phase primarily concentrated on domain recognition and item generation. A thorough review of the existing literature was done to find out the current state of knowledge, attitude, awareness and practice related to physiotherapy among the various healthcare professionals. However, we discovered that there is no specific tool that addressed knowledge, attitude and practice about neurophysiotherapy treatment. Three domains were identified knowledge, attitude and practice. The "knowledge" questions were designed to assess knowledge of specific neurophysiotherapy techniques, patient outcomes, and treatment approach. The "attitude" questions were developed to understand practitioners beliefs, values and perception regarding neurophysiotherapy treatment. The "practice" domain covered questions focused on the referral of patients to neurophysiotherapy rehabilitation. Each domain consisted of 10 items and the questionnaire was draft.

Content Validation: The content validation of the questionnaire was measure through a process of expert validation. This process involved selection of a panel of experts to review and evaluate the questionnaire the panel consisted of ten experts in the field of neurophysiotherapy with a minimum experience of 10 years in the field. The experts were sent an online content validation form with clear instruction. Evaluation of the clarity and relevance of items was done using 4 point Likert Scale, ranging from 1 to 4 where, 1= not relevant; 2= somewhat relevant; 3= quite relevant; 4= highly relevant. The Content Validation Index (CVI) was calculated for each item by dividing the number of experts who rated the items as 3 or 4 by the total number of experts. The average CVI across all items was computed to determine the overall content validity of the questionnaire. The final copy of questionnaire consisted of 2 parts. First part consisted demographic characteristics, the second part consisted of 30 items labelled into 3 domains as follows: (1) Knowledge- 10 items, scored 0 to 3 where 0= no knowledge and 3= know very well. The overall scoring of the domain ranges from 0 to 30, where 1-10= limited knowledge; 11-20= moderate knowledge; 21-30= satisfactory knowledge (2) Attitude- 10 items, scored 0 to 3 where 0= never and 3= always. The overall scoring of the domain ranges from 0 to 30, where 1-10= negative attitude; 11-20= neutral attitude; 21-30= positive attitude (3) Practice- 10 items, scored 0 to 3 where 0= never and 3= always. The overall scoring of the domain ranges from 0 to 30, where 1-10= poor practice; 11-20= fair practice; 21-30= good practice. The overall scoring of this self developed questionnaire ranges from 0 to 90 where 0-30= fair; 21-60= good; 61-90= excellent. The copyright of the questionnaire is registered.

Phase II

Validity of Questionnaire: A pilot study was conducted to validate the KAPA- NPTHCSP questionnaire with a sample of 50 (25 health care students and 25 professionals) from diverse Healthcare Institutions of Belagavi City. Convenience sampling technique was used. Prior to the commencement of the study, the subjects were explained about the study and obtained a written informed consent from them following which the developed questionnaire was administered face-to-face. The health care students (pursuing postgraduate program: Medical, Dental, Allied Health Sciences, Ayurveda, Homeopathy) and professionals of all genders, were included, where as participants not willing to participate and individuals of physiotherapy field were excluded from the study.

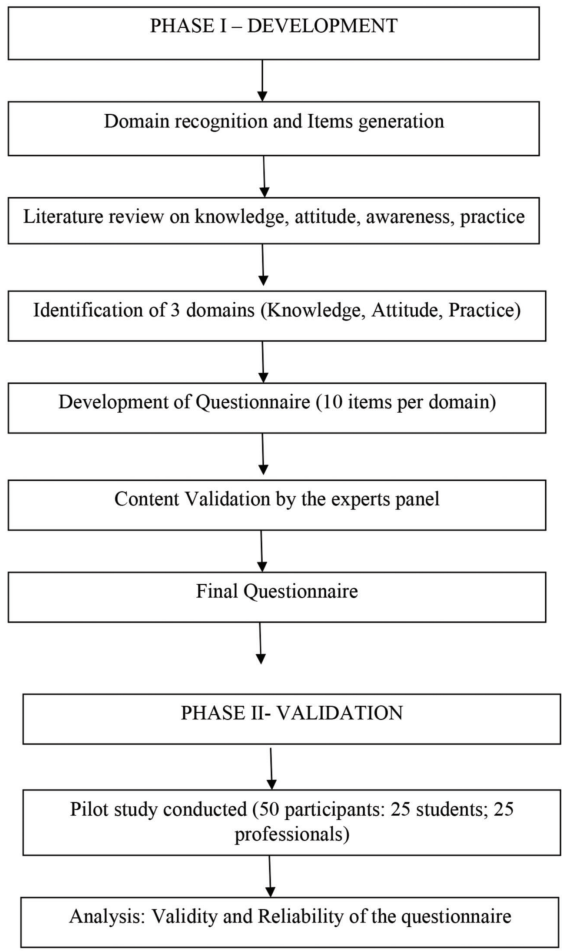

Figure 1: Flowchart summarizing the questionnaire development and validation process

Statistical Analysis

The content validity index for the expert review was analysed by using Microsoft Excel Sheet 2016. The data were summarized by using a descriptive statistics. The validity and reliability was analysed using the Item- total correlation and Cronbach's

Alpha respectively. The collected data in this study was statistically analysed using SPSS version 23.

Results

The questionnaire domain validity was assessed using the item-level content validity index (I-CVI). The I-CVI scores for knowledge, attitude and practice domains were 0.91, 0.95 and 0.84 respectively. The CVI value of the questionnaire was found to be 0.9. The acceptable cut- off score of CVI values for least 9 experts is 0.78.[15] A validation and reliability study included 50 subjects: 25 P.G students and 25 professionals of different specialty (Figure 2). The age of all the subjects lied between 23 to 55 years, out of which 32 were males and 18 were female.

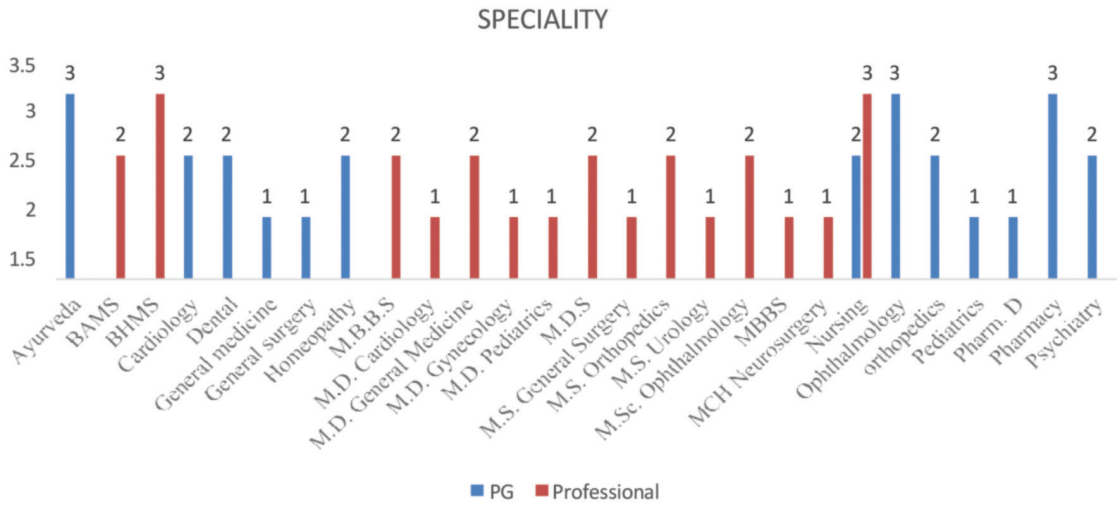

Figure 2: Specialty of P.G. students and Professionals

Item Reliabilty

KAP about neurophysiotherapy treatment was analyzed with the help of 30 questions, 10 questions in each domain and respondents were requested to provide their views on the listed statements. In order to determine the reliability of the respondents; Cronbach's Alpha values were analyzed. For P.G. students, it was observed that the KAP domains scored at 0.858, 0.892, 0.854 respectively and the overall was 0.915. Whereas for the professionals, scores for KAP domains were 0.906, 0.857 and 0.897 respectively and the overall was found to be 0.949 that is statistically excellent. (Table 1, 2)

Table 1. Item Reliability of each domain of KAPA-NPTHCSP

Domains	Cronbach's Alpha for Students	Cronbach's Alpha for Professionals	No. of items
Knowledge	0.858	0.906	10
Attitude	0.892	0.857	10
Practice	0.854	0.897	10

Table 2. Reliability analysis of KAPA- NPTHCSP

Questionnaire	Cronbach's Alpha for Students	Cronbach's Alpha for Professionals
KAPA- NPTHCSP	0.915	0.949

Item Total Corelation of The Domains

The validity analysis was carried out using Item- Total Correlation. The correlation values for knowledge in students and professionals are 0.7 and 0.8 respectively. For attitude in students and professionals are 0.8 for both but Q2A for students has to be eliminated as it showed lower reliability. For practice in students and professionals are 0.7 and 0.8 respectively but Q7P and Q10P for students has to be eliminated as these showed lower reliability. (Table 3) And the overall in students and professionals showed 0.6 and 0.8 respectively.

Table 3. Item-Total Correlation

	Knowledge for Students		Knowledge for Professionals			Attitude for Students		Attitude for Professionals			Practice for Students		Practice for Professionals	
	CITC	CAID	CITC	CAID		CITC	CAID	CITC	CAID		CITC	CAID	CITC	CAID
Q1K	.744	.830	.461	.907	Q1A	.499	.746	.310	.857	Q1P	.651	.765	.693	.883
Q2K	.722	.830	.456	.907	Q2A			.548	.845	Q2P	.633	.773	.698	.882
Q3K	.622	.840	.765	.890	Q3A	.648	.733	.862	.813	Q3P	.639	.763	.822	.873
Q4K	.430	.856	.478	.906	Q4A	.482	.746	.720	.828	Q4P	.764	.744	.735	.880
Q5K	.410	.859	.819	.887	Q5A	.493	.746	.331	.859	Q5P	.646	.760	.805	.874
Q6K	.342	.862	.665	.898	Q6A	.625	.730	.436	.857	Q6P	.581	.771	.497	.895
Q7K	.598	.842	.773	.889	Q7A	.729	.720	.572	.843	Q7P			.527	.895
Q8K	.632	.839	.752	.891	Q8A	.840	.703	.487	.849	Q8P	.483	.784	.625	.888
Q9K	.596	.846	.788	.888	Q9A	.567	.737	.792	.821	Q9P	.791	.743	.647	.886
Q10K	.626	.839	.665	.896	Q10A	.646	.731	.834	.823	Q10P			.350	.902

(CITC - Corrected Item-Total Correlation, CAID - Cronbach's Alpha if Item Deleted, Q – Question, K – Knowledge, A – Attitude, P – Practice)

As seen in the above table, all statements have suggested medium to strong correlation and have recorded correlation value higher than 0.30 which is a standard for validation.

