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Outcome of a Multidimensional Physiotherapy Protocol in the Unique Case of a Bilateral Facial Palsy: Case Report

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Abstract

Background: Bilateral facial palsy is a rare disorder that significantly affects facial expressiveness, emotional well-being and social interactions. Effective rehabilitation approaches play a key role in enhancing functional and psychological outcomes of patients.

Case Report: This study focuses on a 30-year-old woman with bilateral facial palsy of unknown cause. After comprehensive diagnostic evaluations excluded common causes, the patient began an 8-week multidisciplinary physiotherapy program that emphasized motor function, emotional expressiveness, and social participation. Complementary therapy, functional exercise, and patient education were included in the plan.

Result: Notable improvements were observed in the patient's social confidence, speech clarity, and facial motor function. The physical function subscale of the Facial Disability Index (FDI) scores increased from 25/100 to 90/100, whereas the social function subscale scores increased from 55/100 to 100/100. At follow-up, progress was maintained.

Conclusion: Patients with bilateral facial palsy can benefit from a multidisciplinary physiotherapy strategy that combines psychological and physical rehabilitation to improve their quality of life and recovery rate. It is advised that more research be done on the differences in therapy response based on age and gender.

Keywords: Bilateral facial palsy, physiotherapy, rehabilitation, Facial Disability Index, facial muscle function, psychosocial impact, multidimensional approach

Introduction

Bilateral facial palsy (FP) is a rare neurological condition that involves paresis of both sides of the facial muscles, which can occur simultaneously or sequentially. Paresis arises due to infra-nuclear lesions causing malfunctions of the facial nerve (cranial nerve VII), which innervates the mimetic

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muscles of the face.[1] While the annual prevalence of unilateral FP is 20-32.2 per 100,000 people, bilateral FP cases are far less common, with an incidence of 0.2-2%.[2]

Facial expressions, particularly smiling, play a vital role in emotional communication and social interaction. Smiling impairment has been discovered to be a major predictor of depression in patients with facial neuromuscular diseases.[3] Therefore, understanding the clinical presentation and impact of bilateral facial palsy is crucial for diagnosis and treatment.

Facial palsy can be classified based on various factors, including the location of muscle weakness (proximal vs. distal), type of neuron involvement (upper motor neuron vs. lower motor neuron), distribution (unilateral vs. bilateral), and the location of nerve damage (central or peripheral).[4]

The most prevalent acquired etiologies identified in the case series of bilateral facial palsy were Lyme disease, Guillain-Barre syndrome (GBS), sarcoidosis, trauma, and high blood pressure. Rapidly progressing palsy is frequently brought on by autoimmune diseases, infections, or trauma while slowly progressing palsy may be caused by neoplastic disorders.[5-8]

While age and sex do not show significant differences in incidence,[9] certain populations demonstrate higher vulnerability. Pregnant women have a higher incidence of facial palsy (45/100,000 births) than non-pregnant women (17/100,000 births). It generally appears in the third trimester or immediately following childbirth.[10] Additionally trauma-induced facial palsy contributes to five percent of all occurrences of facial paralysis.[11]

Case Report

A 30-year-old woman presented with bilateral facial palsy, referred by a neurologist in March 2023. She reported facial muscle weakness on both sides, difficulty in facial expressions, and impaired oral motor function since November 2022. Examination revealed no pain or weakness in the upper and lower limbs. The patient had no family history of facial palsy.

Investigation

Comprehensive assessments, including chest X-ray, complete hemogram, nerve conduction studies for upper and lower limbs, Liver Function Tests (LFT), thyroid function, angiotensin-converting enzyme (ACE), and creatine phosphokinase (CPK), were performed.

The LFT indicated increased SGOT and SGPT levels, leading to a diagnosis of grade 1 to 2 fatty liver.

The etiology of bilateral Bell's palsy remains unidentified.

The patient had a history of acne and was referred for dermatological treatment. Ophthalmological consultation was conducted for eye health maintenance. She underwent right tooth extraction in March 2023, after which her facial pain and weakness worsened. She was then referred for physiotherapy.

Clinical Assessment

- **Neurological Findings:**
  - Symmetrical facial weakness
  - Slurred speech
  - Difficulty closing both eyes (positive Bell's sign)
  - Absence of forehead wrinkling
  - Inability to hold air/water in the mouth or blow the cheeks
  - Difficulty smiling
  - Watery eyes (epiphora)
  - No sensory deficits
- **Baseline Facial Disability Index (FDI) score:**
  - Physical Functional Subscale: **25/100**
  - Social Functional Subscale: **55/100**

Timeline

November 2022: The patient started with facial muscle weakness

March 2023: Facial weakness symptoms worsened after tooth retraction

19 March 2023 to 15 May 2023: The patient received a functional training program at the physiotherapy clinic

24th July 2023: First follow up

24th October 2023: Second follow up

Management

Patient Goals

- Regain facial expressions and emotional expressiveness.
- Improve speech clarity.
- Enhancing social interactions.

Physiotherapy Goals

- Improving muscle strength and coordination.
- Motivate the patient.
- Restoration of activities of daily living (ADLs), such as brushing and chewing.

A multidimensional approach was implemented based on a previous study by Prakash et al. (2012).[12]

Functional training programs included patient education, functional training, and complementary training components.

Patient Education

Alter the patient's way of thinking so that she will feel or act better even if the situation does not alter. Reconstruct the patient's beliefs and perceptions of concerns, including misconceptions about how others or society view the patient's handicap and unfavorable self-perceptions of facial attractiveness (body image).

Functional Training

Facial movements that play a role in the patient's activities of daily living (ADLs), such as expressing emotions (smiling, frowning, and surprise), speaking, and eating (use of mastication muscles), are essential components of functional facial tasks, particularly for emotional expressiveness. Exercises included jaw opening and closing with and without resistance, lateral jaw movement, and goldfish exercise (opening and closing the mouth in a small and controlled manner). The patient was asked to watch a movie or series and narrate the story during the session to encourage emotional expressiveness in a real-life context.

Complementary Therapy

To aid the facial muscles surrounding the mouth, lips, and eyes in their motor functions. The patient was encouraged to hum or sing her favorite tunes as often as possible to engage the oro-facial muscles.

Other exercises included rinsing water and spitting it out slowly, sucking the cheeks between the teeth, wrapping the lips over the teeth, puckering the lips, and making the speech sounds "sh," "p," "b," and "f" with the teeth clenched. The patient was asked to look down and close their eyes and continue looking down with their eyes closed (eye-closing exercise).

Electrical stimulation was administered in the clinic using a pen electrode five days a week for three weeks. The galvanic current was applied to 11 facial muscles (frontalis, corrugator supercilii, palpebral part of orbicularis oculi, levator labii superioris alaeque nasi, levator labii superioris, levator anguli oris, risorius, orbicularis oris, depressor anguli oris, depressor labii inferioris, and levator menti) to evoke three sets of 30 minimal contractions each. Faradic current stimulation was applied to the nerve trunks (upper, middle, and lower branches) for 10 contractions each.

Physiotherapy treatment was conducted for 45 min per day, six days a week for eight weeks.

Additionally, Home exercises and positive coping strategies were advised. Home exercises included facial muscle massage, functional training exercises, and complementary therapy. The patient was advised to perform the exercises in front of a mirror for better visual feedback.

Outcome

During follow-up, the Facial Disability Index was measured again. FDI score was significantly improved,

- Physical function subscale = 90/100
- Social function subscale= 100/100.

The obtained progress was maintained at the first-month follow-up on 24th July.

Next follow-up was conducted after three months.

No adverse effects or unplanned events occurred during the rehabilitation phase.

Discussion

This case study highlights the effectiveness of comprehensive physiotherapy rehabilitation focusing on the physical, mental, emotional, and psychosocial aspects in rare and complex conditions such as bilateral facial palsy. Our Facial Disability Index (FDI) increased dramatically from 25 to 90 in the physical domain and from 55 to 100 in the social domain. These results are closely aligned with the study by Prakash et al., in which a patient with chronic unilateral facial paralysis demonstrated physical and social FDI improvements from 45 to 95 and 28 to 100 respectively, following an 8-week functional training regimen.[12]

Bilateral facial palsy can be challenging to diagnose and treat. The study by Junyang, et al. analyzed data from 10 studies of bilateral facial palsy involving 75 patients where 80% of patients made a full recovery, while 20% made only partial progress.[9] In most cases, healing is anticipated to occur without intervention, however incomplete recovery does happen occasionally.[13]

Facial function affects a person's emotional, social, and physical health. This includes displaying emotional expressions as well as recognizing and interacting with others.[14] The different parts of the face have a significant impact on speech, eating, and drinking.[15] Additionally, interpersonal attraction is influenced by facial recognition and the impression of facial beauty, which facilitates communication between individuals.[16]

Patients with facial palsy experience functional and aesthetic difficulties that lower their quality of life.[17] Facial paralysis is a complicated ailment that frequently has detrimental psychological and social implications. The study by Saadi et al. showed that both adults and children experienced significantly higher rates of depression.[18]

Therefore, by focusing on emotional and social participation, along with motor control, this study protocol aligns with the biopsychosocial framework. The study of Prakash et al. demonstrated that encouraging context-specific facial functions, positive coping strategies, and social interaction skills was associated with improvements in emotional expression and psychosocial integration.[12] Similarly, our patient reported higher self-confidence and social engagement, reinforcing the concept that emotional and social outcomes are integral to facial rehabilitation.

Numerous studies support the value of active facial exercises and tailored therapy. In large cohorts, including patients undergoing individualized facial rehabilitation, such as neuromuscular training, massage, and home programs, significant improvements in function were observed. Coulson et al. also reported gains in smile symmetry and execution speed using video self-modeling and implementation intentions.[19] Our study adds to the literature by confirming that a structured, context-aware intervention can comparably restore function.

In individuals with Bell palsy, the addition of 3 weeks of daily electrical stimulation following the start of facial palsy (4 weeks) resulted in improved functional facial movements and electrophysiologic outcome measurements at the 3-month follow-up.[20] Although electrical stimulation during the acute phase of Bell's palsy as utilized in this study is safe, it may not be superior to spontaneous recovery and multimodal physiotherapy.[21]

From a psychometric perspective, the FDI is a useful questionnaire, particularly in terms of internal consistency, reliability, and validity. In clinical practice, using FDI alongside clinician-based

grading would be beneficial for providing a better understanding of the social influences on patients.[22]

Conclusion

The primary takeaway from this case study is the incorporation of a holistic approach to physiotherapy. As physiotherapists, our goal should not be merely treating symptoms but treating an individual as a whole. A holistic treatment protocol should encompass the emotional and mental well-being of the patient, alongside the physical aspects. Furthermore, including the patient's goals while planning the treatment protocol is essential for better outcomes.

Patient Perspective

Initially, I was skeptical about whether I would recover from facial paralysis. However, thanks to the care and encouragement I received throughout my recovery, my perspective changed completely. I am truly thankful for the personalized therapy, which has given me the progress and Hope I require to overcome the condition, not only physically but also mentally. Consistent care and visible progress through these treatments gave me hope and gradually restored my confidence. I truly believe I have returned to my former self, and now I can carry out my daily routine with a pleasant smile on my face.

Further Studies

1. The Social Interaction Anxiety Scale (SIAS), Social Appearance Anxiety Scale (SAAS), and Coping Orientation to Problems Experienced Inventory can be used as assessment tools.
2. Comparative studies can be conducted on different genders and age groups.
3. Comparative studies can be conducted on multimodal physiotherapy protocols with and without electrical stimulation.
4. Future research should involve larger cohorts, randomized controlled designs, and longitudinal follow-ups to assess long-term maintenance.

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Comparative Case Study: Difference in Recovery between a Male vs Female Patient Post Total Hip Arthroplasty (THA)

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Abstract

This case study discusses gender-specific differences in recovery trajectory post Total Hip Arthroplasty (THA) surgery. Two age matched patients had their surgery on the same day and were treated two times a week for three weeks by the same physical therapist (PT). Similar PT interventions were followed each session.

Method: Comparative case study.

Results: Both patients demonstrated good overall recovery. The female patient showed better quantitative improvement in hip ROM of abduction and external rotation. In contrast, the male patient showed significant improvement in functional outcomes like Timed Up and go (TUG) score and achieved independence with rollator walker earlier than the female.

Conclusion: These findings suggest that gender may influence post-THA rehabilitation outcomes, highlighting the need for individualized treatment plans.

Keywords: Total hip arthroplasty, gender, physical therapy, rehabilitation, home health.

Background

Total hip arthroplasty is one of the most popular surgeries to treat hip osteoarthritis. Early physical therapy interventions post-surgery with home health have shown improvement in functionality, quality of life, and pain. A study done by Zhang et al shows a significant difference in recovery for patients who receive post-operative rehabilitation versus patients who don't [1]. A Delphi study performed by experts from USA and Canada also concluded the importance of early post operative rehabilitation following THA and the need for development of clinical practical guidelines was highlighted [2].

Potential differences in recovery between male and female patients have not been explored. A scoping review by Giuseppe highlights the need for more gender-related factors to be addressed for better post surgical outcomes, patient satisfaction and to prevent complications [3].

The purpose of this study is to shed light onto the differences in outcomes between a male and a female patient receiving in-home therapy following THA surgery.

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Case Presentations

Both the patients underwent left THA surgery on the same day, 01/27/2025.

Case 1: Female patient

Age: 82 y.o.

Height: 5'4 ft

Weight: 138 lbs

Presurgery diagnosis: severe left hip arthritis.

Goals post THA: To be independent in Activities of Daily Living (ADL), to be able to navigate stairs, to improve range of motion, to have less pain when walking, to be able to get in and out of the car.

Case 2: Male patient

Age: 82 y.o.

Height: 5'6 ft

Weight: 148 lbs

Pre-surgery diagnosis: severe left hip arthritis.

Goals post THA: To be independent in Activities of Daily Living (ADL), to improve Range of Motion (ROM), to have less pain when walking and getting up from the recliner, to be able to get in and out of the car independently.

Assessments

- Both patients started Home Health Physical Therapy (HHPT) one day post-surgery by the same PT 2 times a week for 3 weeks.
- Outcome measures included:
  1. Range of motion (ROM) using a goniometer
  2. Pain based on VAS (Visual Analog Scale)
  3. Gait (Amount of Assistance required)
  4. Timed Up and Go test (TUG)
- A reassessment was done on the 4th session and a discharge was done on the 6th. Data was collected at baseline (1st) session, reassessment (4th) and discharge (6th) sessions.

Differential Diagnosis

- Both patients have the same diagnosis of rehabilitation following left THA surgery.
- Restricted ROM, strength, and mobility following the surgery.

Physical Therapy Interventions/Treatments

After the initial assessment, the patients and therapist worked on collective goals and the following objectives:

1. Improving ROM
2. Reducing pain
3. Formulating an HEP
4. Gait training.

Treatment was given based on Clinical practice guidelines for THA.

The outline of interventions is discussed in **TABLE 1.**

Table 1. PT Interventions.

Session 1	Physical Therapy evaluation(Assessing Gait, TUG, pain,ROM), Formulating a Plan of care (POC), Post surgical precautions discussed, Gentle in bed exercises initiated (Ankle pumps, quad sets, glute sets, Heel slides in supine), Home exercise program (HEP) devised.
Session 2	Gait training(with walker), Exercises: ankle pumps, glute sets, quadricep sets, heel slides (hip knee flexion and hip abduction),Standing weight shifts.
Session 3	Gait training(with walker): Increased ambulatory distance, cues to improve gait pattern. Exercises: continue and progress from session 2 as tolerated, Standing weight shifts, heel raises.

Continue....

Session 4 (Reassessment)	Gait training (with walker) : Increase ambulatory distance, outdoor walking, car transfers. Continue all exercises from session 3, add all exercises to HEP. Test TUG, pain, ROM and gait.
Session 5	Gait training (with walker): stair climbing with cane. Continue and progress all exercises from session 4, Standing mini squats, hip abduction, extension on left leg only.
Session 6 (Discharge)	All exercises reviewed. TUG,Pain and Gait assessed. Patient discharged to Outpatient PT to continue rehabilitation.

Postsurgical precautions and medications were discussed every session. Patients were advised to ice after performing HEPs and post-PT to reduce swelling and pain.

Outcomes

Patient-specific outcomes were collected at 3 points : baseline (initial assessment), reassessment (4th visit) and discharge visit (6th)

1. **Baseline: (1st visit)**

   The patient-specific outcomes for both patients are outlined in **TABLE 2.**

Table 2. Outcomes Baseline (Initial Assessment)

Outcomes	Case 1: Female	Case 2: Male
Pain (VAS)	7/10	5/10
TUG	71 secs	52 secs
Gait (Assistance)	Minimal Assistance with Rollator walker	Minimal Assistance with Rollator walker
ROM (Hip flexion,abduction and External rotation(ER))	70, 5, 15 degrees	75, 0, 10 degrees

As per the assessment, the male patient scored better on the VAS pain scale and TUG and the female patient started with slightly better hip ROM. Both patients required similar assistance for ambulation.

2. **Reassessment (4th visit)**

   Both patients show significant improvement in all outcome measures during this period. Both patients have similar pain levels and the same hip flexion ROM. The female patient showed better improvement in hip abduction and ER ROM as compared to the male.

   The male patient showed a better TUG score and Stand by Assistance when walking vs contact guard assistance for the female.

   The outcomes are outlined in **TABLE 3.**

Table 3. Outcomes Re-assessment (4th visit)

Outcomes	Case 1: Female	Case 2: Male
Pain (VAS)	3/10	3/10
TUG	36 secs	31 secs
Gait (Assistance)	Contact guard assistance with Rollator walker	Stand by Assistance with Rollator walker
ROM (Hip flexion, abduction, ER)	90, 25, 25 degrees	90,15, 20 degrees

3. **Discharge (6th visit)**

   Final outcomes during the discharge visit showed an overall improvement for both patients. The female patient showed better

improvement in all the hip range of motions as compared to the male. The male had a better TUG time but still had minimal pain of 1/10. The outcomes are outlined in **TABLE 4.**

Table 4. Outcomes Discharge (6th visit)

Outcomes	Case 1: Female	Case 2: Male
Pain (VAS)	0/10	1/10
TUG	15 secs	12 secs
Gait (Assistance)	Independent with RW	Independent with RW
ROM (Hip flexion, abduction, ER)	90,35,40 degrees	90,25,30 degrees

Comparison

Patients one and two were treated by the same therapist for 6 visits and had very similar PT interventions.

Patient 1: the female patient had better improvement in overall hip ROM at all 3 data collection points: initial assessment, re-assessment, and discharge as compared to the male patient. Hip flexion ROM remained the same after the 4th visit for both patients showing similar improvement. The graphical description of hip ER and abduction ROM for both male and female at all 3 data points are depicted in **FIGURE 1.**

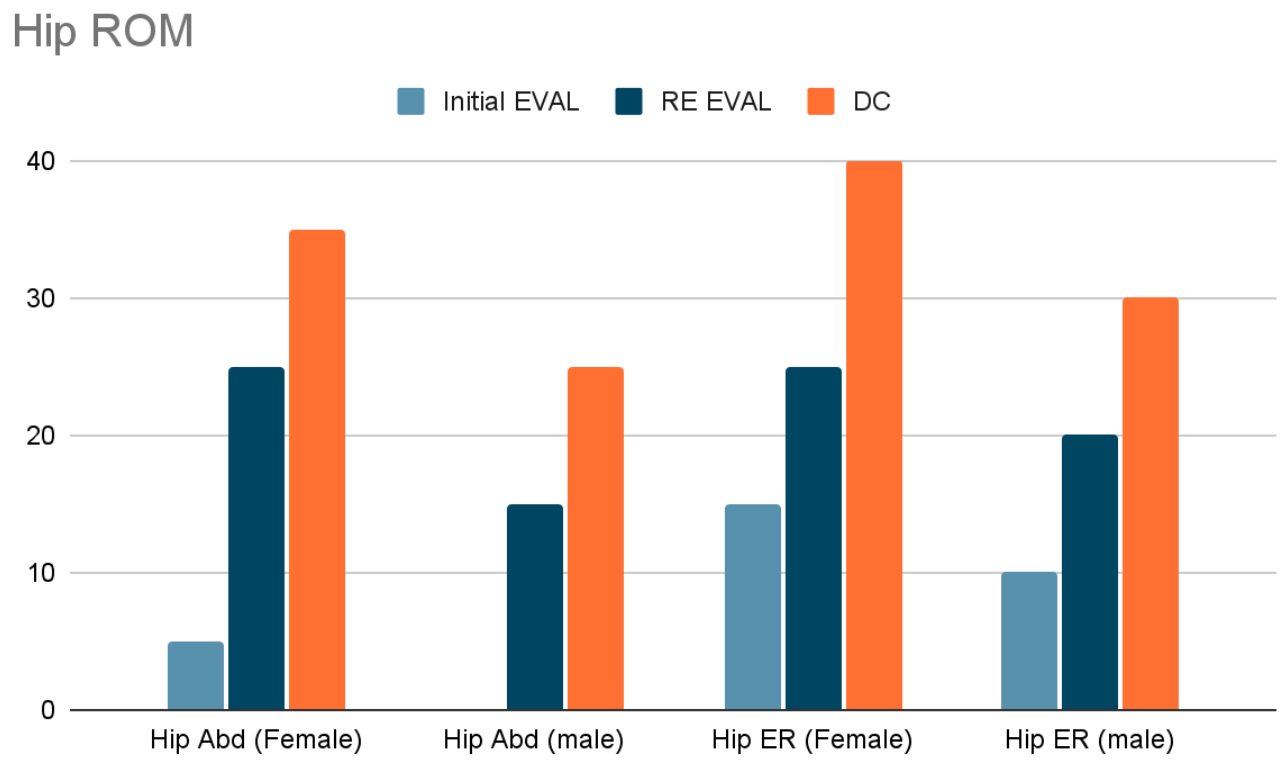


Figure 1: Comparison of HIp Abduction (Abd) and External Rotation (ER) ROM.

Patient 2: the male patient had an overall better improvement in the functional tests like TUG during reassessment and discharge visits. The male patient also required reduced assistance with ambulation prior to the female patient.

The female patient showed more improvement in TUG score from the time of the initial assessment but the male patient performed better and showed consistent improvement at all three phases.

Comparison of TUG between both patients at all 3 intervals are depicted in **FIGURE 2.**

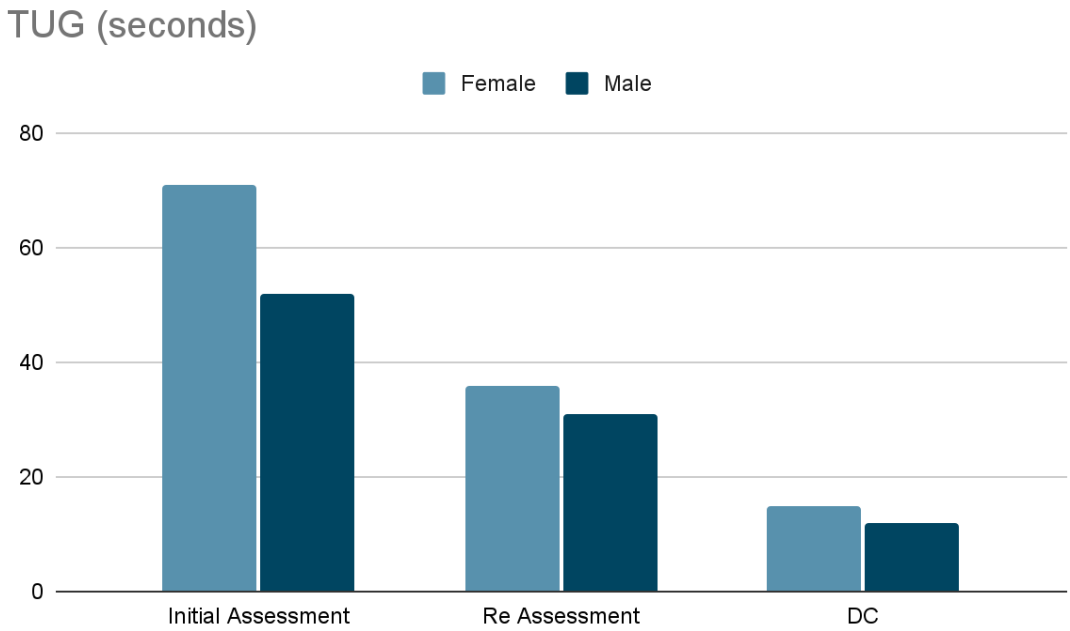


Figure 2: Comparison of TUG score at different intervals.

Discussion

Studies show that THA is one of the most successful surgeries in the world, and 86% of the patients have satisfying results [4]. Gender-based differences in outcomes post-THA have been studied in the past with improved functional activity participation and pain in males as compared to females. It compared outcomes immediately after the surgery and 12 months post surgery [3,5].

This study examines different recovery trajectories of 82 year old male and a female patient undergoing left THA on the same day and treated with identical PT interventions by the same HHPT on the same days.While both patients demonstrated commendable overall improvement in ambulation, ROM and pain following six HHPT visits, there are observed divergences in their recovery patterns. This highlights the potential influence of gender in post operative rehabilitation outcomes.

The female patient's superior gains in hip ROM, particularly abduction and external rotation, may be attributed to inherent anatomical variations in pelvic structure or potentially greater flexibility. Conversely, the male patient's more pronounced improvements in functional mobility, as evidenced by TUG scores and earlier reduction in ambulation assistance, could be influenced by factors such as greater baseline muscle mass or different biomechanical adaptations.

Additionally, hormonal differences also contribute to differences in pain perception and inflammation affecting the recovery pattern. These distinct recovery patterns underscore the critical importance of considering gender as a variable when developing individualized plans of care.

Limitations

- Small sample size (n=2) limits the ability to generalize these findings to a larger population.
- Psychological and social factors like pain coping mechanisms, family support and expectations also play a vital role in recovery.
- Finally, even though both patients were treated by using similar PT interventions, the adherence to HEP could have been varied.

Conclusion

This study highlights the need to explore rehabilitation protocols, consider potential gender based differences as an important variable when planning individualized therapy interventions. This will allow therapists to optimize treatment plans, enhance patient satisfaction post THA and maximize functional gains. Additional research with larger sample size is warranted to further study the differences observed in this study.

Learning Points

- **Gender may play a crucial role in recovery following THA surgery :** Themale patient showed a better recovery in functional outcomes, whereas the female patient showed improved ROM.
- **Early intervention following THA:** Both patients started home health PT one day after surgery and had good outcomes.
- **An individualized plan of care can be key:** Formulating a plan based on gender and other factors is important to get the best results.

Patient Consent

The author states that the research adhered to the principles of "The Declaration of Helsinki", written informed consent was obtained from research participants before initiating the study. The submitted manuscript has maintained confidentiality throughout, and the participants' identity is not revealed in any form.

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No funding was received from external sources

Conflict of Interest: I declare that I have no personal or professional conflicts of interest related to this manuscript.

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Stress, Anxiety and Depression Factors for Disaster Related Pandemic Among Physiotherapists and Nurses in India

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Abstract

Introduction: The COVID-19 pandemic has had a multifaceted impact that has not only overwhelmed healthcare systems but also significantly affected the mental health of essential healthcare workers. Healthcare professionals, including physiotherapists and nurses, have been at the forefront of this emergency,the heightened levels of stress, anxiety, and depression among these professionals, which can be attributed to a complex interaction of professional demands and personal vulnerabilities at the times of disaster related pandemic.This literature review aims to explore the impact of stress, anxiety, and depression factors for disaster related pandemic among physiotherapists and nurses in India.

Methodology: A literature search of databases was conducted to identify relevant articles published between 2013 and 2023. The selected studies covered various disaster contexts and their implications on the mental health of healthcare professionals. The descriptive review specifically focused on stress, anxiety, and depression levels among physiotherapists and nurses in terms of disaster.

Results: Out of total articlesthe ten studies included were in this review, as per the eligibility criteria.The studies found anelevated levels of stress, anxiety, and depression among physiotherapists and nurses experienced during the pandemic. Moreover, the study found that individuals with lower DASS-21 scores demonstrated higher levels of resilience, emphasizing the association between mental health and resilience in disaster situations.

Conclusion: This literature review highlights the importance of addressing the mental health challenges faced by physiotherapists and nurses during disaster situations. The findings underscore the significance of building resilience and establishing support systems to protect the well-being of healthcare professionals. Prompt evaluation of mental health and the implementation of stress management programs are essential to support healthcare professionals during disasters.

Keywords: Resilience, Physiotherapists, Nurses, Disaster Preparedness, India

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Introduction

Disasters, whether natural or man-made, significantly disrupt communities and societies, resulting in severe consequences for public health and safety[1]. In such situations, healthcare professionals, particularly physiotherapists and nurses, play an essential role in disaster preparedness, response, and recovery[2]. Their ability to demonstrate resilience in these challenging circumstances is crucial for maintaining the continuity and effectiveness of healthcare services[3]. Resilience, defined as the capacity to adapt, recover, and thrive in the face of adversity, is a critical attribute for healthcare professionals working in disaster-prone regions[4]. India, with its vast and diverse geography, is susceptible to a wide range of disasters, including earthquakes, floods, cyclones, and public health emergencies. The frequency and impact of these disasters underscore the need for healthcare professionals, such as physiotherapists and nurses, to possess high levels of resilience to respond effectively to the ever-changing demands of disaster situations[5]. However, the specific factors that contribute to resilience among these professionals in the context of disaster preparedness in India remain poorly understood[6]. Disaster preparedness involves planning and organizing in advance to effectively respond to and mitigate the impact of disasters[7]. This process includes measures taken by individuals, communities, organizations, and governments to enhance their ability to handle disasters and reduce potential risks to life, property, and the environment[8]. Key elements of disaster preparedness include:

1. **Risk Assessment**: Identifying potential hazards and vulnerabilities to assess disaster risks[9].
2. **Early Warning Systems**: Implementing systems to detect and issue warnings about impending disasters, allowing for timely precautions and evacuations [10].
3. **Emergency Planning**: Developing detailed protocols for responding to different types of disasters, setting up response teams, identifying evacuation routes, and coordinating resources and logistics[11].
4. **Training and Drills**: Conducting regular training sessions and mock drills to familiarize people with emergency procedures, enabling quick and efficient responses during actual disasters[12].
5. **Resilient Infrastructure**: Building structures that can withstand disasters, stockpiling essential resources, conducting public awareness campaigns, and fostering collaboration among various stakeholders. Learning from experience: refining preparedness plans based on post-disaster assessments to improve future responses[13].

Overall, disaster preparedness is a continuous process that requires ongoing evaluation, updating, and improvement to adapt to changing circumstances and emerging risks. It plays a critical role in reducing the impact of disasters, saving lives, and facilitating quicker recovery.This literature review aims to systematically examine and analyze existing research to explore the various factors influencing the resilience of physiotherapists and nurses involved in disaster preparedness in India. By synthesizing the available evidence, this review seeks to provide valuable insights into the determinants of resilience among healthcare professionals, identify gaps in current knowledge, and offer recommendations to strengthen disaster preparedness efforts.

Factors Influencing Resilience: A positive and active attitude towards life is essential for developing resilience among nurses. Characteristics such as avoiding stress and maintaining a work-life balance are critical when overcoming adversity. Physiotherapists, as frontline professionals, are crucial in managing critically ill patients. During events like the COVID-19 pandemic, their workload and exposure to stressors significantly increased, leading to burnout, emotional exhaustion, and poor sleep quality. Ensuring adequate staffing and support is vital to mitigate these impacts.

Role of Resilience: Investing in resilience enhances a nation's ability to anticipate, prepare for, absorb, recover from, and adapt to adverse events. Improved resilience allows for better disaster anticipation and planning, reducing disaster losses rather than reacting after the event.

Study Aim: The study titled "Review of Factors Affecting Resilience among Physiotherapists and Nurses for Disaster Preparedness in India" aims to conduct a comprehensive and systematic analysis of existing literature to understand the key factors influencing the resilience of physiotherapists and nurses in disaster preparedness. The primary objective is to identify and categorize the factors contributing to resilience, including individual characteristics, psychological traits, social support systems, organizational support, training, and coping strategies.

Need for the Study: This study is significant due to its potential impact on disaster management and healthcare preparedness. Disasters pose immense challenges to public health and infrastructure, making the role of physiotherapists and nurses vital in providing immediate and continuous medical aid. By exploring the factors that contribute to their resilience, the study aims to enhance disaster preparedness and response strategies, ultimately improving healthcare outcomes during crises.

Methodology

Research Framework

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework was utilized to ensure a structured and transparent review process. This framework facilitated the systematic identification, screening, eligibility assessment, and inclusion of relevant literature. The PRISMA flowchart is depicted in Figure 1.

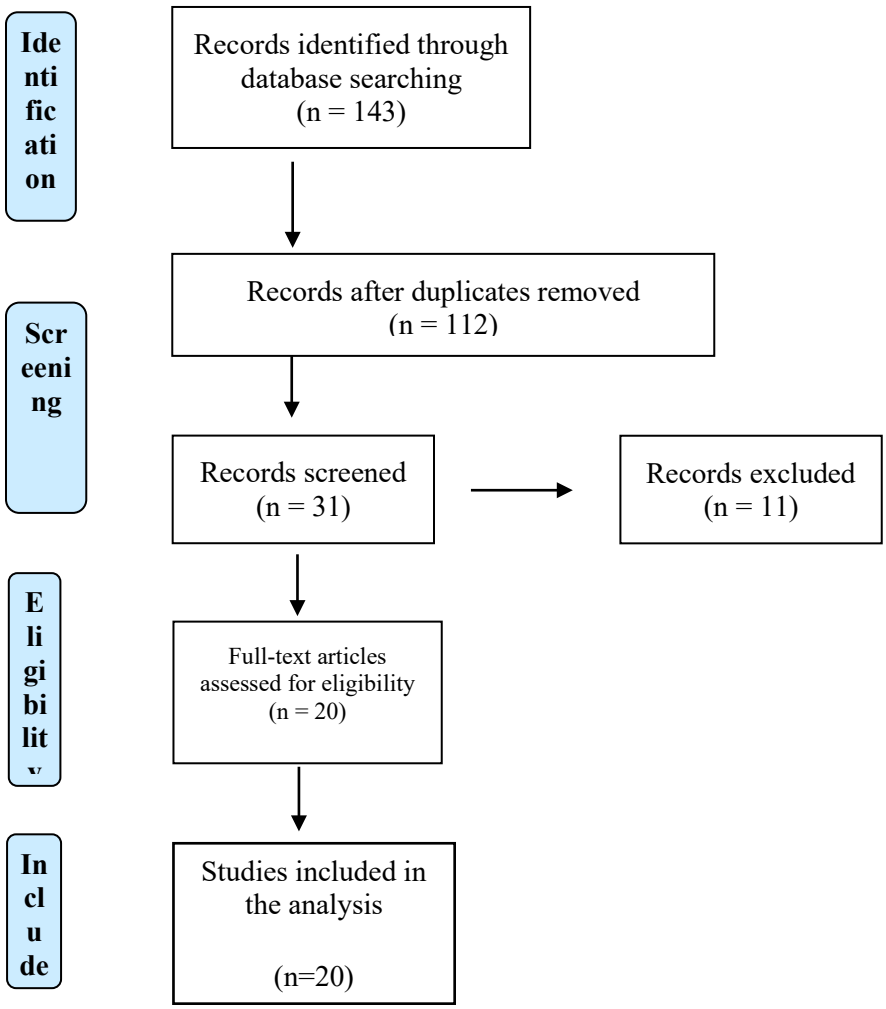


Figure 1: PRISMA Flow Diagram

Search Strategy

A comprehensive search was conducted across multiple databases, including PubMed, CINAHL, PsycINFO, Scopus, Google Scholar, and ERIC. The search focused on peer-reviewed articles and observationalstudies published between May 2012 and May 2023 to ensure the inclusion of recent and relevant research. Key search terms included "Stress", "Anxiety", "Depression", "Nurses", "Physiotherapists", "Disaster", "Pandemic". and related combinations. Boolean operators (AND, OR) were used to refine the search, and filters were applied to include studies in English.

Literature Screening

The literature screening involved three stages: initial screening of titles and abstracts to assess relevance, detailed evaluation of full-text articles based on methodological rigor and quality, and final selection of outcome-based, peer-reviewed studies. Priority was given to research focusing on stress, anxiety, and depression among physiotherapists and nurses during pandemics, particularly in the Indian context or similar healthcare settings.

Data Extraction

Relevant data from included studies were extracted using a standardized data extraction sheet. The sheet captured the following information:

1. Study title, author(s), and year of publication.
2. Research objectives and study design.
3. Population characteristics, including profession and geographical location.
4. Key findings related to stress, anxiety, and depression.

Results

Post screening of the articles through PRISMA, final 20 studies are listed in Table 1

Table 1. Summary of the findings of the inclusion studies

Sl No.	Study Reference	Research Design	Participant Selection	Comparability	Findings
1	(Pavan Kumar et al., 2024)[14]	Cross-sectional survey	Indian HCPs (doctors, nurses, allied professionals)	High, diverse representation	Secondary traumatic stress (STS), optimism, mood states
2	(Mohamed& Subbarayalu, 2022)[15]	Survey study	Physical therapists with direct patient contact	Moderate, focused on a specific group	Knowledge, attitude, practices (KAP), job stress
3	(Nayak et al., 2021)[15]	Cross-sectional survey	Healthcare workers in Trinidad and Tobago	High, cross-sectional analysis	Depression, anxiety, stress levels
4	(Sunil et al., 2021)[16]	Cross-sectional survey	Clinical and nonclinical HCWs in India	Moderate, mixed roles in healthcare	Insomnia, anxiety, depression
5	(Sidiq et al., 2024)[17]	Cross-sectional survey	HCWs in India	High, comprehensive for nurses	Burnout, CBI scores

Continue....

6	(Rifat, 2022)[18]	Cross-sectional survey	Physiotherapists in Dhaka	Moderate, selected age range	Mental health subscales, quality of life
7	(Khasne RWet al., 2020)[19]	Survey study	Indian HCWs (doctors, support staff)	High, national representation	Burnout, work-related stress
8	(MoumitaBasu et al., 2017)[20]	Observational analysis	DFY personnel in Nepal	High, stage-by-stage resource needs	Resource needs in disaster zones
9	(Wilson et al., 2020)[21]	Survey study	Indian HCWs	High, nationwide distribution	Stress, depression, anxiety symptoms
10	(Jose et al., 2022)[22]	Survey study	Nurses in North India	High, focused group	Resilience, distress, anxiety, insomnia
11	(Pandey et al., 2021)[23]	Survey study	Healthcare workers in Nepal	Moderate, varied professional roles	Stress, anxiety, depression
12	((Das et al., 2023))[24]	Survey study	Indian HCWs	High, cross-sectional	Anxiety, stress, depression
13	(Gupta et al., 2020)[25]	Survey study	Indian HCWs aged 45-60 years	Moderate, age-focused	Severe anxiety, sleep quality
14	(Menon et al., 2022)[26]	Telephonic interviews	HCWs across 12 cities in 10 states	High, diverse urban representation	Psychological distress, burnout
15	(Parchani et al., 2021)[27]	Survey study	COVID-19 patients and HCWs	High, disease-specific focus	Stress, anxiety, depression
16	(Tamrakar et al., 2021)[28]	Comparative survey	Nurses in COVID and non-COVID ICUs	Moderate, focused on specific ICUs	Anxiety, depression, sleep disturbances
17	(Karadag et al 2023)[29]	Comparative survey	Nurses Working in COVID-19	Moderate, focused on specific ICUs	Anxiety, depression, sleep disturbances
18	(Uvais et al 2023)[30]	Cross-sectional study	Psychological Morbidities Among Hospital Staff during second Covid 19 wave	Focussed on All departments	Psychological Morbidities
19	Sidiq et al 2025[31]	Cross-sectional study	Knowledge, Awareness, and Practice of Evidence-Based Medicine among Indian Physiotherapists	Focussed on Indian Physiotherapist	EBP
20	(Saravanabavan et al., 2019)[32]	Cross-sectional study	Burnout among Nurses and Doctors in Icy	Focussed on Nurses and Doctors	Psychological and Physical burnout

Discussion

The study by Ghogare et al. (2023) highlighted high levels of unhappiness, apprehension, and stress among postgraduate health sciences students in Maharashtra, India, during the COVID-19 pandemic[33]. It emphasized the importance of mental health evaluations and stress management programs for long-term coping. Similarly, Pigati et al. (2022) found that physiotherapists working with COVID-19 patients experienced lower quality of life and subjective happiness, emphasizing the need for support and interventions to improve their emotional well-being[34].Al-Sum BAet alreported high prevalence rates of depression, anxiety, and stress among medical personnel in India, especially among women and those involved in COVID-19-related jobs. The study underscored the need for emotional support and effective preventive measures to address mental health issues[35].Labrague et al. (2020) investigated anxiety levels among Filipino nurses during the pandemic, finding that social support, personal resilience, and organizational support significantly predicted anxiety levels[36]. Khasne et al. (2020) explored burnout among healthcare workers in India, revealing that over half of the participants experienced burnout due to the pandemic, emphasizing the need for interventions to prevent and treat burnout[19].Saravanabavan et al. (2019) examined burnout among ICU medical staff in India, highlighting the high prevalence of burnout among healthcare workers and the importance of education and awareness programs to address it. The burnout among intensive care unit (ICU) medical staff in India among 204 healthcare professionals from different clinical departments at a tertiary care hospital was investigated. The Maslach Burnout Inventory-Human Service Survey was used to assess burnout levels. The findings indicated that 8 out of 10 healthcare workers experienced significant burnout. Nurses were found to be at the highest risk of burnout, followed by dentists and physiotherapists, and then medical physicians and scientists. The study emphasized the importance of education, awareness, and training programs to prevent and address burnout in the healthcare industry[32].