Discussion

There exists no tool to assess the knowledge, attitude and practice about neurophysiotherapy treatment among healthcare students and professionals. Thus this study aimed to develop and validate a questionnaire to assess the same. As neurophysiotherapy stands at the forefront of rehabilitation, offering vital interventions to enhance the lives of individuals with neurological disorders. However, the effectiveness of neurophysiotherapy interventions relies not only on skills but also on the KAP of healthcare students and professionals. The primary objective of present study is to develop a questionnaire that evaluates the KAP levels related to neuro-physiotherapy and determine the validity and reliability of the KAPA-NPTHCSP questionnaire.

In terms of knowledge the results of the validation demonstrated that the questionnaire can effectively assess the key aspect of neurophysiotherapy treatments- like principles, methods, frameworks, along with knowing when to refer. The previous studies have analyzed that among the other healthcare professionals, physiotherapists are not extensively recognized in administering treatment to the aforementioned patients. Physiotherapy is predominantly acknowledged for its efficacy in orthopedic cases (96%) and sports injuries (80%). The role of physiotherapy in promoting fitness (70%) and addressing neurological conditions (50%) was noted.[16] A research conducted by Karthikeyan P et.al., has revealed a deficiency in the understanding of physiotherapy and its significance among the

surveyed health professionals, which is presumably indicative of the broader health professional community's knowledge base. Consequently, there exists an imperative necessity to enhance educational initiatives pertaining to physiotherapy and rehabilitative services for all categories of health personnel.[17] According to a similar study, medical interns are less likely to possess sufficient knowledge. Since the medical interns will eventually become doctors, it is crucial to teach them about physical therapy through various approaches. This provides them with timely and suitable patient referrals, which will improve patient care and benefit the healthcare system as a whole.[18] Thus evaluating knowledge domain and identifying gaps in education and training according will ensure that the care provided is both comprehensive and specific to the challenges faced by patients.

The attitude component is another crucial element as it influences professionals behavior, guiding whether healthcare workers embrace neurophysiotherapy and integrate it into care. Evaluating attitude is important as it helps assess aspects like acceptance, receptivity and willingness to adopt new practices. According to a survey, clinical physicians' opinions on the physiotherapy field were largely unfavorable. By increasing public awareness, physiotherapy academics and practitioners can help doctors' preconceptions about their services be dispelled. It should be encouraged for medical practitioners to take part in official physiotherapy education and training.[19] Where as a study conducted by Raissi GR et.al., the inadequate rehabilitation training provided to medical students was amply demonstrated and this results can be taken into account for developing and modifying teaching programs towards rehabilitation.[20] Positive attitudes can foster collaboration among healthcare teams, while negative ones might reduce teamwork. Assessing the attitude domain helps to uncover potential misconceptions about neurophysiotherapy and recognizing these barriers allows for targeted educational training initiatives, in turn leading to enhanced patient care and improved rehabilitation outcome.

Practice domain is a part of KAP study as it focuses on how healthcare professionals apply what they know in real-world situations about neurophysiotherapy. This is vital because evaluating practice helps us understand how knowledge and attitudes are translated into actual patient care. Based on a study, healthcare professionals agree to use a multidisciplinary approach to disease management, but they lack the knowledge about physiotherapy services to send their patients to the appropriate specialists. In fact, for usual complaints like pain in the back, doctors frequently send the patients to neurosurgeons or orthopedic surgeons.[21] Analysis of current practices can revel discrepancies between what is known and what is done. Such gaps might indicate the need for further training, better resources ultimately leading to enhance patient care and advance professional growth.

The validation outcomes indicated that the questionnaire is capable of eliciting perspectives on the significance of neurophysiotherapy concerning patient care and its contribution to rehabilitation processes. The questionnaire possesses substantial ramifications for medical education, clinical practice, and the identification of areas necessitating enhancement. It yields insights into the attitudes, behaviors, and knowledge deficiencies of healthcare practitioners within clinical environments, thereby aiding in the formulation of specialized training initiatives and quality enhancement strategies. Furthermore, in the realm of healthcare education, it promotes the creation of targeted educational interventions aimed at augmenting neurophysiotherapy competencies among both students and professionals.

Limitations and Recommendations

The limitation of the study was that in the KAPA-NPTHCSP questionnaire there was no correlation between very few items from attitude and practice domain only for student population but the researcher decided to use all the items for research purpose. Although the items were verified by experts' opinion. Assessing changes in KAP over time among healthcare students and professionals can provide

valuable insights into the effectiveness of educational interventions, changes in practice, and evolving attitudes towards neuro-physiotherapy treatment. Longitudinal studies could help identify areas of improvement and track progress in enhancing neuro-physiotherapy knowledge and practice.

Conclusion

This study represents a significant step toward improving neurophysiotherapy education and practice. The developed questionnaire provides a validated framework for assessing KAP among healthcare professionals, paving the way for enhanced interdisciplinary collaboration and patient-centered care in neurorehabilitation. Addressing the identified gaps through education and training will ultimately contribute to the optimization of neurophysiotherapy treatment strategies and better healthcare outcomes for individuals with neurological disorders.

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Effectiveness of Visual Cueing Versus Dual Task Exercise on Improving Walking Ability in Early-Stage Parkinson's Subjects

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Abstract

Background: Parkinson's disease is a neurological condition that worsens over time. Parkinson's disease primarily affects dopaminergic neurons in the substantia nigra of the midbrain. Parkinson's disease is commonly associated with walking difficulties such as postural instability and a shuffling gait. Physiotherapy interventions such as Tai Chi, strength training, body weight support treadmill training, visual cueing, and dual task training are few of the techniques that are frequently used for gait training and to enhance balance. Most often employed strategies for improving walking ability are dual tasking and visual cueing. Many studies showed the advantages of visual cueing and dual-task training for enhancing gait in Parkinson's disease, but there are no research studies done to directly evaluate the efficacy of these two therapeutic modalities alongside standard physiotherapy in individuals with early-stage Parkinson's disease.This study compares the impact of dual-task workouts and visual cueing on enhancing walking abilities in individuals with early-stage Parkinson's disease.

Methods: A quasi experimental study design, out of 64 subjects, sixty subjects who satisfied the inclusion criteria were split into two groups: thirty in Group A (visual cueing) and thirty in Group B (dual tasking) with mean age of 50-65 years. Interventions were administered in both groups, five days in a week for six weeks. Outcome measures were analyzedusing ink footprint analysis, gait parameters such as step length, stride length, velocity, and cadence were observed.

Result: The results were analyzed using paired T-test to measure pre and post test results within group. When comparing between groups, the analysis of variance (ANOVA) showed a substantial improvement in group B (dual tasking) when compared toGroup A (visual cueing) $p<0.01$.

Conclusion: The findings of this study suggest that walking ability significantly improved after 6 weeks of dual task training and visual cueing exercises along with traditional physiotherapy. However, when compared between groups, it was found that dual tasking exercises is more effective in improving walking ability than visual cueing exercises.

Keywords: Exercises for Parkinson's disease, walking ability, the ink footprint approach, visual cueing, and dual tasking.

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Introduction

Parkinson disease (PD) is a common neuro-degenerative disorder in older adults characterized by motor and nonmotor symptoms resulting from complications caused by degeneration of nerve cells in substantia nigra of midbrain [1]. Parkinson's disease affects the individuals quality of life, increases the chances of mortality, hinders mobility, mental health and effects quality of sleep.The incidence of Parkinson's disease is usually between 10 to 50/1,00,000 person-years, the prevalence is between 100 to 300/1,00,000 population [2]. Parkinson's disease increases with age, 1% in those over 60, and 2% in those over 80 years of age. The main symptoms are resting tremor, muscular rigidity, bradykinesia, postural instabilityand non-motor features include sleep disturbances, depression and cognitive abnormalities. These symptoms are caused due to selective loss of dopaminergic neurons in the substantia nigra pars compacta (SNpc) and decrease in the neuromelanin content of the substantia nigra. Postural instability is caused by aberrant proprioceptive inputs and disturbed motor programming in the basal ganglia [3].

Parkinson's disease is frequently accompanied by walking difficulties, falls, activity limitations, and a loss of independence. In the early stages, there are alterations in walking patterns [4]. The individuals with Parkinson's walks slowly with flexed posture, with less arm swing and jerky steps, in order to chase his or her own center of gravity. Short, rapid, hesitant, shuffling steps are the hallmark of the gait pattern. The most frequently observed gait parameters in Parkinson's disease are gait velocity, stride length, step length, cadence and step width [5].

Parkinson's patients can benefit from physio-therapy interventions such as resistance training, body weight supported treadmill training, visual cueing, and dual tasking exercises to improve their walking skills [6,7]. Susan Bagley reported that visual cueing exercises improve gait quality. In his study he postulated that specific visual cues may enhance gait and proposed that certain visual stimuli were effective in promoting locomotor activity [8]. Visual cues improve gait parameters mainly stride length, foot strike angle and stride time which may improve mobility and reduce falls risk[9].

Yanpei Zheng et al summarized that dual task training is effective for improving cognitive abilities and walking ability in Individuals with Parkinson Disease. Dual task training consists of Walking while singing, walking in tandem, walking backwards, walking on an S-shaped path, walking while repeating words, walking while reciting a brief statement backwards, and walking while responding to simple questions like "yes" or "no" are all included in this category[10].

Dual-tasking or concurrent multitasking is the ability to coordinate the performance of two or more tasks at the same time[11]. When executing any task, people with Parkinson's disease have a decline in their gait and balance [12]. One explanation for dual-task interference in patients with Parkinson's Disease (PD) is that, when two tasks are executed simultaneously, one task is consciously managed by the frontal cortical regions, while the other is automatically regulated by the basal ganglia, whose functions are impaired in PD patients[13].

In this study gait analysis is done using ink footprint method, which is used to quantify step length, stride length, cadence, and velocity. The analysis is done by taking measurements over the central ten meters of the fourteen-meter walkway with the first two meters being allowed for acceleration and the last two meters for deceleration. The first heel strike over the starting line was used to begin the measures, and the first heel strike over the finishing line was used to conclude them[14]. The aim of this study is to investigate the effectiveness of visual cueing versus dual task exercise on improving walking ability in early-stage Parkinson's subjects.

Methodology Study Design

A quasi-experimental study design, a total of 60 subjects participated in the study. Inclusion criteria: including both male and female, aged between 50-65 years who have mild to moderate Parkinson's and grade of 2-3 on Hoehn and yahr scale. Exclusion

criteria: Individuals with open wounds or skin illnesses, extreme hypertension, heart failure, hand, wrist, elbow, or cervical spine pain conditions, cognitive & visual impairments, fractures, cardio respiratory conditions, musculoskeletal disorders, and severe depression, neurological disorders like vertigo, stroke, multiple sclerosis, peripheral neuropathies are excluded. Based on inclusion criteria, 30 subjects each were assigned to groups A (visual cueing) and 30 subjects were assigned into group B (dual task) using convenient sampling. Informed consent was taken from each individual prior to the intervention. The course of treatment lasted for six weeks [one hour per day; 5 days per week]. Using ink footprint analysis, gait metrics such as step length, stride length, cadence, and velocity were recorded throughout a 14-meter corridor.

Materials Used in The Study

White paper roll • White tape • Black tape • Ink Bottles • Paint roller Brush • Scale • Stop watch • Tray

Procedure

Group A: Visual Cueing [8]

Prior to intervention, the individuals' gait parameter was assessed using ink foot analysis. Participants in this visual cue task were instructed to walk down a 10-meter pathway with visual cues in the shape of one-meter strips of black masking tape, each three centimeters wide, spaced two meters apart along the path of movement. These participants were instructed to walk at their preferred pace on the path twice as shown in figure1. The patients were given a 60-second break in between walks, during which they sat in a chair at the end of the walkway. The intervention lasted for thirty minutes.

Group B: Dual Tasking Exercises [15]

Individuals in this group performed two tasks at a time and their gait and balance were assessed. The tasks include walking while singing, walking in tandem, walking backwards, walking on an "S"-shaped path, walking while repeating words, walking while reciting a brief statement backwards, and walking while responding to simple questions like "yes" or "no" were all included in this category.

The intervention lasted for thirty minutes. The six walking situations and the walking procedure are as follows shown in figure 2:

1. Usual Walking with no Dual Tasking: This condition was always first and allowed subjects to become familiar with the walk way. In the following 3 walking conditions (2-4) subjects were asked to perform 3 different cognitive tasks that were included in the training program
2. Verbal Fluency: Subjects were asked to recall as many words as possible beginning with a predefined letter, during 1 minute while walking.
3. Serial 3 Subtractions Task: Subjects walked while performing serial 3 subtractions out loud, starting from a 3-digit number (eg 487)
4. Information Processing Task: Participants are presented with simple arithmetic problems and are instructed to respond as quickly as possible and state whether the outcome is larger or smaller than 4.
5. Performance of an additional dual tasking (DT) not included in Training Session: This task consisted of open ended, complex questions that stimulated every day conversation and required a level of reasoning for example: list 3 reasons against or in favor of being vegetarian.
6. Usual Walking with no dual tasking (DT): This was always the last walking condition and could be used to monitor for effects of fatigue or training. During these 6 walks and during all training, subjects were instructed to walk at their usual walking, preferred pace on level ground in a well-lit, obstacle free, 30 m long corridor for 1 minute. It includes timed up and go test.

Figure 1: Visual cueing Exercises

Figure 2: Dual Tasking Exercises

Figure 3: Ink Foot Print Method

Conventional Physiotherapy for both Group A and Group B:

Conventional exercises consisting of lower limb strengthening exercises using resistance bands, sit to stand and stand to sit, raising from chair, heel raises, and toe offs, knee squats and gait training are given for 30 minutes duration [22].

Results

Statistical analysis was performed by using SPSS software version 23.0 and Microsoft Excel-2021 descriptive statistical data were presented in the form of mean +/- in standard deviation and mean differences percentages were calculated and presented.

Within group analysis: paired t-test was performed to assess statistical differences within the groups for visual cue exercises and Dual task exercise.

Between the groups analysis: An Independent student t-test was performed to analyze the statistically significant difference in mean value between the visual cue exercise and Dual task exercise.

All 60 subjects completed the entire study program in 6 weeks on an outpatient basis and outcomes were assessed using ink foot method pretest and posttest before and after the treatment protocol as shown in figure 3. The outcome measure was step length, stride length, cadence, and velocity.

Table1. Means of Group-A (Visual Cueing Exercises) on GAIT Parameters

GAIT Parameters	Mean	Std. Deviation	T value	P value
Step length pre-test	41.167	4.8642	–26.052	.000
Step length post-test	44.900	4.8661		
Stride length pre-test	115.767	11.4882	–12.883	.000
Stride length post-test	118.900	11.0652		
Velocity pre-test	66.167	10.8535	–14.560	.000
Velocity post-test	68.200	10.6493		
Cadence pre-test	126.700	8.6509	11.762	.000
Cadence post-test	124.467	8.7523		

The above table inference is that there was a significant difference between pre-test and post-test GAIT parameters in Group A. $p<0.05$.

Table 2. Means of Group-B (Dual Task Exercises) on GAIT Parameters

GAIT Parameters	Mean	Std. Deviation	T value	P value
Step length pre-test	41.333	3.7077	–20.210	.000
Step length post-test	48.000	3.9654		
Stride length pre-test	113.500	9.2652	–4.998	.000
Stride length post-test	121.367	6.7081		
Velocity pre-test	66.100	8.2769	–13.268	.000
Velocity post-test	73.233	7.4957		
Cadence pre-test	128.333	5.9209	13.584	.000
Cadence post-test	118.533	8.0290		

The above table inference is that there was a significant difference between pre-test and post-test GAIT parameters in Group B. $p<0.05$.

Discussion

A total of 64 subjects were allocated to this study. Two subjects did not fit the requirements, and two others showed apathy and left thus, 60 people participated in this study. Both groups showed improvements in gait parameters and were statistically significant. Notably, step length, velocity and cadence showed statistical significance ($p<0.05$) between the two groups, suggesting that both interventions had distinct effects on gait parameters. However, stride length did not show any statistical relevance.

The observed improvement in walking abilities in Dual-task exercise group may be attributed to the underlying mechanism of dual task exercises involving simultaneous performance of cognitive tasks while walking. Dual-task exercise necessitates complex coordination between the brain regions in charge of motor control and cognition since they entail doing cognitive tasks while walking. This dual demand encourages people to use their attentional resources wisely, addressing deficiencies including attention and executive function impairments that are frequently linked to Parkinson's disease. Dual-tasking promotes neuroplasticity, which allows for adaptive modifications in brain connections and may result in better gait parameters [16]. Temporal aspects of gait (velocity, step length) improved under all dual task conditions, while postural aspects of gait (step width, arm swing) varied by cognitive task[17].

In this study visual cuing exercises also showed improvement in gait.These findings are in agreement with Muthukrishnan et al, study which concluded that cueing can be an effective component of locomotor therapy for people with Parkinson's disease (PD) who experience gait deficits[18]. Parkinson's patients may use visual cueing to provide spatial information to guide movements, which may allow them to bypass their defective basal ganglia during walking[19]. Visual signals offer outside stimuli that help improve gait parameters such as reduction in the number of strides, an increase in the speed of gait, and an increase in the duration of the swing phase with a corresponding reduction in the stance phase. These cues improve step initiation, promote a more consistent rhythm, and aid in overcoming frozen spells by utilizing the visual feedback. Visual cues provide exact timing and spatial direction, which enhances coordination and decreases hesitations when walking. This enhances step timing, resulting in more coordinated and efficient gait patterns [20]. Cui Wang, in their study on Gait analysis in the early stage of Parkinson's disease with a machine learning approach concluded that visual cueing greatly enhanced the majority of gait characteristics, such as gait speed, stride length, cadence, and gait variability[21].

The findings of this study will provide insight about visual cueing exercises and dual task exercise on improving walking ability in early-stage Parkinson's subjects using gait parameters. The results of this study will provide clear evidence on whether there is any significant difference between the two exercises in improving the walking ability in in early-stage Parkinson's subjects.

Conclusion

The study concluded that both visual cueing and dual tasking exercises are effective in improving walking ability in Parkinson's patients. But when compared between groups, dual task exercises showed statistically significant improvement than visual cueing exercises in improving walking ability in Parkinson's patients. Hence this study concludes that dual task exercises along with conventional therapy is effective in improving walking ability in early-stage Parkinson's subjects.

Limitations

The study was done over a short period of time. Only immediate effects of exercises are studied after 6 weeks.

Recommendations for Further Research

Future research should explore the long-term effects of both visual cueing and dual-task exercises in Parkinson's disease. This would help understand the sustainability of improvements and inform the development of extended rehabilitation protocols.

Utilize standardized and Accurate equipment for outcome measures, including both objective and subjective assessments. The Mechanism of Dual Tasking Exercise program require more study for further reference in improving walking disability Parkinson's subjects.