Kannan et al. (2017) focused on disaster preparedness among dental surgeons in India, emphasizing the need for emergency preparedness education and adequate training for handling mass casualty disasters. The survey included 132 dental surgeons, and the results indicated that approximately one-third of the population were experts in handling major calamities, but their technical knowledge fell short. The study emphasized the importance of including emergency preparedness education as part of internships and called for dental surgeons to be adequately trained and involved in disaster response teams[37]. The literature review on factors affecting resilience among physiotherapists and nurses for disaster preparedness in India reveals the significant impact of the COVID-19 pandemic on the mental health and well-being of healthcare professionals. Stress, anxiety, and burnout were found to be prevalent among healthcare workers, especially those directly involved in COVID-19 patient care. The studies highlight the need for comprehensive mental health support, stress management programs, and interventions to build resilience in healthcare professionals. Additionally, education and training on disaster preparedness are essential to enhance the capacity of healthcare workers to cope with crises effectively. These findings underscore the importance of a long-term strategy to protect the mental health and well-being of healthcare professionals during and beyond the COVID-19 pandemic.

Conclusion

The review of factors affecting resilience among physiotherapists and nurses for disaster preparedness in India provides valuable insights into the psychological challenges faced by healthcare professionals during times of crises. The studies included in the review shed light on the impact of stress, anxiety, and depression on the capacity of physiotherapists and nurses to cope with the pandemic threat posed by events such as the COVID-19 pandemic. The findings from various studies indicate that a significant proportion of

healthcare professionals experienced high levels of stress, anxiety, and depression during the COVID-19 pandemic. These psychological challenges were particularly pronounced among physiotherapists and nurses who directly interacted with COVID-19 patients. The review also reveals that individuals with lower depression, anxiety, and stress levels showed higher levels of resilience, indicating the importance of addressing mental health concerns to enhance resilience among healthcare professionals. The studies included in the review point towards the need for rapid evaluations of mental health and stress management programs to support the well-being of physiotherapists and nurses during disaster situations. Additionally, the findings highlight the significance of implementing measures to protect healthcare professionals from mental health issues arising from extreme stress. Overall, the review underscores the importance of building resilience among physiotherapists and nurses to enhance their capacity to respond effectively to disaster situations. Long-term strategies aimed at promoting psychological well-being and providing emotional support are essential to mitigate the impact of stress, anxiety, and depression on healthcare professionals during such challenging times.

Limitations

The study focussed on stress, anxiety, and depression among physiotherapists and nurses during pandemics. Only full-text English articles were considered for the review.

Source of Funding: There was no funding for the study

Conflict of Interest: There is no conflict of interest

Ethical Clearance: No intervention was conducted for the review, ethical clearance is not required

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Review Article https://doi.org/10.37506/jk6cb486

The Role of Muscle Energy Technique on Hamstring Muscle Flexibility in Recreational Athletes: A Scoping Review

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Abstract

Background: The hamstrings, located at the back of the thigh, are crucial for hip extension and knee flexion but are prone to tightness and injury, especially in athletes and healthy individuals. Recreational athletes with hamstring tightness often experience reduced flexibility, impaired performance in activities requiring sprinting or bending, and a higher risk of muscle strains or lower-limb injuries. Muscle Energy Technique (MET), a manual therapy using controlled muscle contractions, effectively improves flexibility, reduces pain, and enhances joint mobility, making it a valuable technique in treating hamstring tightness.

Objective of The Study: This review aims to **map and summarize the existing evidence** on the use of Muscle Energy Technique (MET) for improving hamstring flexibility in recreational athletes and explores its clinical relevance in the management of hamstring tightness.

Method: A comprehensive literature review in accordance with PRISMA-ScR was conducted using electronic databases from PubMed, Google Scholar, Research Gate, SPORTDiscus, and ScienceDirect, focusing on full-text articles from 2018-2024. Twelve studies that examined the effect of MET on hamstring muscle flexibility in recreational athletes were included in the analysis.

Result: A total of 3799 studies were retrieved, and after removing duplicates and those not meeting inclusion criteria, 12 studies conducted between 2018 and 2024 were included, comprising RCTs, comparative, interventional, quasi-experimental, and experimental designs, the findings suggest thatMuscle Energy Technique (MET), when applied alone or in combination with Myofascial Release Technique (MFR), Post Facilitation Stretch (PFS), Post Isometric Relaxation (PIR), Active Release (ART), Suboccipital Muscle Inhibition (SMI), Whole Body Vibration (WBV), Proprioceptive Neuromuscular Facilitation (PNF), or the Active Knee Extension Test (AKET) in a neural slump position, results in significantly greater improvements in flexibility and reductions in muscle stiffness.

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Conclusion: MET is highly effective for improving hamstring flexibility, its neuromuscular engagement and mechanisms like post-isometric relaxation and proprioceptive enhancement lead to better results. MET can be preferred by physiotherapists for managing hamstring tightness

Key Words: Hamstring muscle, flexibility, muscle energy technique, Athletic Performance, Recreational Athletes, Muscle Stretching Techniques.

Introduction

The hamstring muscle complex comprising the biceps femoris, semimembranosus, and semitendinosus is located in the posterior thigh. These muscles originate from the ischial tuberosity, except for the short head of the biceps femoris, which arises from the femoral linea aspera. They function in hip extension and knee flexion, playing a crucial role in gait, especially during the final swing phase, and in joint stabilization[1].Hamstring tightness is common, especially among recreational athletes and individuals with prolonged sitting habits, contributing to reduced range of motion (ROM) and altered gait[2,3]. Liyanage et al. reported a 68% prevalence of tightness in students aged 18–25 years. Risk is higher in males and increases with age[4,5]. Hamstring injuries often occur during sprinting and stretching activities and are slow to heal, with high recurrence rates. Risk factors are intrinsic (e.g., weakness, poor flexibility) or extrinsic (e.g., inadequate warm-up)[6].

Flexibility can be static or dynamic. Static flexibility refers to ROM without movement, while dynamic flexibility involves motion and muscle resistance [7,8]. Muscle energy technique (MET), introduced by Fred Mitchell, uses voluntary muscle contraction against resistance to improve flexibility, reduce tone, and enhance mobility [9,10]. MET includes post-isometric relaxation (PIR) and reciprocal inhibition (RI), both targeting neuromuscular mechanisms like Golgi tendon organ and stretch receptor activation. This review synthesizes current literature, primarily experimental and RCTs, to map the existing evidence on the use of Muscle Energy Technique (MET) for enhancing hamstring flexibility in recreational athletes.

Methods

Literature Search Strategy

After receiving the exemption from review approval from the Ethics Committee of Yenepoya (Deemed to be University) YEC-1 Protocol no: YEC-1/2024/310, a comprehensive literature search was conducted using electronic databases in PubMed, Google Scholar, ScienceDirect and Research gate. The search focused on full-text articles published in English between 2018 till 2024 January The final search strategy included the following terms and Boolean operators: "Hamstring muscle" or "hamstring tightness" or "hamstring strain"and "flexibility" or flexible or "range of motion" or "joint mobility"and"muscle energy technique" or MET or "manual therapy" or "muscle stretching technique "and "recreational athletes" or "athletic performance" or "sports participants" and "physical therapy" or "physiotherapy" or rehabilitation. : A comprehensive search was conducted across **PubMed**, **Google Scholar**, **ResearchGate**, **SPORTDiscus**, and **ScienceDirect** for studies published between **2018 and 2024**. A combination of **keywords** and **Medical Subject Headings (MeSH)** was used to ensure comprehensive coverage.

Eligibility Criteria

Articles were included if they met the following Inclusion criteria: a) studies involving participants aged 18 to 27 years, b) randomized controlled trials (RCTs), comparative, interventional, quasi-experimental, and experimental designs, c) studies which muscle energy technique as the primary intervention. Exclusion criteria were: reviews and meta-analyses, books, notes, conference proceedings, theses or dissertations, letters and abstracts. Studies

that implemented muscle energy technique solely as a passive intervention were excluded. The records retrieved from the search strategy were screened for eligibility by two independent reviewers, and any disagreements were resolved through discussion and consensus; when consensus could not be reached, a third reviewer was consulted. The study selection process has followed the PRISMA-SCR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews) flowchart was used to identify relevant studies via databases during the initial phase. A total of 12 articles that met the study criteria, as represented in Table 1, were selected for this scoping review

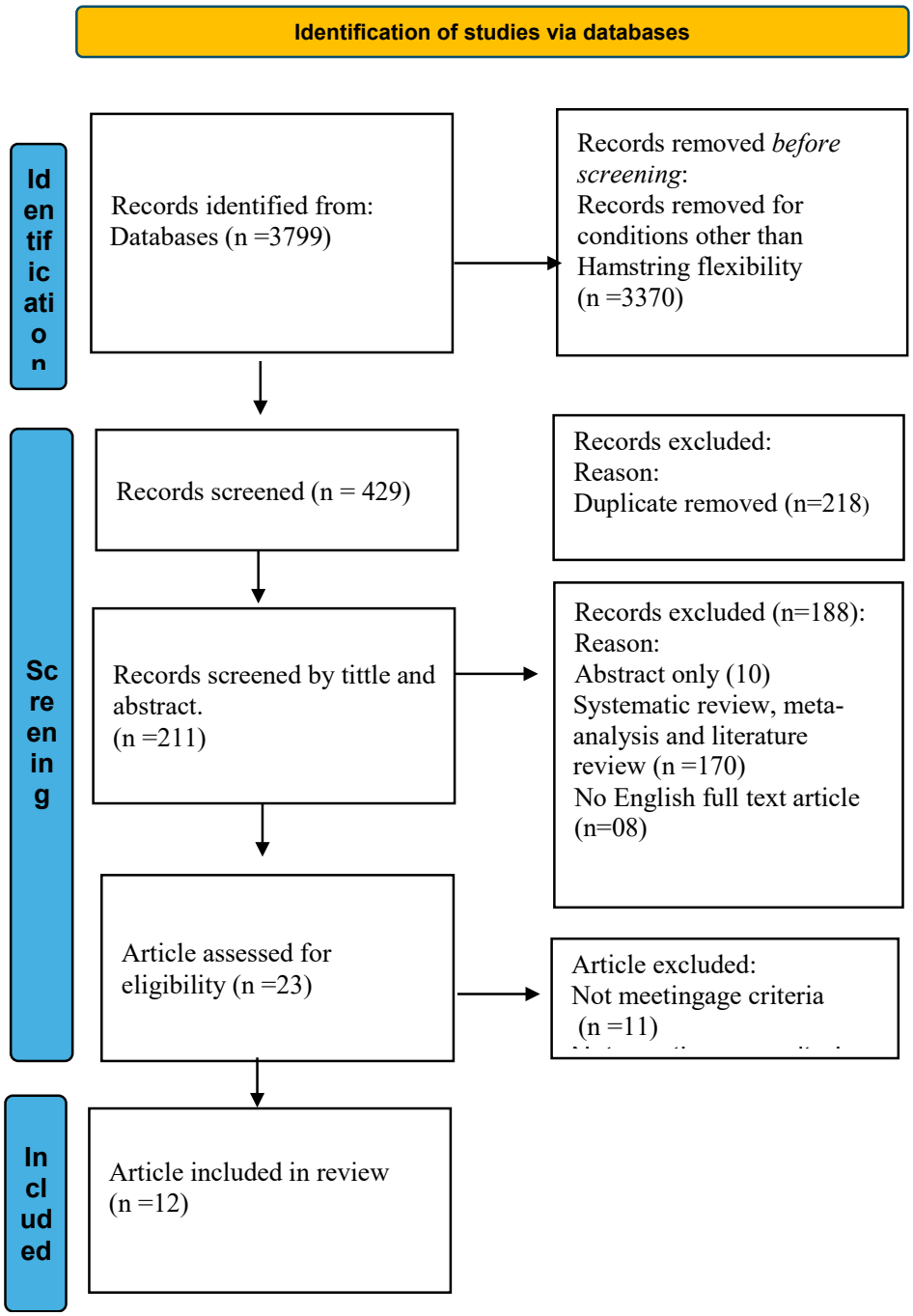


Figure 1: PRISMA flowchart

Result

The mapped evidence from 12 studies highlights the application of Muscle Energy Technique (MET) for hamstring flexibility in recreational athletes, with reported positive outcomes across studies. The findings suggest that MET, whether applied independently or along with other techniques, effectively enhances flexibility and reduces muscle stiffness. These outcomes have important implications for athletes, physiotherapists, and fitness professionals, as improved flexibility and reduced stiffness can contribute to better functional performance, reduced injury risk, and enhanced recovery. Therefore, incorporating MET into regular training or rehabilitation programs may offer measurable benefits. The mapped evidence from 12 studies highlights the application of Muscle Energy Technique (MET) for hamstring flexibility in recreational athletes, with reported positive outcomes across elegiblestudies.

Table 1. Summary of Included Articles

Author	No. Of Participant	Type of Study	Methodology	Conclusion
Ahamed F et al [11] (2023)	60	Randomized controlled trial	60 healthy adults were assigned into MET group and static stretching group. Hamstring flexibility was measured using the AKETand SLR, with angles recorded using a goniometer in a supine position.	Both MET and Static stretching are effective for improving hamstring flexibility in young adults.
Bhutta AH et al[15] (2023)	60	Randomized controlled trail	**60 young athletes** were randomly assigned into PIR, PFS and HNL groups. Hamstring flexibility was measured using SLR and YMCA sit and reach test. and performance (agility run) was assessed before and after each phase.	The study concluded that PFS, PIR, HNL highlights significant reduction in hamstring tightness and improve agility performance in athletes.
Patel A et al[13] (2023)	102	Comparative study	102 subjects are allocated into two groups by chit methods, Group A (MET) and Group B (MFR). Patient was evaluated before and after the intervention by AKE test and ASLR test	The study concluded that both MET and MFR are effective for the improving flexibility of hamstring muscles in footballers
Bhutta AH et al[2] (2023)	60	Randomized clinical trail	60 subjects were allocated into three groups (Group A, B, C) PFS, PIR, HNL. They receivedintervention for 1 month. Pre and post intervention measurement of hamstring flexibility was taken using YMCA sit and reach box test.	PFS technique is highly recommended for athletes with muscular tightness, when used as part of an eccentric muscle strengthening protocol, followed by the PIR.

Continue....

Vijay A et al[16] (2022)	30	experimental study	30 healthy recreational athletes 17 male and 13 females, received MET for 4 weeks, 5 sessions/ week. The Modified Back Saver's sit and Reach Test (BSSR test) was the outcome measure.	The study found that there is a significant difference in non-ballistic AKET with MET as prime intervention helps in management of bilateral hamstring tightness.
Seth R et al[14] (2022)	30	experimental study	30 footballers are divided into two groups by random sampling Group A (MET-PIR) Group B (ART). Both the groups performed a set of 3exercises-eccentric and core stability andpilates afterthe intervention. Pre and postintervention measures were taken to assess the hamstring tightness. By using AKET.	The study concluded that both MET-PIR and ART are immediately effective in improving hamstring muscle tightness
Dinesh D et al[12] (2022)	30	Experimental study	30 subjects are divided into two groups: Group A (MET) Group B (PNF) for 4 weeks – 5 sessions/ week. The Modified Back Saver's Sit and Reach Test was used as outcome measures.	The study found that Non-ballistic AKET and PNF show significant reduction in hamstring tightness and improves flexibility
Azizi M et al[17] (2021)	56	Experimental study	56 subjects were divided into two Groups: Group A (MET) and Group B (WBV). Active Knee Extension (AKE) and Modified Sit & Reach (Mod S &R) tests measured Hamstring flexibility,	This study found that single WBV and MET increase flexibility and decreases stiffness of hamstring muscles.
Sundarm SS et al[18] (2020)	31	Quasi-experimental design	31 subjects with (19 males and 11 females) where given MET. for 7-10 sec with 20% of force from the subjects. pre and post intervention measurement was taken using AKET.	The study found that MET is effective in increasing flexibility of tight muscles.
Sojitra N et al[19] (2020)	40	Intervention study	40 subjects are divided into two groups: Group A(SMI) and Group B (MET) where intervention was given. Pre and post intervention measurement were taken using AKET.	The study found that SMI and MET both are equally effective to improve hamstring flexibility

Continue....

Banerjee SB et al[20] (2020)	60	Comparative study	60 subjects are divided into two groups using random sampling method: Group A (Non-ballistic AKET in neural slump position) Group B (MET). Hamstring tightness was measured using active knee extension (AKE) test.	The study found that both the interventions are improving hamstring flexibility, however Non-ballistic AKET in neural slump position shows greater improvement
Sailor S et al[21] (2018)	24	Randomized controlled trial	24 Subjects are randomly divided into Group A (MET) Group B (PRT) both the interventions are given for 5 days per week for two weeks. pre and post intervention measurement was taken using AKET and SLRT using universal goniometer.	The study found that both MET and PRT are effective for improving hamstring flexibility. The change in ROM after two weeks are higher in MET than PRT

Discussion

This scoping review explores the effectiveness of Muscle energy technique (MET)in improving Hamstring Flexibility and compared its efficacy with other commonly used interventions in the literature. However, High-quality evidence on the effectiveness and long-term benefits of MET for hamstring flexibility is limited and the reliability of current research is compromised by small sample sizes, variability in outcome measures, and uncontrolled factors such as hydration and physical activity. Since, Findings suggest that this intervention may contribute to an immediate improvement in flexibility. The study incorporates various outcome measures, including the Active Knee Extension (AKE) test, Popliteal Angle (PA), Forward Flexion Distance (FFD), Straight Leg Raise (SLR), and the Sit and Reach Test (SRT), to assess changes in flexibility. Muscle Energy Techniques (MET) helps in improving hamstring muscle flexibility, particularly in athletic and recreational populations. Compared to other interventions such as static stretching, myofascial release, active release technique, and proprioceptive neuromuscular facilitation, MET consistently demonstrates superior or comparable outcomes due to its active engagement of the neuromuscular system. Key mechanisms including post-isometric relaxation, Golgi Tendon Organ activation, enhanced proprioception, and improved viscoelastic properties contribute to both immediate and sustained improvements in muscle length and flexibility.

Ahmed et al. (2023)[11] compared MET with static stretching in young adults and found both methods significantly improved hamstring flexibility. However, MET produced more lasting gains because its voluntary isometric contractions actively engage the neuromuscular system, improving motor control, proprioceptive feedback, and stretch tolerance. Dharmalingam et al. (2022)[12] examined MET in recreational athletes using the non-ballistic Active Knee Extension Test and observed marked improvements in hamstring length. These gains were linked to biomechanical changes—better viscoelastic properties of the muscle–tendon unit—and neurophysiological effects such as post-isometric relaxation, which temporarily reduces muscle tone, enabling more effective stretching. Patel et al. (2022)[13] compared MET with Myofascial Release in football players, reporting significant flexibility improvements from both. MET's advantage lay in its activation of Golgi Tendon Organs, leading to reflex muscle inhibition, and in facilitating connective tissue creep and plastic deformation, allowing muscles to adapt to a longer resting length. Sheth et al. (2022)[14]

contrasted Post-Isometric Relaxation (a MET variant) with Active Release Technique. While both enhanced hamstring flexibility and knee extension, ART excelled at breaking down myofascial adhesions from cumulative microtrauma, whereas PIR reduced muscular tension and pain by restoring full stretch length through neuromuscular inhibition. Dinesh et al. (2022) compared MET and Proprioceptive Neuromuscular Facilitation in recreational athletes, finding both effective, with MET showing slightly better results. MET works through connective tissue extensibility, post-isometric relaxation, and increased stretch tolerance, while PNF mainly operates via autogenic and reciprocal inhibition to promote muscle relaxation. The evidences strongly support the use of Muscle Energy Technique as an effective intervention for improving hamstring flexibility. Its efficacy can be attributed to the interplay of biomechanical and neurophysiological mechanisms, including post-isometric relaxation, Golgi Tendon Organ activation, increased proprioception, and plastic deformation of the connective tissues. These adaptations lead to improved muscle length, reduced tone, and enhanced functional range of motion. Given its active nature and safety profile, MET is especially beneficial for athletes and individuals with recurrent muscle tightness. The consistent findings across multiple studies further validate MET as a reliable clinical tool in the field of physiotherapy for managing hamstring flexibility

Limitations

There is limited high-quality evidence, where quality of articles was decided on the basis of PEDro for studying effectiveness and long-term benefits of MET for hamstring flexibility. Small sample sizes, inconsistent outcome measures, and uncontrolled factors like physical activity and hydration reduce reliability. Additionally, this review included only English-language studies, possibly missing relevant research.

Conclusion

The availability of evidences suggests that Muscle Energy Technique (MET) is highly effective for improving hamstring flexibility in both athletes and recreational individuals. It's Safe, adaptable, and backed by strong evidence, MET is a trusted choice for physiotherapists in treating hamstring tightness. However, further studies are needed to confirm its efficacy and long-term effect of MET on hamstring flexibility across diverse population.

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Ethical Clearance: This study is a scoping review. An exemption from ethical review was obtained from the Ethics Committee of Yenepoya (Deemed to be University), YEC-1, Protocol No: YEC- 1/2024/310

Conflicts of Interest Statement: The authors declare no conflicts of interest.

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Review Article

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Enhancing Quality of Life Through Physiotherapy in Palliative Care: A Systematic Review of Evidence, Implementation Barriers, and Future Perspectives

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Abstract

Background: Palliative care aims to enhance the quality of life (QoL) for patients with life-limiting illnesses. Physiotherapy is a key component, but its full scope and impact require synthesis. This systematic review critically evaluates current evidence on physiotherapy's role and effectiveness in palliative care, focusing on improving patient QoL.

Methodology: The data was collected analyzing the research studies published between 2010 and 2025 from databases like Google Scholar, PubMed, and Scopus using appropriate keywords. The review covers physiotherapy interventions (exercise, manual therapy, symptom management, education) for diverse patient groups (cancer, neurological, cardiopulmonary, HIV, frailty) across various palliative care settings.

Results: Consistent evidence shows that physiotherapy improves physical function, manages symptoms (pain, fatigue, dyspnea), enhances psychological well-being, and supports independence; the positive impact of interventions on QoL of patients; the significant barriers to integration, including lack of awareness, underutilization, training gaps, and resource limitations; and the need for more robust research and holistic outcome measures.

Conclusion: Physiotherapy is essential for enhancing the quality of life for patients in palliative care; however, addressing barriers through education, collaboration, resource advocacy, and research is crucial to optimize its benefits for patients and families.

Keywords: Physiotherapy; Physical Therapy; Rehabilitation; P.T.; Palliative care

Introduction & Background

Palliative care represents a vital and expanding field within healthcare, fundamentally focused on enhancing the quality of life (QoL) for individuals and their families confronting life-limiting illnesses. Central to its philosophy is a holistic, multidisciplinary approach aimed at preventing and alleviating suffering through meticulous assessment and management of physical, psychosocial, and spiritual challenges (World Health Organization). As global demographics shift towards aging

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populations and the prevalence of chronic, non-communicable diseases increase, the demand for accessible and comprehensive palliative care services is intensifying worldwide. Within this essential framework, the contributions of allied health professions, notably physiotherapy, are increasingly recognized as integral components of effective care.

Physiotherapy, often traditionally linked with rehabilitation following acute events, offers a distinct and valuable skill set when applied within the palliative care context. Here, the focus transcends curative ambitions, shifting towards optimizing functional capacity, maximizing patient independence, managing burdensome symptoms, and promoting overall well-being throughout the illness trajectory, including the end-of-life phase. The professional development of physiotherapy within palliative care reflects broader healthcare trends toward interdisciplinary collaboration and holistic patient management.

Contemporary palliative physiotherapy practice encompasses diverse therapeutic modalities including exercise interventions, manual therapy techniques, respiratory management, pain control strategies, and functional rehabilitation approaches [16]. Research has consistently demonstrated physiotherapy's effectiveness in managing primary symptoms, including pain, dyspnea, fatigue, and functional decline often associated with serious illness, while simultaneously addressing psychological distress and enhancing patient autonomy [20]. This comprehensive scope of practice reflects the profession's evolution toward addressing not only physical symptoms but also contributing to qualityof life improvements and psychosocial well-being for patients with life-limiting conditions [12]. These outcomes have established physiotherapy as an essential component of comprehensive palliative care delivery, contributing to reduced healthcare costs, decreased hospital stay lengths, and improved patient satisfaction [2].

Recent healthcare challenges, including the COVID-19 pandemic, have further demonstrated the adaptability and essential nature of palliative physiotherapy services. Practitioners have successfully adapted clinical practices to ensure patient safety while maintaining high care standards through innovative service delivery models, including expanded telerehabilitation services and modified treatment protocols [7]. These adaptations reflect the profession's commitment to maintaining comprehensive care delivery even under challenging circumstances, reinforcing physiotherapy's integral role in palliative care provision.

Despite these demonstrated benefits and the strong rationale for its inclusion, the potential of physiotherapy within palliative care settings remains significantly underutilized globally. This Gap stems from several interconnected factors; a lack of awareness and understanding regarding the physiotherapist's specific role among other healthcare professionals, patients, and the general public; insufficient specialized training and educational opportunities for physiotherapists in the principles and practice of palliative care; systemic resource limitations, particularly pronounced in low- and middle-income countries and community-based care settings; and inherent challenges in defining and measuring holistic outcomes that extend beyond purely physical metrics. Addressing these multifaceted barriers is essential to ensure equitable access to high-quality palliative care that fully incorporates the vital contributions of physiotherapy.

This systematic review aims to provide a comprehensive synthesis of the current state of knowledge regarding the role, effectiveness, and scope of physiotherapy in palliative care. It explores the multifaceted contributions of physiotherapy across diverse palliative patient populations and various care settings (including hospice, hospital, and community environments). Subsequently, the review will delve into the evidence supporting the efficacy of specific physiotherapy interventions in managing key symptoms such as pain, fatigue,

and dyspnea and in improving patient-reported outcomes, particularly QoL and functional independence. The paper will critically examine the significant implementation barriers and facilitators that influence the integration of physiotherapy services, encompassing professional, educational, systemic, and resource-related factors. Finally, the review will discuss future perspectives, highlighting critical areas for further research, outlining needs for enhanced education and training pathways, and proposing strategies for policy development and clinical practice improvement to optimize the role of physiotherapy in enhancing QoL for individuals receiving palliative care.

Methodology

This study delved into enhancing Quality of Life through Physiotherapy in Palliative Care,using a systematic review of the literature following the PRISMA guidelines and analyzing the research studies published between 2010 and 2025 from databases like Google Scholar, PubMed, and Scopus. A combination of keywords and subject headings related to physiotherapy and palliative care was used. The core concepts searched included physiotherapy interventions, palliative care context, pain management, and symptom relief, Quality of Life, mobility, or independence. Searches were adapted for the syntax requirements of each database (Google Scholar, PubMed, Scopus).

Search Strategy: Physiotherapy" OR "Physical Therapy" OR "Rehabilitation" OR "Exercise Therapy" OR "Intervention" OR "Palliative Care".

Google Scholar: Physical therapy and Palliative care

PubMed: (((((Physiotherapy) OR (Physical therapy)) OR (Rehabilitation))) OR (P.T.)) AND (Palliative care)

Scopus: Physical AND therapy AND palliative AND care AND (LIMIT-TO (SUBJAREA, "MEDI") OR LIMIT-TO (SUBJAREA, "NURS") OR LIMIT-TO (SUBJAREA, "HEAL") OR LIMIT-TO (SUBJAREA, "MULT")) AND LIMIT-TO (LANGUAGE, "English"))



Flowchart of the article selection process

Inclusion Criteria

- Studies focusing on physiotherapy, physical therapy, or rehabilitation interventions within a recognized palliative care context or for patients with clearly defined palliative needs.
- Studies involving adult or pediatric populations diagnosed with life-limiting illnesses (e.g., advanced cancer, progressive neurological disorders-Multiple Sclerosis, Stroke, end-stage cardiopulmonary disease, Constipation, HIV/AIDS, severe frailty).
- Articles examining the role, scope, effectiveness, specific interventions, implementation challenges, educational aspects, or patient/provider perspectives related to physiotherapy in palliative care.
- Studies reporting on outcomes relevant to palliative care, such as quality of life, symptom control (pain, fatigue, dyspnea, etc.), functional

status, mobility, independence, patient satisfaction, or caregiver burden.

- Original research (quantitative, qualitative, mixed-methods), randomized control trials, practice guidelines, and descriptive studies.
- Articles published in the English language.

Exclusion Criteria

- Studies focusing exclusively on rehabilitation in non-palliative contexts (e.g., acute post-operative recovery, sports injuries) without reference to life-limiting illness or palliative goals.
- Studies where physiotherapy was not a primary intervention or focus of investigation.
- Articles not available in English.
- Editorials, letters to the editor, conference abstracts, or commentaries lacking substantial original data or synthesis.
- Studies focusing solely on pharmacological or surgical interventions for symptom management without a physiotherapy component.

The methodological quality of included studies was evaluated using appropriate tools-Randomized controlled trials were assessed with the Cochrane Risk of Bias Tool 23. Other study designs were evaluated for risk of bias and methodological rigor as appropriate. The literature consistently portrays physiotherapy in palliative care as extending far beyond mere physical symptom management. The role is dynamic, adapting from a rehabilitative focus in earlier stages to supportive care as the disease progresses, often employing multiple models concurrently [15]. PTs act as "specialist generalists," addressing holistic needs beyond specific symptoms [15]. Furthermore, the palliative approach, including physiotherapy, is advocated not just at the end stage but much earlier in the disease trajectory [12]. This systematic review synthesizes current evidence regarding the role, effectiveness, implementation strategies, and evolving practices of physiotherapy interventions within palliative care settings, encompassing both adult and pediatric populations across diverse diagnostic categories.

Analysis & Interpretation

The research data highlights a few key themes:

Core Transformation: The literature documents a fundamental shift in physiotherapy practice from cure-focused rehabilitation to comfort-oriented, quality-of-life enhancement approaches that honour patient dignity while addressing complex physical and psychosocial needs.

Multi-Dimensional Impact: The evidence shows that physiotherapy interventions create cascading positive effects across multiple symptom domains simultaneously, suggesting these treatments influence neurochemical, psychological, and social pathways more profoundly than traditional rehabilitation approaches.

Sophisticated Clinical Reasoning: The research demonstrates that effective palliative physiotherapy requires advanced clinical decision-making that balances therapeutic benefit with patient tolerance, prognosis, and individual preferences - challenging assumptions about treatment limitations in advanced illness.

Expanded Professional Roles: The literature reveals that physiotherapists in palliative care settings have evolved beyond traditional physical interventions to include family education, equipment management, psycho-social support, and collaborative care coordination.

Evidence-Based Innovation: The research documents measurable benefits, including reduced healthcare costs, shorter hospital stays, improved functional independence, and enhanced quality of life, while also revealing the need for specialized outcome measures that capture comfort and dignity alongside traditional physical metrics.

Professional Transformation: The literature documents a significant expansion of physiotherapist roles beyond traditional boundaries, requiring specialized training and raising important questions about competency requirements and scope of practice.

This interpretation highlights how the evidence base supports physiotherapy as an essential, sophisticated component of comprehensive palliative care that addresses the full spectrum of human needs during life-limiting illness.

Implementation Considerations: The analysis reveals that successful physiotherapy integration depends on multidisciplinary collaboration, flexible service delivery models, and adaptation to local healthcare system characteristics.

Table No. 1: Physiotherapy in Palliative Care (Literature Review Summary)

Author	Year	Findings	Methodology
AlJohi	2025	Review of isometric spinal stabilization exercises showed positive impacts across multiple outcomes: pain reduction, quality of life improvement, enhanced physical functioning, decreased physical fatigue, and improved bone health.	A Systematic Review -8 studies included 116 adults with spine metastasis. The supervised exercise interventions, conducted by a physical therapist or exercise physiologist, included isometric spinal stabilization exercises supervised for approximately 2 weeks and continued as home exercises ranging from 12 to 24 weeks.
Pennycooke	2024	Nearly half of patients showed improvement in the palliative care phase, and over half were discharged home or to residential care rather than dying in hospital. Interventions helped patients achieve goals of maintaining independence and quality of life.	A prospective clinical audit was undertaken in a metropolitan palliative care service of all inpatient and community palliative care patients referred for physiotherapy review and intervention, over 4 weeks.
Navarro-Meléndez et al.	2023	Quantitative evidence of functional improvements through physiotherapy: decreased patients with total dependence (Barthel Index) and reduced non-functional ambulators (Functional Ambulation Categories). Physiotherapy inclusion contributed to better functionality, increased independence, and improved ADL skills.	An observational, prospective, descriptive, practice-based study was undertaken involving patients admitted to the PCU of Spain. Participants were assessed prior to initiating and at the end of the physiotherapy program. A descriptive analysis was performed, and scale scores before and after treatment were compared using the Wilcoxon signed-rank test.
Raznatovska	2023	Physical therapists play vital roles in pulmonary rehabilitation within palliative care teams. Focus on improving physical functioning essential for patients with chronic respiratory disorders, addressing complex respiratory challenges in terminal illness management.	The primary method employed in this paper is a comprehensive review of existing literature. Various studies and references related to pulmonary rehabilitation in patients with chronic respiratory diseases who are in palliative and hospice care have been analysed. This approach allowed them to gather a wide range of data on the characteristics and frequency of pulmonary rehabilitation usage in this specific patient population.

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Polastri& Cuomo	2022	Reinforced physiotherapy's crucial role in comprehensive palliative care, effective in managing dyspnea, improving physical function, and providing emotional support to patients and families. Integration of respiratory management with emotional support exemplified a holistic approach.	An editorial It discusses the importance of evidence-based practice, multidisciplinary collaboration, and patient-centered care in the context of palliative physiotherapy for end-stage respiratory diseases.
Drouin	2020	During COVID-19, physiotherapists globally adapted clinical practices to ensure patient safety while maintaining high care standards. Utilized standards of practice, critical thinking, and patient preferences to prioritize treatments and develop expanded telerehabilitation services.	Responses were solicited from PTs serving as Member Organization Liaisons to the IPT- HOPE Subgroup. Other PTs contributed responses during the virtual session and through e-mails after watching the recording of the session. Twenty-five PTs from 16 countries shared their clinical decisions and experiences in this public forum.
Montagnini	2020	Comprehensive goals of palliative physiotherapy: maximizing functional ability, managing symptoms, educating patients and caregivers, and improving overall quality of life for patients with life-limiting illnesses. Reflected evolution toward comprehensive, holistic care delivery models.	A perspective paper. It synthesizes findings from various studies to discuss the role, assessment, and specific interventions of rehabilitation in hospice and palliative care settings.
Leysen& Van Daele	2019	Physiotherapy's significant role in minimizing symptom impacts while sustaining or improving quality of life and ADLs. Addressed variety of symptoms including pain, fatigue, anxiety, depression, and reduced physical functioning, demonstrating comprehensive scope of intervention.	An exploratory web-based survey. Between September 2017 and May 2018. Ninety-one therapists who treated palliative patients within the last year used a variety of different interventions. This study investigated the OP and PT interventions used in palliative care in Belgium. a total of 91 respondents were included.
McLeod	2019	Physiotherapists' roles included addressing physical aspects (mobility, function, pain, comfort management), managing equipment, teaching patients and families techniques, and contributing to quality of life and psychosocial/ emotional needs. Practice demonstrated patient-centred and goal-driven approaches.	Qualitative research utilizing inductive thematic analysis. The data was collected through semi structured telephone interviews and emailed submissions from physiotherapists and (n=14)one physiotherapy student with current or recent palliative care experience in Ontario, Canada. The researchers then performed a secondary qualitative analysis of these interview records and email submissions.

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Tidmarsh & Bradfield	2019	Pilot study of rehabilitative palliativecare physiotherapy and gym programs showed measurable improvements in patients' mental health even when physical improvements weren't evident. Highlighted importance of psychological outcome measures alongside physical assessments.	Existing and new patients to the gym have completed an IPOS and have been asked to complete the PHQ-9 (Depression) and GAD-7 (Anxiety) questionnaires. Patients are then reviewed approximately every 12 weeks. Results of the review and questionnaires are collated and used to identify not only further physiotherapy intervention but whether the patient would benefit from other parts of the rehabilitation and wellbeing service.
Baldwin	2018	Comprehensive review evidence supporting physiotherapy's crucial role in palliative care: better symptom management, reduced healthcare costs, decreased hospital stays, lower readmission rates, enhanced satisfaction, and improved quality of life. Established physiotherapy as essential component of comprehensive palliative care delivery.	Peer-reviewed articles regarding PT within PC as it relates topublic policy and health care reform were retrieved that described a variety of aspects of the effect of public policy andhealth care reform on the integration of PT and PC.
Olsson Möller	2018	Person-centred palliative care integrated into daily physiotherapy activities. Treatments were varied, complex, and interconnected, leading to meaningful interventions. Physiotherapy activities aimed to bridge gaps between what patients wanted to do and their physical abilities.	Using a free-listing approach, ten physiotherapists working in eight specialized palliative care settings inSweden were included (directly or indirectly) during 10 days. The statements were analysed usingqualitative content analysis.
Wittry	2018	Physical therapy contributed to better symptom management, reduced healthcare costs, decreased hospital stay lengths, lower readmission rates, enhanced patient and provider satisfaction, and improved quality of life. Literature review supported effectiveness of various rehabilitation interventions including exercise programs.	A literature review of cancer rehabilitation topics and techniques specifically applied to patients with life-limiting conditions. Exercise and other rehabilitation interventions were analyzed for their effects on common symptoms and disabilities experienced by this patient population.
Belchamber	2017	Described how physiotherapy established itself as indispensable component of palliative cancer care. Practitioners evolved to meet complex, multifaceted needs of vulnerable populations, reflecting professional metamorphosis toward patient-centered, compassionate care addressing physical, emotional, and spiritual needs.	A single qualitative case study design. Multiple methods of data collection, which included fourdata sets: interviews (healthcare professionals [10]); interviews(service users [10]); observations (physiotherapists [2] treatingservice users [5]); and policy document collection (NICE guidelines; white papers [12]). A thematic approach to data analysis was used within and across the four datasets.

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Trylińska-Tekielska &Gidziński	2017	Patients' expectations differed significantly before and after physiotherapy treatment, revealing transformative impact on patient perspectives, understanding, and overall well-being. Physiotherapy interventions addressed physical symptoms and fundamentally altered patient perceptions and coping strategies.	Studied group consisted of 22 patients, aged 30–80 years, in advanced stage of cancer disease. The patients' expectations were recorded on Questionnaire of Expectations Patient-Physiotherapist (QEPP). The patients' expectations were based on Questionnaire of Expectations Patient-Physiotherapist (QEPP).
Kaur	2016	Multiple sclerosis case study showing effectiveness of early palliative care integration with physiotherapy. Positive outcomes from aerobic training (static cycling, treadmill walking), balance retraining with Tai-chi principles, pelvic floor strengthening, and cognitive rehabilitation including motor imagery techniques.	This is a case report.
Minosso	2016	Rehabilitation played significant roles in helping patients achieve daily activities and structure their lives, leading to improved quality of life. Established functional rehabilitation as viable strategy to combat functional decline and enhance quality of life for palliative care patients.	An integrative review was undertaken. The guiding question was: what are the results of functional rehabilitation in adult palliative care patients? To answer the question, the PICO- Population, Intervention, Comparison and Outcome strategy was used.
Pyszora	2016	Specific, short-term physiotherapy programs significantly reduced cancer-related fatigue in advanced cancer patients receiving palliative care. Measurable improvements in general well-being and reductions in coexisting symptoms including pain, drowsiness, appetite loss, and depression as measured by ESAS. Multi-symptom approach characteristic of palliative physiotherapy practice.	A randomized controlled trial. Sixty patients diagnosed with advanced cancer receiving palliative care were randomized into two groups: the treatment group (n = 30) and the control group (n = 30). The therapy took place three times a week for 2 weeks. The 30-min physiotherapy session included active exercises, myofascial release, and proprioceptive neuromuscular facilitation (PNF) techniques.
Barawid& Covarrubias	2015	Rehabilitation services significantly improved the quality of life for patients with life-threatening illnesses by addressing functional decline, mobility limitations, pain management, and psychological well-being. Benefits included enhanced psychological well-being, increased independence, and reduced caregiver burden across various conditions.	A narrative review article. It synthesizes existing research and clinical experience to discuss the benefits of rehabilitation interventions for patients with late-stage illnesses.

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Pyszora, Jagielski, & Jagielska	2015	Case study evidence demonstrating successful treatment of specific pain syndromes in advanced cancer patients, particularly myofascial pain syndrome. Established physiotherapy as viable, evidence-based treatment for complex pain presentations.	This is a case-study.
Campbell et al.	2014	Comprehensive programs combining psycho-education, exercise, and relaxation techniques led to improvements in patient confidence and overall quality of life, plus enhanced strategies for managing condition exacerbations.	A commentary. It synthesizes existing information and research to support its arguments and provide rationale for integrating rehabilitation services into palliative care.
Clemens & Jaspers	2010	Majority of palliative care patients with lymphedema experienced clinical improvements in symptom intensity (pain and dyspnea) immediately following manual lymphatic drainage interventions. Established adjuvant physiotherapeutic manual lymphatic drainage as valuable for pain and symptom management.	Retrospective study (reflexive control design) of data of the 208 patients admitted to our palliative care unit from January 2007 to December 2007. Demographic and disease-related data (diagnosis, symptoms, Karnofsky performance status and effect of manual lymphatic drainage interventions) were documented and compared. Statistics: mean + SD, median; Wilcoxon's test.
Pyszora & Krajnik	2010	Highlighted physiotherapy's role in treating constipation for advanced cancer patients through abdominal massage, myofascial release techniques, and therapeutic exercises supplementing prescribed laxative medications. Demonstrated integration of manual therapy with conventional medical management.	This is a case-report.

Discussion

Symptom-Specific Interventions and Clinical Effectiveness

The evidence robustly demonstrates that physiotherapy interventions in palliative care are highly effective, often targeting multiple symptom clusters simultaneously and challenging the assumption that patients with advanced cancer cannot benefit from rehabilitative strategies.[1,23]

Further case studies highlight the successful treatment of specific conditions such as myofascial pain syndrome and constipation through targeted physiotherapy techniques, underscoring the broad applicability of these interventions.[23,24]

Exercise-Based Interventions and Functional Outcomes

Structured exercise is a cornerstone of palliative physiotherapy, with significant evidence supporting its safety and effectiveness.The research demonstrates the multifaceted nature of exercise prescription in palliative care, which also yields measurable improvements in psychological stress.[1]

Specialized Manual Therapy Techniques

The literature provides significant evidence for the use of specialized manual therapy in palliative care. [6,24]

Patient-Centered Care and Expectation Management

A crucial aspect of palliative physiotherapy is its patient-centered approach, which can transform patient perspectives. [15,28]

Functional Independence and Activities of Daily Living

A substantial body of evidence confirms physiotherapy's vital role in maintaining and improving functional independence for patients in palliative care. [14,17]

Respiratory and Cardiopulmonary Management

Physiotherapy is essential in managing the respiratory complications common in palliative populations.[20,25]

Multidisciplinary Integration and Collaborative Care

Contemporary palliative physiotherapy operates within a sophisticated multidisciplinary framework.[12]

Outcome Measurement and Quality of Life

Quantifying the effectiveness of physiotherapy in palliative care presents both challenges and successes.[27]

Service Delivery Models and Innovation

The field is characterized by evolving service delivery models that enhance accessibility and effectiveness. The integration of person-centered care into daily physiotherapy activities leads to varied, complex, and interconnected treatments that are meaningful for patients. [(8)]

Functional Rehabilitation and Quality of Life Enhancement

Ultimately, the goal of physiotherapy in palliative care is to enhance the quality of life. By helping patients achieve daily activities and structure their lives, rehabilitation significantly improves their overall well-being. The evidence consistently shows that by addressing functional decline, managing symptoms, and providing psychological support, physiotherapy enables patients to live more fully despite their life-limiting illnesses. [(14)]

Conclusion

Physiotherapy plays a vital and multifaceted role in palliative care, significantly enhancing the quality of life for patients with advanced illnesses. Despite these benefits, physiotherapy remains underutilized in many community and home-based palliative care settings, with access often influenced by socioeconomic and clinical factors. Patients frequently report unmet needs related to physical activity, daily functioning, and symptom management, which could be alleviated through greater integration of physiotherapists into palliative care teams. The evidence also underscores the importance of person-centered, individualized care plans and the need for improved communication and training among physiotherapists to optimize their impact in palliative contexts. While physiotherapy is a safe and effective component of palliative care, further rigorous research and broader implementation are needed to ensure that all patients can benefit from its full potential.

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Awareness and Knowledge of Carpal Tunnel Syndrome Among Pregnant Women: A Questionnaire Based Cross-Sectional Study

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Abstract

Background: Carpal Tunnel Syndrome (CTS) prevalence ranges from 31% to 62% among pregnant women, particularly during the third trimester. It is characterized by symptoms such as numbness, tingling and pain in the hands and wrist, resulting from increased fluid retention and hormonal fluctuations that compress the nerve. Early diagnosis and appropriate management are crucial, as untreated CTS can lead to persistent symptoms and functional impairments.

Methods: This cross-sectional study was carried out among 95 first-time pregnant women (primiparous) aged between 26 and 30 years, living in and around Bangalore. The aim of the study was to assess their existing knowledge and level of awareness about CTS. A self-designed questionnaire was used for data collection, which included three main sections: demographic details, knowledge, and awareness. Each section had an equal number of questions. The collected data was analyzed using appropriate statistical methods to draw meaningful conclusions..

Results: Among 95 primiparous pregnant women aged between 26-30 years involved in this study 7.4% were diagnosed with CTS. The average knowledge score was 10.715 ± 3.044, whereas average awareness score was: awareness regarding causes 3.315 ±3.255, awareness regarding prevention 4.157 ± 2.878 and awareness regarding activities 4.168 ± 2.412. These finding indicates that knowledge and awareness were significantly less in Bangalore population.

Conclusion: These findings indicate that knowledge and awareness regarding CTS among primiparous pregnant women were not sufficient, most of them were not aware about the condition and it is affecting their QoL and work life. Complete examination of hand and wrist during antenatal check-up needs to be done.

Keywords: Carpal Tunnel Syndrome, Pregnancy, Awareness, Knowledge, Questionnaire- based study.

Introduction

The carpal space is an anatomical region within the wrist, encompassed by the transverse carpal tendon and carpal bones. The floor of tunnel is created by the concave palmar surface of the carpal bones, while the roof is formed by the flexor retinaculum, a thick fibrous band that spans across the wrist. The flexor

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retinaculum attaches laterally to the scaphoid and trapezium bones and medially to the pisiform and hamate bones [3]. The carpal tunnel includes nine tendons that enter the middle passage and line of radial side. The sensory branches of the lateral median nerve transmit sensation to the three radial half-digits of the fourth digit, causing CTS symptoms in those fingers. The palmar sensory branch of the median nerve innervates the skin of the cutaneous palm and is located 6 cm proximally to the transverse carpal ligament [14].

Carpal Tunnel Syndrome was first described by Sir James Paget in 1854; the term was coined by Moeirisch [12]. Carpal tunnel syndrome is one of the most common entrapment neuropathies due to median nerve compression. CTS is named from the Greek word 'Karpo' which means "wrist" in addition a small space where the median nerve passes between the bones of the wrist. Commonly occurs in the third trimester of pregnancy but it can occur during first and second trimester also [2]. The prevalence of CTS in pregnancy varies between 31 and 62%. Pregnancy often leads to Carpal Tunnel Syndrome (CTS), caused by fluid collection in the wrist tissues [5].

The incidence of CTS is higher in females during their pregnancy and lactation period. Pregnant women may develop carpal tunnel syndrome (CTS) due to hormonal changes, fluid retention, nerve hypersensitivity, and fluctuations in glucose levels. During pregnancy, the placenta releases hormone called relaxin, which may increase the risk of developing carpal tunnel syndrome (CTS) [6]. Simultaneously levels of progesterone, aldosterone and estrogen are highly increased, which supports the causation of CTS. Kidney plays a major role in elevating blood volume by enhancing fluid retention, in addition to pregnancy, red bone marrow is in a more active state comparatively producing increased blood cells favoring enhanced blood volume. Therefore, 1-2 liters of additional blood flows in the mother at the time of eutocia [6].

Consequently, pregnant women with hypertension and pre-eclampsia, immoderate weight gain, and pregnancy induced hyperglycemia are at an elevated risk of developing CTS [6]. Breastfeeding may delay the recovery in women with pregnancy- related CTS [5]. As the trimester progress and the parity of women enhances, the signs and symptoms of CTS enhances [8]. Due to fluid buildup, the median nerve gets compressed, which leads to numbness, tingling and weakness in the hand and fingers [17]. Symptoms typically appear in the second or third trimester and may persist or worsen after childbirth [13]. Women who experience CTS in one pregnancy are more likely to develop it in future pregnancies [16]. While CTS can affect the entire hand, the dominant hand and first two fingers are usually most affected. Sleeping with curled hands can aggravate the symptoms, leading to increased discomfort in the morning [13].

CTS results in considerable pain and discomfort, loss of sleep and work disability, paresthesia, and limitation of activities of daily living. The painful sensations in the patient's hand are brought on by the pressure of the middle nerve inside this tunnel. Muscle weakness will be seen in opponents pollicis brevis, abductor pollicis brevis and flexor polices brevis. Hyperextension, passive flexion of the affected hand at the wrist for more than 60 seconds may worsen symptoms. Anatomical variations in the median nerve can lead to atypical clinical presentations, as these deviations may affect nerve function and sensory distribution [17].

Pregnancy induces significant physiological and physical changes in the female body, often leading to the first episode of carpal tunnel syndrome (CTS) due to hormonal fluctuations and fluid retention [14]. This swelling increases pressure within the carpal tunnel, compressing the median nerve and causing tingling and numbness in the hands and fingers. Pregnant women frequently experience hand and wrist issues, with a significant number reporting such complaints. Routine antenatal checks should include assessments for such complaints to ensure a good quality of life during pregnancy and to prevent these issues from advancing to a chronic state [6].

Early detection of carpal tunnel syndrome (CTS) during pregnancy can be achieved through non-invasive methods, as invasive procedures

are contraindicated. Carpal tunnel syndrome is diagnosed based on the patient's medical history and clinical examination findings. Common signs of carpal tunnel syndrome (CTS) include numbness in the thumb, index, middle, and the lateral half of the ring finger, often occurring in the night [5]. In the early stages, patients may report numbness in these digits, especially during nighttime or while holding objects like a phone or newspaper. During the physical examination, healthcare providers may use nerve conduction tests to confirm CTS if necessary [20]. These procedures involve the use of electrodes or needles taped into the skin to record and analyse the electrical signals transmitted through the nerves. Lesion to the median nerve can result in blocked or delayed signals Additionally, Tinel's test is often used to detect the nerve damage; this involves gently tapping over the affected nerve area, and if the patient such as a pregnant woman experiences a tingling sensation, it may indicate nerve impairment [4].

Health care professionals' especially gynecology physiotherapists can educate pregnant women on risk factors, symptoms, and preventive measures, such as regular stretching, good posture, avoiding aggravating activities, wearing wrist splints, and exercising to maintain wrist and hand mobility [3]. Development of educational programs and preventive strategies for pregnant women, promoting early detection and management of CTS [4]. The purpose of this study is to bridge this knowledge gap by evaluating the extent of awareness and understanding of CTS among pregnant women. By identifying areas of limited knowledge, the study seeks to inform targeted educational interventions that can enhance awareness, promote early detection, and improve management of CTS during pregnancy. Such initiatives are crucial for reducing the functional impact of CTS and ensuring better maternal health outcomes [16].

Methods

This study employed questionnaire-based cross-sectional design. The research was conducted in the selected hospitals in Bengaluru (REGAL Kidney and multi-speciality hospital, FOSTR Health care multi-speciality health clinic). The sample consisted of 95 primiparous pregnant women aged between 26-30 years.

1. Sample Size Calculation

The anticipated level of knowledge regarding CTS is 55.9% (Albaker et al (2023)). The following formula is used for sample size calculation,

$$n = \frac{Z2p\,(1 - p)}{E2}$$

Where Z = 1.96, the standard normal score

p = 55.9% the anticipated level of knowledge

E = 10%, the margin of error

With 95% level of confidence, 10% margin of error a total of 95 pregnant women were included in the study.

After obtaining ethical approval and participant consent, eligible participants based on inclusion and exclusion criteria were given a structured questionnaire for assessing the awareness and knowledge of Carpal Tunnel Syndrome (CTS).

Inclusion Criteria

- Pregnant women aged between 26-30.
- Primiparous women.
- Pregnant women who had at least college level of education.
- Pregnant women who were living in Bangalore.

Exclusion Criteria

- Pregnant women who were having neurological issues.
- Women who were working in computer field.
- Women with a history of fracture, dislocation and trauma to hand diagnosed with de-Quervain syndrome, multiple sclerosis,

pronator syndrome and anterior interosseous syndrome.

Data collection occurred over three months, with measures taken to protect participant's privacy and confidentiality. SPSS version 20 was used for data analysis. Descriptive statistics described demographic characteristics and Carpal Tunnel Syndrome knowledge and awareness. The Kolmogorov-Smirnov and Shapiro-Wilk tests confirmed non-normal distribution. Accordingly, the Kruskal-Walli's test and Spearman's correlation were applied to assess differences and relationships between awareness and knowledge.

Results

The study consisted of 95 pregnant women in total. The demographic data showed (Table 1.1) 32.6% were 28-year-old,31.6 % were 26 years old,16.8% were 30 years old and 9.5% were 27and 29 years 7.4% diagnosed with Carpal Tunnel Syndrome were among age 26-30 years. Based on educational level 63.2% were college level, 36.8% participants were higher level of educated people. 36.8% of the participants were from the Southern region of Bangalore, 22.1% were from the Western region, 18.8% were from the Eastern and Northern parts of Bangalore.

Table 1. The descriptive information of knowledge and practice towards Carpal Tunnel Syndrome (N=95).

Variable	Statement	Number	Percentage
Section 2:	1.Have you been diagnosed with	I Don't	15.8%
Population	CTS?	know:15	76.8%
knowledge		No: 73	7.4%
about the		Yes:7	100.0%
clinical		Total: 95	
features of	2. Do you know the details about CTS	No:57	60.0%
Carpal	in wrist, hand and fingers?	Yes:38	40.0%
Tunnel		Total :95	100.0%
Syndrome	3.Does CTS cause pain in the wrist	No:51	53.7%
(CTS)	hand and fingers?	Yes:44	56.3%
		Total :95	100.0%
	4.Does CTS cause tingling or	No:55	57.9%
	numbness in the thumb, index or	Yes:40	42.1%
	middle?	Total:95	100.0%
	5.Does CTS cause weakness in the	No:57	60.0%
	thumb muscle?	Yes:37	38.9%
		Total:95	100.0%
	6.Does CTS cause decrease in overall	No:54	56.8%

Continue....

	hand grip?	Yes:40	42.1%
		Total:95	100.0%
	7.Does CTS cause muscle wasting in	N0:62	65.3%
	the affected hand?	Yes:32	33.7%
		Total:95	100.0%
	8.Does CTS cause a change of pain	No:53	55.8%
	intensity while doing the wrist	Yes:40	42.1%
	movement?	Total:95	100.0%
Section 3:	1. Do you think that any hand injury	I Don't	52.6%
Awareness	may lead to CTS?	know:50	24.2%
of causes		No:23	23.2%
lead to		Yes:22	100.0%
CTS		Total: 95	
	2. Do you think that repeated physical	I Don't	49.5%
	activities like household chores may	know:47	17.9%
	lead to CTS?	No:17	32.6%
		Yes:31	100.0%
		Total:95	
	3. Do you think that wrist fracture or	I Don't	61.1%
	dislocation may lead to CTS?	know:58	14.7%
		No:14	24.2%
		Yes:23	100.0%
		Total:95	
	4. Do you think that rheumatoid	I Don't	62.1%
	arthritis may lead to CTS?	know:59	21.1%
		No:20	16.8%
		Yes:16	100.0%
		Total:95	
	5. Do you think that tumor (cancer	I Don't	60.0%
	growth) of bone may lead to CTS?	know:57	20.0%
		No:19	20.0%
		Yes:19 Total:95	100.0%

Continue....

Section 4:	1.Do you think that avoiding all	I Don't	31.6%
Awareness	repetitive wrist movements can	know:30	22.1%
about	prevent CTS?	No:21	46.3%
prevention		Yes:44	100.0%
strategies		Total:95	
of CTS	2. Do you think that using soft splint	I Don't	43.2%
	(splint used for CTS) during day,	know:41	12.6%
	night or both night and day can	No:12	44.2%
	prevent CTS?	Yes:42	100.0%
		Total:95	
	3. Do you think that keeping	I Don't	41.1%
	warm/hot packs in areas of pain can	know:39	15.8%
	prevent CTS?	No:15	43.2%
		Yes:41	100.0%
		Total:95	
	4. Are you aware of the physiotherapy	I Don't	41.1%
	treatment option for CTS?	know:39	20.0%
		No:19	38.9%
		Yes:37	100.0%
		Total:95	
Section 5:	1. Do you think that CTS can affect	I Don't	40.0%
Population	sleep patterns like wrist in bonded	know:38	20.0%
awareness	position or sleep on hand?	No:19	40%
of CTS		Yes:38	100.0%
effect in		Total:95	
their daily	2. Do you think that CTS can affect	I Don't	35.8%
activities	the quality of your life?	know:34	7.4%
		No:7	56.8%
		Yes:54	100.0%

Continue....

		Total:95	
	3. Do you think that CTS can affect social life like family care?	I Don't know:40 No:20 Yes:35 Total: 95	42.1% 21.1% 36.8% 100%
	4. Do you have any chronic diseases like metabolic and musculoskeletal disease (Diabetes mellitus/ Hypothyroidism/Rheumatoid arthritis/others?)	No:94 Yes:1 Total:95	98.9% 1.1% 100.0%

The descriptive information of knowledge and practice towards Carpal Tunnel Syndrome

Prevalence of Knowledge (Clinical Features) in Pregnant Women

The questionnaire had three major categories knowledge, awareness and practice. In the knowledge category, In the first part gathered questions about CTS clinical aspects, whereas in the awareness category, the questions gathered about the causes of CTS. The practice category included questions about CTS preventative measures and the link between CTS and chronic diseases. Table 1.5 reveals that the prevalence of knowledge about the clinical features of Carpal Tunnel Syndrome (CTS) over all 38 (40%) pregnant women knew information regarding CTS in the wrist, and 44 (56.3%) knew about pain. Knowledge regarding numbness or tingling in the thumb was reported by 40 (42.1%) participants, while 37 in addition 40 pregnant women accepted that CTS may lead to weakness in the thumb (38.9%), reducing hand grip (42.1%). Out of 32 pregnant women (33.7%) accepting that muscle wasting may be experienced by CTS, and 40 (42.1%) agreeing that pain intensity may vary in CTS.

Awareness of CTS causes in Pregnant Women

In the category of awareness, trauma was considered as a major cause of CTS, a total of 7 (7.4%) pregnant women agreed upon this. A total of 31 (32.6%) pregnant women acknowledged that repeated physical activities like household work cause CTS, while 23 (24.2%) pregnant women accepted that wrist fracture is associated with CTS. Most of the participants perceived that 19 (20.0%) bone tumor was the major reason behind CTS. Only 16 (16.8%) pregnant women agreed that arthritis is the major cause for CTS.

Awareness about Prevention Strategies

Regarding preventive measures, a total of 44 (46.3%) pregnant women agreed that avoiding repetitive movements can prevent CTS, 42 (44.2%) agreed that using soft splint (splint used for CTS) during day, night or both night and day will prevent CTS. 41 (43.2) reported that keeping warm/hot packs in areas of pain will prevent CTS. Only 37 (38.9%) knew about the physiotherapy treatment for CTS.

Population Awareness of Cts Affects their Daily Activities

A total of 38 (40%) pregnant women were accepting that CTS will affect sleep patterns like wrist in bonded position or sleep on hand, 54 (56.8%) are reported that the CTS is affecting their quality of life. 60 (63.2%) participants agreed that CTS is not affecting their social life like family care, a huge population is accepting that there is no correlation between the chronic diseases like metabolic and musculoskeletal diseases (Diabetes mellitus/ Hypothyroidism/Rheumatoid arthritis/others).

Table 2. Mean score of knowledge, awareness and practice Mann-Whitney U Test based on educational level

	Level of education	N	Mean	%	p-value
Knowledge	College level	60	47.37	63%	0.767
	Higher education	35	49.09	37%	
	Total	95			
Awareness of causes lead to CTS (AC)	College level	60	45.67	63%	0.270
	Higher education	35	52.00	37%	
	Total	95			
Awareness about prevention strategies of CTS (AP)	College level	60	46.85	63%	0.589
	Higher education	35	49.97	37%	
	Total	95			
Population awareness of CTS effect in their daily activities (PA)	College level	60	48.53	63%	0.801
	Higher education	35	47.09	37%	
	Total	95			

Mean score of knowledge, awareness and practice Mann-Whitney U Test based on educational level

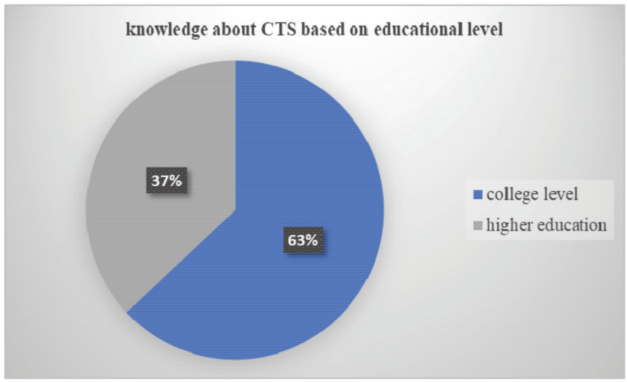


Figure 1: Knowledge about CTS based on the level of education

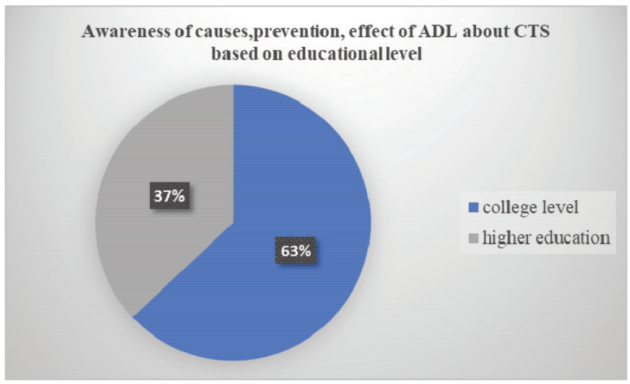


Figure 2: Awareness about the causes, prevention, effect of ADL about CTS based on educational level

Discussion

A total of 95 primiparous pregnant women with the age group of 26-30 years included in this questionnaire based cross-sectional study, includes 3 sections demographic data, knowledge and awareness,37% of the participants were from southern region of Bangalore and 63% were having the college level of education. 7.4% of participants were diagnosed with Carpal tunnel syndrome, in that 56.3% had pain in the wrist, hand and fingers. 42.1% were numbness/ tingling in the fingers, 40.0% participants are not aware of the details of CTS. To make sure the high quality of life during pregnancy and post-partum all pregnant women should examine their hands and wrists during their antenatal checkup.

Similar study was conducted by Dr Garg et al (2022) examined the prevalence of Carpal Tunnel Syndrome among pregnant women in various countries. Pregnancy- related carpal tunnel syndrome rates range from 0.8% to 70%, according to different research. women with pregnancy-related carpal tunnel syndrome (PRCTS) may experience serious symptoms than the people with idiopathic CTS [20].

Almughais et al 2023 conducted A cross-sectional study in Hali Saudi Arabia to assess the knowledge

and practice of Carpal Tunnel Syndrome among pregnant and mom-pregnant women, it was noted that 49% of adults lacked community awareness, while 59% of pregnant women experienced worsening symptoms. The patient awareness and knowledge are crucial for Carpal Tunnel Syndrome along with early diagnosis and management is needed before the nerve compression occurs [1].

A cross-sectional study done in Multan to assess the prevalence of Carpal Tunnel Syndrome in middle aged pregnant females. The study found that 22% of women had CTS throughout pregnancy. It was more common among women in their third trimester, aged 18 to 28 years. Approximately 13.1% experienced mild pain, while 2.3% experienced serious pain in the wrist. The results reveal that as gestational age increases, the frequency of CTS rises, whereas asymptomatic instances decrease. MCH practitioners should be aware of the increased risk of carpal tunnel syndrome (CTS) during pregnancy and offer appropriate information and assistance to pregnant women who may be at risk (Rehman et al 2023) [3].

A Quasi- experimental study was done at Obstetrics and Gynecology outpatients' clinic, Benha University Hospital. The study was aimed at evaluating the effect of an educational intervention regarding Carpal Tunnel Syndrome on pregnant women' knowledge, symptom severity and function status. 58.0% of the participants were aged from 30-40 years, 78.0% of them were working, and 74% of them were obese before pregnancy. The educational intervention regarding CTS declining their symptom severity of Carpal Tunnel Syndrome and improving their functional status (Elmoniem et al 2018) [2].

Conclusion

This study concluded that the knowledge and awareness regarding Carpal Tunnel Syndrome among primiparous pregnant women is not sufficient, most of them are not aware about the condition and it is affecting their quality of life and work life. History taking and clinical examination could not detect all the cases, complete examination of hand and wrist during antenatal check-up need to be done. This study found the prevalence of CTS is 7.4%.

Limitations

- The sample size of the study was small to detect the prevalence of Carpal Tunnel Syndrome among pregnant women inside Bangalore.
- It was difficult to find the sample size as it was vulnerable population

Implications for Future Research

- Future studies should include more diverse population across geographical regions and socioeconomic backgrounds to generalise the findings
- Future studies should conduct trimester wise prevalence and severity to understand the depth of knowledge and awareness of the pregnant women for further educational sessions.

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Ethical Clearance: The study was approved by the Yenepoya Ethics Committee – 1(YEC-1), Date: 24-10-2024, Approval No: YEC-1/2024/337.

Conflicts of Interest Statement: The authors declare no conflicts of interest.

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Original Article

Effect of Relaxation Training and Self-Managementstrategies on Pain and Distress in Young Adults Withprimary Dysmenorrhea– A Pre-Post Experimental Design

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Abstract

Background: Painful menstruation with idiopathic origin or absence of other pelvicdiseases is primary dysmenorrhea. Mitchell's method of physiological relaxation has higher benefits in relaxation of the pelvic floor and reduction of pelvic tone; the technique might be useful in the reduction of symptoms of dysmenorrhea. This study aimed to inquire into the effectiveness of Laura Mitchell's relaxation technique and self-management strategies on young adults with Primary Dysmenorrhea.

Methods: Based on inclusion criteria, 21 subjects have undergone detailed assessment and data collection for menstrual distress, pain catastrophisation, sleep quality, physical activity level, pain rating and bleeding volume. Mitchell's relaxation training was administered for 6 session per week for 6 weeks; along with educationabout self-management strategies followed by every session was given thrice a week for six weeks.

Conclusion: After 6 weeks of intervention, individuals have reported with reduced menstrual distress($p<0.001$) pain ($p=0.006$), improved physical activity level ($p=0.031$) and sleep quality with slight improvement in pain catastrophising behaviour compared to one week of immediate effects implying longer the duration of training will have greater improvement. It is concluded that Mitchell Method Relaxation Technique (MMRT) and self-management strategies have a significant effect on reduction of menstrual distress before 4 days of menstrual cycle and during the cycle, sleep quality, physical activity levels and pain rating.

Key words: Primary dysmenorrhea, Mitchell method of relaxation, Self-management, Menstrual distress, Sleep quality, Pain catastrophization, Physical activity.

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Introduction

Among women of reproductive age, dysmenorrhea is one of the most prevalent-gynaecological conditions. It is characterised by painful menstrual cramps that originate in the uterus.[1] Primary and secondary kinds of dysmenorrhea are distinguished based on their pathophysiology, traits, and physiological variations. Primary Dysmenorrhea(PD) is defined as painful menstruation that has an idiopathic cause or is not associated with any other pelvic disorders. It is the most prevalent gynaecological problem that affects women in their reproductive phase or between the ages of 15 and 49, and it usually manifests after menarche. It is the cyclically felt discomfort that radiates to the lower limb from the hypogastric, suprapubic, groin, and lower back areas. Common menstruation symptoms include headache, nausea, vomiting, fatigue, lightheadedness, and diarrhoea.

The prevalence of dysmenorrhea in India was 70.2% The majority of the subjects experienced pain for one or two days during menstruation. 23.2% of the dysmenorrheic girls experienced pain for 2-3 days.[2] It is experienced due to fluctuating hormonal levels or might be due to overproduction of prostaglandins (PGs), leading to pain. Prostaglandins are responsible for the induction and triggering of the menstrual cycle,but overproduction of them leads to altered physiological functions and excessive cramping. PGs cause pain by increasing uterine contractions and uterinepressure. Impaired uterine perfusion, ischemia, hypoxia, and metabolites from anaerobic metabolism may also play a role in the cause of pain.[3] All the physical and emotional stress related to menstruation that befalls just before, during, or just after the bleeding days of the menstrual cycle,which is caused by the fluctuations of female reproductive hormones is called menstrual distress.[4]

Pain catastrophizing is a psychological response marked by intense negative thoughts about pain, which can destabilize mental health over time. This often leads to procrastination, disengagement from treatment, ineffective recovery, and an increased risk of chronic pain. In individuals with dysmenorrhea, sleep is significantly affected.[5] The pain can cause frequent shifts in sleeping positions and difficulty falling asleep, which in turn impair dailyperformance and cognitive function. This disruption not only reduces productivity but also raises the risk of absenteeism and sleep disorders.

There is a strong connection between dysmen-orrhea and poor sleep quality, impacting subjective sleep quality, overall sleep, and daytime functioning. Addressing these concerns is essential for enhancing physical and psychological well-being. It affects their daily performance, reducing their abilities and attention, which is a preceding factor forabsenteeism from work and causing the development of sleep disorders. There is a direct correlation between the presence of dysmenorrhea and the domain of sleep quality. Subjective sleep quality, total sleep quality, and daytime dysfunction are affected.[5]

Physical activity, menarche age, and nutritional health are some of the variables that can affect dysmenorrhea. Prostaglandin levels can be influenced by an individual's nutritional status, which might result in dysmenorrhea. Additionally, regular exercise helps improve circulation throughout the body and lower stress levels, both of which improve mental and physical health together.[6]

Relaxation methods are therapeutic activities designed to help individuals reduce stress and anxiety both physically and psychologically.[7] The Mitchell Method of Physiological Relaxation (MMRT), often referred to as the "simple method of relaxation," is a technique that focuses on relaxing either the whole body or specific parts. Once learned and practiced, this method can be easily applied anywhere to help alleviate muscle tension caused by stress.[8] It is particularly beneficial for relaxing the pelvic floor and reducing pelvic tone, which may help to ease the symptoms of dysmenorrhea. This effectiveness stems from its ability to correct nervous system imbalances, ultimately promoting a relaxation response that positively influences cardiorespiratory functions.[9,10]

Women often take the initiative to manage their pain through self-management techniques, which, although subjective, can be highly effective. Many

women utilize non-drug methods such as heat therapy (61.5%), tea (42.4%), and massage (30.9%) to alleviate menstrual pain.[11] Chamomile tea is celebrated for its anti-spasmodic and antiinflammatory properties, supported by scientific evidence for its effectiveness in easing primary dysmenorrhea (PD).[12] Walking, aerobic exercises, and strength training are examples of regular physical activity that can improve overall quality of life and alleviate primary dysmenorrhea symptoms. Three days prior to menstruation, exercise helps improve pelvic blood flow and prevent the buildup of prostaglandins that cause pain. Furthermore, exercising during menstruation discomfort can aid in the removal of extra substances from the uterus, which can ultimately shorten the pain's length.[13] Women who use these techniques can take charge of their menstrual health and lead more active, satisfying lives.

Primary dysmenorrhea is the most common yet neglected health problem of the current female population, although many pharmacological treatments are available, their safety and reliability in the long run are uncertain. Exercise intervention is an important component for the treatment of neurological, musculoskeletal rehabilitation, and fitness training. But its significance in gynecological conditions is unnoticed. Relaxation techniques are popular among psychological conditions and other musculoskeletal conditions, but their practicality in primary dysmenorrhea is not well discussed. Thus, the study is intended to show the effect of MMRT and self-management strategies in primary dysmenorrhea, which are usually safe, convenient, economical, and can be performed easily with no greater effort by any population.

Methodology

The study was a pre-post experimental study, involving 21 samples obtained throughconvenient sampling. The sample population consisted of young adults aged between 18 and 24 years. Specifically, it included females aged 19 to 24 who were diagnosed with PD and had been experiencing symptoms for at least three months. Participants had a WaLIDD score greater than 4, experienced regular menstruation lasting from 3 to 8 days, and were nulliparous (i.e., had never givenbirth). The study didn't include individuals with the following characteristics: irregular menstruation, other pelvic pathologies (such as fibroids, endometriosis, or cysts), use of contraceptives or birth control, other gynecological conditions, alcohol or tobacco consumption, and a Numerical Pain Rating Scale (NPRS) score higher than 8. Patient-reported outcome measures as the Short Form Menstrual Distress Questionnaire (SF-MDQ), Pain Catastrophizing Scale, Pittsburgh Sleep Quality Index, and International Physical Activity Questionnaire-7, are the primary outcome measures, followed by NPRS and pad count for bleeding volume as secondary outcome measures.

The procedure and purpose of the study were clearly explained to all participants after obtaining approval. Baseline data were collected and documented, including age, gender, BMI, bleeding volume and duration (measured by the number of pads), menstrual distress (measured by the MDQ), pain catastrophization (measured by the PCS), pain rating (using the NPRS), sleep quality (assessed with the PSQI), and physical activity levels (evaluated with the IPAQ 7). This data was gathered during the late luteal phase, on the fourth day of menstruation, and again in the next menstrual cycle.

The subjects were positioned on a firm surface in a comfortable position placing pillows under neck and knees for support and ensuring complete relaxation. The instructor kept her voice low and smooth for an overall tranquil experience. Verbal explanation has been done to follow the sequence of relaxation from shoulders to legs to body to face keeping three things in mind

- Relax your mind and body and try to focus only on the body part being relaxed.
- Don't stop breathing and try to breathe with your diaphragm.
- Move away from the position of stress, stop, hold the pull, feel the new position for a few seconds and relax.
- Drag your jaw downwards and hold it for a few seconds until the tension is felt, relax and get into new position.
- Pull your shoulders down towards your feet, hold tension for a while until you feel it and then release.
- Move your elbows away from your body, let them fall and relax.

- Stretch your fingers wide apart.Tighten buttock muscles so that the legs go outwards and settle them comfortably, ensure the legs are not straight. Open (60 degree) angle behind knee Point the toes (plantar flexion) hold and then release.
- Wiggle toes to and fro to ensure no cramping occurs.
- Push yourself into the support. Release. Push your head into pillow. Breath using the diaphragm. Push tummy out as you breathe in. Four seconds in and hold for four seconds then breathe out for four seconds.
- Pull the jaw toward body with lips lightly touching. Press the tongue down into the roof of mouth and release.
- Close the eyes lightly and look through the eye lids at the red/black color and count to four slowly. Raise your eyebrows relax and feel the smoothening of forehead. The subjects are asked to imagine something calming and peaceful a scenario or a person to enhance the relaxation experience.[14,15]

This is a whole sequence, as the session concluded, subjects are asked to open their eyes slowly and observe the surroundings. Each session usually lasts from 20 to 25 minutes. The above-mentioned relaxation technique was administered 6 sessions/ week for 6 weeks. Education about self-management techniques for dysmenorrhea pain, such as heat packs, warm beverages or chamomile tea, self-hygiene, avoidance of spicy foods during the cycle, explaining the importance of hydration and nutrition, physical activity, and exercise was given for 3 sessions/week for 6 weeks. After 6 weeks of intervention, post-data for the immediate, following cycle, and the next month's cycle were collected.

Data Analysis

The collected data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) software version 20.0. The mean and standard deviation of the baseline data obtained were calculated. The normality was analyzed using the Shapiro-Wilk test. Based on normality, the pre- and post-data were analyzed using parametric or non-parametric tests to determine the significance ($p<0.05$) of selected outcomes.

Results

Table 1 displays the chosen variable's mean and standard deviation. Sleep quality, physical activity, pain rating, menstrual distress, and pain catastrophization all displayed normal distributions. A non-normal distribution of bleeding volume was observed.

Table 1. Descriptive and normality distribution of Baseline Characteristics

Variable	N	Mean	SD	Min.	Max.	Shapiro Wilk p-value*
Menstrual distress-4 days before (SF-MDQ)	21	47.52	23.149	13	101	0.2712
Menstrualdistress-During the cycle (SF-MDQ)	21	79.45	24.055	21	120	0.7303
Pain catastrophisation (PCS)	21	24.59	10.711	10	47	0.2332
Sleep quality (PSQI)	21	7.57	3.78	2	15	0.3703
Physical activity (IPAQ)	21	688.64	339.051	231	1440	0.1055
Pain rating (NPRS)	21	7.59	.666	6	8	0.2
Bleeding volume	21	2.82	.664	2	4	0.0001*

sample size; SD-Standard Deviation; SF-MDQ- Short Form Menstrual Distress Questionnaire; PCS-Pain Catastrophizing Scale; PSQI-Pittsburgh Sleep Quality Index; IPAQ-International physical activity questionnaire; NPRS-Numerical Pain Rating Scale

Descriptive statistics; Shapiro wilk normality test; p-value-<0.05(Significant)*

The paired t test results, which were used to evaluate the statistical significance of menstruation distress, pain catastrophization, sleep quality, physical activity, and pain rating following a week of intervention, are displayed in Table 2.1.

Table 2.1. Baseline vs 1 week post intervention of menstrual distress, pain catastrophization, sleep quality, physical activity & pain rating

Variable	N	Mean	SD	t-value	p-value*
Menstrual distress-4 days before (SF-MDQ)	21	9.864	20.861	2.218	0.019*
Menstrualdistress-During the cycle (SF-MDQ)	21	17.818	29.722	2.812	0.005*
Pain catastrophization(PCS)	21	-.864	16.084	-.252	0.402
Sleep quality (PSQI)	21	7.57	3.78	0	1.000
Physical activity (IPAQ)	21	16.091	78.195	.965	0.173
Pain rating (NPRS)	21	.773	1.193	3.039	0.003*

N-Sample size; SD-Standard Deviation; SF-MDQ-Short Form Menstrual Distress Questionnaire; PCS-Pain Catastrophizing Scale; PSQI-Pittsburgh Sleep Quality Index; IPAQ-International physical activity questionnaire; NPRS-Numerical Pain Rating Scale

Paired t-test; p-value-<0.05(Significant)*

Following a week of intervention, the Wilcoxon signed rank test was used to determine whether the bleeding volume was statistically significant. The results are displayed in Table 2.2.

Table 2.2. Baseline vs 1 week post intervention of bleeding volume

Variable	N	Mean	SD	Z-value	p-value*
Bleeding volume	21	2.76	0.7	0.000	1.000

N-Sample size; SD-Standard Deviation

Wilcoxon test; p-value-<0.05(Significant)*

Table 3.1 shows the result of paired t test which was used to assess the statistical significance of menstrual distress, pain catastrophization, sleep quality, physical activity & pain rating after one month of intervention.

Table 3.1. Baseline vs 1 month post intervention of menstrual distress, pain catastrophization, sleep quality, physical activity & pain rating

Variable	N	Mean	SD	t-value	p-value*
Menstrual distress-4 days before (SF-MDQ)	21	16.500	19.801	3.909	0.001*
Menstrualdistress-During the cycle (SF-MDQ)	21	29.136	28.293	4.830	0.001*
Pain catastrophization(PCS)	21	5.273	14.733	1.679	0.54
Sleep quality (PSQI)	21	1.818	4.283	1.991	0.30
Physical activity (IPAQ)	21	-79.773	162.179	-2.307	0.016*
Pain rating (NPRS)	21	-.182	12.823	-0.67	0.474

N-Sample size; SD-Standard Deviation; SF-MDQ-Short Form Menstrual Distress Questionnaire; PCS-Pain Catastrophizing Scale; PSQI-Pittsburgh Sleep Quality Index; IPAQ-International physical activity questionnaire; NPRS-Numerical Pain Rating Scale

Paired t-test; p-value-<0.05(Significant)*

Table 3.2 shows the result of Wilcoxon signed rank test which was used to test the statistical significance of bleeding volume after one month of intervention.