Declaration by Authors

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Effectiveness of Mulligan Mobilization Versus Scapular Mobilisationtechnique on Functional Ability in Subjects with Adhesive Capsulitis of Shoulder Joint

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Abstract

Background and aim: Frozen shoulder or Adhesive capsulitis is determined by pain, progressive loss of active and passive shoulder range of motion due to the contracture of the joint capsule and fibrosis. The Mobilizations with movement (MWM) for joints are used separately or along with other hands-on techniques to increase the quality of joint intra articular gliding, neurodynamic and to assist the correct muscle demand. The goal of study is to assess the effectiveness of Mulligan 'MWM' and Scapular mobilization technique on functional ability in subjects with adhesive capsulitis of shoulder joint.

Methods: Total 40 subjects were selected based on the inclusion and exclusion criteria. The detailed procedure was explained to subjects, and Informed consent form was collected before starting the study. The Pre and Post test values were measured using ROM and Shoulder Pain and Disability Index. The subjects were divided into two groups: Mulligan 'MWM' with exercise: (n=20), Scapular mobilization technique with exercise: (n=20). Both groups received Arm Circles, Pendulum stretch, Towel stretch, Wand exercise, wall climbing, upper body stretch for 3 days a week and continued for 6 weeks (2 sets, 10 repetition with 10 seconds hold were given).

Result: The collected data was statistically analyzed using an unpaired t-test. Mulligan 'MWM' indicates significant effects ($p < 0.01$) in reducing pain and improving functional activity when compared to Scapular mobilization technique along with exercise, assessed by ROM and SPADI.

Conclusion: This study concluded that mulligan 'MWM' is more effective than Scapular mobilization technique along with exercises reducing pain and improving functional activity in adhesive capsulitis of shoulder joint.

Keywords: Adhesive capsulitis, ROM, SPADI, Mulligan 'MWM', Scapular mobilization technique.

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Introduction

Frozen shoulder or Adhesive Capsulitis is determined by pain and the progressive loss of active and passive shoulder range of motion due to the contracture of the joint capsule and fibrosis. Mobilizations with movement (MWM) for joints are used separately or along with other hands-on techniques to increase the quality of joint intra-articular gliding, neurodynamics, and to assist the correct muscle demand. It is a combination of active movement along with passive accessory mobilizations to attain painless movement by restoring the reduced accessory glide.[1] Adhesive capsulitis usually affects females more than males in the age group between 40-70 years. Insulin-dependent diabetes patients have a higher incidence of ACS with bilateral involvement of the shoulder. Adhesive capsulitis of the shoulder (ACS) typically lasts 12 to 18 months with a cycle of three clinical stages.[2] Frozen shoulder involves structures outside the joint capsule, including the coracohumeral ligament in the rotator interval, the musculotendinous unit, and the subacromial bursa. The primary cause of ACS is due to immunological, biomechanical, and hormonal imbalances. The secondary causes may include recent injuries, lack of use due to pain, recent surgeries, and other medical factors such as diabetes mellitus, inflammatory arthritis, etc.[3] External rotation is more affected in the diabetic frozen shoulder because the collagen connected to the bone becomes sticky due to high blood sugar levels, resulting in the limitation of movements and stiffness of the joint.[4] Patients complain of pain over the shoulder while lying on the affected side for more than a few weeks, especially at night, and are unable to perform day-to-day activities, mostly overhead activities such as combing the hair and reaching the back pockets. The patient's non-dominant hand is affected more.[5] Shoulder pain is the third most common musculoskeletal disorder that affects the general population. Patients often complain of adhesive capsulitis. Pathological changes that affect the joint increase intra-articular pressure and restrict the range of motion. The aim of manual therapy is to improve the range of motion.[6]

Adhesive capsulitis is characterized by three distinct stages of variable duration. Typically, the first stage lasts for 3 to 6 months, the second stage from 3 to 18 months, and the final stage from 3 to 6 months. Alternative methods are available to improve the range of motion and function of muscles. These include wax therapy (heating therapy), stretching exercises done by a physiotherapist and self-stretching by the patient, and scapular exercises along with pendular exercises.[7] From a biomechanical point of view, mobilization of the humerus over the scapula results in unbearable pain and discomfort, prompting the therapist not to apply further mobilization. Rather, the mobilization of the scapula with respect to the humerus, which directly stretches the capsule, should be painless and is a better mobilization technique to be performed.[10] The combination of capsular distension and subsequent intensive rehabilitation shows a rapid beneficial effect and improvement from the first week itself. It has been reported that steroid injection is superior to physical therapy alone for functional improvement.[11]

Scapulothoracic joint mobilization, a combination of therapeutic techniques, is used for treating frozen shoulder because it improves the shoulder complex through movement and scapulohumeral rhythm. Scapulothoracic joint mobilization reduces stress on the glenohumeral joint through the correction of the scapula over the thoracic cage.[12] A frozen shoulder restricts scapular motions, including depression, downward rotation, external rotation, and posterior tilt. With a normal radiological appearance, there is pain along with limited elevation and external rotation, a delayed rise in pain near the deltoid insertion, and difficulty sleeping on the affected side.[13] The articulation between the scapula and the humerus during shoulder abduction and flexion follows a scapulohumeral rhythm. The GH joint rotates 120 degrees during shoulder abduction, while the scapulothoracic joint rotates 60 degrees, forming a 2:1 ratio. The scapula rotates more in reverse SHR than the humerus.[14]

Materials and Methods

This study was a randomized clinical trial study design. The study duration was 9 months, from May 2023 to February 2024. The subjects were collected

from the outpatient department at Saveetha Medical College and Hospital. Samples were selected using the simple random sampling technique. A total of 40 subjects were selected based on the inclusion and exclusion criteria. This study was conducted at Saveetha Medical College and Hospital after obtaining Institutional Scientific Review Board (ISRB) approval from Saveetha College of Physiotherapy. Females with a diabetic history, aged between 45-60 years, who had shoulder pain for at least 1 month, painful restriction of active and passive glenohumeral motion, and were in the freezing or frozen stages of ACS were included. Subjects with symptomatic rotator cuff tendinopathy and muscle weakness were also included in this study. Subjects with a recent history of shoulder surgery, a previous history of fracture, myositis ossificans, calcification of tendons, limited shoulder mobility due to neurological deficits, osteoarthritis, rheumatoid arthritis, osteoporosis, osteomalacia, skin deformities/cuts, any bone disease, tumors, or infections were excluded from the study.

Before starting the research study, the researcher explained the study to the subjects. Then, informed consent was collected from all the subjects. The subjects were randomly allotted into two groups using the lottery method, with 20 subjects allocated to each group. The subjects were assessed for shoulder ROM and SPADI. The assessment was conducted after clearly explaining the procedure of the test. Group A (n=20) received Mulligan's 'MWM' with exercise, and Group B (n=20) received the Scapular Mobilization Technique with exercise. Both groups received arm circles, pendulum stretches, towel stretches, wand exercises, wall climbing, and upper body stretches three days a week for six weeks (2 sets of 10 repetitions with a 10-second hold were given).

Group A: Mulligan 'Mwm' Technique

The mobilization with movement (MWM) technique was followed with 3 sets of 10 repetitions and a 2-minute rest in between sets for a period of 3 days per week. The patients were adequately treated with the help of an adjustable couch.

To improve shoulder abduction ROM, the subject was seated comfortably. A belt was fixed around the therapist's hip, and one hand was placed on the humeral head to apply an effective glide. With the other hand, the therapist gently applied counterpressure over the scapula. Slow, active shoulder movements helped maintain the glide until the end of the pain-free range was achieved. At this stage, the glide was released, and the initial position was returned to normal.

To improve shoulder internal rotation ROM, the subject stood with their hand behind their back in an internally rotated position. The affected shoulder was supported by the therapist. To apply a downward traction force on the humerus, the therapist placed one hand on the patient's flexed elbow while the other hand, positioned in the axilla, acted as a fulcrum to stabilize the scapula. The therapist used their abdomen to adduct the patient's upper arm while instructing them to internally rotate the shoulder with the help of the other hand, leading to lateral distraction of the humerus.

To improve shoulder external rotation ROM, the subject was in a supine position. The therapist stood above the plinth on the affected side. One hand was positioned over the humeral head, and a belt was fixed around the bottom of the therapist's foot to provide an inferior glide to the humeral head. The patient attempted to rotate the affected arm to the end of a pain-free range while a downward force was applied to the shaft of the humerus. At this stage, the force was released, and the initial position was returned to normal.

Group B: Scapular Mobilization Technique

Scapular mobilization was performed with 2 sets of repetitions, with a rest interval of 30 seconds between sets.

For scapular superior glide, the patient was positioned lying on the unaffected side. The therapist placed the index finger of one hand beneath the medial scapular border of the affected side while holding the upper border of the scapula with the other hand. The scapula was then shifted upward for a superior glide.

For scapular inferior glide, the patient remained in the same position. The therapist placed the index finger beneath the medial scapular border and held the upper border of the scapula with the other hand, shifting the scapula downward for an inferior glide.

For scapular upward rotation, the patient lay on the unaffected side. The therapist placed one hand's index finger beneath the medial border of the scapula while holding the superior border with the other hand and rotated it upward.

For scapular downward rotation, the patient lay on the unaffected side. The therapist placed one hand's index finger beneath the medial border of the scapula while holding the superior border with the other hand and rotated it downward.

For scapular distraction, the patient lay with the arm at the side. The therapist positioned their ulnar fingers below the medial scapular border to distract the scapula from the thorax.

Exercise Programme

The exercise programme included arm circles, pendulum stretch, towel stretch, wand exercises, wall climbing, and upper body stretches. These exercises were performed 3 days a week and continued for 6 weeks. For each session, 2 sets of 10 repetitions with a 10-second hold were given.

Statistical Analysis

Using descriptive and inferential statistics, the acquired data was tabulated and evaluated. The mean and standard deviation (SD) were applied to all parameters. Significant differences between pre-test and post-test measures were analyzed using a paired t-test. A significance level of $p < 0.01$ was considered statistically significant when using the unpaired t-test to examine changes between the two groups.

Limitations

Smaller sample size was one of the limitation of study, long term effects can be analysed, age category can divide, muscle strength can be assessed using EMG as an outcome measure.

Ethical Considerations: This study was approved by the Institutional Scientific Review Board (ISRB) of Saveetha College of Physiotherapy [01/001/2023/ISRB/PGSR/SCPT].