Table 3.2. Baseline vs 1 month post intervention of bleeding volume

Variable	Sample Size	Mean	SD	Z-value	p-value
Bleeding volume	21	2.86	0.560	-0.312	0.755

N-Sample size; SD-Standard Deviation

Wilcoxon test; p-value-<0.05(Significant)*

Menstrual distress: The intervention has provided a significant reduction of menstrual distress during the menstrual cycle after a week(p-value<0.05) and a month of intervention. The results have shown better alleviation of symptoms.

Pain catastrophization: The intervention showed no effect or decrease in the pain catastrophizing behaviour after one week of intervention but a slight decrease is observed after 1 month of intervention administration. This result shows that MMRT and self-management strategies don't have a significant impact on pain catastrophization in amonth.The result would've been significant if the intervention is performed for longer duration or with a greater sample size.

Sleep quality: The intervention showed zero improvement in the sleep quality of individuals after one week of intervention, but after one month of intervention, a non- significant trend toward improved sleep quality was observed showing that MMRT and self management strategies education is reliable for improving sleep quality in PD.

Physical activity: After a week of intervention, mean of physical activity levels has slightly reduced in individuals this may be due to pre menstrual pain or distress but after a month of MMRT and education on self-management strategies the individuals have increased their physical activity, indicating enhanced physical engagement throughout the day following the relaxation and education program.

No significant long-term changes in pain were found compared to the immediate results taken after one week of intervention but whereas reduction in NPRS was observed after a week of intervention.

Bleeding volume: MMRT and education on self-management strategies don't have any effect on bleeding volumes even after one week and after one month. Implying that the intervention does not have any effect on bleeding volume.

Discussion

There is a large and significant female population exhibiting severe pain with associated symptoms during the menstrual period, resulting in varying levels of impairment of personal and social functions and absenteeism from work and inability to perform daily routine.[16,17] Individuals with PD may benefit more from exercise interventions and lifestyle changes rather than pharmacological treatment, ensuring a holistic approach to wellness. This study aimed to evaluate the effectiveness of Mitchell's physiological relaxation technique alongside self-management education in reducing pain and distress related to PD. We assessed menstrual distress, pain catastrophizing behaviors, sleep quality, physical activity, pain levels, and bleeding volume before the intervention, one week later, and one month later.

Following a week of intervention, the results showed a significant decrease in menstrual distress. Following a month of intervention, the p-value for the four days prior to and during the menstrual cycle phases further dropped to less than 0.001. Studies by Nam-Young Yang et al. (2016), which investigated the effects of a yoga program on menstrual cramps and menstrual distress in undergraduate students with PD,[18] and M. Malarvizhi et al. (2022), which investigated the efficacy of the Mitchell Relaxation Technique in conjunction with Kegel exercises to alleviate PD,[19] corroborate this conclusion. Both studies demonstrated a significant decrease in menstrual distress. The observed effect may be attributed to the relaxation response induced by the Mitchell Relaxation Technique, which triggers the release of hormones that exert a widespread influence on the cardiorespiratory system. This

can significantly alter diastolic and systolic blood pressure, oxygen consumption, heart rate, and respiration rate, ultimately helping to relieve muscle tension.

The findings of our study showed no significant impact of the intervention on pain catastrophization at either the one-week or one- month follow-up. Although there was a slight decrease after one month, it was not statistically significant. This highlights the need for further investigation, potentially involving a larger sample size or a longer intervention duration, to better understand and address pain catastrophization in PD management.

There was no improvement in sleep quality after one week of intervention, likely due to premenstrual discomfort and the body's slow adaptation to relaxation techniques. Although the p-value was slightly above significance, the effect size indicates a meaningful improvement after a month of training. This aligns with findings from Amirova et al., which demonstrated thatMindfulness-Based Movement and Relaxation Training effectively reduces pain, sleep disturbances, and fatigue, with significant results for sleep issues and sleep inadequacy.[20]

According to Ria Y T.et al,(2024)stress and lack of physical activity had strong positive and negative correlations with dysmenorrhea pain levels, with r=0.782 and r=-0.748, respectively.[21] As a result, educational self-management strategies emphasized physical activity for its health benefits. While there was no immediate effect of education and training on METs and IPAQ 7 scores after one week, a month later, a significant improvement in physical activity levels was observed.

Pain alleviation is a key concern in primary dysmenorrhea, and the Numeric Pain Rating Scale (NPRS) indicated a significant reduction in pain after one week, likely due to the calming effects of relaxation training. However, no further improvement in pain symptoms was observed after a month. This aligns with Amirova et al., who noted that practicing the Mindful Movement Relaxation Technique three times a week significantly reduced pain.[20]

MMRT and self-management had no impact on bleeding volume, which appears to be controlled more by intrinsic factors than lifestyle changes. According to Demiralp Ovgun et al., relaxation techniques may enhance blood flow during menstruation, aiding in pain reliefwhen practiced over longer duration.[22]

Future Scope of the Study

Results of the study can be used to prove the effectiveness of relaxation techniques and could be recommended as a non-invasive treatment plan for dysmenorrhea, reducing the dependence on NSAIDS and painkillers. Alleviation of symptoms due to reduction in muscle tension, activity of the sympathetic nervous system, and improved deep breathing capacity, along with psychological calmness.The study has found a significant reduction in the symptoms of dysmenorrhea, like menstrual distress, sleep quality, physical activity, and pain rating. We can continue larger-scale studies on different populations to further validate the technique. Comparative studies can also be carried out, such as relaxation vs resisted exercises. Relaxation intervention can also be combined with other exercise interventions to find out the combined effectiveness, which can be used as treatment prescription or management, and alleviation of symptoms of primary dysmenorrhea.

Limitation

The study was performed on students of physiotherapy who already have a knowledge of concepts and procedures of the intervention. Application of the intervention to other populations would improve acceptance of the study. The sample size was limited.The duration of the study was less (6 weeks), which may not have given the expected result on some outcomes, as the technique needs to be practiced for a week to get the body into a complete

relaxation phase.As most of the samples are students, there was a time restriction and absenteeism.

Conclusion

From this study, it has come to a limelight that relaxation techniques are effective in management of primary dysmenorrhea, breaking the myth that exercise interventions don't have impact on gynaecological conditions. Education on self-management strategies along with relaxation have provided a 360-degree approach addressing all components of health making this study a biopsychosocial approach.

It is concluded that MMRT and self-management strategies have a significant effect on reduction of menstrual distress before 4 days of menstrual cycle and during the cycle, sleep quality, physical activity levels and pain rating.

Ethical Consideration: Approval obtained from the Malla Reddy University's institutional scientific/ ethical research committee (Reference Number: ISC/ SOAHS-PT/2025/070) on 03/01/2025.

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Original Article

Establishing Normative Height-Normalized Gait Speed in Indian Young Adults: Influence of Indoor and Outdoor Environments

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Abstract

Objective: The Primary objective is to establish normative data for height-normalized gait speed in healthy younger adults aged 18-25. The secondary objective is to assess the impact of environmental conditions on gait speed.

Methods: A cross-sectional observational study was conducted in Mysuru using convenience sampling. A total of 316 healthy participants underwent the 10-meter walk test in both indoor and outdoor settings. Descriptive statistics were used to derive normative values, while paired and independent t-tests compared indoor versus outdoor speeds and examined gender differences, respectively.

Results: Indoor mean gait speed 0.085 ±0.09 m/sec and outdoor mean gait speed 0.93±0.1 m/sec. Gait speed was significantly higher outdoors ($p<0.001$), with no significant gender difference ($p>0.005$)

Conclusion: Height-normalized gait speed allows physiotherapists to assess mobility more equitably across individuals with varying statures, enhancing diagnostic precision in both indoor and outdoor settings., It supports more personalized rehabilitation goals and progress tracking.

Keywords: Gait speed, height normalization,normative data,10-meter walk test,environmental influence

Introduction

Gait is defined as how a person walks, and it differs from locomotion, which refers to an individual's capacity to move from one place to another.[1]The fundamental unit of walking is the gait cycle, which can be defined using various parameters, including spatial (distance) and temporal (time) parameters.[1]Temporal parameters are cadence, gait speed, step time, stride time, duration of phases and sub-phases, while spatial parameters are step length, step width, stride length, and foot angle.[1]Numerous factors contribute to gait speed, including joint mobility, muscle strength, sensory function, neural control, cognitive status, and energy level,so it can reflect overall health.[1] Walking speed also correlates with functional ability, physiological changes, and balance confidence;hence, it can be used to assess an individual's functional mobility.[2] The gait speed in young adult men is between 1.27 m/sec to 1.44 m/sec, and in women, it is from 1.23 m/sec to 1.44 m/sec.[3]

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Gait speed is a significant determinant of health and is used as a predictor of decline in functional mobility.[1] Gait speed is used not only to evaluate physical function but also to assess the general health status[4].Gait speed can be measured both subjectively and objectively.[4] The traditional scales used to analyse gait parameters in clinical conditions are semi-subjective, carried out by specialists who observe the quality of a patient's gait by making them walk.[5] Objectively, gait speed is measured using automatic sensors and a manual stopwatch.[5] Non-Wearable Sensor(NWS) systems require the use of controlled research facilities where the sensors are located and capture data on the gait while the subject walks on a clearly marked walkway.[5] In contrast, Wearable Sensors (WS) systems make it possible to analyse data outside the laboratory and capture information about the human gait. There is also a third group of hybrid systems that use a combination of bothmethods.[5]

Gait speed in younger adults is important for optimizing physical activity programs and setting personalized exercise targets.[4] The variations in gait speed among young adults are associated with differences in physical and cognitive function, this highlights the importance of assessing gait speed and also it helps the healthcare providers can tailor physical activity programs to enhance endurance, strength and efficiency in walking.[6] Walking speed plays a vital role in setting physical activity goals, particularly in distinguishing moderate and vigorous intensity exercise.[6] Study suggests that brisk walking speed aligns with moderate-intensity activity, which is essential for cardiovascular and metabolic health.[7] Furthermore, engaging in higher gait speeds has been linked to increased engagement in vigorous physical activity, promoting overall fitness.[7] Additionally, gait speed assessments enable early detection of mobility issues, even in the younger population.[7] Slower than average gait speed may indicate neuromuscular inefficiencies or any other underlying health issues. [6]Regular monitoring of gait speed ensures that individuals can track their progress and adjust their activity levels.[7] Therefore, incorporating gait speed assessments into physical activity planning for younger adults provides a structured approach to improving fitness and monitoring health.[8] By setting specific speed targets, individuals can achieve optimal physical activity levels and maintain long-term mobility.[8]

Normative gait speed data provide essential benchmarks for assessing mobility, yet most existing studies are based on Western populations with limited representation of Indians.[910] Given that Indians generally have shorter stature and leg length than Europeans, their gait patterns may differ due to inherent anthropometric variations. Recent trends in urban India show gradual increases in height alongside rising BMI and obesity rates, both of which significantly influence gait speed and walking efficiency[11]. These evolving physical characteristics underscore the need for ethnicity-specific normative values that reflect the Indian population's unique profile. Establishing such data would enhance the accuracy of physical activity prescriptions and rehabilitation protocols. Therefore, a dedicated study is needed to develop normative gait speed values tailored to Indian demographics. Hence, the aim of this study is to establish the normative height normalised gait speed in younger adults in the Indian population between the age group of 18-25 years and to identify the effect of the environmental variable on gait speed.

Methods

A cross-sectional observational study was conducted to establish normative data for height-normalized gait speed and assess the influence of environmental factors in indoor and outdoor settings on gait speed in healthy young adults aged 18-25 years. This study was carried out in Mysuru, India over the span of one year. Data collection was conducted at predefined indoor and outdoor settings with a flat, obstaclefree 10-meter walkway.

Participants were recruited using convenience sampling based on their availability and willingness to participate to ease the access of the participants and overcome the time constraints. Ethical clearance was granted by the Institutional Research Committee of the Physiotherapy College in Mysuru, India. Inclusion was limited to healthy individuals aged 18 to 25 years, while those with

recent musculoskeletal injuries or surgeries, reliance on assistive devices such as orthoses, prostheses, insoles, or chronic illnesses were excluded. Written informed consent was obtained from all participants prior to participation in the study and the participants were recruited based on their availability and willingness to participate.

Each participant underwent a 10-meter walk test in both indoor and outdoor settings. To ensure accurate timing, 2-meter zones at the beginning and end of the walkway were excluded as acceleration and deceleration phases, and only 6-meter in between were timed in each environment. Rest intervals of approximately 90 seconds were provided between the trials to minimize fatigue. Gait speed was calculated as distance divided by time, and height-normalizedgait speed was obtained by dividing gait speed(meters/sec) by height (in meters).

The sample size was calculated using the formula for estimating a mean as: $n= (Z_{1-\alpha/2}\ \sigma/\ d)^2$.With $\sigma=0.098$ and $d=0.01$, the required sample was 370. A total of 316 participants completed the study.[12]

All data were entered into Microsoft Excel and analyzed using Jamovi (version 2.6.45). Descriptive statistics, including mean, median, and standard deviation, were used for height-normalized gait speed. A paired t-test was used to compare the gait speed between indoor and outdoor environments, and an independent t-test evaluated differences between genders. Effect size was calculated using Cohen's d to determine the magnitude of environmental influence on gait speed.

Results

The initial calculated sample was 370, however, 316 participants completed all the phases of data collection and were included for data analysis. 54 participants did not participate due to the incompletion of the phases, and some were not available on the date of data collection.

Table 1 presents the demographic characteristics of the study participants, categorized by gender (male and female). It includes the key variables of age, height, weight, and BMI, each with its respective standard deviation. The average age of the female participants is 20.58 years with the SD of 2.34, while males have an average age of 20.90 years with an SD of 2.13. The height measurements, which are measured in meters, showed that females have an average height of 1.70 meters (± 0.06), whereas males are taller with an average height of 1.70 meters (± 0.09). In terms of weight, females weigh around 56kg (± 11.07), whereas males have a higher average weight of 66.05kg (± 11.07). BMI values are nearly the same for both groups, with females at 22.40 (±4.73) and males at 22.40 (±4.23), indicating a similar body composition despite differences in height and weight.

Table 1. Demographic characteristics of the participants ± SD Standard Deviation

Demographic details	Female ±SD	Male ±SD
Age (in years)	20.58 ± 2.34	20.90 ± 2.13
Height (in meters)	1.58 ± 0.06	1.70 ± 0.09
Weight (in kgs)	56± 11.07	66.05 ± 11.07
BMI (kg/m²)	22.40± 4.73	22.40 ± 4.23

Height- Normalized Gait speed (Descriptive statistics)

Descriptive statistics were used to examine the distribution of height-normalized gait speed which is presented in Table 2, Figure 1

Table 2. Descriptive statistics for height-normalized gait speed

Height-normalized gait speed		Indoor			Outdoor		
Age (years)	**No. of participants**	**Mean SD**	**Median**	**Min-Max**	**Mean SD**	**Median**	**Min-Max**
18-21	206	0.085±0.09	0.88	0.75-1.10	0.93±0.1	0.932	0.76-1.15
22-25	115	0.897± 0.09	0.878	0.71-1.05	0.94±0.1	0.925	0.77-1.15

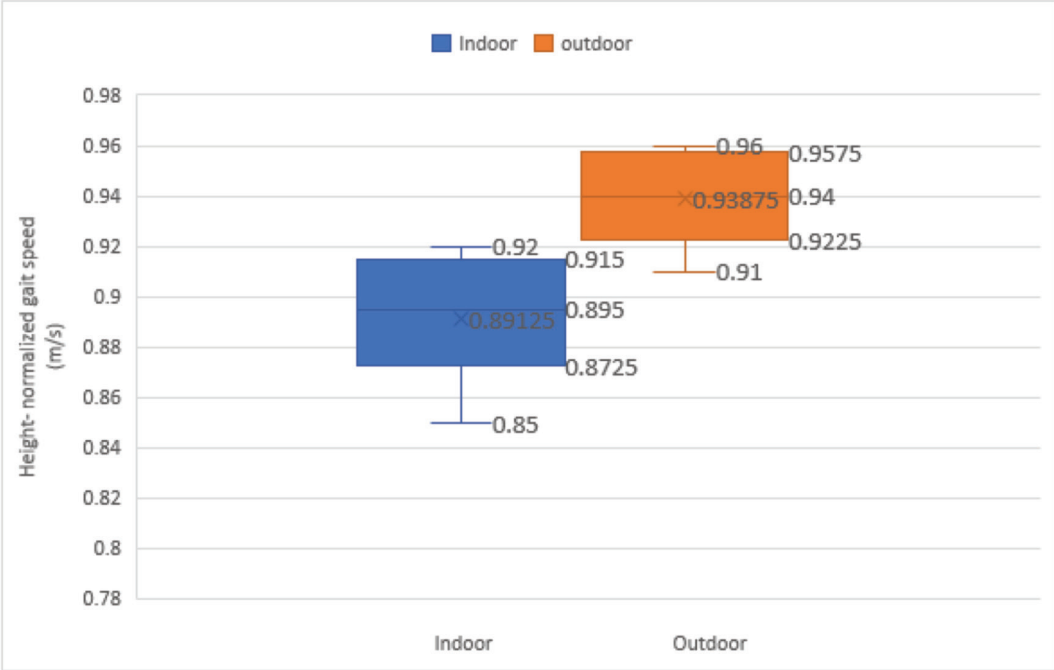


Figure 1: Comparison of height-normalized gait speed in indoor and outdoor environments

Table 2 represents the descriptive statistics for height-normalized gait speed among young adults from 18-25 years, comparing indoor and outdoor level surface walking. The mean gait speed varies across the age groups, mean value of 0.085±0.09 for 18-21 years and 0.897± 0.09 for 22- 25 years in indoor and mean value of 0.93±0.1 for 18-22 years and 0.94±0.1 for 22-25 years in indoor. This shows that outdoor gait speed appears to be higher than the indoor gait speed in the age group of 18-25 years. The standard deviations (SD) values, which indicate variability in gait speed, show relatively small differences, ranging from 0.07 to 0.14 and 0.09 to 0.15 in indoors and outdoors, respectively, suggesting that outdoor conditionshave slightly higher variability. The median values are closely aligned with the median, indicating that the data distribution is approximately symmetrical across both conditions. Minimum and maximum values of indoor gait speed range from 0.63 m/s to 1.10 m/s, while outdoor gait speed ranges from 0.73 m/s to 1.20 m/s.

The plot shows that the median and mean gait speed in the outdoor environment is higher than in the indoor setting, indicating that participants walked faster outdoors. The interquartile range (IQR) for indoor gait speed is slightly wider, suggesting greater variability in walking speeds indoors. The whiskers indicate the minimum and maximum gait speeds within each condition. This shows that walking outdoors results in higher gait speed compared to indoors.

Comparison of indoor and outdoor gait speed (Paired t-test)

A paired t-test was conducted to compare height-normalized gait speed in indoor and outdoor environments. Since the same participants were tested in both conditions, a paired test was appropriate to assess whether the environmental context significantly influenced gait speed. The results of the paired t-testare presented in Table 3.

Table 3. Paired t-test for indoor and outdoor gait speed

Condition	t- value	df	p-value	Effect size (cohen's d)
Indoor vs Outdoor Gait Speed	-17.88	320	<0.001	-1.00

df: degrees of freedom

As shown in Table 3, this indicates a statistically significant difference between indoor and outdoor gait speed, t-test- t-value of -17.88, p <0.001. The negative t- test value suggests that indoor gait speed is lower when compared to outdoor gait speed. Additionally, the effect size, Cohen's d= -1.00, suggests a large effect, indicating that the difference between the two conditions is substantial. Since the p-value is less than 0.001, the null hypothesis (which assumes no differences between indoor and outdoor gait speed) is rejected. This confirms that gait speed is significantly influenced by the environment, with outdoor conditions facilitating a faster gait speed compared to indoor conditions.

Gender difference in Gait speed (Independent t-test)

An Independent Sample T-Test was conducted to examine whether there were significant differences in gait speed between males and females in both indoor and outdoor environments. Although an attempt was made to ensure an equal distribution of male and female participants, the final sample was not evenly distributed. Despite this, the independent t-test was performed to assess whether gender had a significant impact on gait speed. The result of this t-test is represented in Table 4

Table 4. independent t-test for gender differences in gait speed in indoor and outdoor

Condition	t-value	Df	p- value
Indoor	1.63	319	0.105
Outdoor	0.87	319	0.382

Table 4 shows that there is no significant difference in gait speed between males and females for both indoor environments (t-value =1.63, df= 319, p=0.105) and outdoor environments (t-value = 0.87, df=319, p=0.382). Since both p-values are greater than 0.05, it fails to reject the hypothesis, suggesting that gender does not have a significant effect on gait speed in either environment. This finding shows that gait speed is relatively similar across genders in both indoor and outdoor conditions

The result indicated that there is no significant difference between males and females in both indoor and outdoor. Despite slight variations in mean values, both males and females exhibited the same gait speed in both environments. Overall, the findings suggest that young adults walk faster in outdoor environments compared to indoor settings, with no significant gender differences in gait speed. These results contribute to the understanding of gait speed variations in different conditions.

Discussion

This study was conducted to establish height-normalized gait speed for young adults in both indoor and outdoor environments. The study results obtained from our study are consistent with the results of previous studies conducted in different parts of the world. The average gait speed obtained is 0.73-1.14m/s in females and 0.76-1.14 m/s, which shows no gender difference. However, the results obtained contradict the study conducted in Qatar, the Gulf, and the Southeast Asia regions, by Majeed B et. al, Murtagh EM et.al, and Yang M et.al, respectively, which showed that the preferred walking speed for females is lower when compared to males. [4,13,14] In 2023, a study conducted by Keklik S S et.al, in Turkey, showed that there were no significant differences in gait speed by gender, which is similar to the study outcomeobtained.[15] Our study found that the gait speed is reduced in an indoor setup.The possible reason could be because of the restricted nature of walking space, where people walk faster outdoors may be due to individuals feeling freer and less restricted in a wider environment.[13] To the best of the author's knowledge, this is the first study in India assessing height-normalized gait speed in young adults within these two settings.

Strength of the study used standardized outcomes of the 10-meter walk test in both indoor and outdoor environments, ensuring consistency and precision in gait speed measurement. The dual-environment approach offers valuable insights into how environmental factors influence gait speed, which provides a reference value.

The normative height-normalized gait speed values established in this study provide a useful reference for evaluating functional mobility in

Indian young adults and can inform both clinical assessment and exercise prescription. The higher gait speeds observed outdoors highlight the importance of considering environmental context when planning assessments and designing interventions, while the absence of gender differences suggests that rehabilitation protocols may be applied uniformly across males and females. Incorporating outdoor walking into therapy or training routines may also enhance functional mobility and improve the ecological validity of rehabilitation programmes.

This study has several limitations. The use of a 10-meter walk test did not consider for fatigue effects, and although efforts were made to control confounding factors such as weather, footwear, and outdoor surface type, these variables may still have influenced gait speed outcomes. Additionally, the outdoor environment was levelled but not standardized, limiting the generalizability of findings to uneven or gradient terrains. The use of convenience sampling, a restricted geographic region within Mysuru, and a relatively small sample size further constrain the representativeness of the results.The planned sample was ~370, but only 316 participants were included; while this reduced sample size slightly decreased precision, it remains acceptable for exploratory normative data.To enhance external validity, future research should include larger, more diverse samples across multiple regions of India and utilize standardized outdoor conditions. Such efforts would strengthen the applicability of normative gait speed data to broader populations.

Conclusion

In conclusion, this study established normative data for both absolute gait speed and height-normalized gait speed in healthy young adults aged 18-25 years and provideda reliable reference value for self-selected walking speed, which can be used in clinical and research purposes.Moreover, by comparing indoor and outdoor walking conditions, we concluded that environmental factors have a significant impact on gait speed, where participants showed higher gait speed outdoors when compared to the indoor environment

Ethical Clearance: was obtained from Institutional Research Committee, JSS College of Physiotherapy on 18/06/2024. Ref no: JSSCPT/IRC/41/2023-2024

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Conflict of Interest: The authors declare no conflict of interest.

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Original Article

Patient-Centric Customised Isokinetic Training Improves the Muscular Performance and Physical Function of an Individual with Bone-Patella Tendon-Bone Autograft Anterior Cruciate Ligament Reconstruction: A Case Report

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Abstract

Background: Anterior Cruciate Ligament Reconstruction using Bone-Patella Tendon-Bone autograft is a commonly performed surgical procedure to restore knee stability. Postoperative rehabilitation plays a vital role in optimizing muscle performance and restoring functional mobility. However, the application of individualised isokinetic training combined with task-specific biofeedback remains limited in clinical practice.

Case Presentation: This case report presents a 23-year-old male who underwent Anterior Cruciate Ligament Reconstruction using Bone-Patella Tendon-Bone autograft following a sports-related injury. A six-week rehabilitation program was implemented, emphasizing patient-specific progressive isokinetic training and task-specific biofeedback exercises using an isokinetic dynamometer.

Methods: The rehabilitation protocol was tailored to the individual's strength profile and functional goals, incorporating real-time visual and auditory feedback to improve neuromuscular control. Outcome measures related to muscular performance and physical function were assessed both before and after the intervention. Objective assessment of muscle performance was done through isokinetic testing, while physical function and knee-related quality of life were evaluated using the Knee Injury and Osteoarthritis Outcome Score.

Results: Following the intervention, the subject showed consistent and significant improvements in isokinetic strength parameters and functional performance. Increases in muscle torque, endurance, and improvements in the Knee Injury and Osteoarthritis Outcome scores indicated positive clinical outcomes. The individualised protocol was well-tolerated, with no adverse effects reported.

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Conclusion: The novel patient-centric customised isokinetic training, combined with task-specific biofeedback exercises, significantly improved both muscle performance and physical function in this post-Anterior Cruciate Ligament Reconstruction individual. This case report demonstrates that muscular performance and physical functions can be effectively enhanced through a structured and individualised isokinetic rehabilitation program, suggesting promising applications for broader clinical use.

Keywords: Isokinetic training, Anterior cruciate ligament reconstruction, ACL Rehabilitation

Introduction

A variety of exercise training regimes have been proven to prevent associated complications following anterior cruciate ligament reconstruction (ACLR) surgery. Employing isokinetic exercise training is one of the stand-alone methods used in reconditioning patients following ACLR to have sufficient power and endurance to return to their routine daily life[1] and various clinical trials have also shown that musculotendinous soft tissues could adapt to progressive Isokinetic exercises without obligatory muscle damage whilst obtaining benefits in increasing muscle mass and strength under repeated bout effects.[2,3]

However, this case report aims to describe the effects of employing a novel patient-centric progressive isokinetic training along with task-specific biofeedback exercise protocol in improving muscle performance and physical function in an individual following bone-patella tendon-bone autograft ACLR surgery which has not been studied elsewhere.

Case History

The subject is a 23-year-old male with a degree in agriculture and a body mass index of 20.5 kg/m². He injured his right knee during a college football game and later experienced recurrent instability and pain after a slip in the bathroom. Ten months post-injury, he was diagnosed with a complete Anterior cruciate ligament tear and underwent reconstruction surgery. Following surgery, he participated in a regular progressive rehabilitation program. Three months later, after obtaining written consent, he began isokinetic testing and training (Figure 1).

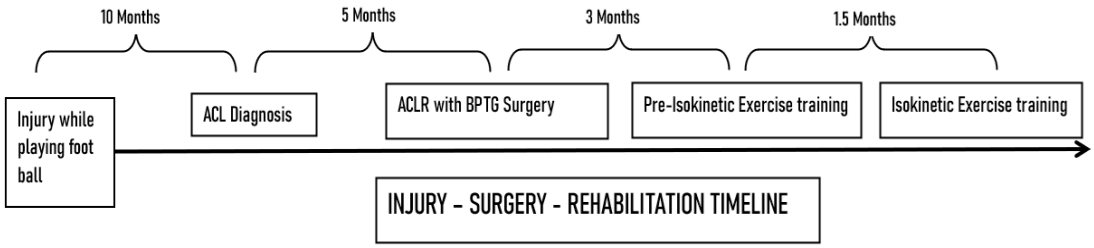


Figure 1: Timeline of injury, surgery, and rehabilitation

Procedures and Outcome Measures

A routine pre-therapy evaluation was conducted to assess knee stability post-surgery before isokinetic training. This included the Lachmann test, Pivot shift test, and unilateral semi-squats, with pain intensity measured using a Visual Analogue Scale before and after each session. The muscle performance and physical function were evaluated pre and post-intervention (before and after the Isokinetic exercise training program of six weeks).

Dynamometry testing was performed in concentric isokinetic mode at 15 °/s using a TUR Isoforce Dynamometer (TUR Therapietechnik GmbH., Rostock, Germany). The subject was seated on the dynamometer and stabilized with belts around the trunk, and thighs. The dynamometer set-up was as follows: height = 0°, rotation = 40°, tilt = 0°, chair rotation = 60°, back seat tilt: 100°, Chair height = 3-5 and Chair horizontal = 110° (TUR Isoforce – Positioning Guide, 2014). All the device

calibration and operational procedures followed the equipment manual. The subject was encouraged to exert maximum effort, aided by verbal support and visual feedback. Specifically designed Anterior-sheer knee Adapter was used to control undue stress developed by anterior translation forces over the repaired ACL graft and the patellar tendon while performing Isokinetic exercise training. The built-in Isoforce Smart-Pro software of the device performed isokinetic data processing.

The outcome measures evaluated concerning the subject's muscular performance and physical function were briefly listed in the outcome summary (Table 1). The isokinetic evaluation objectively measured knee performance, while the Knee Injury and Osteoarthritis Outcome Score (KOOS) assessed physical function, with scores calculated using the Free Online KOOS Calculator from the Ortho Toolkit website.

Table 1. Overview of outcome measures

Table 1

OUTCOME MEASURES		
1.	**Muscular Performance**	**Isokinetic testing variables** • **Peak Torque (Peak TQ)** - the highest muscular Peak Torque produced by the muscle in Nm. • **Maximum Mean Torque** - the average of the maximum torques produced by the muscle in Nm. • **Mean of peak Torques** - average of the peak torques produced by muscle in Nm. • **Time to peak Torque** - a measure of time from the start of a muscular contraction to the point of the highest torque development in seconds of work for every repetition performed in the bout. • **Time to peak to Relaxation** - a measure of time from the point of the highest torque development to the end of a muscular contraction in seconds. • **Mean Power** - the amount of total work divided by the time to complete that total work. • **Fatigue Index** - ratio of the difference between the work carried out in the first three repetitions compared to work in the last three repetitions which was measured in percentage.
2.	**Physical Performance**	**The Knee Injury and Osteoarthritis Outcome Score (KOOS)** • Overall Score • Pain • Symptoms • ADL Function • Sport and Recreation Function • Quality of Life

.

Intervention

After setting up the dynamometer, the subject engaged in daily continuous passive motion training as a warm-up using the isokinetic device. Following this, the isokinetic protocol included three sets of ten repetitions, starting at 90°/s. A gradual reduction in velocity was implemented over time to increase exercise complexity, along with different modes of isokinetic exercise training applied in a randomized order. Each session included a 15-second rest between sets and was conducted five times per week over a six-week training period (Figure 2).



Figure 2.The subject undergoing Isokinetic training using an Isokinetic dynamometer.

Following each isokinetic session, proprioceptive visual biofeedback training was provided using three built-in programs with varying muscular torque, challenge levels, duration, and exercise modes. A detailed description of the post-surgical ACLR rehabilitation protocol and a training video are available as supplementary material for this study.

Results

The study suggests that isokinetic training presents a significant positive difference in the components of muscular performance, such as torque, work, power, and fatigue; details of the same are shown in Table 2. It shows the various pre and post-isokinetic tests for knee extension and flexion at the velocity of 15 deg/s for the reconstructed (ACLR) limb at the start and 6 weeks post-isokinetic training.

Table 2
Isokinetic Muscular Performance

Parameters (Unit)	Extension			Flexion		
	Pre-test	Post-test	Percent changes	Pre-test	Post-test	Percent changes
Peak Torque (Nm)	155.1	202.7	**30.68**	120.5	123.3	**2.32**
Maximum Mean Torque (Nm)	75.6	106.9	**41.40**	54.6	65.9	**20.69**
Mean of Peak Torques (Nm)	126.7	174.9	**38.04**	105.6	116.8	**10.60**
Time to peak Torque (sec)	1.148	1.123	**-2.17**	0.543	0.668	**23.02**
Time to peak to Relaxation (sec)	4.693	4.935	**5.15**	4.830	4.488	**-7.08**
Maximum Work (joules)	84.3	140.3	**66.42**	66.0	76.0	**15.15**
Mean Power (Watts)	11.0	20.4	**85.45**	9.0	13	**44.44**
Fatigue index (%)	-8.2	13.3	**21.5**	26.5	10	**-16.5**

The results indicate a significant difference for most of the isokinetic parameters analysed in this study (Graph 1).



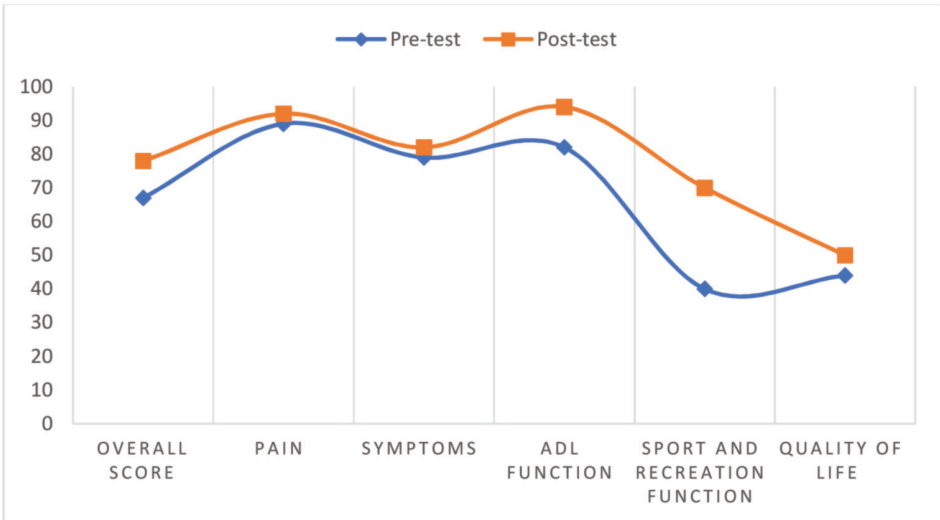
Graph 1: Isokinetic Muscular Performance (Pre & Post test Percent change)

The differences in the total KOOS score and its various subscale scores were detailed (Table 3).

Table 3
Physical performance KOOS Scores

	Pre-test	Post-test
Overall Score	67	78
Pain	89	92
Symptoms	79	82
ADL Function	82	94
Sport and Recreation Function	40	70
Quality of Life	44	50

The significant increments in the overall scores and sub-scale were identified (Graph 2).



Graph 2: Pre and Post-KOOS Scores

Discussion

This case report examines the effects of patient-specific tailored progressive isokinetic training combined with task-specific biofeedback exercises on muscle performance and physical function in an individual after bone-patella tendon-bone autograft ACL reconstruction surgery.

The study results show consistent improvements in muscle performance and physical function, with significant positive changes in knee extensor and flexor isokinetic parameters at 15 °/s before and after therapy. This speed was chosen because lower pre-set velocities can produce more torque concentrically, leading to greater motor unit recruitment for more realistic muscular performance with regard to evaluation based on the principle of Isokinetics[4]. Although low-speed training can increase anterior tibial translation, the anti-shear adapter minimizes strain on the surgical ACL graft[5].

As this study focuses on improving power and speed rather than endurance, the training employed slow velocity isokinetic exercises (30 to 90 °/s), which resulted in increased fatigue index values. This likely indicates a predominance of fast-twitch muscle fiber recruitment, as noted by Carr et al.[6]

The physical functional status improved significantly, with most KOOS sub-scales showing notable post-test scores, except for quality of life. The limited improvement in this area can be attributed to the fact that Individuals who have had anterior cruciate ligament reconstruction often experience long-term impairments and slow progression in the quality of life.[7]

There are some limitations of this case report. Firstly, the isokinetic training in this study focuses only on low-speed power training (less than 90°/s of velocity) and not on high-speed endurance training. Also, to add the individual was trained in high sitting position focusing predominantly on the extensor group. Prone lying will be useful for exclusive knee flexor training.

Overall, this case report presents a novel patient-centric approach to progressive isokinetic training and biofeedback exercises, highlighting their potential to improve muscle performance and physical function after ACL surgery.

Patient Perspective

"Isokinetic exercise training really helped me recover from my surgery after ACL injury. They made my knee muscles stronger in a safe and controlled way. I felt more confident as I saw my progress and could tell my knee was becoming more stable. This training also helped me worry less about getting injured again."

Conclusion

The results of this case report demonstrate that six weeks of patient-centric progressive isokinetic training combined with a task-specific biofeedback exercise program enhances muscle performance and physical function in an individual after bone-patella tendon-bone autograft ACLR surgery.

Key Messages

- The novel patient-centric customised Isokinetic training, along with task-specific biofeedback exercise protocol, improves both muscle performance and physical function in an individual following bone-patella tendon-bone autograft Anterior cruciate ligament reconstruction surgery.
- The muscular performance and physical functions were significantly enhanced following Iso-kinetic training in individual following Anterior cruciate ligament reconstruction surgery.

Ethical Permission and Informed Consent

Ethical permission was obtained from the Institutional Ethics Committee of JIPMER, Puducherry, India (Approval No: JIP/IEC/964(161)/2024, dated 16th May 2024). Written informed consent was obtained from the subject for participation in the study and the publication of associated data, images, videos, and the patient's perspective included in this report.

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SUPPLEMENTARY MATERIAL 1:

POST ACLR ISOKINETIC REHABILITATION TRAINING PROTOCOL

PHASE – I	**PRE – ISOKINETIC EXERCISE TRAINING PHASE**
0-3 Weeks	Isometric Quads Ankle pumps Partial weight-bearing walking with long leg brace with crutches Knee Closed chain exercises
3-6 Weeks	Isometric Quads Ankle pumps Full weight-bearing walking with knee brace with crutches Knee open-chain exercises
6-8 Weeks	Knee muscle strengthening exercises Knee ROM exercises Static cycling Full weight-bearing exercises without braces and crutches
8-14 Weeks	Progressive muscle strengthening exercises Static cycling (Forward/Reverse) Treadmill walking Proprioception training using wobble board Jogging on the spot
PHASE – II	**ISOKINETIC EXERCISE TRAINING PHASE**
14 – 16 Weeks	Progressive CON/CON Isokinetic training (90 °/s Ext & 90 °/s Flex → 60°/s Ext /90 °/s Flex) * Routine pre-isokinetic exercise training workups**
16-18 Weeks	Progressive CON/CON Isokinetic training (60°/s Ext & 90°/s Flex → 30°/s Ext & 40°/s Flex) * Biofeedback Proprioceptive Isokinetic training (Isotonic mode) Routine pre-isokinetic exercise training workups**
18-20 Weeks	Alternate day CON/CON Isokinetic training (30°/s Ext /40°/s Flex → 20°/s Ext & 35°/s Flex) *and ECC/ECC Isokinetic training (90°/s Ext & 90°/s Flex → 70°/s Ext &/65 °/s Flex)* Biofeedback Proprioceptive Isokinetic training (Isometric mode at multiple angles > 40-degree extension) Routine pre-isokinetic exercise training workups**

- CON/CON – Concentric/Concentric type of Isokinetic training
- ECC/ECC – Eccentric/Eccentric type of Isokinetic training
- * 3 sets x 10 reps, 5 days a week
- **Pre-isokinetic exercise training phase (8-14 weeks)
- → Gradually progressed over 2 weeks

SUPPLEMENTARY MATERIAL – 2:

Isokinetic training Video- https://www.youtube.com/shorts/v8bTPJkKPaY

Original Article

Comparison of Dynamic Balance between Male and Female Collegiates Using Star Excursion Balance Test

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Abstract

Background: This study aimed to compare the dynamic balance between male and female collegiates using star excursion balance test (SEBT). Anterior, posteromedial, and posterolateral balance of healthy male and female collegiates was assessed to see if there are gender variations in dynamic balance and whether fatigue exacerbates any possible disparities.

Methods: Twenty subjects age range between 17- 25 yrs were included in the study. The individuals were split up into two groups. Ten male participants made up group 1, and ten female subjects made up group 2. Demographic data was collected and recorded.

Results: The study showed that the maximum reach was measured in right posterolateral direction among all the participants. The minimum reach was measured in right anterior direction. Participants of group 1 showed maximum and minimum reach in right posterolateral and right anterior direction. Similarly, participants of group 2 showed maximum and minimum reach in right posterolateral and left anterior direction. The test showed that there was no significant difference between the two groups for all the six directions as the *p* value was >0.05.

Conclusions: The present study concludes that there is no significant difference between male and female collegiate concerning dynamic balance using SEBT. Hence, gender does not play significant role in dynamic balance. Another point that can be concluded is that the minimum reach among all the participants was right anterior and the maximum reach is in the right posterolateral direction. Hence, the participants can be more prone to injury in the direction of minimum reach.

Keywords: Star Excursion Balance Test (SEBT), Right-Anterior (RA), Right Posteromedial (RPM), Right Posterolateral (RPL), Left Anterior (LA), Left Posteromedial (LPM), Left Posterolateral (LPL)

Introduction

The ability to sustain one's body's position above its basis of support regardless of whether that base is stationary or transferring is called balance. Static balance refers to maintaining postural sway control under stable circumstances[1]. Dynamic balance refers to a degree of anticipated movement around a support base. This could entail actions like jumping or hopping to a new spot and trying to stay still as

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soon as you can, or trying to make controlled segment movements (reaching) without compromising the established base of support[2].

Clinically viable tests evaluating balance have become more common since lower extremity injuries have been linked to poor balance. Specifically, a well-liked clinical evaluation of dynamic balance and postural control is the Star Excursion Balance Test (SEBT)[3]. The SEBT consists of a series of single-limb squats in which the non-stance limb is extended to its maximum potential to contact a spot along one of eight marked ground lines. The lines are placed 45 degrees apart in a grid that radiates from a central point. Different combinations of sagittal, frontal, and transverse movements are needed for each reaching direction, which presents unique obstacles. The terms anterior, anteromedial, anterolateral, medial, lateral, posterior, posteromedial, and posterolateral refer to the reaching directions concerning the stance limb. The objective of the task is to have the person place the stance limb in the center of the testing grid, create a stable base of support there, and maintain it through a maximal reach excursion in one of the designated directions[2]. The extent to which the participant can go without breaking any of the specified rules is the measurement or result of the SEBT performance. The reach distance data serve as a dynamic postural control index; a greater distance reached denotes more effective dynamic postural control[2].

Test-retest reliability estimates were provided for the four diagonal reach directions of the test (anteromedial, anterolateral, posteromedial, and posterolateral). The intraclass correlation coefficients (ICCs) indicating the intratester reliability for each direction varied from 0.67 to 0.87[4]. There was a significant degree of shared variance among the eight reach directions noted alternatively, there was a strong correlation between a person's reaching distance in one direction and the remaining seven directions[5]. Only three reach directions—anterior, posteromedial, and posterolateral—should be executed as a result of this. The SEBT takes a lot less time now that this update has been implemented[6].

A study including recreationally active male and female participants concluded that the anterior, medial, and posterior performance of healthy men and women to see if there are gender variations in dynamic balance and whether fatigue exacerbates any possible disparities. The idea that there is no performance difference between the sexes was disproved by the finding that women outscored males in all three directions[7].

Recent evidence suggests that an increased risk of noncontact lower extremity injuries during a competitive American football season may be linked to poor SEBT performance[8]. Similarly, another piece of evidence concluded that male athletes seem to have better dynamic balance in the posteromedial direction than female athletes do when playing NCAA soccer and lacrosse. For female soccer and lacrosse players, adding posteromedial-focused dynamic balancing exercises may help prevent injuries to the lower extremities[9]. Therefore, it can be stated that individuals with poor lower limb balance are more prone to injuries.

Research on the comparison of the dynamic balance between male and female collegiates population is scarce. Thus, the study aims to use SEBT to compare the dynamic balance between male and female collegiates.

Methodology

Study design: Cross-sectional

Sampling method: Randomized Control Trial (RCT)

Sample size: 20 subjects (10 in each group)

Age: 17-25 years

Study duration: 6 Months

Study Place: Department of Physiotherapy, Teerthanker Mahaveer University, Moradabad

Inclusion Criteria

- Age:17-25 years
- Both male and female collegiates.

Exclusion Criteria

- Any recent lower limb surgery.
- Any recent lower limb injury.
- Any neurological deficit.
- Any deformity of lower limb.

Instrumentation

- Star Excursion Balance
- Inch tape
- Marker
- Calculator

Outcome Measure: The outcome measure used for the study is the Star Excursion Balance Test (SEBT).

Procedure

- All subjects participated voluntarily in the study.
- They were given clear instructions about the procedure of the study.
- Informed consent was obtained from each subject, and the rights of the subject were protected throughout the study.
- They were divided into two groups. Group 1 consisted of 10 male subjects and group 2 consisted of 10 female subjects based on the inclusion and exclusion criteria.
- Demographic details of the subject (gender, age, height, weight, and BMI) were collected.
- The dominance of the lower limb was known by throwing a ball toward the subject and asking him/her to kick the ball. The limb that the subject used first to kick the ball was considered dominant.
- The following steps were taken to note down the SEBT readings.
- The subject stands on one limb and extends their reaching limb as far as they can along each reaching line. They then return the reaching limb to the starting position in the center of the grid, resuming a bilateral stance, and gently touch the line with the most distal portion of their reaching foot without shifting their weight to or coming to rest on this foot.
- The trial is not deemed to be finished if the subject makes heavy contact with the ground with the reaching foot to keep balance, comes to rest at the touchdown point, or lifts or moves any portion of the stance limb's foot.
- Following four trials, a five-minute rest period was administered. The test was then resumed again with the dominant limb first followed by the other limb.
- The distance between the grid's center and the reach leg's greatest excursion point was measured by the investigator and marked on the tape for each reach distance.
- When reaching the lateral and posterolateral directions, the participants were required to reach behind the stance leg to complete the task.
- The reach started with the anterior direction and progressed to posteromedial and posterolateral directions.
- Three readings of each direction were taken and then the mean of each direction was calculated.

Flow Chart

Ten subjects in each group were recruited based on inclusion & exclusion criteria

⬇

The procedure was explained to the subjects

⬇

Demographic details (age, height, weight, BMI, leg dominancy) were collected

⬇

Three readings in each direction (anterior, posteromedial, posterolateral) were taken from right and left limbs one by one.

⬇

The mean of the readings taken was calculated for each direction

⬇

Data analysis using SPSS.

Data Analysis

- Data analysis was done using Statistical Package for Social Sciences (SPSS) version 29.0.1.0. The mean and standard deviation (SD) of age, height, weight, and BMI of all 20 participants were calculated.

- The mean of six directions [Right-Anterior (RA), Right Posteromedial (RPM), Right Posterolateral (RPL), Left Anterior (LA), Left Posteromedial (LPM), Left Posterolateral (LPL)] was also calculated for both the groups.
- The student's t-test was used to compare the dynamic balance between the male and female collegiates groups for all six directions.

Table 1. Mean and SD of age, height, weight, and BMI

n=20	Mean ± SD
Age (years)	21.55 ± 1.8
Height (m)	5.41± 0.23
Weight (kg)	56.25± 8.5
BMI (kg/m^2)	20.30± 3.11

SD: Standard Deviation

Table 2. Mean and SD of age, height, weight, and BMI of group 1 and group 2 are given below:

Group 1 (n=10)	Mean ± SD
Age (years)	20.9 ± 1.59
Height (m)	5.521 ±0.23
Weight (kg)	58.6 ±8.26
BMI (kg/m^2)	20.1 ±3.07
Group 2 (n=10)	**Mean ± SD**
Age (years)	22.2 ± 1.87
Height (m)	5.31 ±0.23
Weight (kg)	58.6 ±8.26
BMI (kg/m^2)	20.1 ± 3.07

SD: Standard Deviation

Table 3. Mean value of all three directions of reach by right and left limb is given below:

Mean	RA(cm)	RPM (cm)	RPL (cm)	LA(cm)	LPM (cm)	LPL (cm)
n=20	63.58	68.14	71.03	64.30	68.43	68.43
Group1 (n=10)	65.00	71.37	72.79	67.25	70.91	70.00
Group 2 (n=10)	62.16	65.46	69.28	61.36	65.95	66.86

Group 1: Male, Group 2: Female, RA: Right-Anterior, RPM: Right Posteromedial, RPL: Right Posterolateral, LA: Left Anterior, LPM: Left Posteromedial, LPL: Left Posterolateral.

Table 4. Gender based comparison of all the six directions.

Directions	Male		Female		n (20)	p^*
	Mean	SD	Mean	SD	t	
RA	65.00	8.92	62.16	10.41	0.65	0.52
RPM	71.37	12.11	65.46	8.24	1.27	0.21
RPL	72.79	12.05	69.28	9.34	0.72	0.47
LA	67.25	9.36	61.36	9.08	1.42	0.17
LPM	70.91	15.69	65.95	8.94	0.86	0.39
LPL	70.00	12.62	66.86	8.55	0.65	0.52

SD: Standard Deviation, RA: Right-Anterior, RPM: Right Posteromedial, RPL: Right Posterolateral, LA: Left Anterior, LPM: Left Posteromedial, LPL: Left Posterolateral, *level of significance =<0.05.

Result

The results of the study showed that the maximum reach was measured in right posterolateral direction among all the participants. The minimum reach was measured in right anterior direction. Participants of group 1 showed maximum and minimum reach in right posterolateral and right anterior direction. Similarly, participants of group 2 showed maximum and minimum reach in right posterolateral and left anterior direction.

The student's t test is used to compare the dynamic balance among male and female collegiates. The results of the test showed that there was no significant difference between the two groups for all the six directions as the *p* value was >0.05 i.e. non-significant.

Discussion

The study aimed to compare the dynamic balance between male and female collegiates using SEBT. The study's findings demonstrated no significant difference in dynamic balance between the two groups in any of the six orientations involving the left and right limbs. This suggests that gender may not be a determining factor in balance performance among healthy collegiate populations. The broader implications for college students include the potential for developing standardized training, assessment, and rehabilitation programs that do not need to be gender-specific. In the field of sports science and physical therapy, these results support a more individualized approach to balance training and injury prevention, contributing to more inclusive and evidence-based practices in collegiate health and performance programs. Another finding of the study, which reveals the consistent limitation in anterior reach, suggests a need for focused training to improve strength, flexibility, and neuromuscular control in the anterior direction. This could help address imbalances and enhance overall performance. These directional patterns can serve as benchmarks in regular balance assessments to monitor progress, detect early signs of dysfunction, or evaluate the effectiveness of training programs over time.

According to **Yasushi Kurihara et al (2024)** modified SEBT was used to compare the maximum reach among injury and non-injury groups and it was concluded that the results of modified SEBT were related to previous injury levels of lower limb i.e. the lower the reach distance of SEBT, higher the changes of pre-injury levels[10]. In the present study the participants were healthy male and female collegiates with no recent injury or surgery to the lower limb. Therefore, no such conclusions can be drawn from our study.

According to **Ava D. Segal et al (2023)** there was less dynamic balance in all three directions among healthy older adults compared to healthy young adults. The posterolateral direction showed the most variation, which suggests that poor balance can be used in clinical settings to identify balance decrement early on and recommend more effective treatment. Leg dominance and sex differences did not significantly alter the SEBT score[11]. The results are similar to our study as there was no significant difference between male and female collegiates groups in SEBT scores in all six directions i.e. gender does not affect the dynamic balance. Additionally, the leg dominance of all the participants of both groups was the same (right dominant). In the present study, the minimum reach distance in group 1 and group 2 was right anterior and left anterior respectively.

According to **Mikel R. Stiffler et al (2015)** there were gender differences in SEBT score among 393 healthy National Collegiate Athletic Association Division I collegiate athletes from 8 sports. There was an anterior directed significant sex-by-sport interaction. Women's ice hockey players reached the furthest across all teams, with notable variations seen in the posterolateral and posteromedial directions. The athletes who covered the greatest distances were wrestlers and men's ice hockey players[16]. The results of the current study are different from the aforementioned study because our study included healthy male and female collegiates in contrast to the participants of the above-mentioned study which included an athletic population from eight different sports. Additionally, the sample size the study was also small as compared to the above study.

According to **Robert J. Butler et al (2013)**, a simple dynamic balancing test conducted in the offseason was effective in identifying individuals who suffered an injury sustained during the season among American footballers. The results of this investigation provide support to the theory that lower scores on dynamic balancing tests are linked to a higher risk of injury. In our study, there was no significant difference between male and female collegiates concerning maximum reach on SEBT. But, the minimum reach was measured in the

right anterior direction, which concludes that there is increased risk of injury to participants in this direction[8].

Conclusion

The findings of the present study indicate that there is no statistically significant difference in dynamic balance performance between male and female collegiate students, as assessed through the Star Excursion Balance Test (SEBT). This suggests that gender is not a determining factor in dynamic balance capabilities within this population. Furthermore, the data revealed that the shortest reach distance across all participants occurred in the right anterior direction, while the longest reach was observed in the right posterolateral direction. These directional differences in reach performance may have important implications; specifically, the reduced reach in the anterior direction could point to a potential area of weakness or instability. As a result, participants may be at a greater risk of sustaining injuries when moving or bearing load in this direction. These insights underscore the need for targeted balance training and injury prevention strategies that address directional limitations, particularly in the anterior plane of movement.

Limitation

One of the main limitations of the study is the small sample size. Another limitation is that all the collegiates were from same college or department.

Future Recommendations

Future studies can be conducted with a large sample size and participants from various departments. Additionally, comparison of dynamic balance can be done between collegiates and other population like older adults or athletic population. Rehabilitation exercises can be incorporated with the assessment to improve the dynamic balance. Lastly, comparison between static and dynamic balance can be done with a study of lower limb muscle recruitment so that it can aid in rehabilitation process.

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Funding: The study was not funded by any source.

Conflict of Interest: The authors declare no conflict of interest.

Informed Consent: Informed written consent was taken from the subjects (or volunteers) prior from explaining the procedure of this investigation.

Ethics: At the time of conducting the project, formal ethical clearance was not mandated by the institution for undergraduate classroom-based / non-invasive research projects. However, all standard ethical principles were followed, including obtaining informed consent from participants, ensuring confidentiality, and maintaining participants' safety throughout the study.

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Original Article

Retrospective Survey of Indian Patient Satisfaction in Immersive Virtual Reality with AI based Motion Sensor Therapy: Feasibility and Acceptance Insights and Implications

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Abstract

Background: Virtual Reality (VR) therapy is an emerging innovation in Indian healthcare, showing promise in the rehabilitation of neurological, chronic pain, pediatric rehabilitation and orthopedic conditions. While clinical effectiveness is being increasingly documented, limited attention has been paid to patient satisfaction, an essential component for optimizing therapeutic interventions and outcomes.

Objective: This study aims to retrospectively assess patient satisfaction with Immersive VR therapy among Indian patients receiving rehabilitation for neurological and orthopedic conditions.

Methods: A retrospective survey was conducted with 35 patients from two physiotherapy outpatient centers in Tamil Nadu, India. Eligible patients had undergone at least five sessions of VR therapy between November 2024 and February 2025.A 10-item questionnaire based on a 5-point Likert scale was administered in English and Tamil, capturing various dimensions of satisfaction.

Results: Most patients found VR therapy effective (74%), with 85% reporting symptom improvement and 77% noting functional gains. Additionally, 82% considered it as effective or more effective than traditional therapy. The therapy was perceived as comfortable (90%), engaging (79%), personalized (79%), and easy to understand (87%). Overall satisfaction was high (77%).

Conclusion: The study highlights high patient satisfaction with VR therapy in an Indian rehabilitation setting. Results support its feasibility and relevance in enhancing engagement, comfort, and functional outcomes. These findings lay the groundwork for broader integration of VR in physiotherapy.

Keywords: Virtual reality therapy, Patient satisfaction, AI – based motion sensor, Chronic pain, Stroke, VR survey

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Introduction

The integration of virtual reality (VR) technology into therapeutic practices represents a groundbreaking advancement in modern healthcare in India. VR has emerged as a promising treatment approach for patients undergoing rehabilitation like neurological, chronic pain, orthopedic, pediatric and cardiopulmonary conditions[1,2]. By leveraging the principles of interaction, immersion, and engagement, VR therapy enhances patient motivation and adherence to rehabilitation protocols. This innovative approach not only complements traditional therapy methods but also offers a unique and effective means of improving the overall therapeutic experience and clinical outcomes[3].

Patient satisfaction is a crucial clinical metric for evaluating the effectiveness and acceptability of therapeutic interventions. High levels of satisfaction often correlate with better adherence to treatment protocols, improved clinical outcomes, and enhanced quality of care. Despite the growing adoption of VR therapy, understanding the patient experience and satisfaction levels is essential to optimize VR therapy protocols, ensure patient-centric care, and guide future innovations in this rapidly evolving field. The insights derived from this analysis will provide valuable guidance for healthcare providers, helping them to design and implement VR therapies that are more effective, user-friendly, and patient-centered. It also seeks to identify patient acceptance and satisfaction.

This retrospective analysis aims to fill this gap by examining patient satisfaction data from patients who have participated in the VR therapy program. It will explore various dimensions of satisfaction, including the usability of VR therapy, the perceived effectiveness of therapy, and overall patient experiences. A thorough review of the current literature reveals no previous studies that have systematically investigated patient satisfaction with virtual reality therapy in India, positioning this study as the first of its kind.

Materials and Methods

Study Design

This study was designed as a retrospective cross-sectional survey aimed at evaluating patient satisfaction with Virtual Reality (VR) therapy in an Indian clinical context.

Survey Development

The survey questionnaire was developed by clinical physiotherapists from the Rewin Team. It was reviewed for content validity by a panel of three experienced clinicians, two internal physiotherapists and one external physiotherapy expert. The final survey consisted of 10 questions covering multiple dimensions, including:

- Satisfaction with VR therapy
- Usability of VR systems
- Acceptance of VR in rehabilitation
- Patient-perceived benefits
- Overall engagement and experience

To ensure accessibility, the survey was administered through Google Forms and made available in both English and Tamil, the regional language of Tamil Nadu.

Participant Criteria

Inclusion Criteria

- Patients aged 10+ with neurological or orthopedic conditions who completed ≥5 VR sessions.

Exclusion Criteria

- Severe cognitive impairments or contraindications to VR (e.g., epilepsy).

Sampling Method

A random sample of patients who underwent a minimum of five VR therapy sessions for various clinical conditions was selected for participation in the study.

Duration and Timeline

Patients included in the study had undergone VR therapy between November 2024 to February 2025. Data collection was carried out during and immediately following this treatment period.

Ethical Considerations

Prior to participation, all respondents provided informed consent, affirming their voluntary agreement to participate in the study. As this was a non-invasive, survey-based study involving no clinical interventions, no specific ethical clearance was obtained.

Data Collection

The survey was distributed through multiple channels to maximize response rates, including:

- Direct interactions with outpatients following their therapy sessions
- Phone calls to eligible patients

Data was collected from two outpatient Physiotherapy centers

- 10 responses from Ciranjev Rehab Centre, Chidambaram
- 25 responses from the Rewin Health Physiotherapy Clinic, Chennai

Results

Patients Demographics

A total of 35 patients were enrolled in the VR therapy satisfaction survey. Of these, 23 patients were undergoing therapy for neurological conditions, while 12 patients were receiving therapy for orthopedic conditions (refer table.1)

Table 1 Distribution by Clinical Category

Clinical Category	No. of patients
Neurological	23
Orthopedic	12
Total	35

Age Distribution

Patients ranged in age from under 10 years to over 80 years. Most respondents were aged between 51 and 70 years (refer table.2)

Table 2. Age Distribution of patients

Age Group	No. of patients
10 Yrs	1
11-20 yrs	2
21-30 yrs	2
31-40 yrs	4
41-50 yrs	4
51- 60 yrs	8
61-70	10
71-80	2
81-90	2

Clinical Condition

The types of neurological and orthopedic conditions are detailed in table 3.1 & 3.2.

Table 3.1. Neuro Conditions

Conditions	No. of patients
Behavioral therapy	1
Brain Tumor	1
Essential Tremor	1
GBS	2
Left hemiplegia	8
Right hemiplegia	8
Parkinson's	1
Neuromuscular	1

Table 3.2. Orthopedic conditions

Conditions	No. of patients
Left Knee OA	3
Right Knee OA	6
Hip muscle weakness	1
Post OP TKR	1
Neck pain	1

Distribution of Clinical Conditions

VR Therapy Survey Analysis

A 10-item survey was administered to 35 patients to assess their experiences with VR therapy. Each item on the survey utilized a 5-point Likert scale, with response options ranging from "Strongly Disagree" to "Strongly Agree" (refer Table 4).

Table 4. Frequency Distribution of VR Therapy Survey Responses

S. No	Survey Question	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	How helpful was VR therapy in addressing your concerns/ goals?	2%	5%	17%	34%	40%
2	How comfortable did you feel during VR therapy sessions?	0%	0%	8%	48%	42%
3	How would you rate your level of engagement during VR therapy?	0%	2%	17%	25%	54%
4	Do you think VR therapy would benefit others with similar conditions?	0%	8%	11%	25%	54%
5	How was VR therapy compared to traditional therapy?	0%	0%	17%	37%	45%
6	Did you notice improvements in your condition/symptoms after VR therapy?	2%	0%	11%	34%	51%
7	Was VR therapy personalized to your needs/preferences?	2%	2%	14%	28%	51%
8	Did VR therapy help you improve your functional goals?	0%	5%	17%	37%	40%
9	Were you able to understand the VR therapy instructions?	5%	0%	5%	25%	62%
10	Overall, how satisfied are you with your VR therapy experience?	2%	0%	20%	31%	45%

To enable a more structured interpretation of the results, the frequency of responses for each option was converted into percentages, reflecting the proportion of patients selecting each response. These percentages offer a clearer understanding of the distribution across the different Likert scale categories. Furthermore, the findings were categorized and analyzed based on the focus of each individual survey item, allowing for targeted insights into specific aspects of the VR therapy experience.

Additionally, the findings were systematically categorized and analyzed according to the specific focus of each survey item, providing targeted insights into the various aspects of the VR therapy experience.

Additionally, the findings were systematically categorized and analyzed according to the specific focus of each survey item, providing targeted insights into the various aspects of the VR therapy experience as outlined below,

1. **Perceived Helpfulness of VR Therapy**

   A significant proportion of patients (74%) found VR therapy either "Agree" (34%) or "Strongly Agree" (40%) in addressing their concerns and goals (refer table.4).

2. **Patient Comfort during VR therapy:**

   The majority of patients (90%) expressed a high level of comfort. The absence of any patients who disagreed or strongly disagreed suggests that comfort was a prominent feature of the VR therapy experience (refer table.4).

3. **Patient Engagement Levels During VR Therapy**

   A large majority (79%) of patients reported feeling engaged during the VR therapy, with 54% strongly agreeing and 25% agreeing (refer table.4).

4. **Perceived Benefits of VR Therapy for Patients with Similar Conditions**

   About 80% believed that VR therapy could also benefit others with similar conditions, reinforcing its broader applicability and relevance (refer table.4).

5. **Effectiveness of VR therapy compared to traditional therapy**

   More than 82% rated VR therapy as equally or more effective than traditional rehabilitation methods, suggesting a favorable perception in terms of clinical value (refer table.4).

6. **Patient Recovery Following VR therapy**

   85% reported noticeable improvements in their symptoms, reinforcing the potential clinical efficacy of VR-based interventions (refer table.4).

7. **Personalization of VR therapy to patient needs**

   Around 79% agreed that the therapy was tailored to their needs, highlighting the adaptability and customized approach of the sessions (refer table.4).

8. **Functional improvements with VR therapy**

   77% observed functional improvements, supporting the role of VR in helping patients meet specific recovery goals (refer table.4).

9. **Understanding VR Therapy Instructions**

   A high 87% found the instructions easy to understand, demonstrating the accessibility of the therapy interface (refer table.4).

10. **Satisfaction with VR Therapy Experience**

    General satisfaction was strong, with over 77% of patients expressing a positive experience(refer table.4).

Discussion

This retrospective survey provides valuable insights into patient satisfaction with Virtual Reality (VR) therapy among Indian patients with neurological and orthopedic conditions. The findings underscore the generally positive reception of VR therapy, particularly in terms of patient comfort, engagement, and perceived therapeutic benefits.

1. **Perceived Helpfulness of VR Therapy**

   In the present study, 73% of patients indicated a positive perception of the helpfulness of virtual reality (VR) therapy in addressing their individual rehabilitation goals and concerns. While numerous high-quality systematic reviews incorporating randomized controlled trials have demonstrated that the addition of VR to conventional therapy yields significant improvements in upper limb function, balance, gait, and cognition following stroke, there is a notable absence of evidence regarding patients' subjective experiences and perceived benefits of VR therapy[4]. This study represents the first known investigation specifically aimed at exploring patients' perspectives on the perceived helpfulness of VR therapy in the context of post-stroke rehabilitation.

2. **Patient Comfort during VR therapy**

   In this study, 90% of patients reported a high level of comfort while using the virtual reality (VR) headset, indicating strong acceptance and tolerability of the technology in a rehabilitation setting. While existing literature supports the use of VR for clinical testing—such as visual

field assessments with real-time eye tracking—and confirms its general acceptability and feasibility, most of this evidence pertains to diagnostic or remote monitoring contexts[5]. To date, there is limited evidence addressing patient comfort and acceptance of VR specifically within rehabilitation. This study helps to bridge that gap, highlighting the importance of evaluating not only clinical efficacy but also patient experience when implementing VR in therapeutic settings.

3. Patient Engagement Levels During VR Therapy

In this study, 79.7% of patients reported feeling engaged during VR therapy, underscoring the importance of engagement as a key factor in patient experience. Engagement appears to function as a crucial intermediary between an individual's tendency for immersion, their sense of spatial presence, and the resulting emotional responses. Patients who demonstrated higher levels of immersion and engagement within the virtual environment experienced notable emotional improvements. The findings are consistent with prior research that identifies engagement as a crucial element in achieving the psychological benefits of VR-based interventions, particularly in cancer care settings[6]. Notably, engagement should be recognized as a key indicator to overall patient satisfaction in the context of VR-based rehabilitation.

4. Perceived Benefits of VR Therapy for Patients with Similar Conditions

The willingness of patients to recommend VR therapy to others with similar conditions serves as a significant indicator of both patient satisfaction and the perceived efficacy of the intervention. Patients who undergo VR therapy often report experiencing meaningful benefits directly addressing their specific symptoms, such as anxiety, distress, pain, or motor impairment which in turn fosters confidence in endorsing the treatment to peers facing comparable challenges. Notably, a substantial proportion of patients (79.7%) express the belief that VR therapy would be beneficial for others with similar conditions, with over half strongly affirming this view. This positive perception is well-supported by research demonstrating consistently high patient satisfaction and a readiness to recommend VR therapy across diverse clinical populations, including those with anxiety disorders, psychosis, and chronic pain[7].

5. Effectiveness of VR therapy compared to traditional therapy

The effectiveness of VR therapy, when compared to traditional therapeutic approaches, has been increasingly supported by patient-reported outcomes and clinical studies. In the present study, 82% of patients perceived VR therapy to be more effective than conventional therapy alone. This subjective perception aligns with existing evidence demonstrating the added value of VR-based interventions in physical rehabilitation. For instance, studies have shown that integrating VR with conventional therapy produces moderate improvements in balance outcomes among post-stroke patients, surpassing the results of conventional therapy alone[3]. Similarly, in individuals with Parkinson's disease (PD), VR-based rehabilitation has been associated with significantly greater improvements in balance and gait performance compared to traditional physical therapy [8]. These findings suggest that VR therapy not only enhances patient engagement but may also amplify therapeutic outcomes.

6. Patient Recovery Following VR therapy

Most patients in the present study (85%) reported noticeable improvements in motor symptoms and a reduction in pain following VR therapy, particularly in neurological and orthopedic conditions. These self-reported outcomes are consistent with existing evidence supporting the therapeutic benefits of VR in rehabilitation settings. A systematic review

and meta-analysis focusing on post-stroke rehabilitation found that VR interventions significantly improve motor function and quality of life. This is largely attributed to task-specific and goal-oriented activities delivered through immersive environments, which stimulate neuroplasticity and facilitate functional recovery[2]. Similarly, in orthopedic contexts such as knee osteoarthritis (KOA), VR-based exercise therapy has demonstrated promising results. Studies have shown that VR interventions significantly reduce pain and improve muscle strength, as well as enhance the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) total scores in KOA patients[9]. However, while reductions in pain and improvements in general function are evident, changes in joint stiffness and specific physical function metrics have been less pronounced. These findings suggest that VR therapy holds considerable potential as an adjunct to traditional rehabilitation, particularly for enhancing pain management and motor recovery.

7. Personalization of VR therapy to patient needs

Personalization is a critical factor in the success of VR-based rehabilitation. In the present study, 79% of patients reported that their VR therapy was tailored to their individual needs and medical conditions. This finding aligns with current best practices in rehabilitation and pain management, where customizing interventions are essential for optimizing therapeutic outcomes. Existing literature emphasizes that tailoring virtual environments to match patient-specific abilities and goals can significantly enhance engagement, attention, and motivation[10]. Neurorehabilitation experts further recommend adjusting the level of stimuli, incorporating realistic tasks with timely feedback, and monitoring fatigue throughout the therapy process. Such personalized approaches are believed to support more effective recovery and facilitate the transfer of skills to real-world settings.

8. Functional improvements with VR therapy

In the present study, 77% of patients reported improvements in their functional goals following VR therapy. These findings are supported by existing literature indicating that VR interventions can enhance functional outcomes in various rehabilitation contexts. Systematic reviews have shown that VR therapy contributes to improved treatment adherence and increased pain tolerance, while also supporting the achievement of key rehabilitation endpoints such as enhanced range of motion, functional performance, and overall functional measures, particularly in individuals with chronic pain[1]. These results suggest that VR can be an effective tool for promoting functional recovery alongside symptom management.

9. Understanding VR Therapy Instructions

A vast majority of patients (87.1%) in the present study reported that the instructions provided during VR therapy were clear and easy to understand. This finding reflects a high level of usability, which is essential for patient engagement, adherence, and the overall success of digital health interventions. While previous research has emphasized the importance of user-friendly design and intuitive interfaces in VR-based rehabilitation, there is limited empirical evidence specifically evaluating patients' understanding of VR therapy instructions. To our knowledge, this is among the first studies to directly explore patients' perceptions of instruction clarity within therapeutic VR applications. These findings highlight the value of accessible, well-structured guidance in supporting independent task execution and optimizing rehabilitation outcomes in VR environments.

10. Satisfaction with VR Therapy Experience

This study found a high level of satisfaction with the VR therapy experience, with 77.1% of patients reporting positive responses—45.7% strongly agreed and 31.4% agreed. In the context of rehabilitation, patient satisfaction

is a key indicator of intervention success, as it directly influences motivation, adherence, and continuity of care. The immersive and interactive nature of VR likely contributes to this positive experience, making therapy more engaging and less monotonous than traditional approaches. These results add to the growing body of evidence positioning VR therapy as not only clinically effective but also patient-centered and well-tolerated, particularly within neurological and orthopedic rehabilitation frameworks.

Conclusion

This retrospective analysis is among the first of its kind to assess patient satisfaction with Virtual Reality therapy in an Indian clinical context. The findings indicate that VR therapy is not only well-accepted but also perceived as effective by patients across neurological and orthopedic rehabilitation domains. Although clinical assessmentwere conducted, their analysis lies beyond the scope of the present study. High levels of comfort, engagement, and clarity of instruction contributed significantly to the overall positive experience. The study reaffirms the value of VR as a complementary tool in rehabilitation, particularly for enhancing patient motivation, personalizing care, and potentially improving functional outcomes.

Patient satisfaction emerged as a crucial indicator of VR therapy's feasibility and relevance in routine physiotherapy practice. These results underscore the need to continue refining VR applications with a patient-centric focus, ensuring accessibility, personalization, and user-friendliness.

Limitations

This study's small sample size and retrospective design limits generalizability and may introduce recall bias. Data were collected from only two centers in Tamil Nadu, which may not represent the wider Indian population. The lack of a control group and reliance on self-reported measures restrict comparison with traditional therapy and the age distribution of participants was not analyzed.

Way Forward

Future research should focus on larger scale, multicentric studies across diverse regions of India to enhance the generalizability of findings and capture demographic variations in patient satisfaction with VR therapy. Integrating patient satisfaction data with objective clinical outcome measures—such as range of motion, pain scores, and mobility indices—will provide a more comprehensive evaluation of VR therapy's effectiveness. Additionally, developing condition-specific VR content, incorporating localized and multilingual options, will improve usability and cultural relevance, facilitating wider adoption. Standardized training protocols for therapists and clear clinical guidelines should be established to ensure consistent and effective VR therapy delivery.

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Original Article

Effect of Multimodal Physiotherapy Approach on Grade I and Grade II Knee Osteoarthritis in Overweight Females

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Abstract

Background: Knee osteoarthritis is a degenerative condition causing pain and disability, especially in overweight females. Conventional physiotherapy mainly relieves symptoms, while a multimodal physiotherapy approach addresses both physical and psychosocial aspects.

Materials and Methods: A randomized experimental study was conducted on 60 overweight females, aged 40 to 60 years, diagnosed with grade I or grade II knee osteoarthritis. Participants were randomly allocated into two groups, with 30 subjects in the experimental group (group A) and 30 subjects in the control group (group B). All participants had a body mass index ranging from 25 to 29.9 kg/m^2. Outcomes were assessed using validated scales for pain, function, body mass index, and adherence.

Conclusion: Between groups, Group A had higher adherence ($p < 0.001$) and lower post-intervention NPRS ($p < 0.001$) and WOMAC scores ($p < 0.001$) than Group B.

Keywords: Knee osteoarthritis, Multimodal physiotherapy, Biopsychosocial model, Overweight females, Adherence to treatment

Introduction

Arthritis is inflammation within the joints, characterized as a chronic, age-related, degenerative condition. [1, 2] Osteoarthritis is a joint degenerative disease leading to loss of articular cartilage, which normally reduces friction during movement. [3] Individuals with knee osteoarthritis experience mobility impairments that limit activities of daily living and reduce quality of life. [4]

The knee, the largest synovial joint in humans, comprises bones including the distal femur, proximal tibia, and patella; cartilage such as the meniscus and articular cartilage; ligaments; infrapatellar fat pad; and synovium, which produces synovial fluid to lubricate and nourish cartilage. [5] Muscles

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including quadriceps femoris, popliteus, biceps femoris, semitendinosus, and semimembranosus facilitate flexion, extension, rotation, and locking and unlocking of the joint. [6] Cruciate ligaments, menisci, and other soft tissues provide stability, shock absorption, load distribution, and cartilage nutrition, with meniscal injuries contributing to osteoarthritis. [7] Clinically, knee osteoarthritis presents with pain, morning stiffness, swelling, crepitus, and functional limitations. [8, 9] Radiographs, including anteroposterior, lateral, and skyline views, alongside the Kellgren and Lawrence grading system, classify severity from grade 0 to grade IV. [6, 7, 10] Osteoarthritis progresses gradually, with worsening symptoms over time. [5]

The etiology of knee osteoarthritis is multifactorial, including increased tibiofemoral forces, altered femoral curvature, bone marrow lesions, cartilage loss, joint space narrowing, and tibial plateau compression. [7] Mechanical stress and inflammation drive cartilage erosion via matrix metalloproteinases and A Disintegrin and Metalloproteinase with Thrombospondin motifs, leading to chondrocyte loss, subchondral bone remodeling, and synovial inflammation. [14, 15] Age, gender, genetics, metabolic syndrome, trauma, and lower limb malalignment influence disease onset and progression. [5, 7, 16] Advancing age alters cartilage properties, reduces hydration, and promotes catabolic pathways, while women exhibit higher incidence due to smaller knee sizes, higher Q angles, gait variations, and postmenopausal hormonal changes. [14, 16, 17]

Overweight individuals are at higher risk, as obesity increases mechanical loading and triggers metabolic changes, including altered adipokine production and systemic inflammation, affecting cartilage, subchondral bone, menisci, synovium, and infrapatellar fat pad. [8, 14, 16, 18, 21] Fat mass plays a greater role in women, accelerating disease progression through mechanical and biological pathways. [18, 21]

Globally, osteoarthritis affects approximately 100 million people and is the twelfth leading cause of disability. [1, 19] In India, prevalence rose from 23.46 million in 1990 to 62.35 million in 2019, with higher rates among women (51%) than men (33.09%). [1, 14] Knee osteoarthritis contributes significantly to disability-adjusted life years and years lived with disability, particularly in aging populations. [4, 20]

Non-surgical management is recommended as first- and second-line treatment, reserving joint replacement for refractory cases. [11, 12] First-line interventions include lifestyle modification, physical therapy, over-the-counter medications, and assistive devices, while second-line treatments involve prescription medications, intra-articular injections, and specialized physical interventions. [11] Physiotherapy integrates exercise therapy, manual therapy, electrotherapy, patient education, and weight management. [11, 22, 23]

Adherence is critical for effective outcomes, yet patients often face barriers such as low motivation, time constraints, environmental limitations, and lack of understanding. [11, 24, 25] Strong therapeutic alliances, individualized care, and patient education improve adherence, enhancing pain reduction, functional improvement, and long-term joint health. Multimodal physiotherapy addresses both physical and psychosocial factors, promoting consistent participation and better outcomes. [23, 26]

The biopsychosocial model supports individualized care by integrating physical, psychological, and social factors. [25, 26] Multimodal physiotherapy, combining exercise, manual therapy, education, and other interventions, systematically targets all components of knee osteoarthritis, improving pain, function, balance, and quality of life. [13, 22, 27, 28, 29, 30, 31] Despite evidence for multimodal interventions, few studies focus on overweight females, a high-risk population due to mechanical, hormonal, and metabolic factors. [4, 23] There is a need for protocols that are personalized, emphasize adherence, and address the multifactorial pathology of knee osteoarthritis. This study aims to develop and evaluate a multimodal physiotherapy protocol for overweight females, targeting anatomical, functional, and psychosocial impairments, thereby addressing a critical gap in the literature. [4]

Methods

Research Design: Completely Randomized Design (Two group simple randomized experimental designs).

Research Setting

1. OPD, based in physiotherapy department of Guru Nanak Hospital, Amritsar
2. Flying wings physiotherapy and rehabilitation Centre, Amritsar
3. OPD, based in physiotherapy department of Khalsa College, Amritsar

Sample Size

$$\text{Sample size} = \frac{2SD^2(1.96 + 0.84)^2}{d^2} = 68.06$$ [40]

60 participants were divided into two groups, with 30 in the control group and 30 in the experimental group. Outcomes were assessed by an independent assessor blinded to group allocation

Sampling method: Participants were allocated using simple random sampling by a lottery (chit) method.

Inclusion Criteria

1. Age: 40 to 60 years.
2. Overweight females with body mass index (BMI) ≥ 25 to 29.9 kg/m^2.
3. GRADE1 and GRADE 2 knee osteoarthritis (Pre-diagnosed).
4. Women complaining of pain since 3 months.
5. Subjects taken were fluent in english language.

Exclusion Criteria

1. History of knee ligament or meniscal injury.
2. Recent fractures in the knee joint.
3. History of knee joint surgery or corticosteroid injections within a specified timeframe.
4. Presence of systemic, metabolic, infectious, or neuromuscular diseases that may affect the knee joint.
5. Pregnancy or lactation
6. Diagnosis of ankylosing spondylitis, rheumatoid arthritis, osteomalacia, Paget's disease, or other conditions that may interfere with the study objectives.
7. Participation in other limb strengthening programs during the study period.
8. Patient has not taken any painkillers in the last 3 months.
9. Pain medications are not permitted within 4 weeks of the protocol timeframe.
10. Patients having back pain, ankle pain, hip pain.
11. Patients having radiculopathy and neuropathy.

Variables

Dependent Variables:

- BMI
- NPRS
- WOMAC
- ADHERENCE RATING SCALE

Independent Variables

- Conventional physiotherapy
- Multimodal physiotherapy program

Equipment used: Stadiometer and Weighing machine.

Data Collection: Data is collected at baseline and after 4 weeks physiotherapy session.

Statistical Analysis: Independent t-tests

Dependent t-test

Procedure: Participants were randomly assigned to a control group (conventional treatment) or an intervention group (multimodal physiotherapy protocol), each consisting of 30 participants. On the first day, all participants underwent initial assessments including knee history, general musculoskeletal assessment, Western Ontario and McMaster Universities Osteoarthritis Index, Numerical Pain Rating Scale, Adherence Rating Scale, and Body

Mass Index. The intervention group also received a comprehensive biopsychosocial assessment and individualized treatment. They attended weekly 30-minute, patient-specific educational sessions for four weeks. At the end of the four-week period, all participants were reassessed using the same outcome measures to evaluate treatment effectiveness.Tables given below represents the exercise protocol followed by the control and intervention groups, detailing the proper dosage, duration, and frequency.

Physiotherapy for Control Group

1. Knee Isometric Exercises

- **Description:** Isometric contractions of the quadriceps muscle.
- **Sets/Repetitions/Hold Time:** 3 sets of 10 repetitions, each held for 10 seconds.
- **Rest:** 2 seconds between repetitions, 30 seconds between sets.
- **Duration:** Performed three times per week for 4 weeks.