Research Gap

Frozen shoulder (Adhesive Capsulitis) is a debilitating condition characterized by pain and progressive loss of shoulder mobility due to joint capsule fibrosis. While various physiotherapy techniques, including Mobilizations with Movement (MWM) and scapular mobilization, have been studied for their effectiveness, there remains a lack of comparative studies assessing their impact on functional outcomes in individuals with adhesive capsulitis. Previous research has primarily focused on either MWM or scapular mobilization separately, with limited evidence on their comparative efficacy. Additionally, while both techniques are commonly used in clinical practice, their relative effectiveness in improving shoulder range of motion (ROM) and reducing pain has not been clearly established through randomized clinical trials. Thus, there is a need for more robust evidence to determine the superior technique for optimizing functional recovery in adhesive capsulitis.

Need for the Study

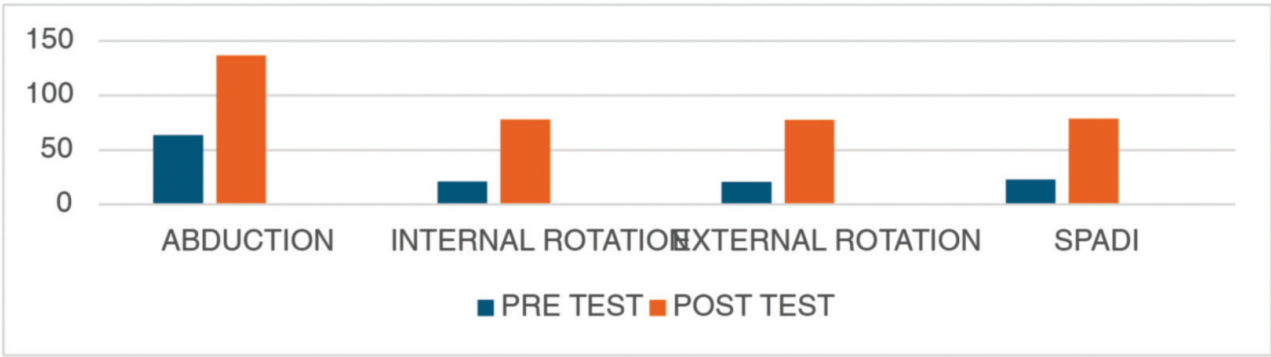
Adhesive capsulitis significantly impairs daily activities, causing pain and restricted movement, particularly in diabetic individuals. Identifying the most effective physiotherapy intervention is essential for improving patient outcomes and enhancing quality of life. This study aims to address the existing research gap by comparing the effectiveness of Mulligan's MWM and scapular mobilization techniques in individuals with adhesive capsulitis. By assessing their impact on pain reduction and functional improvement using ROM and the Shoulder Pain and Disability Index (SPADI), this study provides valuable insights into evidence-based clinical decision-making. The findings can help physiotherapists adopt the most effective rehabilitation approach, ensuring faster recovery and better functional independence for patients suffering from adhesive capsulitis.

Result

The mean and standard deviation (SD) were applied to all parameters. The significant differences between pre-test and post-test measures were analyzed using the unpaired t-test to examine significant changes between two groups. Subjects of members with the adhesive capsulitis of shoulder joint are assessed for pre-test and post-test using Table 1: compare pre-test values and post-test values of ROM in Mulligan MWM, showing that the pre-test value is 5.80 were decreased to 2.20 in post-test and SPADI value were decreased from 3.60 to 5.00 with the P value < 0.0001, the finding was statistically significant. Table 2: Compare the pre-test and post-test values of ROM in Scapular mobilization group, showing the pre-test value is 5.80 were decreased to 3.00 in post- test and SPADI values were decreased from 3.60 to 4.80 with the P value of < 0.0001, the finding is statistically significant. Table 3: Compare post-test values of both groups, Mulligan MWM mean was 2.20 for ROM and 5.00 for SPADI and Scapular mobilization technique mean was 3.00 for ROM and 4.80 for SPADI, p value is <0.0001 are statistically significant.

Table 1. Pre and Post test values of mulligan 'MWM' by using ROM and SPADI

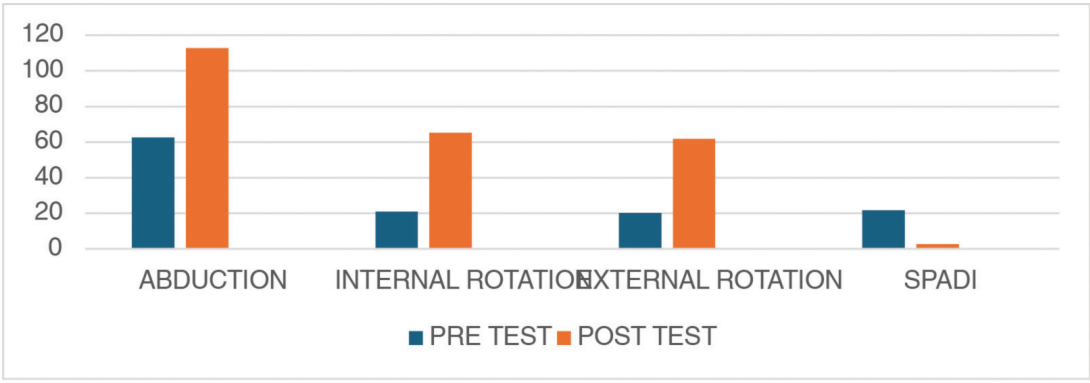
OUTCOME PARAMETER		MULLIGAN 'MWM'	MEAN	SD	t-value	p-value
RANGE OF MOTION	ABDUCTION	Pre-test	63.70	14.79	15.6925	<0.0001
		Post-test	136.80	20.15		
	INTERNAL ROTATION	Pre-test	21.10	3.91	20.1777	<0.0001
		Post-test	78.00	11.26		
	EXTERNAL ROTATION	Pre-test	20.90	3.60	23.6382	<0.0001
		Post-test	77.80	9.17		
SHOULDER PAIN AND DISABILITY INDEX		Pre-test	22.80	4.44	18.5805	<0.0001
Post-test		78.60	13.76			



Graph 1: Pre and Post test values of Mulligan 'MWM'

Table 2. Pre and Post test values of Scapular mobilization by using ROM and SPADI

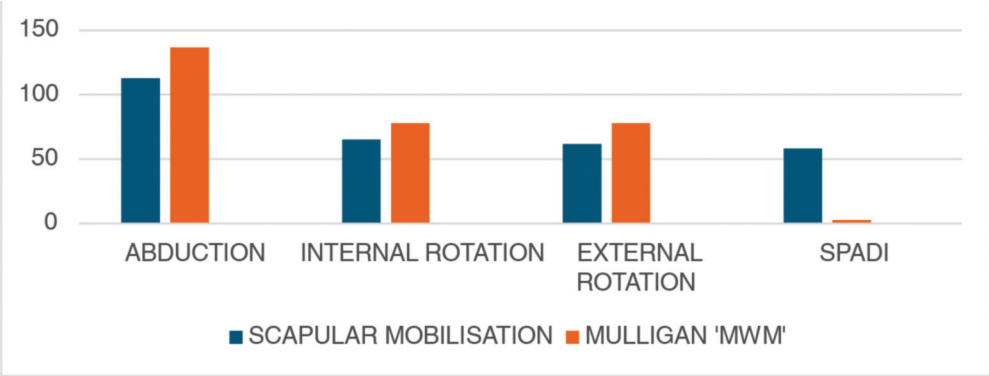
OUTCOME PARAMETER		SCAPULAR MOBILISATION	MEAN	SD	t-value	p-value
RANGE OF MOTION	ABDUCTION	Pre-test	62.60	13.77	11.7780	<0.0001
		Post-test	112.80	9.61		
	INTERNAL ROTATION	Pre-test	21.00	3.58	22.6804	<0.0001
		Post-test	65.20	6.68		
	EXTERNAL ROTATION	Pre-test	20.30	3.01	38.1783	<0.0001
		Post-test	61.80	5.13		
SHOULDER PAIN AND DISABILITY INDEX		Pre-test	21.80	4.51	16.6839	<0.0001
Post-test		58.20	8.45			



Graph 2: Pre and Post test values of Scapular mobilization

Table 3. Post test values of both groups by using ROM and SPADI

OUTCOME PARAMETER		GROUPS	MEAN	SD	t-value	p-value
RANGE OF MOTION	ABDUCTION	Mulligan 'MWM'	136.80	20.15	4.8085	<0.0001
		Scapular mobilization	112.80	9.61		
	INTERNAL ROTATION	Mulligan 'MWM'	78.00	11.26	4.3733	<0.0001
		Scapular mobilization	65.20	6.68		
	EXTERNAL ROTATION	Mulligan 'MWM'	77.80	9.17	6.8088	<0.0001
		Scapular mobilization	61.80	5.13		
SHOULDER PAIN AND DISABILITY INDEX		Mulligan 'MWM'	78.60	13.76	5.6511	<0.0001
Scapular mobilization		58.20	8.45			



Group 3: Post test values of both groups by using ROM and SPADI

Table 4. Demographic breakdown of the samples

Variable	Group A (MWM + Exercise) (n=20)	Group B (Scapular Mobilization + Exercise) (n=20)	Total (N=40)
Age Range (Years)	45-60	45-60	45-60
Mean Age (Mean ± SD)	52.5 ± 5.2	53.0 ± 5.5	52.75 ± 5.35
Gender (%)	100% Female	100% Female	100% Female
Diabetic History (%)	100%	100%	100%
Duration of Symptoms (Months)	≥ 1 month	≥ 1 month	≥ 1 month
Stage of Adhesive Capsulitis	Freezing/Frozen	Freezing/Frozen	Freezing/Frozen
Dominant Side Affected (%)	60% Right, 40% Left	60% Right, 40% Left	60% Right, 40% Left