2. Self-Stretching Exercises

- Muscles Targeted:
  - Hamstrings
  - Quadriceps Femoris
  - Gastrocnemius-Soleus
- **Protocol:** Single set of 3 repetitions for each muscle, with each repetition held for 30 seconds.
- **Rest:** 30 seconds between repetitions.
- **Duration:** Performed three times per week for 4 weeks.

3. Transcutaneous Electrical Nerve Stimulation (TENS)

- **Frequency:** 100–150 Hz
- **Pulse Width:** 100 to 500 milliseconds
- **Intensity:** 12–30 milliamperes (mA)
- **Application Time:** 15 minutes per session.
- **Duration:** Performed three times per week for 4 weeks.

4. Precautionary Advice (Dos and Don'ts)

- **Description:** Education session on safety measures and lifestyle modifications for managing knee osteoarthritis.
- **Frequency:** One session during the 4-week intervention.
- **Duration:** Conducted once within the 4-week period.

Physiotherapy for experimental group:

1. Individualized Treatment Based on Assessments

- **Description:**Treatment was customized for each patient based on general musculoskeletal and biopsychosocial assessments. The treatment was given according to the patient centric approach that is individualized care was given, and exercises and modalities were selected from a pool of nine, so not all participants received the full set
- **Frequency:** One session
- **Timing:** Administered at baseline (before starting intervention)

2. Patient Education Sessions

- 1st Session (Week 1):
  - **Content:** Introduction to knee osteoarthritis, causes, joint changes, physiotherapy role, precautions, and protocol significance.
  - **Duration:** 30 minutes
- 2nd Session (Week 2):
  - **Content:** Motivation, correcting misconceptions, managing unrealistic expectations.
  - **Duration:** 30 minutes
- 3rd Session (Week 3):
  - **Content:** Progress discussion, addressing false expectations, accurate information reinforcement.
  - **Duration:** 30 minutes

- 4th Session (Week 4):
  - **Content:** Recap and forward guidance: importance of activity, healthy weight, lifestyle, ergonomics, follow-ups, and dos/don'ts.
  - **Duration:** 30 minutes
- **Frequency:** One session per week for 4 weeks

3. Aerobic Exercise – Pedometer Cycling

- **Description:** Patient-specific cycling (self-selected speed and seat height)
- **Sets/Repetitions:** 3 sets of 50 repetitions
- **Rest:** 30 seconds between sets
- **Frequency:** Three times per week for 4 weeks

4. Progressive Resistance Exercise (PRE)

- Muscle Groups Targeted:
  - Knee extensors/flexors
  - Hip extensors/flexors/abductors/external rotators
  - Ankle dorsiflexors and plantar flexors
- **Sets/Repetitions:** 3 sets of 10 repetitions, each held for 10 seconds
- **Rest:** 2 seconds between repetitions, 30 seconds between sets
- **Frequency:** Three times per week for 4 weeks

5. Therapist-Assisted Stretching Exercises

- Muscles Targeted:
  - Hamstrings
  - Quadriceps femoris
  - Gastrocnemius-Soleus
- **Protocol:** Single set of 3 repetitions with a 30-second hold
- **Rest:** 30 seconds between repetitions
- **Frequency:** Three times per week for 4 weeks

6. Neuromuscular Training

- Exercises:
  - Frenkel Exercises: Axial turning, stair climbing, side-stepping [30]
  - Standing balance on an unstable surface
- **Repetitions (Frenkel):** 3 sets of 15 repetitions
- **Repetitions (Balance):** 3 sets of 3 repetitions with a 60-second hold
- **Rest (Balance):** 2 seconds between repetitions and 30 seconds between sets
- **Rest Between Frenkel Sets:** 120 seconds between repetitions and between sets
- **Frequency:** Three times per week for 4 weeks

7. Maitland Mobilization

- Joints Targeted:
  - Patellofemoral
  - Tibiofemoral
  - Distal tibiofibular
  - Talocrural
  - Talocalcaneal
  - Hip joint
- **Grade:** I and II mobilizations
- **Protocol:** 6 repetitions, 3 sets
- **Frequency:** Three times per week for 4 weeks

8. Soft Tissue Manipulation (Massage)

- **Technique:** Effleurage [31]
- **Areas Covered:**
  - Peripatellar tissue
  - Quadriceps, hamstrings, hip adductors
  - Gastrocnemius-Soleus
  - Fascia of thigh and leg musculature
- **Duration:** 3 to 5 minutes per session
- **Frequency:** Three times per week for 4 weeks

9. Kinesio Taping (KT)

- Application Details:
- **1st Strip (Y):** Over quadriceps; tails wrap patella medially and laterally with 50% tension during max knee flexion.
  - **2nd Strip (Y):** From tibial tuberosity to inferior pole of patella; applied at 90° knee flexion.
  - **3rd Strip (I):** Applied mediolaterally over patella at 30° knee flexion with 50% tension.

- **Application Schedule:**
  - Applied **twice weekly** (Friday and Monday)
  - **Weaning off:** Monday and Wednesday

Outcome Measure

Primary outcomes for this study included pain, body mass index (BMI), adherence, functional mobility, quality of life, and activities of daily living. Pain was assessed using the Numeric Pain Rating Scale (NPRS) (0-10) [35]. Functional mobility, quality of life, and daily activities were measured with the modified Western Ontario and McMaster University (WOMAC) Osteoarthritis Index (Likert 0-4) [36]. Adherence was evaluated using a specific scale (0-4, 0=good) [24, 37]. BMI was calculated as weight (kg) / height (m)2; overweight was defined as BMI ≥25 to 29.9 kg/m^2 [34]. All measures were taken pre- and post-intervention.

Data Analysis

Between the group comparison:

Unpaired T Test	Comparison			
	ADHERENCE SCALE			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	3.90	3.70	0.00	3.90
S.D.	0.305	0.466	0.000	0.305
Number	30	30	30	30
Mean Difference	0.20		3.90	
Unpaired T Test	1.966		70.007	
P value	0.0540		<0.001	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Significant	

Table No. 1. Between the group Comparison for adherence

Unpaired T Test	Comparison			
	WEIGHT (Kg)			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	71.37	69.33	68.80	69.34
S.D.	5.732	5.441	5.455	5.410
Number	30	30	30	30
Mean Difference	2.03		0.54	
Unpaired T Test	1.409		0.383	
P value	0.1642		0.7034	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Not-Significant	

Table No. 2. Between the group Comparison for Weight

Unpaired T Test	Comparison			
	BMI			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	27.13	26.93	26.23	26.94
S.D.	1.354	1.151	1.179	1.136
Number	30	30	30	30
Mean Difference	0.20		0.71	
Unpaired T Test	0.606		2.385	
P value	0.5468		0.0203	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Significant	

Table No. 3. Between the group Comparison for BMI

Unpaired T Test	Comparison			
	NPRS			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	5.10	4.80	3.07	4.87
S.D.	0.607	0.664	0.785	0.571
Number	30	30	30	30
Mean Difference	0.30		1.80	
Unpaired T Test	1.825		10.155	
P value	0.0731		<0.001	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Significant	

Table No. 4. Between the group Comparison for NPRS

Unpaired T Test	Comparison			
	WOMAC			
	Pre		Post	
	Group A	Group B	Group A	Group B
Mean	34.93	34.90	15.83	33.27
S.D.	10.544	10.420	5.718	10.342
Number	30	30	30	30
Mean Difference	0.03		17.43	
Unpaired T Test	0.012		8.080	
P value	0.9902		<0.001	
Table Value at 0.05	2.00		2.00	
Result	Not-Significant		Significant	

Table No. 5: Between the group Comparison for WOMAC

Results

Out of the 60 subjects recruited in the preliminary study, 30 subjects in each group completed the study program. Between the groups, Group A had higher adherence ($p < 0.001$) and lower post-intervention NPRS ($p < 0.001$) and WOMAC scores ($p < 0.001$) than Group B. The overall significance for the chosen factor, the multimodal physiotherapy approach, was found to be statistically significant. Therefore, the administered intervention protocol, consisting of a combination of biomedical and biopsychosocial approaches, was found to be significantly effective in the management of knee osteoarthritis in overweight females, leading to reductions in pain, lower body mass index(BMI), improved adherence, and reduced Western Ontario and McMaster University (WOMAC) Osteoarthritis Index scores

Discussion

This study assessed the effectiveness of a multimodal physiotherapy protocol, combined with a biopsychosocial approach, in managing knee osteoarthritis among overweight females. Traditional physiotherapy often emphasizes symptom management and follows a biomedical model, overlooking psychological and social influences. The biopsychosocial model addresses this gap by integrating physical, emotional, and social aspects into patient care. It encourages individualized care through better communication and therapeutic alliance between patient and therapist [25].

Previous studies have highlighted poor adherence to treatment protocols as a barrier to successful outcomes despite the proven benefits of exercise and electrotherapy [23, 22]. Psychological factors such as anxiety and depression are also associated with increased pain and disability in early osteoarthritis, underlining the importance of a more holistic treatment strategy [32]. However, clinical application of the biopsychosocial model faces challenges like limited training, unclear roles, and patient expectations [33].

The findings of this study align with existing evidence showing that multimodal interventions improve pain, physical function, balance, and overall quality of life in patients with knee osteoarthritis [4, 13, 28]. Statistical analysis demonstrated significant improvements in body mass index, pain scores, functional outcomes, and adherence levels in the intervention group receiving multimodal care compared to the control group.

In conclusion, this study supports the implementation of a multimodal physiotherapy protocol grounded in the biopsychosocial model. This approach is effective in addressing the complex nature of knee osteoarthritis in overweight females and has the potential to improve patient outcomes while reducing the broader healthcare burden.

Limitations

1. Small sample size.
2. Small geographical area.
3. Dietary advice and lifestyle modification for weight loss management.

Future Scope

1. Long term follow up.
2. This study only focuses on females but male counterparts can also be explored.

Conflict of Interest: None

Source of Funding: Self

Ethical Clearance: A written informed consent was obtained from the patient, and the study was performed with the approval of ethical committee at Khalsa college Amritsar. Ref no IEC/KCA/PT/2024/02 Dated:15/01/24.

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Original Article

Efficacy of Muscles Training Versus Stretching in Plantar Fasciitis Management: A Comparative Study

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Abstract

Background: Plantar fasciitis (PF) is a common cause of heel pain, often linked to muscle tightness and weakness affecting foot biomechanics.

Objective: To compare the effect of plantar fascia and gastro-soleus stretching versus hip abductors, soleus and intrinsic muscles of foot training in PF.

Methods: A total of 40 subjects diagnosed with PF were randomly assigned into two groups: Group A (n=20), received plantar fascia and Gastro-soleus stretching and Group B (n=20), treated with training for intrinsic foot muscles, soleus and hip abductors. Visual analogue scale (VAS) and Foot Function Index (FFI), as outcome measures were evaluated at 0 day, 3rd week and 6th week for both groups and analysed.

Results: There were no significant differences on VAS and FFI scores on "0" day between the groups. Both treatment methods were found to be equally effective for pain reduction on 3rd and 6th week. Group B showed significant improvement ($p<0.05$) for FFI scores on 3rd and 6th week as compared to group A.

Conclusion: Training of muscles is found to be more effective than stretching in PF.

Keywords: plantar fasciitis, strengthening, stretching.

Introduction

Plantar fasciitis (PF) is the most common cause of heel pain, significantly contributing to foot pain cases. [1] It results from inflammation of the plantar fascia aponeurosis at its origin on the calcaneus, presenting as sharp heel pain, particularly during the first few steps in the morning or after prolonged inactivity. The pain typically extends from the medial border of the plantar fascia at the medial tuberosity of the calcaneus.[2]

PF is associated with both inflammatory and degenerative changes in the fascia, often due to factors such as obesity, over-pronation, repetitive strain, and overuse.[3] The condition affects about

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10% of the general population, with 83% being active adults aged 25 to 65 years.[2,4] Risk factors are categorized as anatomical (e.g., pes planus, pes cavus, obesity, fat pad atrophy, shortened Achilles tendon), biomechanical (e.g., limited ankle dorsiflexion, excessive subtalar joint pronation, weak plantar flexors and intrinsic foot muscles), and environmental (e.g., walking barefoot, trauma, hard surfaces).[4]

An abnormal biomechanical structure is considered to play an important role. Includes tightness in the Achilles tendon and plantar fascia and reduced foot and ankle muscle strength.[5] Patients with PF often also have myofascial restrictions and muscle stiffness or tightness in the gastro-soleus complex and plantar fascia.[4,5] Reduced strength of the plantar flexors, toe flexors and abductor hallucis muscles as well as a reduction in muscle volume in forefoot are reported to contribute to PF. Weakness of the intrinsic and extrinsic muscles of the foot may result in the recurrent symptoms of PF due to improper functioning of the muscle and joint positioning during walking.[5]

The closed kinetic chain theory suggests that proximal core hip strength is needed for control of distal segments to prevent injury. Weakness of the hip abductor muscles during walking may result in plantar flexion muscle overuse, which can increase the load on the plantar fascia.[6,7]

The exercise regimens mentioned earlier like hip abductor strengthening play a role in promoting PF recovery by enhancing muscle strength and alleviating muscle tightness. However, due to a scarcity of comparative studies evaluating the efficacy of muscle training versus stretching exercises, it remains unclear which type of exercise yields greater improvement in PF symptoms. Therefore, this study aimed to investigate the effects of muscle training and stretching exercise programs combined with a physical therapy intervention on pain intensity, disability and activity restriction in patients with PF.

Outcome measures include the visual analogue scale (VAS) for pain.[8] The Foot function index (FFI) for functional status.[9] Unlike earlier studies that generalize interventions, this study targets specific muscles hip abductors, soleus and intrinsic foot muscles to better understand their role in PF management and improve treatment outcomes.

Methodology

Study Design

This is a randomized controlled trial involving 40 subjects diagnosed with PF.

Sampling Procedure

The sample size is calculated by using G POWER SOFTWARE (version 3.1.0), to evaluate the power needed to test for an interaction within and between participant variables. The intention of priori sample size calculation was to achieve 95% power with alpha value 5% (Type 1 error) to detect standard Sampling technique effect size of 1. Considering the mean difference 81, standard deviation 1.0.

A prior estimate resulted in the total sample size of 36 participants. An assumption of 10 percent dropout rate estimates the addition of 4 samples which gave overall sample size to be 40 which was further divided into 20 in group A and 20 in group B respectively.

Ethical approval was obtained from the Institution Ethics Committee (Ref no. SDMIEC/2024/732 Dated 16.05.2024), and CTRI number is CTRI/2024/07/070263, SDM college of Medical Sciences and Hospital, Dharwad and informed consent was acquired from all participants.

The intervention was carried out in SDM Hospital Orthopaedic Physiotherapy out patient department between time periods of july 2024 to june 2025

Participants

Participants were randomly divided into two groups by randomization using concealed envelope method.

Group A (n = 20): plantar fascia and gastro soleus stretching.

Group B (n = 20): training of hip abductors, soleus and intrinsic foot muscles.

Inclusion criteria were confirmed diagnosis of unilateral/bilateral PF by medical practitioners, Age range from 20 to 60 years, Pain in the heel on the first step in the morning, Pain with tenderness on palpation of the medial calcaneal tubercle.

Exclusion criteria included Individuals not willing to participate, Any deformity in affected lower limb, Earlier episodes of PF treated surgically/ corticosteroids injection at heel, Any fracture in the affected lower limb within past 6 months, subjects who has/had neurological problems affecting the involved lower limb, Pregnant women, Having undergone physiotherapy intervention for affected lower limb in previous six months.

Intervention

Exercise Protocol For Group A

1. Plantar Fascia Stretch: The participants sat in a high sitting position and placed the lateral aspect of the affected ankle over the distal thigh of the opposite leg. One hand stabilized the heel, while the other pulled the toes toward the shin until a stretch was felt along the sole.[10]
2. To stretch the Gastro-Soleus: In standing, the participants were asked to face the wall with hands against wall at shoulder level for support. Participant stride forward with one foot, keeping the heel of the back foot flat on the floor (the back foot is one being stretched). To stretch the gastro-soleus muscle, the knee of the back leg was kept extended.[11]

Dosage

Participants performed each stretch 3 times, holding for 30–60 seconds with 1-minute rests, twice daily for 6 weeks. They attended physiotherapy OPD twice weekly, and only those completing at least 65 of 84 sessions (per compliance sheet) were included in the analysis. A compliance sheet was provided, and data of participants performing a minimum 65 sittings of exercise out of total 84 sessions were included for data analysis.

Exercise Protocol For Group B

1. Intrinsic Foot Muscle Training: Participants sat with the affected foot flat on the ground and scrunched a napkin under the toes while keeping the heel down. The exercise was done for 1–2 minutes, three times daily for 6 weeks, with progression by adding weight on the napkin.[12]
2. Seated calf raise to train the soleus muscle: Participants sat on a chair with feet flat, knees at 100°, and ankles in 5–10° dorsiflexion. Resistance was applied over the distal thigh. Keeping the back straight, they lifted their heel by pressing through the forefoot, focusing on soleus contraction, and lowered it slowly with control. The exercise was performed for 3 sets of 50 reps, three times daily for 6 weeks, with progression using 0.5 kg weight increments over the distal thigh.[13]
3. Hip Abductor Training: participants performed side lying hip abduction (3 sets of 5 reps, thrice daily for 6 weeks) 0.5–1 kg thigh weights progression.[6,7,13] These exercises were given as a home program, data of participants performing a minimum 97 sittings of exercise out of the total 126 planned sessions were included for data analysis.

Common Therapy (Ultrasound)

Subjects in prone with foot positioned off the bed. After cleaning the affected heel, ultrasonic gel was applied. The transducer head moved in slow circular motions for 7–8 minutes using 3 MHz frequency at 0.8–1 W/cm² intensity in continuous mode. This was done twice a week for 3 weeks, then once a week for the next 3 weeks.[14]

Statistical Analysis

All the analysis was performed using Statistical Package for the Social Sciences (SPSS) version 30.0. The tests for normality was done using Shapiro-wilk test for all the outcome measures which showed that the data in both groups was not normally distributed.

The analysis for within group differences for group A and B was done using friedmans ANOVA and Wilcoxon Sign Rank test. To compare the difference between two groups, Mann Whitney U test was used. The statistical significance was considered as $p<0.05$.

Demographic Table

Gender distribution was identical in both groups, with 45% males and 55% females. Chi-square test showed no significant difference in gender distribution (p = 1.000).

Table 1. Comparison of gender distribution between group A and B

Gender	Group A	%	Group B	%	Total	%
Male	9	45.00	9	45.00	18	45.00
Female	11	55.00	11	55.00	22	55.00
Total	20	100.00	20	100.00	40	100.00
Chi-square=0.0001, p=1.0000						

Table 2: Comparison of mean age between group A and B using Independent t test.

Table 2. revealed no significant difference in age between the groups (p = 0.601).

Group	n	Mean	SD	SE	t-value	P-value
Group A	20	42.55	10.37	2.32	0.5269	0.6013
Group B	20	40.90	9.41	2.10		

P<0.05

Normality of VAS and FFI scores at all time points in both groups using Shapiro wilk test. Indicates that most VAS and FFI scores did not follow normal distribution (p<0.05).

Post Intervention Results

The study found that both stretching and muscle training led to significant improvements in pain and function in patients with PF. VAS scores (table 3) showed significant pain reduction within both groups over six weeks (p < 0.0001), with no significant difference between groups at 3rd week and 6th week (p>0.05) indicating similar pain relief.

Table 3. Within group analysis of VAS scores in group A and B using Friedmans ANOVA and Wilcoxon test shows significant difference.

Groups	Times	Mean	SD	Mean Diff.	% of change	Effect size	Z-value	P-value	Friedman ANOVA	P-value
Group A	Day 0	7.10	0.85						34.880	0.0001*
	3 weeks	5.20	0.95	1.90	26.76	2.23	3.8230	0.0001*		
	Day 0	7.10	0.85							
	6 weeks	3.35	1.63	3.75	52.82	4.40	3.8230	0.0001*		
	3 weeks	5.20	0.95							
	6 weeks	3.35	1.63	1.85	35.58	1.94	3.4794	0.0005*		
Group B	Day 0	7.10	0.85						36.026	0.0001*
	3 weeks	4.60	1.23	2.50	35.21	2.93	3.8230	0.0001*		
	Day 0	7.10	0.85							
	6 weeks	2.95	1.47	4.15	58.45	4.87	3.9199	0.0001*		
	3 weeks	4.60	1.23							
	6 weeks	2.95	1.47	1.65	35.87	1.34	3.3869	0.0007*		

*p<0.05

However, Group B showed significantly greater improvements in functional outcomes as measured by the FFI. Group B had a 75.65% improvement compared to 53.50% in Group A. Between-group analysis (table 6) showed significant differences in FFI scores at 6 weeks (p = 0.0092), from day 0 to week 6 (p = 0.0372), highlighting the superior effect of muscle training on foot function.

Table 4. Within group analysis of FFI scores in group A and B using Friedmans ANOVA and Wilcoxon test.

Groups	Times	Mean	SD	Mean Diff.	% of change	Effect size	Z-value	P-value	Friedman ANOVA	P-value
Group A	Day 0	40.23	6.99						36.026	0.0001*
	3 weeks	28.86	5.32	11.37	28.26	1.63	3.8230	0.0001*		
	Day 0	40.23	6.99							
	6 weeks	18.71	10.67	21.53	53.50	3.08	3.9194	0.0001*		
	3 weeks	28.86	5.32							
	6 weeks	18.71	10.67	10.16	35.90	1.91	3.4128	0.0006*		
Group B	Day 0	41.28	8.33						40.000	0.0001*
	3 weeks	27.08	8.84	14.21	34.42	1.71	3.9195	0.0001*		
	Day 0	41.28	8.33							
	6 weeks	10.05	2.83	31.23	75.65	3.75	3.9199	0.0001*		
	3 weeks	27.08	8.84							
	6 weeks	10.05	2.83	17.02	21.77	1.93	3.9193	0.0001*		

P<0.05*

Table 5. Comparison of Group A and B with VAS scores at day 0, 3weeks and 6 weeks treatment time points by Mann-Whitney U test

Time points	Group A			Group B			Effect size	Z-value	p-value
	Mean	SD	Mean rank	Mean	SD	Mean rank			
Day 0	7.10	0.85	20.50	7.10	0.85	20.50	0.00	0.0000	1.0000
3 weeks	5.20	0.95	23.75	4.60	1.23	17.25	0.28	1.2898	0.0708
6 weeks	3.35	1.63	22.30	2.95	1.47	18.70	0.15	0.1564	0.3252
Day 0 to 3 weeks	1.90	1.02	17.55	2.50	1.24	23.45	0.25	-1.5960	0.1026
Day 0 to 6 weeks	3.75	2.00	19.40	4.15	1.76	21.60	0.09	-0.5951	0.5548
3 weeks to 6 weeks	1.85	1.57	21.38	1.65	1.46	19.62	0.07	0.4734	0.6366

P<0.05*

Table 6. Comparison of Group A and B with FFI scores at day 0, 3weeks and 6 weeks treatment time points by Mann-Whitney U test

Time points	Group A			Group B			Effect size	Z-value	p-value
	Mean	SD	Mean rank	Mean	SD	Mean rank			
Day 0	40.23	6.99	20.45	41.28	8.33	20.55	0.00	-0.0271	0.9892
3 weeks	28.86	5.32	22.95	27.08	8.84	18.05	0.21	1.3255	0.1891
6 weeks	18.71	10.67	25.32	10.05	2.83	15.68	0.41	2.6103	0.0092*
Day 0 to 3 weeks	11.37	6.77	18.52	14.21	8.04	22.48	0.17	-1.0685	0.2914
Day 0 to 6 weeks	21.53	13.16	16.62	31.23	8.74	24.38	0.33	-2.0964	0.0372*
3 weeks to 6 weeks	10.16	9.06	16.90	17.02	8.38	24.10	0.31	-1.9476	0.0529

$P<0.05^{*}$

Discussion

The present study demonstrated that both stretching and muscle training protocols significantly reduced pain and improved function in individuals with PF. However, participants in Group B, who underwent muscle training targeting gluteus medius and piriformis, the soleus, and the intrinsic foot muscles, showed greater functional gains, especially on the FFI. These findings suggest that muscle-specific strengthening strategies are more effective in addressing the biomechanical deficits contributing to PF.[13]

PF is commonly associated with altered lower limb biomechanics, where muscle weakness and poor motor control increase load on the plantar fascia.[15] The gluteus medius plays a crucial role in controlling pelvic drop and femoral internal rotation during the stance phase of gait, particularly from heel strike to midstance.Weakness in this muscle leads to excessive femoral and tibial internal rotation, promoting overpronation at the subtalar joint. This results in medial and inferior movement of the talus and navicular, contributing to the collapse of the medial longitudinal arch and placing tension on the plantar fascia.[13]

The piriformis, primarily an external rotator, also stabilizes the hip. Its weakness permits uncontrolled femoral rotation, further propagating compensatory mechanics at the tibia and foot. Strengthening the gluteus medius and piriformis in Group B likely helped maintain pelvic and femoral alignment, thereby reducing distal compensations and plantar fascia strain.[13]

The soleus muscle plays an essential role during the foot flat to midstance phase, controlling tibial advancement. As the tibia progresses over the foot, the talus plantarflexes and adducts, while the navicular shifts medially and inferiorly, lowering the arch. If the soleus is weak, tibial progression becomes too rapid, increasing dorsiflexion and collapsing the arch further. This increases stress on the calcaneal origin of the plantar fascia, exacerbating microtrauma. Eccentric training of the soleus, as done in this study, decelerates tibial movement, supports arch integrity, and reduces pathological tension on the fascia.[11]

Anatomically, the soleus originates from the posterior surface of the head and upper third of the fibula, and the soleal line and middle third of the tibia, inserting into the calcaneus via the Achilles tendon. Its spiral origin from the fibular head may facilitate smooth internal rotation of the leg during stance. Thus, training the soleus may have helped control leg rotation and tibial advancement through eccentric release.[12]

The intrinsic foot muscles (e.g., abductor hallucis, flexor digitorum brevis) play a concentric role in reforming and stabilizing the medial arch during gait. Weakness in these muscles leads to poor dynamic support and increased reliance on passive structures like the plantar fascia. Toe-curl exercises in Group B

reactivated these muscles, enhancing the windlass mechanism and foot stability.[12]

Together, these muscle groups modulate forces acting on key bony structures femur, tibia, talus, navicular, calcaneus and preserve arch integrity during the gait cycle. By improving strength and motor control at both proximal (hip) and distal (foot) levels, the Group B intervention provided a comprehensive correction of the kinetic chain contributing to PF.

In contrast, Group A stretching protocol likely provided transient relief by reducing muscle and fascial stiffness.[10]

In conclusion, strengthening interventions targeting key hip, leg, and foot muscles address the multi-segmental nature of PF more effectively than stretching alone. A kinetic chain approach should be prioritized in clinical practice to ensure long-term symptom resolution and recurrence prevention.

Limitations

- Small sample size.
- Duration of intervention was limited to six weeks.
- No long term follow up
- Single centred population
- Study focused only on pain and function, did not assess objective changes such as gait parameters, plantar pressure distribution, muscle activation patterns via EMG.

Conclusion

- Findings of study suggests that within both the groups A and B showed statistically significant difference in reduction in pain on VAS, and increase in function on FFI.
- Between groups A and B, both showed better effects on all the outcome measures in PF patients. Based on P value group B showed to be more effective in increasing function on FFI scale.

Future Scope

- Larger and more diverse sample size.
- Long term follow up should be conducted.
- Incorporating instrumented gait analysis, EMG or plantar pressure mapping.
- Future research may explore combination protocols, comparing stretching and strengthening versus isolated approaches to determine synergistic effects.

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Original Article

Relationship between Hip Internal Rotators and Back Extensor Endurance in Mechanical Low Back Pain

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Abstract

Background & Objective: Low back pain is a prevalent musculoskeletal disorder that often leads to mechanical alterations during various activities. A reduced range of hip rotation and decreased endurance of the paraspinal muscles are considered contributing factors to biomechanical low back pain. This study aims to examine the relationship between hip internal rotator flexibility and back extensor endurance in females aged 18-30 years experiencing biomechanical low back pain.

Methodology: The study included 120 females aged 18-30 years, selected based on specific inclusion and exclusion criteria. Hip internal rotation range was assessed using a goniometer, while trunk extensor endurance was evaluated using the Biering-Sorensen test.

Results: The results of Spearman's rank correlation coefficient test that there is a weak positive correlation between hip internal rotation (right) $r = 0.101$ and left ($r = 0.063$) with back extensor endurance and are not statistically significant ($p > 0.05$).

Conclusion: This study demonstrated that there is no significant relationship between hip internal rotation and back extensor endurance in individuals with mechanical low back pain.

Keywords: Mechanical low back ache, External and internal hip rotation range of motion, Trunk extensor endurance, Lumbar instability

Introduction

Low Back Pain (LBP) is characterised as discomfort or pain commonly seen in the region between the coastal margin and the inferior gluteal fold.[1,2] LBP has emerged as a significant global health concern with life time prevalence of approximately 70-85% of the population leading to disability and work absenteeism, resulting in financial burden which indirectly leads to deficit in productivity.[3] As reported by Ferguson et al. neck and back pain are second major contributors for disability after iron deficiency anaemia in India.[4,5] Various factors contribute for LBP, with mechanical LBP being the most common

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form of chronic pain. Mechanical low back pain is characterised as nociceptive pain which commonly originates intrinsically from the spine, intervertebral discs, or surrounding soft tissues.[6,7,8]

Low back pain (LBP) is more common in women, who also experience chronic musculoskeletal pain more frequently than men. Sex differences in pain are influenced by biological, psychological, and sociocultural factors, with heightened pain sensitivity contributing to women's higher pain reports.[9]

The biomechanical interplay within the hip, pelvis and the spine including the involvement of shared muscles such as psoas, quadratus lumborum, erector spinae, gluteus maximus, etc. makes the hip joint to be a major contributor in LBP.[10,11] The association between LBP and hip rotation ROMs is significant as the hypothesis states that there will be a compensation in the motion of the lumbopelvic region when there is limited hip ROM. These compensatory movements lead to the development of LBP symptoms due to an increase in the loads and stress in the joint tissues of the lumbopelvic region.[10,12,13]

The trunk extensors, including the erector spinae and multifidus, play a crucial role in maintaining spine stability and posture, making them essential for preventing low back pain (LBP).[14] Trunk extensor endurance refers to the ability of the back and core muscles, especially the erector spinae group, to sustain contractions over time without fatigue or loss of strength. These muscles are crucial for maintaining an upright posture, stabilizing the spine, and facilitating movement. Weak trunk extensor muscles can contribute to low back pain, as they are responsible for maintaining proper spinal alignment and stability.[15] This can put a strain on the hip joint and limit the range of motion, including internal rotation. On the other hand, limited hip internal rotation can also affect trunk extensor endurance by altering the alignment and mechanics of the spine.[16]

There is a basic belief among manual and physical therapists that structural imbalances and asymmetry in the body can result in painful musculoskeletal conditions. In this model, the imbalances and asymmetries increase the abnormal mechanical/ physical stress imposed on the musculoskeletal system. The need of the study was to find out the relationship between hip internal rotation and back extensor endurance in mechanical low back pain of the age group between 18-30 years old.

Methodology

An observational study was carried out at the Tejasvini Hospital Group of Institutions, involving 120 female participants aged between 18 and 30 years. The study focused on specific predictor variables, including age (in years), weight (in kilograms), height (in centimetres), and BMI, which were recorded for each participant following a brief explanation of the study's purpose. Hip internal rotation was assessed using a goniometer, while back extensor endurance was evaluated using the Biering-Sorensen Test.

The inclusion criteria comprised females aged 18–30 years experiencing mild to moderate low back pain. Exclusion criteria included pregnancy, a history of lumbar spine surgery within six months prior to testing, psychological illnesses, neurological conditions, rheumatic diseases, congenital deformities, or unwillingness to participate in the study.

Outcome Measures

(a) A universal goniometer was used to evaluate hip rotation range of motion. The patient was seated at the edge of the table, with their legs hanging off of it and their knees pressed against the table. The patella served as the fulcrum, and the goniometer was positioned along the tibia's shaft. After that, the patient was instructed to actively rotate the hip medially while staying within their pain threshold. One therapist measured the internal rotation of an average of three recordings. For both groups, all measurements were recorded bilaterally. As reported, the goniometer's reliability for hip range of motion is very high, with Cronbach α values of 0.90.[17]

(b) Biering - Sorensen Test was used to asses Back extensor endurance strength. The patient was positioned in prone on a table with ASIS placed at the end of the table, for safety a chair was placed in front of the patient so that the

patient so that the patient could hold on to the chair when fatigued. With arms bent across the chest, and hips fully extended, the subject was asked to perform a concentric contraction to place the spine in horizontally. This was visually assessed by the clinician. The test was terminated when the subject was unable to maintain the position or becomes too fatigued to continue, or experience any kind of pain. An intra-rater reliability of the Biering-Sorensen test was reported as (ICC = 93.2%). [18]

(c) A visual analogue scale (VAS) was used to measure the pain intensity with NPRS ICC = 0.991.[19] VAS is usually a horizontal line, 100 mm in length, with the amount of pain that a patient feels ranges across a continuum from no pain to severe pain. The patient was asked to mark the point on the line representing the perception of their current state.

Statistical Analysis

Statistical package SPSS 14.0 was used to analyse the data. All the quantitative descriptive data were expressed in mean and standard deviation and categorical data in percentage. The relationship between hip internal rotation and back extensor endurance was evaluated in Spearman's rank correlation test. P value ($p > 0.05$) was considered significant.

Results

The mean and Standard deviation of demographic characteristics of the participants data representing the age (in years), height (in cm), weight (in kg), BMI (in kg/m^2), hip internal rotation (in degree), and back extensor endurance of the study participants are presented in Table 1.

Table 1. Demographic Characteristics of the Study

Variables	Mean ± SD
Age (years)	19.75 ± 1.6
Height (cm)	154.9 ± 7.9
Weight (kg)	51.3 ± 11.9
BMI (kg/m^2)	21.3 ± 4.5

Table 2 represents the variables analysed using Spearman's rank correlation coefficient test. Spearman's rank correlation coefficient test found a weak positive correlation between hip internal rotation (right) with back extensor endurance and no significant relationship between hip internal rotation (left) with back extensor endurance.

Table 2. Variables analyzed using Spearman`s rank correlation coefficient test.

VARIABLES	TRUNK EXTENSOR ENDURANCE r value (p-value)
HIP INTERNAL ROTATION (right)	0.101 (0.273)
HIP INTERNAL ROTATION (left)	0.063 (0.409)

Discussions

This study provides valuable insights into the relationship between hip internal rotation and back extensor endurance in individuals with mechanical low back pain (LBP), specifically female participants. The findings indicate a weak positive correlation between right-side hip internal rotation and back extensor endurance, while no significant relationship was observed for the left side. These results highlight the complexity of hip-lumbar interactions and suggest that hip mobility restrictions may play a role in endurance capacity, although they are not the sole determinant.

The partial alignment with previous research reinforces the role of hip mobility in lumbar stability and endurance. Van Dillen et al. (2008) demonstrated the contribution of altered hip rotation in individuals engaged in rotational sports, suggesting compensatory movement patterns associated with LBP.[14] Similarly, Krishna et al. (2020) reported significant differences in hip rotation range of motion (ROM) between individuals with chronic LBP and healthy controls, reinforcing the premise that hip mobility deficits may influence spinal loading and endurance.[20]

Despite these similarities, the weak correlation observed in this study suggests that additional factors influence back extensor endurance beyond hip mobility. Roach et al. (2015) found that

individuals with chronic LBP exhibited reduced passive hip ROM, supporting the idea that mobility constraints may be prevalent.[21] However, the lack of significant association with left-side hip internal rotation indicates potential asymmetries in hip function, warranting further investigation into movement compensations.

The biomechanical interplay between lumbar stability and hip mobility remains complex. Prior research has highlighted the effectiveness of hip-targeted interventions for improving lumbar stability (Handrakis et al., 2012; Lee & Kim, 2015).[22,23] The absence of a strong correlation in this study may indicate that hip rotational restrictions affect spinal endurance through neuromuscular mechanisms rather than direct linear interactions. Gender-based factors may also contribute, as studies like Bento et al. (2020) have reported sex-specific differences in LBP presentations, with females potentially experiencing unique biomechanical adaptations due to pelvic morphology and hormonal influences.[24]

This study was limited by its sample size, which may have influenced statistical power. Additionally, the focus on female participants restricts generalizability to male populations, requiring future research to explore gender comparisons. Investigations into bilateral hip mobility patterns, muscle recruitment strategies, and the neuromuscular interactions between hip function and lumbar endurance could further clarify the mechanisms at play. Longitudinal studies assessing structured rehabilitation programs may provide additional insights into the dynamic relationship between hip rotation and endurance.

Understanding the nuanced relationship between hip mobility and back extensor endurance can assist clinicians in developing targeted rehabilitation programs. Hip-focused interventions, particularly for individuals with restricted internal rotation, may enhance lumbar endurance and reduce pain-related dysfunction. Given the gender specificity of this study, rehabilitation strategies should incorporate individualized assessments to determine how hip mobility limitations influence spinal endurance in female patients.

Conclusion

This study explored the association between hip internal rotators and back extensor endurance in females aged 18-30 years with mechanical low back pain (LBP). The primary objective was to determine whether hip internal rotators and back extensor endurance contribute to mechanical LBP. The findings indicated a weak positive correlation between right-side hip internal rotation and back extensor endurance, while no significant relationship was observed between left-side hip internal rotation and back extensor endurance. These results underscore the complex interplay between hip mobility and lumbar endurance in mechanical LBP, offering valuable insights for rehabilitation approaches that emphasize hip mobility and spinal endurance in female populations.

Future research should consider longitudinal designs with larger, diverse cohorts and incorporate additional variables such as pelvic alignment, lower limb strength ratios, and movement compensations. Investigating the effects of targeted intervention on both hip rotator strength and lumbar endurance may also help refine rehabilitation protocols for improved clinical outcomes.

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Original Article

Comparison of Functional Performance in Knee Osteoarthritis Patient with Diabetes Mellitus and Without Diabetes Mellitus-A Comparative Study

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Abstract

Background: The presence of Diabetes Mellitus is associated with a worsening of knee pain and greater physical and mental issues in Osteoarthritis patients. The pain in the patients with knee Osteoarthritis leads to functional limitations. It has been proved that the patient with diabetes mellitus demonstrate the higher intensity of pain.

Aim: The aim of the study to compare of functional performance in knee osteoarthritis patients with diabetes mellitus and without diabetes mellitus

Settings and Design: A cross-sectional study (comparative study) was conducted at tertiary care hospital.

Subjects and Methods: The present study included 50 patients 25 in each group. The patients were grouped into 2 groups. Group A included patients with Diabetes Mellitus and Knee Osteoarthritis and group B included Knee Osteoarthritis patients without Diabetes Mellitus. To assess the functional limitation **Western Ontario and McMaster Osteoarthritis Index** (WOMAC), and **Time Up Go** (TUG) test was used. ACR criteria was used to diagnose Osteoarthritis. The patients of 40-55 age group and Grade 2 Osteoarthritis were included in the present study, patients with knee surgery and history of trauma were excluded.

Statistical Analysis Used: The data was analyzed using a Graph-pad version 3.06.Appropriate test of statistical significance was applied test (for normally distributed) and **Mann whitney** (for not normally distributed)

Results: The mean NPRS Was Group -A was 6.560 ($\pm$1.261) and Group -B was 6.560 ($\pm$1.466).Therewas nosignificance difference in the WOMAC score between the two groups. The mean of TUG test was group -A 18.48($\pm$2.220) and group -B was 18.96($\pm$2.791) there was no significant difference between two groups (p- >0.527)

Conclusions: The present study concludes that though the NPRS and functional limitation is greater in Knee Osteoarthritispatients with Diabetes Mellituswhen compared to patient with Knee Osteoarthritis patients without Diabetes Mellitus but the difference is not statistically significant.

Keywords: Diabetes Mellitus, WOMAC, TUG, Knee Osteoarthritis.

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Introduction

The most common and incapacitating joint disease in adults is osteoarthritis (OA) [1]. The chronic metabolic disease known as diabetes mellitus is typified by hyperglycemia,the two broad etiopathogenetic categories of type 1 and type 2 DM, Type 1 DM is due to an absolute lack of insulin and has an autoimmune basis. An immune mediated destruction of β cells is the hallmark of the disorder, and hyperglycemia only ensues when ~ 90% of β cells are lost. Type 2 DM is the commonest form of diabetes and accounts for ~ 90–95% of cases. The Type is commonly found in Diabetes is linked to more severe OA and is a risk factor for the disease. Osteoarthritis (OA) and diabetes mellitus (DM) are both common and progressive disorders with rising incidence [1,2]. OA is the leading cause of chronic disability in the field of musculoskeletal diseases and the primary cause of disability in the elderly [3]. The main characteristics of OA, gradual irreversible loss of articular cartilage accompanied by degeneration of other joint tissues, interfere with quality of life [4] and result in pain and motion restriction. DM is a metabolic disorder characterized by high blood glucose levels that originates either from peripheral insulin resistance with subsequent failure of the pancreatic β-cell to adequately compensate for the insulin resistance (type 2) [5] or the T-cell mediated destruction of insulin-producing cells in the pancreas (type 1) [6]. The incidence and prevalence of the more common DM type (DM type 2) has nearly doubled within the last two decades [7], and its presence is reported in a high proportion of knee OA cases[8,9]. Both diseases share many risk factors [10,11], which may explain the increased prevalence of musculoskeletal diseases in diabetics [12] however, the underlying pathophysiology and biologic relationship between these two diseases is not yet completely understood.

Subjects and Methods

A comparative study was conducted involving a total of 50 individuals, divided into two equal groups of 25 participants each. Group A consisted of patients diagnosed with both Diabetes Mellitus and Knee Osteoarthritis, while Group B included patients with Knee Osteoarthritis but without Diabetes Mellitus. The study included patients between the ages of 40 and 55 years who had been clinically diagnosed with knee osteoarthritis. All participants were selected based on the American College of Rheumatology (ACR) classification criteria. Group A included individuals who had been diagnosed with Diabetes Mellitus for at least two years and had a random blood sugar level greater than 126 mg/dL. Group B consisted of patients with Grade 2 knee osteoarthritis who did not have Diabetes Mellitus and had a random blood sugar level less than 100 mg/dL.

Participants who were able to walk independently without the use of assistive devices were considered for inclusion in the study. Individuals with a history of cardiovascular, neurological, or other orthopedic conditions that could affect functional performance were excluded. Additionally, patients who had undergone previous knee surgery, those who had received injectable steroids for knee pain within the past three months, or those who used assistive devices for walking were not included in the study. Ethical approval for the study was obtained from the research committee at Dr.VithalraoVikhePatil College of Physiotherapy.

The study was conducted over a period of six months. Demographic data of all participants were recorded. Each participant was provided with a detailed explanation of the assessment tools used in the study, including the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire and the Timed Up and Go (TUG) test. Participants completed the WOMAC questionnaire, which assessed pain, stiffness, and physical function related to knee osteoarthritis. The TUG test was used to evaluate functional mobility, and the average time taken by each participant to complete the test was documented for analysis.



Figure 1: WOMAC SCALE DATA COLLECTION



Figure 2: TUG test (Starting Position)



Figure 3: TUG

Results

The mean Numeric Pain Rating Scale (NPRS) score for Group A was 6.56 (±1.261), and for Group B, it was 6.56 (±1.466). There was no statistically significant difference between the two groups, with a p-value of 0.9689. The mean WOMAC score for Group A was 47.16 (±15.762), while for Group B, it was 48.8 (±8.13). This difference was also not statistically significant, with a p-value greater than 0.527. For the Timed Up and Go (TUG) test, the mean time recorded for Group A was 18.48 seconds (±2.220), and for Group B, it was 18.96 seconds (±2.791). Again, the difference between the two groups was not statistically significant, with a p-value greater than 0.527.

Table 1. Pain Assessment (NPRS) of Group A and B

NPRS	Mean (SD)	Median	Mann whitney test 'U'	P value
Group-A	6.560(±1.446)	7	310	0.9689
Group-B	6.560 (±1.261)	7		

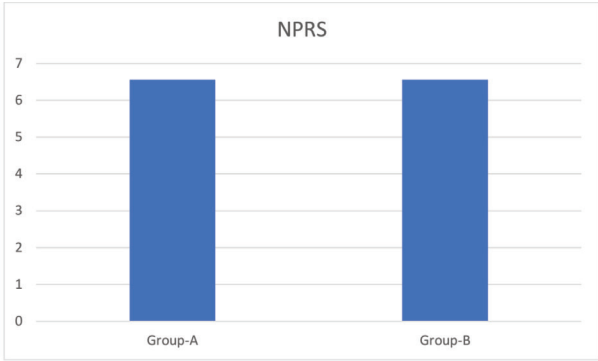


Table 2. Physical Function Assessment (WOMAC) of Group A and B

Womac	Mean (SD)	Median	Mann whitney test	P value
Group-A	47.16(±15.762)	47	293	0.527
Group-B	48.8(±8.813)	49		

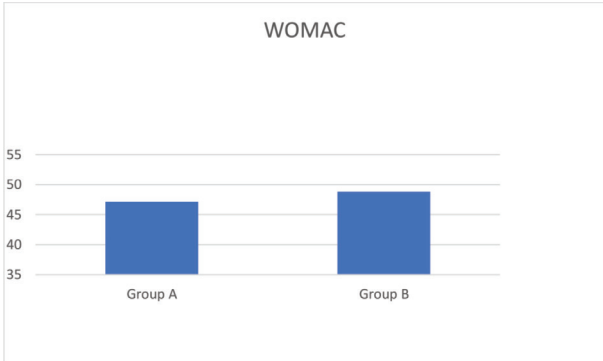
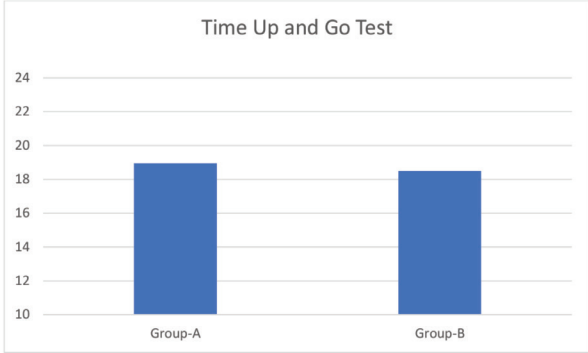


Table 3: Balance Assessment (TUG) of all Group A and Group B

TUG	Mean (SD)	Median	Mann whitney test	P value
Group-A	18.96(±2.791)	19	293	0.527
Group-B	18.48(±2.220)	19		



Discussion

The present study evaluated the functional performance of patients with knee Osteoarthritis. The Knee Osteoarthritis patients were divided into 2 groups. Group A included Knee Osteoarthritis patients with Diabetes mellitus and Group included Knee Osteoarthritis patients without Diabetes mellitus. The mean age of group A patients was 50.92 and of group B was 51.24. In group A 20% were male and 80% were female, in group B 40 % were male and 60 % were female. The mean BMI of group A was 25.084 ± 3.23 and of group B was 24.092 ± 2.33.

We aimed to compare the functional performance of the diabetic and non-diabetic knee Osteoarthritis patients. **WOMAC** and **TIME UP GO TEST** was used to assess the functional performance**.** The mean WOMAC of Group A was 47.16 ±15.77 and of Group B was. 48.8 ± 8.813 this demonstrates that functional performance of knee patients without diabetes mellitus is greater. The difference between the functional performance between the two groups was not found to be statistically significant with a p value of 0.527. In the previous study by Shi Ruiet. al. the muscle strength and balance was compared between the Diabetes mellitus and non- Diabetes mellitus knee Osteoarthritis patients, they found that Knee osteoarthritis had a significantly different physical and psychosocial profile in com parison with groups with diabetes or knee osteoarthritis alone [2]. Louati et al. (2015) also reported a strong association between Diabetes mellitus and Osteoarthritis severity, supporting the idea that diabetic patients may experience greater functional impairment.[5] The finding of the present study is Contrary to previous, the studies as the present study revealed **no statistically significant difference** in functional performance between the two groups.

NPRS of groups A was 6.560 1±47 whereas of group was 6.560 1±27. There was no difference between the two groups.

TIME UP GO TEST is most extensively used to assess functional performance and balance in elderly knee Osteoarthritis patients. In current study the mean TIME UP GOTEST of Group A was 18.48 ± 2.220 and of group B was 18.96 ± 2.79. There was no difference in the TIME UP GO TEST of both the groups with a p value of 0.627. The study done Elboim-Gabyzon et al.in 2012 that Diabetes mellitus contributes to peripheral neuropathy and muscle weakness, which may impair balance and gait [8]. This finding is similar to other study by Debi R, Mor A they found that diabetic patients have increased time of TIME UP GO TEST test results showed a slight increase in time for diabetic patients compared to non-diabetic patients [10]. Debi et al. 2012 also found that metabolic factors in Diabetes mellitus could lead to altered biomechanics, further worsening mobility in Osteoarthritis patients. The result of the previous studies are contrary to finding of the present study.

These findings suggest that the presence of diabetes may not necessarily worsen self-reported symptoms or physical mobility in individuals with Knee Osteoarthritis,

First, it is possible that the diabetes in the sample was relatively well-controlled, thereby minimizing its potential impact on physical performance. Poor glycemic control and long-term complications such as peripheral neuropathy, muscle weakness, and reduced proprioception are known to influence mobility and joint health. In the present majority of patients were on oral medication, no patients were of uncontrolled Diabetes mellitus this can influence the performance.

Second, both groups in this study may have had comparable levels of physical inactivity, joint degeneration, or pain coping strategies, leading to similar WOMAC and TIME UP GO TEST scores regardless of diabetic status. It is also worth considering that other factors such as BMI, age, and overall physical function may have had a stronger influence on functional outcomes than diabetes alone, potentially overshadowing any isolated effect of the condition.

The findings of this study are in contrast with some previous reports that have demonstrated poorer functional outcomes in Knee Osteoarthritis

patients with comorbid diabetes. However, other studies have also failed to find significant differences, suggesting that the relationship between diabetes and functional performance in Osteoarthritis may be more complex and influenced by multiple interacting variables.

Limitation

The sample size was smaller. Diabetes-related variables such as duration of disease, glycaemic control, and presence of complications were not assessed. Other confounding factors like physical activity levels, medication use, and psychosocial factors were not controlled.

Conclusion

The present study concludes that though the NPRS and functional limitation is greater in Knee Osteoarthritispatients with Diabetes Mellituswhen compared to patient with Knee Osteoarthritis patients without Diabetes Mellitus but the difference is not statistically significant.

Ethical Clearence: Ethical committee (institutional ethics committee college of physiotherapy Ahilyanagar) approval was obtained on 21/10/2024 (Reference no:625). Written informed consent was obtained from all participants prior to data collection

Conflicts of Interest: There was no conflict of interest reported among all authors of this clinical research.

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Original Article

Physiotherapist's Sex Preferences Among Patients: Findings from A Cross-Sectional Survey

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Abstract

This cross-sectional study explored patient preferences regarding physiotherapist gender across age groups and sexes to develop a framework for gender-specific physiotherapy. Data were collected through an online questionnaire via Google Forms in June-July 2023 on a university campus. Of 450 questionnaires distributed, 413 were returned and analyzed. Results indicated gender preferences were not significantly associated with age, marital status, or income ($p = 0.56$). However, a notable preference was observed among female patients, with 58.1% favouring female physiotherapists. Male patients showed a balanced preference: 28.4% preferred male physiotherapists, while 23.9% preferred female ones ($p < 0.001$). Educational level significantly influenced gender preferences ($p = 0.022$), with less educated patients preferring female physiotherapists. This research highlights the importance of considering patient preferences in physiotherapy settings to enhance treatment outcomes. Incorporating gender-sensitive methodologies may lead to more effective and personalized physiotherapy care.

Keywords: Physiotherapy, Gender, Patient preferences, India, Healthcare utilization

Introduction

Physiotherapy is a diverse field of study that employs a variety of methods to restore, conserve and enhance body functions. It is also defined by a holistic idea, in which various connections between the physical body, the environment, and the individual experiences are acknowledged. The profession is dedicated to evidence-based practice, which combines clinical skills with the best evidence and patient values to serve good quality[1]. Remarkable progress has been made in the field of physiotherapy, which is a highly sophisticated Allied practice[1]. The latest annual membership census in India in 2022 revealed that approximately 80,000 physiotherapists are practicing in the country, with approximately

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70% being female and 30% being male[2]. The impact of physiotherapist sex on patient satisfaction is a complex matter that has been the subject of various studies, some of which have produced conflicting results. While some research indicates that the sex of the physiotherapist may affect patient satisfaction, male patients report higher levels of satisfaction in certain areas of care than female patients[3]. Nonetheless, previous research has indicated that the satisfaction rates may be higher among female patients especially when these patients are treated by female physiotherapists. This observation indicates that the perceived satisfaction potentially depends on the concordance between gender between patients and providers[4]. It is notable that there is a degree to which the sex of the physiotherapist would make a difference in the satisfaction of the patient and this depends on the context. In Japan, the female patients portray more satisfaction when the physiotherapists are female and the male patient has no definite preferences regarding the sex of their physiotherapists[5]. In the meantime, physiotherapy, an Australian emergency department, the liking of the patients towards the physiotherapy did not rely on the sex of the physiotherapists but rather the quality of the care and interpersonal skills of the physiotherapist[6]. On the other hand, in Australian emergency ward, patient satisfaction on physiotherapy had no direct relationship with the gender of the physiotherapist, only with the quality of the care and the bedside manner of the care provider (physiotherapist)[7]. This study aimed to investigate patient preferences regarding the sex of physiotherapists in various age groups and sexes to establish a framework for practice with sex-specific physiotherapy. Additionally, this study aimed to raise awareness of sex preferences among patients and inspire new considerations for future research.

Method

Survey Design and Location

This cross-sectional study was conducted using Google Forms at our university campus between June and July 2023. Questionnaires on patients' preferences for gender physiotherapy were distributed using WhatsApp and Gmail to collect data. The questionnaire was carefully designed to prioritize the anonymity of the participants and ensure that their answers were only for research purposes. First, they were interviewed on whether they were willing to take part. The latter questions in the questionnaires became available only when there was a choice of Yes. This method promoted free participation. This study was guided by questionnaire, which was informed by the tool that was already developed by Dagostini et al. It was specifically tailored to examine patient preferences regarding sex. Seven of the 11 items included in this research questionnaire were taken from the study by Dagostini et al[8]. Permission to use this questionnaire was obtained via email, with minor modifications made to adapt it to the specific context of the present research and the Institutional Human Ethics Committee approved this study. (DRC/PT/84/23, dated May 21, 2023).

Population Studied

The study participants were selected through convenience sampling on online platforms. Individuals with experience or knowledge of physical therapy were recruited, although they were not necessarily recipients of these services. To be eligible for the study, the participants met three criteria. First, they were required to be at least 18 years old and capable of comprehending communication. Second, they were required to know about physical therapy and its purpose. Finally, participants were required to provide informed consent by affirmatively responding to the initial section of the questionnaire.

Questionnaire Design

The questionnaire used in this study comprised two sections: demographic details and preference-related information. The demographic section, which consisted of six items, asked for basic participant information such as name, age, sex, marital status, level of education, and monthly income, expressed as the Indian minimum wage per month. In contrast, the preference-related section contained two

items that focused on the participants' preferences regarding physical therapy. The first item asked participants to indicate their gender preference for a physical therapist, whereas the second item asked for explanations of their stated preferences. This structured approach enabled a comprehensive examination of demographic characteristics, thus providing insights into patients' perspectives on physical therapy. Sample size calculation

The sample size was determined using the Raosoft calculator, which is commonly used to calculate sample sizes in studies. The Q questionnaire population was approximately 20,800, with a desired margin of error of 5% and a confidence level of 95%. The recommended sample size was 378 participants. The sample size was sufficient to provide reliable and statistically significant results for examining patients' sex preferences for physical therapy at the selected site.

Statistical Analysis

All statistical analyses were performed using STATA 16 software. Descriptive statistics were calculated for demographic characteristics, including age, sex, marital status, level of education, and monthly income. The preference for the physiotherapist's sex was stratified according to the above characteristics, and a chi-square test was used to compare the differences in responses between the different groups. Sex and marital status categories accounted for less than 5% of the data, and Fisher's exact test was used for statistical assessment. Statistical significance was determined using a threshold of $p \leq 0.05$, and a 95% confidence interval was applied. The questionnaire responses were expressed as frequencies.

Results

Of the 450 distributed questionnaires, 432 were received. Of these, 419 completed the questionnaire. After eliminating errors, 413 complete responses were deemed suitable for the analysis (Figure 1). Comprehensive demographic information of the participants is presented in Table 1. A total of 65.85% were under the age of 25, 22.27% were between the ages of 25 and 50, and 11.86% were over the age of 50. The sex distribution revealed a predominance of females, which constituted 62.46% of the sample, whereas males comprised 37.53% of the sample. Regarding marital status, 0.7% of the participants were widowed, 28.81% were married, and 70.46% were single. With respect to educational attainment, most participants (53.22%) obtained a degree, whereas a substantial percentage (39.95%) had not completed their graduation. According to the data on monthly income, most of the cohort (64.64%) earned less than 20,000 INR. The preferences of physiotherapists across the different demographic characteristics are shown in Table 2. There were notable variations according to sex, with female participants favouring female physiotherapists 58.1% of the time and male participants displaying a more evenly distributed preference between female (23.9%) and male (28.4%) physiotherapists ($\chi^2 = 98.27$, $p < 0.001$). Age ($\chi^2 = 7.22$, $p = 0.12$), marital status ($\chi^2 = 3.37$, $p = 0.49$), and monthly income ($\chi^2 = 4.81$, $p = 0.56$) did not substantially affect preferences. The preference for female physiotherapists was greater among those with less than a high school education (60%) and a high school degree (70.8%) than among those with incomplete or complete graduation (37%) and 48.4%, respectively ($\chi^2 = 14.28$, $p = 0.022$). However, education level had a significant effect. No statistically significant differences were found in the preference for sex of physiotherapists according to age ($p=0.12$), marital status ($p=0.36$), or monthly income ($p=0.56$) (Table 2). The present study revealed a statistically significant preference for the sex of the physiotherapist ($p<0.001$) (Table 2). Among the female participants, 58.1% preferred female physiotherapists, and 0.8% preferred male physiotherapists. Among the male participants, 23.9% preferred female physiotherapists and 28.4% preferred male physiotherapists. Similarly, the present study revealed a statistically significant preference for physiotherapy sex according to educational level ($P =0.022$) (Table 2). Alternatively, 48.4% of complete and 37% of incomplete graduate patients preferred female physiotherapists. Moreover, 70.8% of high school patients and 60% of patients with less than a high school education preferred female physiotherapists.

Table 1. Detailed demographic data of the participants

Variable	Frequency
Age	<25 years of age – 272 (65.85%) 25-50 years of age – 92 (22.27%) >50 years of age – 49 (11.86%)
Gender	Male – 155 (37.53%) Female – 258 (62.46%)
Marital status	Single – 291 (70.46%) Married – 119 (28.81%) Widowed – 3 (0.7%)
Education level	Below high school – 5 (1.21%) High school – 24 (5.81%) Incomplete graduation - 165 (39.95%) Complete degree - 219 (53.02%)
Monthly Income	<20,000 INR - 267 (64.64%) 20,000-40,000 INR - 52 (12.59%) 40,000-60,000 INR - 34 (8.23%) >60,000 INR - 60 (14.52%)

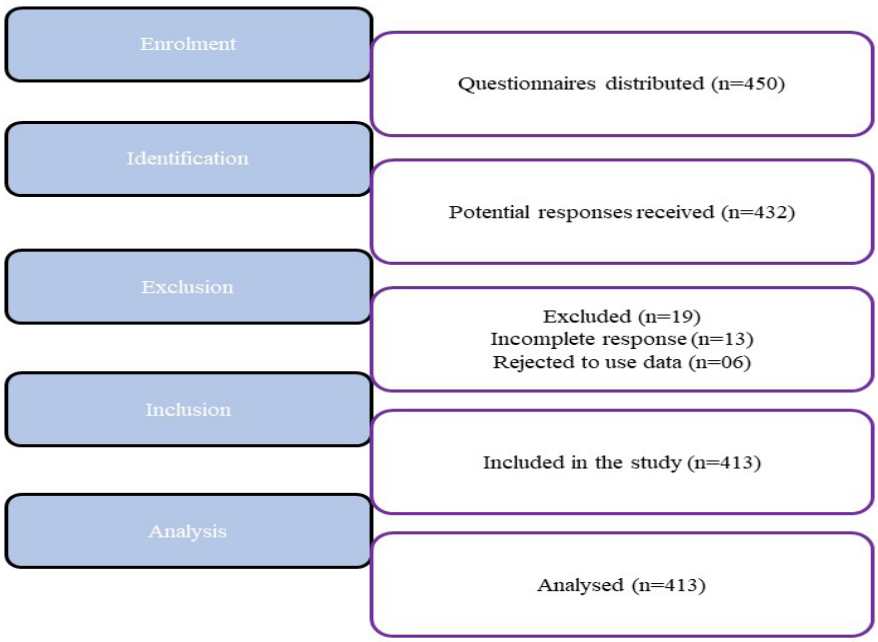


Figure 1: Flowchart of sampling.

Table 2. Preference for physiotherapists' sex according to age category, sex, marital status, level of education, and monthly income.

Variables	Participants' preference			χ^2 value/ Fisher's exact test	p value
	Female Physiotherapist	Male physiotherapist	No preference		
Age					
<25 years (n=272)	118 (43.4%)	29 (10.7%)	125 (46%)	7.22	0.12
25-50 years (n=92)	48 (52.2%)	37 (40.2%)	7 (7.6%)		
>50 years (n=49)	21 (42.9%)	10 (20.4%)	18 (36.7%)		
Gender					
Female (n=258)	150 (58.1%)	2 (0.8%)	106 (41.1%)	98.27	**<0.001***
Male (n=155)	37 (23.9%)	44 (28.4%)	74 (47.7%)		
Marital status					
Single (n=291)	127 (43.6%)	33 (11.3%)	131 (45%)	3.37	0.49
Married (n=119)	57 (47.9%)	13 (10.9%)	49 (41.2%)		
Widowed (n=3)	3 (100%)	0 (0%)	0 (0%)		
Level of Education					
Below high school (n = 5).	3 (60%)	1 (20%)	1 (20%)	14.28	**0.022***
High school (n = 24)	17 (70.8%)	2 (8.3%)	5 (20.8%)		
Incomplete Graduate (n=165)	61 (37%)	17 (10.3%)	87 (52.7%)		
Complete Graduate (n=219)	106 (48.4%)	26 (11.9%)	87 (39.7%)		
Monthly Income					
<20,000 INR (n=267)	119 (44.6%)	29 (10.9%)	119 (44.6%)	4.81	0.56
20,000-40,000 INR (n=52)	26 (50%)	5 (9.6%)	21 (40.4%)		
40,000-60,000 INR (n=34)	19 (55.9%)	2 (5.9%)	13 (38.2%)		
>60,000 INR (n=60)	23 (38.3%)	10 (16.7%)	27 (45%)		

χ^2 value: Chi-square value; [a]: Fisher's exact test; * statistically significant.

Discussion

We discovered a highly statistically significant inclination towards the preference of physiotherapists based on the patient's sex (p<0.001). A substantial majority of females (58.1%) expressed a clear preference for female physiotherapists, whereas males demonstrated a more diversified preference, with 23.9% females (n=258) and 28.4% males (n=155). Moreover, we observed noticeable variances in preferences based on educational level (p=0.022). Notably, participants with lower educational attainment (below high school and high school) were more inclined towards female physiotherapists than were those with higher educational achievement (incomplete graduates and complete graduates). Though, no serious difference was detected in the preferences on physiotherapists across the various categories of age groups (p=0.12), the younger participants tended to show

stronger preferences on female physiotherapists (<25 years: 43.4%; 25--50 years: 52.2%; >50 years: 42.9%). More than that, no significant differences in preferences were observed according to marital status (p=0.49). Nevertheless, it was found that the stronger preference on female physiotherapists is in the case of single participants (43.6%) compared to married participants (47.9%). It is important to mention that no meaningful difference was observed among preferences according to the monthly income (p=0.56). Nonetheless, one seems to observe the tendency of preference to female physiotherapists being higher among the participants with lower income levels.

A recent study indicated that Croatian patients' attitudes towards physiotherapists and self-referrals to physiotherapy were not influenced by sex[9]. On the other hand, (Jahan et al., 2021)[10] reasoned out that sex is also linked to the satisfaction with the physiotherapy services provided in Libya with female and unemployed patients showing a higher satisfaction level[11]. Nevertheless, this relationship has nothing to do with the attraction to the gender of a physiotherapist but reflects the fact that people are more likely to get satisfaction mainly due to their age, gender, or generation. Interestingly, while these studies have focused on physiotherapy, research in other medical fields within the context of sex preference has shown varying results. For example, Varia et al. (2014) reported that Hispanic women had a stronger gender preference for endoscopists than men, whereas Kamani et al. (2021) reported a significant gender preference among Muslim patients for same-gender endoscopists (Kamani et al., 2021) [12,13].

These results indicate that gender preference can be stronger in selected cultural or religious set-ups or the kind of medicine. Recent research findings have been offered on the gender preferences of patients to health care providers and this can possibly be taken as indirect evidenceSchneider et al. (2009).It stated that low level of income was a main determinant of sex preference amongst endoscopists[14]. Even though it is not specifically connected to physiotherapists, gender preferences when choosing a care provider may be driven by financial capabilities. Interestingly, although central to gender preference when choosing physiotherapist, the financial status is not directly associated with gender. As pointed out by OHman and Hagg (1998) gender has been an issue in the profession that depicts the varying attitudes of male and female physiotherapists[14]. This may also have an indirect influence on patient preference in case these attitudes are manifested in practices that are received differently by patients depending on their socioeconomic background. Öhman and Hägg (1998) stated that the literature reported gives a legal and delicate perception concerning preferences of male patient concerning sex of caregivers such as physiotherapists[14]. When it came to mental health care, it was particularly found that a large percentage of men made no mention of preference with regards to the gender of their therapists. Nevertheless, some of the participants wanted gender orientation with some demographic variables or psychological requirements (Seidler et al., 2022) [15]. Likewise, the study in urology also showed that patients who are male consider male doctors, especially, in more invasive procedures, and religious identification is a very good predictor of this preference (Shimonov et al., 2016)[16].

Gender issues in the physiotherapist profession are however visible in the province of Quebec, where, even though representing a minority the male physiotherapist is more engaged into leadership positions (Öhman and Hägg, 1998) or even in the historical study of the emergence of physiotherapy profession (Linker, 2005) [14,17]. Nevertheless, gender relations in the physiotherapy career can be found in the province of Quebec, where though the male physiotherapists form a minority, they are more engaged in the leadership roles (Gagnon et al. 2022)[18]. This implies that patient preference of gender of physiotherapists is not necessarily discussed but gender can be a factor in professional relationships within the field and sex of physiotherapists can determine the issues experienced by patients in one way or another as most studies have displayed in the literature collected. It was identified that female physiotherapists are more confident in

dealing with patients with chronic pain and mood/ anxiety disorder and acknowledged the necessity of training in the detection of affective disorder (Chiesa et al., 2024)[19]. Also, the agreement of patient and physiotherapist in pain rating, which is subjected to sex dynamics has been linked to improved short-term patient outcomes in patients with low back pain(Dionne and Perreault, 2006)[20].

Moreover, patients would favour physio-therapists according to gender in such a manner that women would favour women practitioners (Lewith et al., 2012). In as much as sex can contribute to the preferences and perceptions of the patients, it does not have a straight correlation to the outcome of treatment and patient satisfaction[21]. To take one more example, patients affected by knee osteoarthritis expressed satisfaction with physiotherapists, irrespective of their sex, during the course of care provided; however, they wanted additional information related to specific education and to management in the long term (Lewith et al., 2012)[21]. In addition, some sex disparities among the physiotherapists, namely discrimination and work stress, may indirectly influence the patient care due to the possibility of developing burnout among young female physiotherapists (Lewith et al., 2012)[21].

Strengths

This research revealed several notable characteristics, notably, a comprehensive investigation of patient preferences for the sex of physiotherapists across various demographic factors. The methodological approach, involving a meticulously designed survey administered through Google Forms and a substantial sample size in conjunction with statistical analysis via SPSS, enhances the validity and trustworthiness of the study's results. Moreover, this study addressed a glaring gap in the literature regarding patient preferences in healthcare settings, providing invaluable insights that can enrich future inquiries and clinical practice in physiotherapy. These findings are noteworthy and offer new perspectives in the Indian context, as scarce resources are available.

Limitations

This study, however, was limited in a number of ways. Our study was carried out in only one university in the state of Uttar Pradesh in India, which could have restricted the possibility of generalizing our findings to a larger sample or area. The sample was mostly represented by younger people, females, and single individuals, which may have introduced sampling bias and prevented the adequacy of the findings. The study also resorted to convenience sampling techniques including distribution to the study participants through WhatsApp and Gmail among others, which might have led to self-selection bias. Besides, the cross-sectional study method and absence of the longitudinal correlations do not allow arriving at a conclusion about the causality and the possibility to observe the preference shifting as time goes. Last, there is the issue of possible social desirability bias which could have affected the responses given by the participants, especially in matters which are sensitive like gender preferences, hence could have been a contributory factor in determining whether the results could be accurate or not.

Conclusion and Future Prospective

This study investigated the substantial preference of patients regarding the sex of physiotherapists, particularly in India. The results indicated a strong inclination toward female physiotherapists, particularly female patients. This preference appears to be influenced by several demographic factors, including gender and educational level. Although age and marital status demonstrated less pronounced effects on preference, noticeable trends suggested a greater preference for female physiotherapists among younger and single individuals. These findings have important implications for physiotherapy practice and highlight the importance of considering patient preferences to enhance the appropriateness and effectiveness of treatment. Nonetheless, the limitations and weaknesses of the study such as single-site, nature of the sample, and possible biases require the generalization of the research findings. Future studies must be geared towards use of a

wider representation and longitudinal design to further examine the dynamics of the sex preferences of patients to the physiotherapists and its implication in clinical practice.

Taking into consideration the rich diversity of the Indian culture, it is important to educate training modules that lay more focus on the cultural sensitivity of the physiotherapists. In this way, physiotherapists will be able to appreciate and accommodate the cultural beliefs and practices of the patients hence patient centred care and better treatment results. By implementing the use of sex-specific physiotherapy programs which may be adapted to the preferences and needs of both male and female patients, one may enhance the patient satisfaction and interest in the therapy process. By constantly providing physiotherapists with opportunities to learn and practice gender sensitivity and relevant implications on patient care, it would be possible to bring a sense of inclusiveness into a patient-centred healthcare facility, thereby enhancing patient outcomes. Ensuring the comprehensive and holistic care of the patients, particularly those with complex health needs, can be achieved by the implementation of the collaborative care models including the involvement of multidisciplinary teams, such as physiotherapists, doctors, nurses, and social workers to provide this care to the patients. What is more, initiating patient advocacy programs and enable patients to provide their preferences and concerns surrounding the delivery of physiotherapy services can create a culture of patient involvement and mutual decision-making in healthcare delivery, which will enhance patient outcomes.

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Original Article

Bridging the Gap: Awareness and Perceptions of Physiotherapy Among Healthcare Professionals

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Abstract

Introduction: In India, physiotherapy plays a vital role in rehabilitation but remains under-recognized compared to other healthcare professions. Despite its increasing relevance, limited awareness among healthcare professionals continues to restrict its effective integration into the healthcare system. This often results in delayed referrals, underutilization of services and gaps in patient care. Therefore, this study aimed to assess healthcare professionals' knowledge and attitudes toward physiotherapy to support more collaborative and timely patient management.

Material and Methods: A cross-sectional study was conducted from May to June 2025 involving 82 healthcare professionals from various medical and allied disciplines, each with at least one year of professional experience. Physiotherapists, physiotherapy students, undergraduate students and administrative personnel without clinical roles were excluded. Data were collected using a self-designed questionnaire via Google Forms to assess awareness and knowledge of physiotherapy. Data analysis was done using SPSS (version 18) and Microsoft Excel 2010.

Result: The study revealed that while 100% of participants were aware of Physiotherapy, while 84.1% knew about the Master's program in physiotherapy, awareness of the Ph.D. (54.9%) and Doctorate (37.8%) was lower. Specialties like Orthopaedics (79.3%), Neurology (67.1%), and Sports Physiotherapy (65.9%) were better known compared to Preventive Medicine (20.7%) and Veterinary Physiotherapy (17.1%). Familiarity with advanced techniques was limited; only 15.9% were aware of PNF, 42.7% of NDT and 30.5% of virtual rehabilitation. Most participants considered physiotherapy to be effective (93.9%) and supported the establishment of physiotherapy centers in hospitals (97.6%).

Conclusion: This study revealed that while awareness of physiotherapy exists among healthcare professionals, detailed understanding especially of advanced techniques and specializations remains limited. A notable proportion were unfamiliar with modern physiotherapy approaches and postgraduate programs. Despite this, most acknowledged its effectiveness and supported its integration in healthcare. These findings highlight the need for structured educational programs to foster interdisciplinary collaboration and improve patient care.

Keywords: Awareness, Healthcare Professionals, Physiotherapy

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Introduction

In India, the delivery of healthcare services involves a wide spectrum of public and private providers, including solo practitioners, specialists and large corporate hospitals that offer advanced super-specialty tertiary care.[1] Healthcare professionals are integral to the functioning of modern healthcare systems. According to the World Health Organization they offer vital services aimed at enhancing health, preventing disease and delivering medical care to individuals, families and communities.[2]

Physiotherapy, as an essential component of healthcare, plays a critical role in the prevention, treatment, and rehabilitation of various health conditions.[3] It refers to the services provided by physical therapists to individuals and populations aimed at developing, maintaining, and restoring optimal movement and functional ability over the course of their lives.[4] Physical therapy, also referred to as physiotherapy and commonly abbreviated as PT, is both a science and an art focused on physical care and rehabilitation. Physiotherapists function both as independent practitioners and as integral members of healthcare teams. Guided by the ethical principles of the World Confederation for Physical Therapy (WCPT), they are qualified to serve as first-contact practitioners, allowing patients to access their services directly without needing a referral from another healthcare professional. [5]

It is recognized as an essential component in the rehabilitation process for individuals affected by severe conditions resulting from injury or illness. Physical therapy, as a professional discipline, encompasses a wide range of specialties, such as sports rehabilitation, neurology, wound management, cardiopulmonary care, geriatrics, orthopaedics and paediatrics. Among these, neurological rehabilitation is notably one of the fastest-growing areas within the field. [6] Moreover, the field also faces several challenges, including limited direct access and autonomy, professional dominance by other healthcare providers, inadequate documentation and use of electronic health records, insufficient evidence-based practice, financial and structural disparities in service delivery and workplace-related constraints such as lack of resources and manpower. [7]

In developed nations such as the United Kingdom and Australia, it is common for physiotherapists to act as the first point of contact for patients.[8] In contrast, within the healthcare systems of developing countries, physiotherapy is still emerging and remains less established compared to other medical professions.[9] In these settings, physiotherapy is typically practiced based on referrals from physicians across various medical specialties.[10] Although the profession is gradually gaining recognition, effective collaboration between physiotherapists and other healthcare professionals is essential. Awareness of physiotherapy among physicians and other medical doctors can lead to timely referrals, facilitating effective management and making the rehabilitation process less burdensome for patients.[11]

While physiotherapy plays a crucial role in multidisciplinary healthcare, limited studies have specifically assessed the level of awareness and understanding of physiotherapy among healthcare professionals, particularly in regions with developing healthcare systems. The lack of current, localized data on how other medical professionals perceive the scope and importance of physiotherapy creates a gap in fostering effective interprofessional collaboration and patient referrals. Therefore, the aim of this study was to assess the level of awareness and understanding of physiotherapy among Healthcare professionals.

Material and Methods

A cross-sectional study was conducted from May to June 2025, involving a total of 82 participants recruited from Guru Gobind Singh Medical College and Hospital and University College of Nursing, Faridkot. The participants included healthcare professionals who had completed their professional degrees in various disciplines such as MBBS (Bachelor of Medicine and Bachelor of Surgery), MD (Doctor of Medicine), Nursing, BHMS (Bachelor of Homoeopathic Medicine and Surgery), BAMS (Bachelor of Ayurveda, Medicine and Surgery), MASLP (Master of Audiology and Speech-Language

Pathology), BMLT (Bachelor of Medical Laboratory Technology), Pharmacy, M.Sc. (Master of Science), and Ph.D. (Doctor of Philosophy). All participants were either actively practicing in clinical or academic settings and had a minimum of one year of professional experience.

Participants were excluded if they were undergraduate students who had not yet completed their degrees, physiotherapists or physiotherapy students, or administrative personnel working in the healthcare field without any direct contact with patients or influence in the management of patient treatment.

All selected participants were informed about the nature and purpose of the study and informed consent was obtained prior to their participation. Data was collected using a self-designed questionnaire developed via Google Forms, which aimed to assess the participants' knowledge and awareness regarding physiotherapy, including its scope, effectiveness, commonly used modalities and the role of physiotherapists in the healthcare system. Content and face validity of the questionnaire were reviewed by a panel of experts (n=3) in physiotherapy and public health. A pilot study was conducted on 10 participants to assess clarity and feasibility of the questionnaire. Cronbach's alpha for internal consistency was calculated and found to be 0.81, indicating acceptable reliability. The questionnaire was distributed to participants through email, allowing them to voluntarily complete and submit their responses.

Results

The collected data was analysed using descriptive statistics, with frequencies and percentages presented in a simplified tabular format.

A total of 82 participants were included in the study consisting of 49 females (59.8%) and 33 males (40.2%). The majority of participants 49 (60%) belonged to the 25–35 years age group. Most participants were from MD program 27 (33%) and a significant proportion had up to 10 years of professional experience 57 (69.5%), as presented in Table 1.

Table No.1. Distribution of socio-demographic factors of participants under study

Variables	Options	N=82	%
Age group (in year)	25-35	49	60%
	36-45	23	28%
	46-55	5	6%
	56-65	5	6%
Gender	Male	33	40.2%
	Female	49	59.8%
Academic course	Nursing	18	22%
	MBBS	13	15.9%
	MD	27	33%
	MASLP	8	9.9%
	Ph.D	5	6%
	BMLT	1	1.2%
	BHMS	1	1.2%
	BAMS	2	2.4%
	Pharmacy	2	2.4%
	Msc	5	6%
Year of service	1-10 years	57	69%
	11-20 years	22	27%
	21-30 years	3	4%

All participants (100%) were familiar with the term physiotherapy, with graduate-level education being the main source of awareness (53.7%). While 84.1% knew about the Master of Physiotherapy (MPT), fewer were aware of the Doctorate in Physiotherapy and Fellowship programs (both 37.8%). Commonly recognized specialties included Orthopaedics (79.3%), Neurology (67.1%) and sports Physiotherapy (65.9%), while less familiar areas were Manual Therapy (24.4%), Preventive Medicine (20.7%) and Veterinary Physical Therapy (17.1%).

Participants were more aware of modalities such as Muscle Stimulators (65.9%), Ultrasound Therapy (64.6%) and Exercise Therapy, including the Positional Release Technique (57.3%), whereas knowledge of Biofeedback, Intermittent Pneumatic Compression (18.3%) and Brunnstrom's Approach (6.1%) was limited. Most participants (64.6%) understood that physiotherapy and occupational therapy are distinct and 89% reported using standardized assessment

protocols. Belief in physiotherapy's effectiveness was high (93.9%), with 97.6% supporting dedicated physiotherapy centers in hospitals.

Additionally, 62.2% viewed physiotherapy as vital inpatient care, 72% recognized its use as a first-line treatment in developed countries and 84.1% acknowledged the need for family-centered services. Only 59.8% considered physiotherapy services affordable. However, misconceptions persisted—many believed its scope was mainly limited to neurorehabilitation (79.3%) and orthopaedic rehabilitation (86.6%), with low awareness of its roles in women's health and burn rehabilitation (both 37.8%). Notably, 50% of those with limited knowledge expressed interest in learning more, highlighting the need for further educational efforts. (shown in table 2)

Table No. 2. Frequency distribution of the items included in the questionnaire

Question	Sub question	N (%)
Awareness about physiotherapy		82(100%)
Know about physiotherapy	During Graduation	44(53.6%)
	Through hospital/ medical centres	29(35.4%)
	Mass media	1(1.2%)
	Colleagues	4(4.9%)
	Word of mouth	4(4.9%)
Physical therapy specialisation	Orthopedics	65(79.3%)
	Neurology	55(67.1%)
	Cardio respiratory	38(46.3%)
	Pediatrics	44(53.7%)
	Hand rehabilitation	26(31.7%)
	Sports	54(65.9%)
	Preventive medicine	17(20.7%)
	Women health	24(29.3%)
	Geriatrics	37(45.1%)
	Manual therapy	20(24.4%)
	Community based rehabilitation	26(31.7%)
	Veterinary physical therapy	14(17.1%)
Are you aware of?	Master of physiotherapy	69(84.1%)
	Ph.D Of physiotherapy	45(54.9%)
	Doctorate of physiotherapy	31(37.8%)
	Fellowship in physiotherapy	29(35.4%)

Continue....