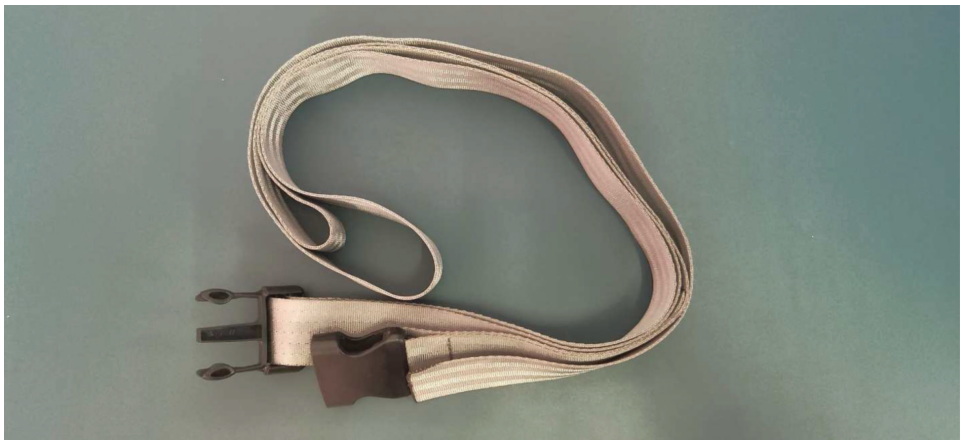


Figure 1: Mulligan belt

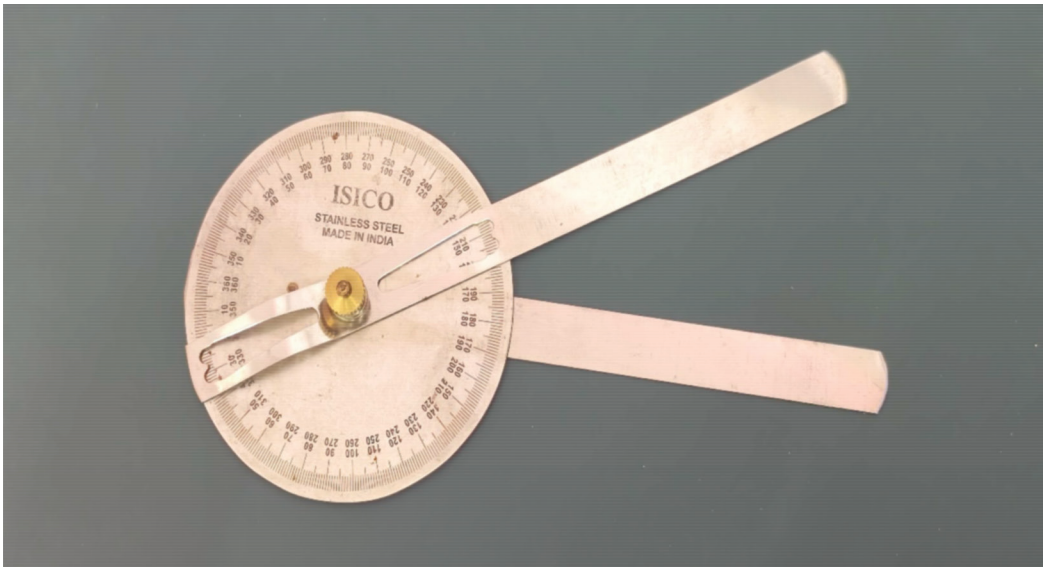


Figure 2: Goniometer

Discussion

Based on the statistical analysis, both groups showed improvement in ROM and SPADI. However, subjects in Mulligan 'MWM' showed better improvement in ROM and SPADI than the subjects in Scapular mobilization group along with exercise. Bhumika Patel, et al., when combined with conventional therapy, 'MWM' helps people with adhesive capsulitis enhance their functional limitations and shoulder range of motion.[2] RK Minerva, Nityal Kumar Alagingi, et al., according to this study, patients with adhesive capsulitis of the shoulder, Mulligan mobilization is better to Maitland mobilization in the form of pain reduction and improving shoulder function.[6] Sumaira Nawaz, Samra Anwar, et al., when treating pain, range of motion, and limitation in patients with adhesive capsulitis, Mulligan mobilization has shown greater effects compared to Post Facilitation Stretch, a muscle energy treatment technique.[8] Hafza Bushra Razaq, Aasma Basharat, et al., according to this study, patients with diabetic adhesive capsulitis recognize improvements in pain, range of motion, and a functional deficit by using both Mulligan's technique and Spencer's muscular energy technique.[5] Sharick Shamsi et al., according to this study, mulligan mobilisation approach gives superior pain VAS score improvement than Maitland. Both approaches perform constantly the same for enhancing the functional score in patient with adhesive capsulitis of shoulder joint.[16] Ujwal L Yeole, Pratiksha D Dighe et al., according to this study, best way for reducing pain and improving range of motion in patients with stiff capsulitis of the shoulder movement paired with mobilisation.[7] B Haveela, Praveen Dowle et al., according to this study, when combined with exercise and ultrasound therapy, Mulligan's MWM technique enhances patients' pain scores, shoulder range of motion, and daily activities in patients with frozen shoulder.[3] Jonathan Zavala-González, Francisco Pavez-Baeza et al., according to this study, joint mobilisation appears to enhance range of motion and minimise pain in individuals with primary adhesive shoulder capsulitis when compared to therapies without manual therapy.[17] K Sreenivasu, VK Paul Daniel et al., according to this study, when assessed to end mobilisation alone, end range mobilisation along with scapular mobilisation enhances range and function effectively.[15] S Pragassame, VK Mohandas Kurup et al., according to this study, compared with conventional therapy, patients who had scapular mobilisation proved a significantly larger level of improvement.[14] NK Antari, Gede Parta Kinandana et al., according to this study, scapulothoracic joint mobilization increases the range of motion

and functional ability more when compared to interventions glenohumeral joint mobilization alone.[12] Hebatallah Mohamed Said Zaghloul, Hesham Ahamed Ali et al., according to this study, when combined with the indicated method, mobilization and flexibility can greatly lower the pain intensity.[10] Umair Ur Rehman, Shakil Ur Rehman et al., according to this study, curing of idiopathic adhesive capsulitis of the shoulder, ultrasound along with mobilization and mobility produced better results.[9] Niraj Kumar, Siddhartha Sen et al., according to this study, people with diabetic frozen shoulder, movement with mobilization (MWM) therapy, strengthening exercises, and moist heat therapy (MHT) greatly improved pain, range of motion, muscle strength, and joint sense.[4] P Khyathi et al., according to this study, when compared to the Spencer technique, MWM proved to be significantly more effective in improving shoulder abduction, external rotation range of motion, and functional limitation in subjects with frozen shoulder.[1]

Conclusion

Finding of the study concludes that Mulligan 'MWM' appears to be more effective than Scapular mobilization technique along with exercises reducing pain and improving functional activity in patient with adhesive capsulitis of shoulder joint.

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Sport-Specific Differences in Static and Dynamic Balance: A Comparative Investigation

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Abstract

Background: Balance is a critical component of athletic performance and injury prevention. Static and dynamic balance are the two components of balance. Static balance involves the ability to balance in a stable environment whereas dynamic involves the ability to maintain equilibrium during movement. These abilities can vary based on different individuals. Emerging evidence suggests that sports-specific demands may significantly influence their development.

Objectives: Sport-specific differences in static and dynamic balance were analysed and discussed.

This study investigated the relationship between static and dynamic balance abilities in athletes.

Methods: Eighty athletes aged 12-18 years from four different sports (gymnastics, judo, soccer, and hockey) participated. Static balance was assessed using the Balance Error Scoring System (BESS) on both firm and foam surfaces. Dynamic balance was evaluated using the Star Excursion Balance Test (SEBT).

Result: Results indicated significant differences in both dynamic and static balance performance across the sports statistically. Gymnasts demonstrated superior static and dynamic balance compared to the other three groups *($p<0.05$)*. Judo athletes also exhibited better static balance than hockey and soccer players *($p<0.05$)*.

Conclusion: These findings suggest that sport-specific sensorimotor demands may influence the development of balance skills. This information can be used to inform the design of sport-specific balance training programs for injury prevention and performance enhancement.

Keywords: Athletes, balance, balance error scoring system, sports, star excursion balance test.

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Introduction

Balance is a complex mechanism which involves maintaining stability and control of the body while moving or stationary. Balance plays a significant role in a young athletes' performance and injury prevention [1].

The selection of different sports for this comparative study was based on varied biomechanical and sensorimotor demands of the following sports, giving us more insight into how these sporting activities influence balance and postural control.

Gymnasts perform exercises which involve physical activity with artistry which often involves complex movements. They use various appliances like bars, beams, vaults, rings etc. to perform their sport. Most of their skills require increased strength, mobility, flexibility and exaggerated range of motion [2].

Athletes playing soccer often require good coordination and strength. They require skills to perform motions like passing, shooting, and dribbling the ball while wearing cleated or non-cleated shoes and running on different surfaces like artificial or non artificial turf [3].

Judo is a martial art where players are required to have incredible leg strength and balance to perform grappling, throwing and submission moves on the tatami-mat on bare foot.

High balance function of the body is needed to support the load on the toes and plantar surface [4].

Field hockey players use a stick to hit a small hard ball across a field and into a goal.

This sport requires players to maintain controlled balance and stability while running, changing directions, tackling, and striking the ball.

We theorized that the discussed sports demand different mechanics, giving us more insight into how these sporting activities influence balance and postural control.

Review of Literature

Comparison of static and dynamic balance in young female collegiate soccer, gymnasts and basketball.

Eadric Bressel, EdD, Joshua C Yonker, MS, LAT, ATC, John Kras, EdD, and Edward M Heath, PhD.

This article studied static and dynamic balance using BESS and SEBT respectively in collegiate Soccer, gymnasts and basketball players.

Results show that gymnasts performed better in static balance by having an error score 55% lower than the basketball group.

Soccer players performed better in the SEBT by 7% showing better dynamic balance as compared to basketball.

Results show no significant difference between static and dynamic balance between gymnasts and soccer players. Basketball players showed inferior static balance as compared to gymnasts and reduced dynamic balance as compared to soccer players [2].

Static and dynamic balance in young athletes

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This article discusses the significance of improving static and dynamic balance in young athletes at different ages. It also talks about how different sports require different postural control and sensorimotor abilities. It further analyses existing literature on athletes at different age ranges and playing sports at different levels. This study highlights the further need for study based on different balance mechanics at different ages and different sports [5].

Dynamic Balance Differences as Measured by the Star Excursion Balance Test Between Adult-aged and Middle-aged Women

Lucinda E. Bouillon, PT, PhD and Joshua L. Baker, PT, PhD

Dynamic balance was tested between Adult aged and Middle aged women in this study. Lucinde et al studied 53 healthy recreationally active women that were divided based on age into 2 groups. (n=29) aged 23-39 y.o and (n=24) aged 40-54 y.o.

Each participant performed the SEBT in anteromedial, medial and posteromedial directions

in randomized order. Results showed significant difference in the scores,with younger women performing approximately 7 cm more in all three directions as compared to older group [6].

The Comparison of Balance Ability Between Judo Players and Non- Athletes

Ching-Cheng Chiang, Jinn-Yen Chiang, Tzyy-Yuang Shian

This study focused on comparison of Static and dynamic balance in Judo players vs non athletes. The groups consisted of 10 elite judo players (mean age 21.2 ± 1.5 years) and 10 non athletes (mean age 19.2 ± 1.9 years)

Static and dynamic balance was tested by using the Kistler force plate system and tensiometer. They assessed the difference of balance on single leg stance with eyes closed, Center of Pressure (COP) of body sway and time of recovery. Results show significant difference between static and dynamic balance between the two groups. Judo players had a smaller radius of body sway COP in static tests than the non-athlete group. In dynamic balance there was a significant difference between the recovery times between the groups[7].

Unilateral balance performance in female collegiate soccer athletes.

Jennifer L Thorpe, Kyle T Ebersole

This study investigated strength and postural control on the SEBT in NCAA Division I female collegiate soccer and non soccer athletes (non soccer n=11, soccer n=12). Isokinetic strength testing was done for all participants in different positions:supine ankle dorsiflexion and plantar flexion, seated leg extension and flexion and supine hip extension and flexion.

In addition these athletes performed maximal SEBT reaches in anterior, medial and posterior directions on both limbs.

Results indicated SEBT test results are similar for both limbs in both groups. Soccer groups had significantly better scores as compared to non soccer athletes. SEBT scores did not have correlation to strength tests. It concluded that SEBT score differences might be due to neuromuscular factors and sport related adaptations [8].

Comparison of the static and dynamic balance performance in young, middle-aged, and elderly healthy people.

by Mei-Yun Liaw, Chia-Ling Chen, Yu-Cheng Pei, Chau-Peng Leong, Yiu-Chung Lau

Chang Gung Medical Journal.

In this study, static and dynamic balance were compared based on age. A total of 107 healthy individuals (n=107) divided into young (16-39 years), middle age(40-59 years) and elderly (60 years and above) groups.

Balance was assessed by computerized dynamic posturography (CDP) on smart balance master. The subtests were as follows: "subtest 1, eyes open, fixed support platform; subtest 2, eyes closed, fixed platform; subtest 3, eyes open, fixed platform; subtest 4, eyes open, swaying platform; subtest 5, eyes closed, swaying platform; subtest 6, swaying visual surround, swaying platform." Motor balance control tests included limit of stability test at 75% in 8 directions: left-right and forward-backward rhythmic weight shift test (RWS)

The tests concluded that elderly individuals tend to use more hip strategy when balancing on swaying support surfaces with low to no visual surround. Elderly individuals also showed increased reaction time and lower directional control in balance performance [9].

Aim and Objectives

Aim:

This study aimed to investigate and compare static and dynamic balance performance across athletes from soccer, gymnasts, judo and hockey disciplines.

Objectives:

The specific objectives of this investigation were to:

- Quantify static balance performance on both firm and foam surfaces and score it based on BESS.
- Evaluate dynamic balance performance using the Star Excursion Balance Test (SEBT).
- Determine and compare inter-sport differences in static balance performance.
- Determine and compare inter-sport differences in dynamic balance performance.

Method and Methodology

STUDY DESIGN: Observational, between-groups design. Independent variables included sports-played and limb (dominant and nondominant).

STUDY SET UP: KridaPrabodhini athletic training facility(Balewadi sports centre) and Loyola high school football centre.

SAMPLING METHOD: Convenient

SAMPLE SIZE: 80 *(n=80), Judo (n=20), Hockey (n=20), Gymnastics (n=20) and Soccer (n=20)*

MATERIALS: measuring tape, pencil, markers, adhesive tape, thera board, stopwatch.

Inclusion Criteria

- Age 12 to 18 athletes
- At least 2 years to 5 years of athletic training
- No injury in the past 6 months.

Exclusion Criteria

- Athletes with any injury,
- Athletes with vestibular problems.

Procedure

The study was reviewed and approved by Sancheti Institute College of Physiotherapy. This study took place at KridaPrabodhini athletic training facility (Balewadi sports centre) and Loyola high school football centre. Permission was obtained from all the above mentioned centers.

Participants were selected based on the inclusion and exclusion criteria. Informed consents were obtained from the participants and their athletic coaches before beginning the study.

Star excursion balance test (SEBT) was used to measure dynamic balance in this test.

Balance error scoring system (BESS) was used to assess static balance. Theraboard was used as the unstable surface and a tiled floor was used as a stable surface for this test.

SEBT: Dynamic balance

This test consisted of forming a star shaped grid by using 8 lines of 120 cm in length each. All these lines were made in 45 degree angle increments. We used athletic tape to make this grid on a firm tiled surface. A small circle was made in the center of the star which marked the position of the stance foot.

As per Gribble and Hertels protocol, the participant would stand on one leg in the center circle and try to reach maximum distance in all eight directions using the other leg. The athletes were instructed to do a touchdown with the reach leg without putting too much weight to support. If the participant would support on the reach leg or lose balance on the support leg then the trial was repeated [10.]

Three trials were performed and there was a 120 sec rest given in between each trial. Participants were given 180 secs to familiarize themselves with SEBT before performing the trial.

Measurements: Each reach distance was measured by putting a chalk mark corresponding to the reach foot. A measuring tape was used to calculate the distance to the nearest millimeter.

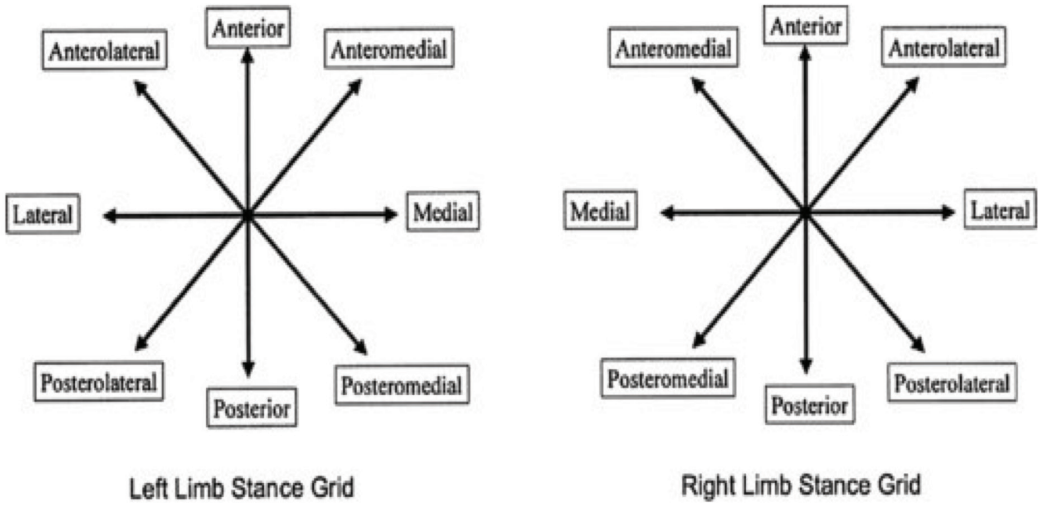

Figure 1: SEBT testing grid

The testing grid for the Star Excursion Balance Tests. The directions are labelled based on the reach direction in reference to the stance limbsource: Hertel et al. 2006)[10.]

BESS : Static balance

Participants performed this test for 20 secs on foam and firm surfaces in 3 different stages:

1st: Feet together

2nd: Single leg stance (non-stance leg at 90 degree knee flexion)

3rd: Tandem stance

They were instructed to stand with hands on their hips and eyes closed.

Measurements

Once the participant has assumed each position, a 20 second timer was started and errors were measured. An error was rated when one of the following occur:

1. Moving hands off iliac crest
2. Opening the eyes
3. Step stumble of fall
4. Abduction or flexion of hip beyond 30 degrees
5. Lifting forefoot or heel off the testing surface
6. Remaining out of the proper testing position for greater than 5 seconds.

Maximum total number of errors for any single condition is 10 [11.]

Results

Static Balance

Table 1. BESS score for different athletes on different surfaces and the total score

SURFACE	HOCKEY	JUDO	GYMNAST	SOCCER
FIRM	6.15 (30)	2.52(30)	3.4 (30)	4.6 (30)
FOAM	9.02 (30)	5.8 (30)	4.9 (30)	10.18 (30)
Total	15.17	8.32	8.30	14.78

Data Analysis

Static Balance

Data analysis was done using Statistical Package for Social Sciences (SPSS) software.

A two way Analysis of variable (ANOVA) was done to compare mean error scores on different surfaces (firm and foam) across different sports.

As inferred from Table 1. the BESS score for Judo players was the least on firm surface 2.52 (i.e. 8.4%) followed by Gymnasts having a score of 3.4 (i.e. 11.33%) followed by soccer and hockey players having values 4.6(i.e. 15.33%) and 6.15 (i.e. 20.5%) respectively.

Static balance on foam surface is shown best by Gymnasts having a BESS score of 4.9 (i.e. 16.33% error) second best shown by Judo players having a score of 5.8 (i.e. 19.33% error), followed by hockey and soccer players having scores of 9.02(i.e. 30.6% error) and 10.18 (i.e. 33.9% error) respectively. Post-hoc Tukey's test indicated significant differences between hockey/soccer and gymnasts/judo across both surfaces *($p<0.05$).*

Static Balance is proved to be better in gymnasts having an error score of 8.30 followed by judo players having a total error score of 8.32 followed by soccer and hockey players. The difference in the total scores are significant as indicated by post-hoc Tukey's test *($p<0.05$).*

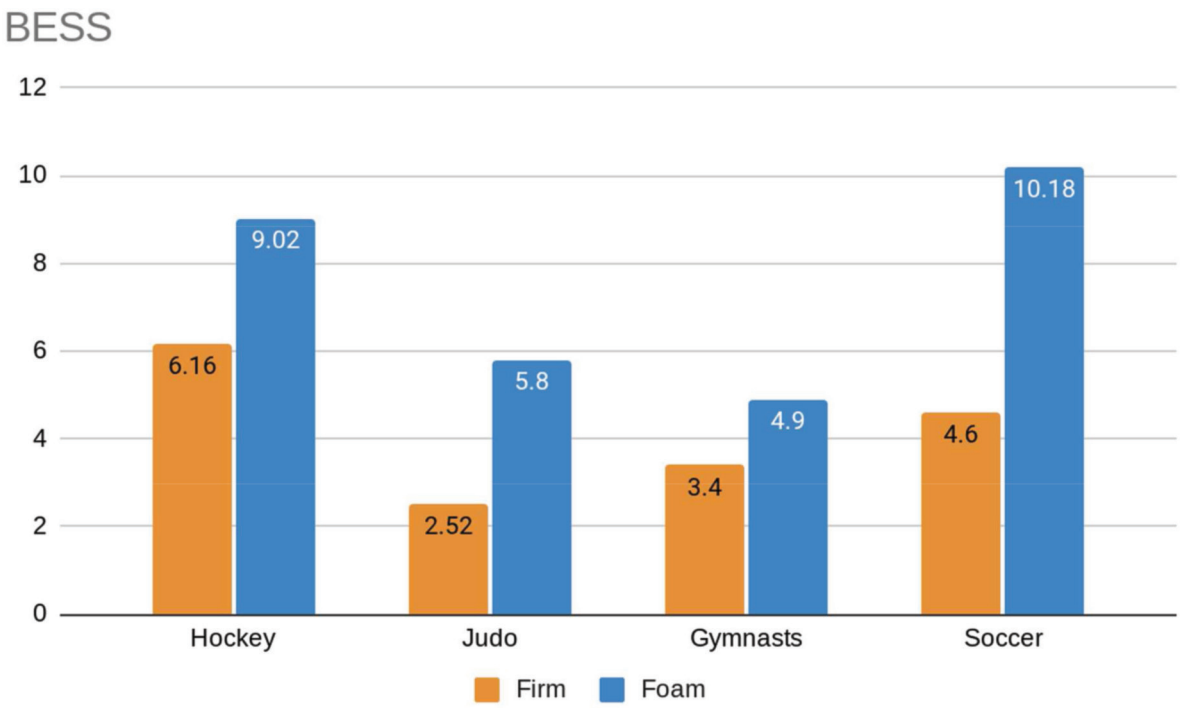

Figure 2: Error scores for different sports on different surfaces

Dynamic Balance

Calculations

Limb length % of all the positions (i.e. Ant, Ant-Lat, Lat, Post-Lat, Post, Post-Med, Med, Ant-Med.) were calculated by using the formula:

Limb Length %= Excursion distance/Limb length x 100

Summation of Limb Length % of all the positions were done for each player for both limbs and the mean of that was taken for every sport. A one way ANOVA test was done to compare the value between these four sports.

Depicted in Table 2. is the mean limb length percentages of different sports. A one way ANOVA study shows significant differences in dynamic balance across sports. Post-hoc Tukey findings reveal that gymnasts had the highest limb length % of 935.58 followed by hockey of 866.85, judo at 811.56 and finally soccer at 782.86. Significant differences were indicated between gymnasts and the rest of the athletes *($p<0.05$)*

Table 2. Comparing summation of limb length % of different sports.

Sports	Hockey	Judo	Gymnasts	Soccer
Summation of Limb length %	866.85	811.56	935.58	782.86

A graphical representation of limb length percentage in different sports is depicted in Graph 2.

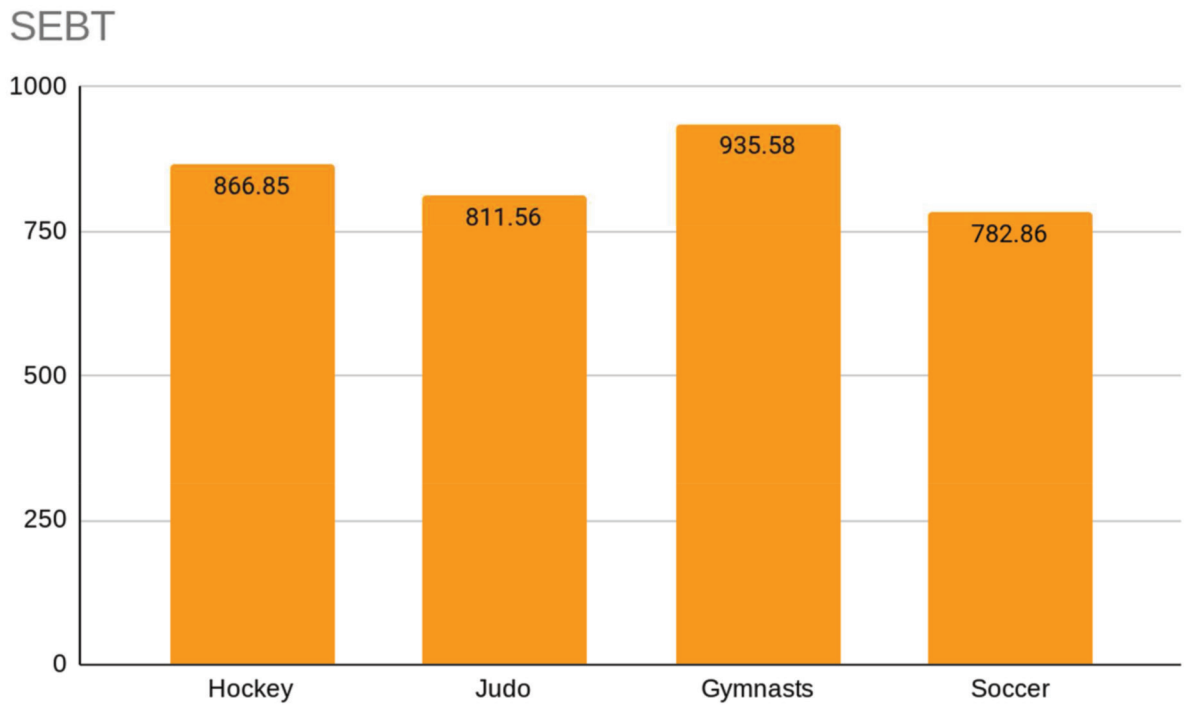

Figure 3: Limb length percentage for different sports

Discussion

This study reveals distinct variations in static and dynamic balance capabilities among athletes participating in different sports. Gymnasts demonstrated superior performance in both static and dynamic balance assessments compared to judo, soccer, and hockey players. Furthermore, judo athletes exhibited enhanced static balance compared to their soccer and hockey counterparts.

These findings suggest a correlation between the specific sensorimotor demands inherent in each sport and the development and expression of balance proficiency. The observed performance variations may be attributed to factors such as the characteristic movement patterns of each sport, the playing surfaces involved, and the degree of emphasis placed on balance training within each discipline. These results offer practical implications for coaches and athletic trainers in the design of sport-specific balance training regimens aimed at optimizing athletic performance and potentially mitigating injury risk.

Further investigation is warranted to elucidate the underlying mechanisms contributing to these inter-sport differences and to evaluate the efficacy

of targeted balance interventions for athletes across various sports. Future research should consider controlling for potentially confounding variables such as training volume, skill level, and history of musculoskeletal injury to more precisely isolate the influence of sport participation on balance abilities. Additionally, the inclusion of measures assessing related factors such as proprioception, strength, and range of motion would contribute to a more comprehensive understanding of the multifaceted determinants of balance performance in athletes.

The literature seems to support that athletes undergoing static and dynamic balance training have lesser incidences of ankle sprains and other musculoskeletal injuries as compared to the control group [12.]

A study conducting static and dynamic balance between female soccer, basketball, and gymnastic athletes discussed that the study will help prescribe different exercises to different athletes to strengthen their performance and reduce injuries [2.]

In addition to knowing which balance training programs are effective, athletic trainers and physical therapists would benefit from knowing which athletes require more balance training to reduce musculoskeletal injuries.

Conclusion

This study successfully demonstrates significant clinical and statistical differences in balance between the four sports: judo, hockey, gymnastics, and soccer. The gymnasts showed superior balance in both static and dynamic measures as compared to the other sports highlighting the importance of flexibility and their sports unique sensorimotor demands.

Judo athletes also showed enhanced static balance scores as compared to hockey and soccer players further supporting the notion of how sport specific training shapes balance abilities.These findings offer valuable insights to coaches, athletic trainers, and sport physiotherapists to develop targeted balance training programs to reduce risk of injuries and improve performances.

Study Limitations

This study acknowledges various limitations that require considerations. Athletes strength and proprioceptors were not assessed prior to the test. The potential of these factors playing an influential role in static and dynamic balance across sports could not be determined. Furthermore, the lower extremity and trunk ROM of these athletes were not measured. The variations in ROM to the balance performances remain unclear. These limitations warrant further need for studies taking into account these variables and its effects on static and dynamic balances.

Scope For Future Studies

To broaden the findings of this investigation, several avenues for future research are proposed. Firstly, increasing the sample size will improve generalizability of the study with more statistical data. Secondly, doing a detailed analysis on male and female athletes will give a better understanding of how gender plays a role in dynamic and static balance. Finally, a study comparing dominant and non dominant legs will give a better insight on lateralized balance control strategies and their potential impacts on sport-specific performance.

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