Level of awareness of modality		
	Shock wave therapy	44(53.7%)
	Ultrasound	53(64.6%)
	Infrared radiation	41(50%)
	Ultraviolet radiation	30(36.6%)
	Muscle stimulator	54(65.9%)
	Laser therapy	37(45.1%)
	Short wave diathermy	28(34.1%)
	Interferential therapy	17(20.7%)
	Electromyography	40(48.8%)
	Bio feedback	15(18.3%)
	Intermittent pneumatic compression	15(18.3%)
Level of awareness of exercise therapy		
	Maitland mobilization	12(14.6%)
	Mulligan mobilization	10(12.2%)
	Rood's approach	12(14.6%)
	Muscle energy techniques	40(48.8%)
	Positional release technique	47(57.3%)
	Buttle mobilization	17(20.7%)
	Neurodevelopmental approach	35(42.7%)
	Craniosacral therapy	20(24.4%)
	Frenkel exercise	20(24.4%)
	Proprioceptive neuromuscular facilitation	13(15.9%)
	Brunnstrom's approach	5(6.1%)
	Virtual rehabilitation	25(30.5%)
Job of physiotherapist		
	Manage neuro rehabilitation	65(79.3%)
	Manage pre/post operative ortho rehabilitation	71(86.6%)
	Manage ICU patient	41(50%)
	Prescribe orthosis and prosthesis	41(50%)
	Manages patient with burns	31(37.8%)
	Gives on field treatment for sports injuries	60(73.2%)

Continue....

Role of physiotherapy in health sector	Very important	51(62.2%)
	Important	29(35.4%)
	Not important	2(2.4%)
	Don't know	0
Physical therapy and occupational therapy are same	Yes	8(9.8%)
	No	53(64.6%)
	Don't know	21(25.6%)
Physical therapy is effective option		
	Yes	77(93.9%)
	No	2(2.4%)
	Don't know	3(3.7%)
Therapist follow assessment protocol		
	Yes	73(89%)
	No	9(11%)
Therapy services are expensive		
	Yes	33(40.2%)
	No	49(59.8%)
Need for physiotherapy centres in hospitals		
	Yes	80(97.6%)
	No	2(2.4%)
Need for family physiotherapist		
	Yes	69(84.1%)
	No	13(15.9%)
First line treatment in developed countries		
	Yes	59(72%)
	No	23(28%)
Interested knowing more about PT		
	Lecture	41(50%)
	CME	18(22%)
	Online	23(28%)

Discussion

The purpose of this study was to evaluate the level of awareness regarding physiotherapy among healthcare professionals. Analysis of the data revealed that all 82 participants were familiar with the term "Physiotherapy," aligning with the results reported by Agni and Battin (2017).[1] Additionally, 53.7% of the respondents reported that they became aware with the field of physiotherapy during their undergraduate education.

The study further revealed that participants were more familiar with specific branches of physiotherapy, particularly Orthopaedic, Neurological and sports physiotherapy specialties. In contrast, there was significantly less awareness of areas such as Preventive Physiotherapy and Veterinary Physical

Therapy, which is consistent with the findings of Alkesh Shah and Champak Mahyavanshi (2022).[12]

Another study conducted by Ahad and Bhardwaj (2024)[13] assessed the beliefs and awareness of physiotherapy among healthcare professionals. The study revealed generally low levels of awareness within the broader healthcare community, highlighting the need for enhanced educational efforts. These findings align with the present study, which also observed gaps in physiotherapy awareness among Health careprofessionals.

Moreover, participants demonstrated limited understanding of certain physiotherapeutic modalities, including biofeedback and intermittent pneumatic compression.

A similar gap in knowledge was noted concerning exercise therapy, which is a core aspect of physiotherapy practice. Adequate education and training with regard to physical therapy can help improve public health utilization by enhancing the awareness. Overall, the findings indicate that healthcare professionals lack sufficient awareness and understanding of the broader scope of physiotherapy.

Limitation

A potential limitation of the present study is that it was carried out at only one Medical University which may limit the applicability of the results to other populations or educational contexts.

Conclusion

This study revealed that while awareness of physiotherapy exists among healthcare professionals, detailed understanding especially of advanced techniques and specializations remains limited. A notable proportion was unfamiliar with modern physiotherapy approaches and postgraduate programs. Despite this, most acknowledged its effectiveness and supported its integration in healthcare. These findings highlight the need to enhance awareness and understanding of the role of physiotherapy among healthcare professionals through regular seminars and educational lectures. Additionally, interactive interdepartmental workshops can be conducted in medical colleges, hospitals and clinics to further educate about the field of physiotherapy particularly to strengthen collaboration between medical professionals.

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Original Article

Evaluation of Health Related Quality of Life in Sub-acute Stroke Subjects using Stroke Impact Scale - A Descriptive Study

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Abstract

Background: Healthrelated quality of life (HRQoL) is becoming important to measure as it is an indication of an outcome after stroke. Stroke Impact scale can be used as a stroke outcome measure that aims to effectively assess the various domains important in determining HRQoL in sub-acute stroke subjects.

Aim: The purpose of this study was to assess the HRQoL in sub-acute stroke subjects using Stroke Impact Scale (SIS) version 3.0 and to estimate the impact of individual characteristics such as age, duration of stroke, co-morbidities and clinical correlates such as cognitive level, functional level and severity on HRQoL in sub-acute stroke subjects.

Materials & Methodology: A total of fifty subjects after eight to thirty days poststroke onset participated in this study. They were evaluated for eligibility using Mini Mental State Examination (MMSE) and Modified Barthel Index (MBI). After history taking, the severity of stroke was assessed using the National Institute of Health Stroke Scale (NIHSS) and the HRQoL was assessed using SIS questionnaire with eight domains: strength, hand function, mobility, physical and instrumental activities of daily living, memory and thinking, communication, emotion and social participation.

Results: There was poor HRQoL in areas of hand function, mobility, social participation and stroke recovery with the highest areas in memory and communication. SIS domains: Strength, mobility, emotion, communication, participation and recovery negatively correlated with co- morbidity whereas only memory positively correlated with MMSE.

Conclusion: The study emphasizes the impact of and the need to take demographic and personal characteristics including age, duration of stroke and co morbidities into account in the planning of post stroke rehabilitation programs. SIS is an important stroke outcome measure that can be used effectively to assess the various domains important in determining HRQoL in stroke subjects.

Keywords: Health RelatedQuality of life, Stroke Impact Scale, Sub-acute stroke, stroke specific scale.

Introduction

Stroke is the second leading cause of death and a major cause of disability worldwide after heart disease and cancer in developed countries. The aging population is contributing to an increase in stroke incidence. [1] The impact of stroke on a subject is devastating requiring major adjustment in the

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lifestyle & psychology of stroke survivors. [2] As stroke mortality rates decline, individuals are increasingly likely to live with their residual impairments which can pose a considerable impact for survivors' subsequent well-being. Therefore, the quality of life (QoL) post stroke is one of the pivotal topics to be considered beneath the functional outcome. HRQoL related to sub-acute stroke is important healthcare outcomes that have not received sufficient attention in the literature. [3]Maintaining or improving optimal QoL of stroke patients remains a challenge for health professionals in developing countries, including India.Health related quality of life (HRQoL) is important to measure as it is an indicator of therapeutic efficacy. Its measurement reflects an individual's subjective perception of his/her current function and overall health. [4] The concept of HRQoL is a multidimensional approach to quantify the patients' burden of disease which includes but is not limited to the concepts of physical, social, and emotional health.It can potentially provide researchers with a more holistic picture of stroke recovery and can assist in the evaluation of medical intervention as well as rehabilitation. [5] There has been a growing interest in tests that measure the HRQoL of post stroke subjects.The scales used to assess HRQoL should include domains commonly affected by stroke as it would be useful both to evaluate treatment efficacy in patients with different deficits and to assess the impact of various types of stroke on HRQoL.[6]Exploring the relationships of HRQoL to physical impairment and functional limitation would enable one to establish whether these 'objective' tools of assessment of stroke outcome are also relevant to subjects themselves, examine the correlation of outcomes with one another and allow one to focus on specific measures rather than the numerous measures currently used in the hope of capturing stroke outcomes. [7]

To assess HRQoL, several generic and specific HRQoL instruments have been developed. Generic HRQoL instruments like Barthel index and the modified Rankin scale fall short in assessing the entire range of symptoms that stroke patients suffer from whereas specific HRQoL instruments e.g., STREAM, Stroke Impact Scale, SF 36, Stroke-Specific Quality-of-Life (SSQoL) etc. have not demonstrated sensitivity to changes in mild stroke and do not address HRQoL dimensions such as emotion, communication and role function. [8]Consequently, these measures have limited ability to evaluate stroke outcomes over time and therefore it was decided to develop a stroke specific measure that may overcome such problems.[9] The ideal stroke scale should be valid, reliable, predictive of patient outcome and easy to administer in multiple settings by a broad range of health care practitioners.[10] In 1999, the Stroke Impact Scale (SIS) emerged as a tool to measure the important multidimensional consequences of stroke and HRQoL into one self- report questionnaire. [8] The SIS was developed by Duncan et al at the University of Kansas Medical Centre and is a more comprehensive measure of health outcome for stroke populations. It is able to capture the impact of stroke across multiple dimensions from impairment to disability and handicap.Duncan et al showed SIS to have less ceiling and floor effects and to be valid and sensitive to change compared with other commonly used measures such as the Barthel Index and Short Form-36 in stroke populations.[11] The domains of SIS are unidimensional, have good reliability and have a wide range of items that capture the difficulties that most individuals with stroke experience in physical and role functions. The composite physical domain is the most robust.[12]

Multiple factors have been associated with decrease in HRQoL which includes age, gender, physical disability, dependency in activity of daily living (ADL), depression, cognitive impairment, speech disturbances etc. [13] However, the results of various studies are inconclusive due to variability in HRQoL measurements & differences in stroke severity & symptoms.[14]Therefore, it is vital for physiotherapists to have knowledge about the specific areas affecting the HRQoL of post-stroke patients, so that those areas can be targeted for intervention or referral. This information will be helpful in developing more comprehensive interventions in conjunction with those specifically for improvement in physical function.[15]HRQoL has widely been assessed in chronic stroke population but

limited studies are done in sub-acute stage of stroke. We considered it useful to explore this sub-acute phase, as patients receive little to no rehabilitation support when discharged to the community and is beyond the sensitive time-window of recovery. So the purpose of this study was to assess the HRQoL in sub-acute stroke subjects using Stroke Impact Scale and also to estimate the impact of individual characteristics such as age, duration of stroke, co-morbidities, cognitive function (MMSE), functional level (BI), severity of stroke (NIHSS) with the SIS domains on HRQoL in stroke.

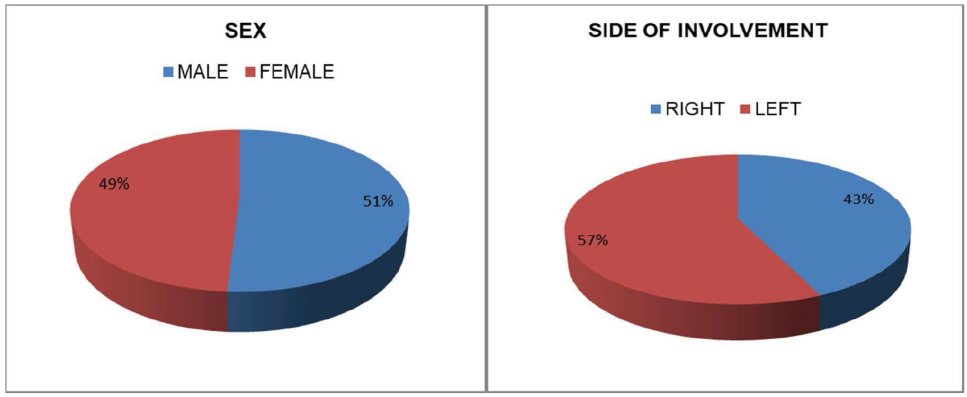
Materials & Method

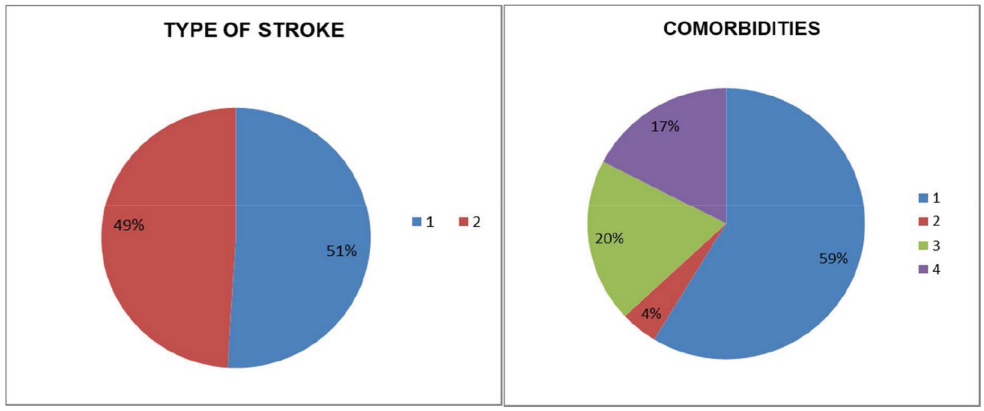
- Study design: Descriptive study.
- Sample size : 50
- Study set up: Central referral hospital & STNM Hospital, Gangtok, Sikkim
- Target population : sub-acute stroke patients
- Study duration : 6 months
- Type of sampling: Convenience sampling

The study was approved by the Institutional Ethical Committee of Sikkim Manipal Institute of Medical Sciences [SMIMS/IEC/2020-MPT1 dated 23.11.2020]. The researchers have chosen the above location to increase the study's generalizability as the population was diverse and these hospitals had high elderly populations which facilitated collaboration.Inclusion criteria were first ever stroke subjects between 8 to 30 days post stroke onset, both genders of 50- 75 years of age, MMSE ≥24 (21 for illiterate subjects) and mild to moderate dependency (Modified Barthel Index of 8-20). Exclusion criteria were aphasia, impaired ability to understand the questionnaires and significant co-morbidities likely to concurrently affect HRQoL (such as class III or IV heart failure, dialysis, pre-existing musculoskeletal disease, active psychiatric disease or dementia). An informed consent was taken from those subjects who fulfilled the eligibility criteria.Baseline characteristics were recorded for all the subjects as shown in table 1. All subjects were subjected to thorough history taking following which clinical neurological examination was performed and measured using the NIHSS.

Table 1. Demographic and clinical data among stroke subjects

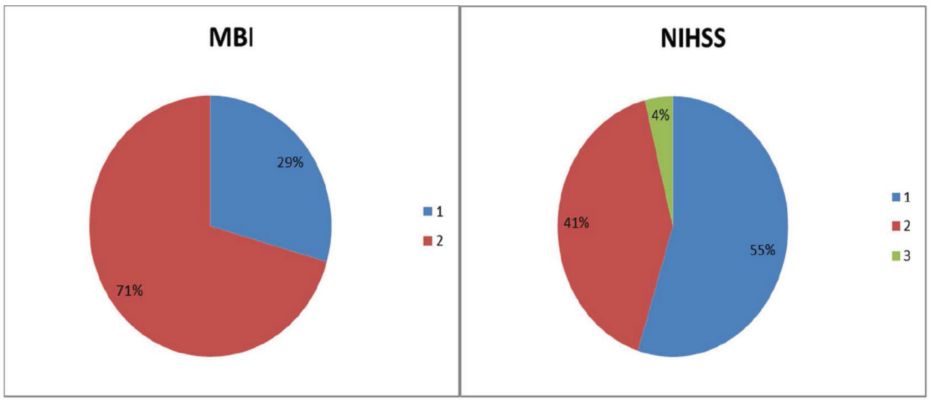
Variable		Number (n= 50)	Percentage (%)
Age (years)	Mean ± SD	60.4 ± 9.38	
Sex	Male	26	51
	Female	24	49
Comorbidities	Hypertension	26	59
	Diabetes Mellitus	2	4
	HTN + DM	9	20
	HTN/ DM + any other	8	17
Side of involvement	Right	21	43
	Left	29	57
Duration of stroke(days)	Mean ± SD	14.98 ± 6.69	
	Range	8- 30	
Type of Stroke	Ischemic	26	51
	Hemorrhagic	24	49
MBI	Mild	15	29
	Moderate	35	71
NIHSS	Mild	27	55
	Moderate	21	41
	Severe	2	4





1- Ischemic
2- Hemorrhagic

1- HTN
2- DM
3- HTN+DM
4- HTN/DM + any other



1- Mild
2- Moderate

1- Mild
2- Moderate
3- Severe

Figure 1: Pie charts for demographic and clinical data

The SIS version 3.0 that included 59 items of self-report assessment to assess HRQoL in 8 domains: strength, hand function, mobility, physical and instrumental activities of daily living (ADL's), memory and thinking, communication, emotion and social participation/ role function. Four of the domains (strength, hand function, ADL's and mobility)arecombined into an overall physical component score. The scores for each domain range from 0-100 and higher scores indicate a better HRQoL. It also includes a question to assess the subject's perceived overall recovery from stroke with 0 indicating no recovery and 100 indicating full recovery. Based on the response of the subjects, the therapist gave a score to the individual domains (self- report). After SIS was administered, the participant was asked to rate their percent recovery on a visual analog scale of 0-100. The total time for the administration of SIS was 30-45 min.

Results

The data were entered and analyzed using descriptive statistics, SPSS statistical package for social science version 16. Mean & standard deviation was calculated for all the domains of SIS. Pearson's correlation coefficient was used for correlation of age, duration of stroke, co-morbidities, cognitive function (MMSE), functional level (BI), severity of stroke (NIHSS) with the SIS domains as the subjects were normally distributed.Level of significance was considered at $p<0.05$. This study was conducted on fifty stroke subjects, 26 (51%) males and 24 (49%) females and their age ranged from 50- 75 years with a mean age of 30.4 ± 5.38 years. The demographic and clinical characteristics of the subjects are shown in table 1. Table 2 shows poorer HRQoL in areas of hand function, mobility, social participation and stroke recovery with the highest areas in memory and communication. Table 3 describes the correlation of sub scores of physical component of the SIS domains with the demographic data and clinical scales. Correlation of other domains of SIS with baseline data is shown in table 4. Strength, mobility, emotion, communication, participation and recovery domains of SIS negatively correlated with co-morbidity whereas only memory domain positively correlated with MMSE.

Table 2. Mean values, standard deviation, standard error of mean, confidence interval and percentile (25%, 75%) of SIS domains

SIS Domains	Number of items	Mean ± SD	SE	95 % of CI	Percentile	
					25%	75%
Strength	4	46.66 ±31.20	4.41	8.86	19	75
Hand Function	5	22.80 ±28.16	3.98	8.00	00	35
Mobility	9	32.96 ±28.O6	3.96	7.97	08	58
ADL'S	10	46.22 ± 17.17	2.42	4.88	32	60
Memory	9	68.92 ± 21.86	3.09	6.21	53	85
Emotional	7	50.50 ± 12.11	1.71	3.44	41	61
Communication	7	87.62 ± 13.21	1.86	3.75	82	100
Participation	8	27.98 ± 17.56	2.48	4.99	15	37
Recovery	11	39.00 ± 26.30	3.72	7.47	10	60

Table 3. Pearson's correlation of Stroke Impact Scale score measures with demographic data and clinical scale

	Strength		Hand function		Mobility		ADL's	
	R	p	r	p	r	p	R	p
Age	-0.04	0.74	0.I4	0.31	0.00	0.97	0.14	.0.30
Duration of Stroke	-0.16	0.26	0.09	0.51	-0.16	0.24	0.00	0.99
Comorbidity	-0.29	0.03	-0.21	0.13	-0.29	0.03	-0.14	0.31
MMSE	0.15	0.29	0.16	0.25	0.07	0.60	0.04	0.77
MBI	-0.07	0.59	-0.11	0.43	-0.00	0.95	0.01	0.91
NIHSS	-0.01	0.92	-0.06	0.66	-0.01	0.92	0.00	0.95

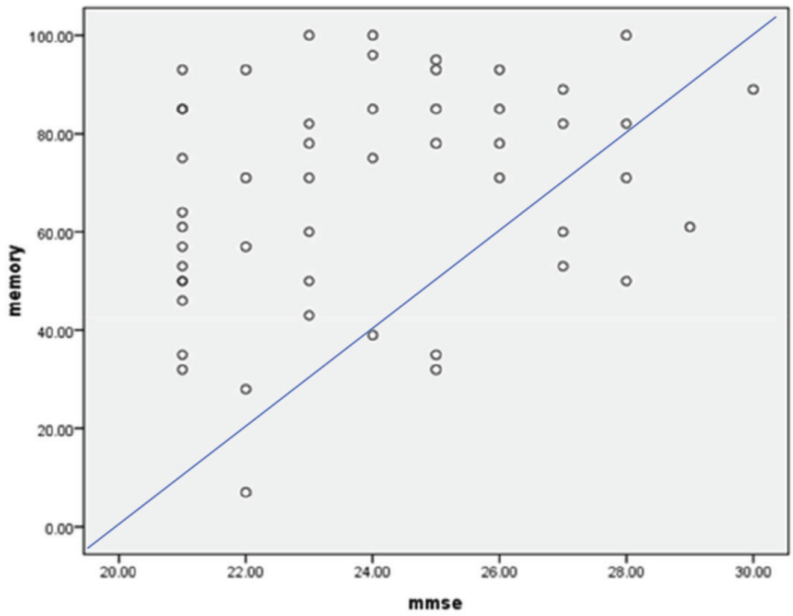


Figure 2: Positive correlation of memory domain of SIS with MMSE

Table 4. Pearson's correlation coefficients of Stroke Impact Scale score measures with demographic data and clinical scale

	Emotion		Memory		Communication		Participation		Recovery	
	r	p	r	p	r	P	r	p	r	p
Age	0.00	0.98	-0.22	0.11	0.09	0.51	-0.09	0.50	-0.11	0.41
Duration of Stroke	-0.19	0.17	-0.15	0.27	0.02	0.84	-0.12	0.38	0.02	0.88
Comorbidity	-0.37	0.00	-0.31	0.02	-0.37	0.00	-0.38	0.00	-0.13	0.35
MMSE	0.04	0.77	0.21	0.13	0.17	0.22	0.16	0.26	0.29	0.04
MBI	-0.01	0.94	-0.19	0.17	0.04	0.76	-0.04	0.75	-0.03	0.80
NIHSS	0.12	0.40	0.00	0.95	-0.08	0.55	0.10	0.46	-0.07	0.59

Discussion

HRQoL is an important index of outcome after stroke and may facilitate a broader description of stroke recovery.[8]In this study the HRQoL was assessed using the SIS version 3.0 in 50 stroke subjects with mild- moderate stroke during sub-acute recovery. Using the SIS, a comprehensive analysis investigating the impact of individual characteristics and clinical correlates on HRQoL in subjects with stroke was done. The higher scores in memory and communication in this study can be attributed to rigorous inclusion criteria including screening for cognition and aphasia. Traditionally, motor recovery is regarded to start earlier than language recovery in post stroke patients, and studies have reported that cognitive functions continue to recover after 3 months. [16] The much lower scores in hand function, mobility, participation and recovery are in agreement with Hackett et alwho found that long-term stroke survivors when compared to controls had significantly lower SF-36 scores in physical functioning, role limitations due to physical problems, general health and role limitations due to emotional problems. The above two findings are supported by Deborah et al. [13, 17]

Older patients with stroke are more prone to have major negative impact on stroke morbidity, mortality, and long-term outcomes.[18] However; Pacian et al found that there was no significant correlation between the patients' overall QoL and age.[19] In accordance with a study by Kong et al, the duration of stroke did not correlate with the SIS domains.[20] Other studies also did not observe significant correlation between the time passed since a stroke and overall QoL. [19, 21]Niemi et al also showed that post-stroke patients deteriorated over time. The different results reported in other studies can be due to sample heterogeneity.[22]

The most common co-morbidities of subjects were hypertension, diabetes mellitus and other illness such as cardiac diseases, arthritis that might be expected to impact physical function more than other HRQoL areas. The co-morbidities were negatively correlated with strength, mobility, emotion, communication, participation and recovery domains of SIS. Nichols-Larsen et alfound associations between stroke risk factors including diabetes, hypertension and ischemic heart disease and HRQoL and these associations may be due to the additive effects of the condition itself and emphasize the hypothetical potential of improving HRQoL after stroke by managing the risk factors more effectively after stroke. [8] The cognitive impairment as measured with MMSE scale positively correlated with memory domain of SIS.None of the SIS domains correlated with the functional status of subjects. On the other hand, the physical functioning domain of SIS evaluates independent ADL's which are more demanding physically. The severity of stroke measured by NIHSS did not correlate with any of the domains of SIS. William et alalso found poor associations between NIHSS and SIS-QoL domains. [23] In contrast, different studies found that a higher NIHSS score on admission was an independent predictor of impaired QoL.[24, 25, 26, 27] Our study found poor correlations between the clinical characteristics and remaining domains of the SIS.This lack of association may be attributable to the relatively high functioning of the sample and as the subjects were asked to rate their emotional domain relative to the past week onlyresulted in the poor performance in emotion domain. Also the emotion scores are expected to exhibit more short-term variability than physical scores. In examining the individual domains of the SIS, it is apparent that demographic and clinical variables have disparate impacts in sub acute mild to moderate stroke population.

Conclusion

This study highlights the importance of using the SIS as a comprehensive evaluation tool throughout the sub acute stage of recovery that may facilitate a better understanding of individual needs and thereby, planning for programming during recovery. Also understanding the different variables after stroke will not only provide an opportunity to develop therapeutic interventions but also allow for developing personalized platforms for patient stratification and prognosis. So the SIS is an important stroke outcome measure that can be used

effectively to assess the various domains important in determining HRQoL in stroke subjects.

Limitations& Future Scope

The sample size was small. The subjects were relatively high functioning for the sub-acute stroke population. Questionnaires were self-reported by the patients; therefore, the probability of misunderstanding cannot be ruled out.Future research can be conducted on long term follow-up study of at least 3 months instead of cross sectional study to obtain more detailed and comprehensive result. The study can be done in different geographic regions of the country in heterogeneous group of population.Additional assessment on depression and family functioning will also aid in better understanding of HRQoL in stroke subjects.

Conflict of Interest: None

Funding Sources: None

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Original Article

Effect of Thoracic Mobilization Exercises on Gluteus Maximus Flexibility - Pre and Post Experimental Study

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Abstract

Background and Objectives: The gluteus maximus (GM) is an essential muscle in the lower limb that plays a critical role in maintaining both static and dynamic postural stability. The thoracolumbar fascia (TLF) and GM work together to support postural stability and weight distribution. However, GM flexibility may decrease due to reduced thoracic mobility. In this study, the effects of thoracic mobilisation exercises on hip flexion range of motion (ROM), thoracic flexion ROM, gluteus maximus flexibility, chest expansion, and pain quality will be investigated.

Methods: This pre- and post-experimental study included 24 participants who met the inclusion and exclusion criteria. Baseline parameters recorded included age, gender, height, weight, BMI, hip and thoracic ROM, flexibility (measured by the Sit and Reach Test), chest expansion, and the Numeric Pain Rating Scale (NPRS). The thoracic mobilization exercises consisted of two sets of ten repetitions each, performed three times a week for four weeks.

Result: Following the intervention, the Sit and Reach Test **(p=0.001)**, hip flexion range of motion **(p=0.001)**, thoracic flexion range of motion **(p=0.006)**, NPRS **(p=0.003)**, and chest expansion **(p=0.022)** all indicated significant improvements, with a significance level of $p<0.005$. The BMI did not significantly alter ($p=1.00$) following 4-week intervention.

Conclusion: Thoracic mobilization exercises significantly improved gluteus maximus flexibility and led to a notable increase in thoracic range of motion. Thoracic Mobilization exercises can be considered as a notable choice of intervention to increase the gluteus maximus flexibility in young adult population.

Key words: Chest Expansion, Flexibility, Gluteus Maximus, Hip Flexion ROM, Thoracolumbar Fascia.

Introduction

The range of motion (ROM) that synovial joints provide determines how humans move. Muscles and joints are two anatomical features that can often restrict range of motion. One essential characteristic for lowering the chance of muscle damage,

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discomfort, and preserving regular biomechanical function is flexibility. Muscular tightness is just one of the numerous causes and factors that contribute to decreased joint range of motion. An increase in tension from either active or passive sources causes muscles to become "tight." Muscles may shorten passively as a result of scarring or postural adaptation, or dynamically as a result of contraction or spasm. Tightness restricts range of motion and can lead to a muscular imbalance, regardless of the cause [2].

For maintaining both static and dynamic postural stability, the Gluteus Maximus (GM) is one of the most important lower limb muscles. This gluteal muscle is the most superficial and is located near the back of the hip joint [7].

Recent studies have revealed that fascia is an active tissue that contributes to proprioception, nociception, joint stability, and overall movement coordination. According to its definition, fascia is "fibrous collagenous tissue, which is part of a body-wide tensional force transmission system." There is mounting proof that the skeletal muscles are morphologically continuous, connected by fascia. Numerous studies emphasise the myofascial connection between anatomically diverse tissues [3].

The Thoraco-Lumbar Fascia (TLF) which separates the paraspinal muscles from the posterior wall muscles, is the largest fascia in the body and is composed of several aponeurotic and fascial layers. The TLF connective tissue planes are inserted by many trunk and extremities muscles of various thicknesses and geometries, which can help regulate the stiffness and tension of quadratus lumborum, GM, and latissimus dorsi. This plays a major role in breathing, weight transmission, and posture [17].

The GM may become less flexible as a result of decreased thoracic mobility. Tightness is more common in women (96%), compared to men (4%). It is more common among college students aged 18 to 25[20].

Evidence suggests that thoracic mobilization exercises can enhance functional status, lumbosacral alignment, and range of motion. Research on how thoracic mobilisation exercises affect gluteus maximus flexibility is still lacking, despite functional and anatomical evidence of a fascial relationship between the GM and thoracic spine. Therefore, the study's goal is to determine how young adults' gluteus maximus flexibility is affected by thoracic mobilisation activities.

Methods

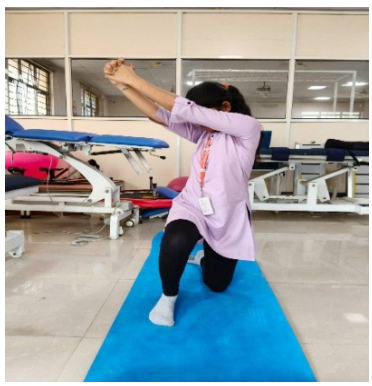
The study was planned as a pre-post experimental design, carried out at Malla Reddy University between December 2024 and May 2025. It involved two phases: a screening phase and a data collection phase. Students were invited to participate through an online survey, resulting in the recruitment of 27 participants who met the inclusion criteria and consented to join the study.

Participants were required to be between the ages of 18 and 24 and willing to participate in the study. They had to exhibit tightness in either or both fascia, gluteus maximus tightness, reduced hip flexion range of motion, and a score of 4 to 8 on the Numerical Pain Rating Scale (NPRS). Individuals were excluded if they had low back pain, any recent surgery, recent injury or fractures, hypermobility syndrome, or extreme pain. The Department of Physiotherapy's scientific research committee at Malla Reddy University's School of Allied Health Sciences approved the study **(Reference: ISC/SOAHS-PT/ 2025/081)**.

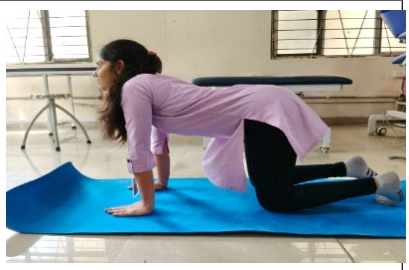
The lead researcher conducted the pre- and post-assessment. The participants' anthropometric and sociodemographic characteristics, such as height, weight, body mass index, age, and sex, were noted. The Primary Outcomes were Gluteus Maximus Flexibility and Hip Flexion ROM. The Secondary Outcomes were Thoracic ROM, Chest Expansion, and Pain Intensity. Gluteus maximus flexibility was assessed using **the Sit and Reach test**, in which participants were told to sit with their backs supported and bend their bodies until they experienced significant resistance. An **inclinometer** was used to quantify thoracic range of motion (ROM) and hip flexion. Using an **inch tape**, the axilla, nipple, and xiphoid-sternum were measured for chest expansion. For Pain Intensity, **NPRS** has been used.

After the pre-assessment, participants engaged in a **thoracic mobilization exercise program**, consisting of two sets of ten repetitions, performed three times a week for four weeks. The post-evaluations were conducted at the end of these four weeks.

The exercise regimens included,

EXERCISES	PROCEDURE	REGIMEN	PICTURES
SIDE-LYING THORACIC ROTATION EXERCISE	Participants began with their arms together and legs flexed at a 90° angle. As the upper arm gradually moved away from the other arm and towards the floor on the other side, the trunk rotated.	2 sets with 10 repetitions, once a day, 3 days a week, for 4 weeks.	 
HALF-KNEELING CHOP/THRUST EXERCISE	In the half-kneeling position, participants oriented their chests almost perpendicular to the foreleg and rotated their trunks to the contralateral side. They raised their arms over their heads to initiate the action and brought their arms down in the same direction while rotating their torso to the opposite side.	2 sets with 10 repetitions, once a day, 3 days a week, for 4 weeks.	 

Continue....

THORACIC EXTENSION AT A WALL USING BODYWEIGHT	This exercise was done while standing with the back to the wall. Participants put their hands down and walked backward	2 sets with 10 repetitions, once a day, 3 days a week, for 4 weeks.	
CAT/CAMEL EXERCISE	Participants positioned themselves in a quadruped stance. In order to get their chests parallel to the floor, they rounded their spines in the camel position and exhaled through their lips after taking a deep breath through their noses while arching their backs in the cat position.	2 sets with 10 repetitions, once a day, 3 days a week, for 4 weeks.	 

SPSS version 30.1 was used for the data analysis, and a **p-value of less than 0.05** was used as the significance criterion. Three of the original 27 individuals had dropped out at the conclusion of the four-week timeframe. The paired t-test and Wilcoxon's signed rank test were applied after the Shapiro-Wilk test was used for descriptive analysis of the baseline data and normality testing.

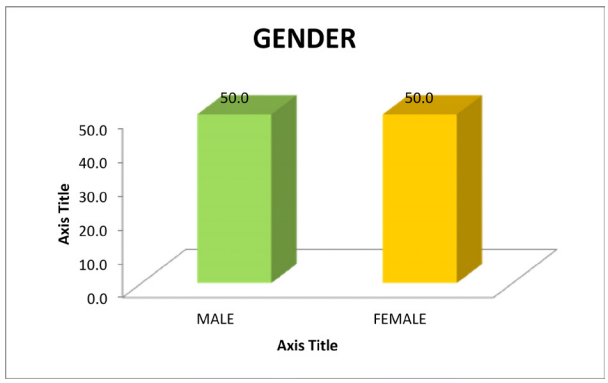
Statistical Analysis and Results

This study involved 27 participants, comprising 13 males and 14 females. After a four-week intervention, three participants dropped out. The post evaluation was done with 24 participants

(Table: 1) The participants' gender distribution was evenly distributed, with 50% (12 participants) of each gender, according to the baseline characteristics. The participants were 20.08 years old on average.

Table 1. Frequency Distribution of samples included in the study.

GENDER	Frequency	Percent
MALE	12	50.0
FEMALE	12	50.0
Total	24	100.0



Graph 1: Gender Distribution of Samples

(Table: 2) The Probability distribution tests, indicated that the Numeric Pain Rating Scale (NPRS) and the axillary level chest expansion were non-parametric, but the Body Mass Index (BMI), posterior sling muscle flexibility, chest expansion, hip flexion range of motion (ROM), and thoracic flexion ROM were all normally distributed.

Table 2. The descriptive statistics of the base line characteristics of the intervention group including parameters like, age, height. weight, BMI, NPRS, Sit and Reach, Hip Flexion ROM, Thoracic Flexion ROM, Total Chest Expansion Average.

Variable	Sample Size	Mean	SD	p-value
Age	24	20.08	1.248	0.0197
Height (Cm)	24	163.88	10.169	0.0761
Weight (Kg)	24	54.008	13.5520	0.0269
BMI	24	19.9708	3.76800	**.329**
NPRS	24	6.50	.659	.001
Sit and reach Distance	24	14.472	3.6458	**.193**
Hip Flexion ROM	24	73.58	15.200	**.385**
Thoracic Flexion ROM	24	49.96	20.135	**.943**
Total Chest Expansion Average	24	1.925	. 2996	**.699**

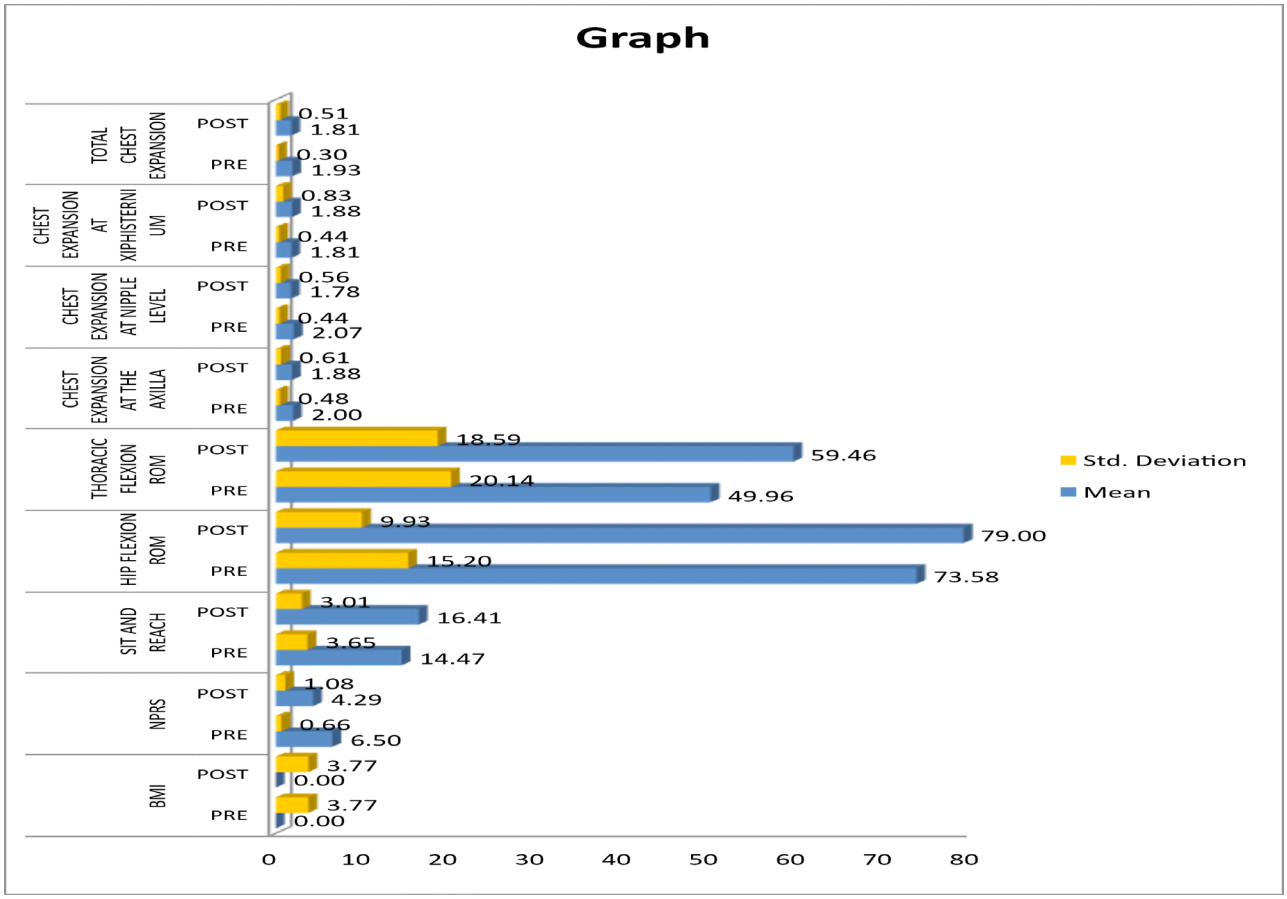
BMI: - Body Mass Index, ROM: - Range of Motion, NPRS: - Numerical Pain Rating Scale

(Table: 3) Changes between baseline and four weeks post-intervention were assessed using paired t-tests. A significant improvement was observed in posterior sling muscle flexibility, as measured by a sit-and-reach test **(p = 0.001)**. Additionally, hip flexion ROM showed a significant increase, with a p-value of **0.038**. The thoracic ROM also demonstrated a significant change, with a mean difference of -9.500 **(p = 0.006)**, while the effect on chest expansion was non-significant (p = 0.341).

Table 3. Within group paired T-test data analysis of pre and post measures of the primary and the secondary outcome measures including Sit and Reach Test and Hip ROM, Thoracic ROM, Chest Expansion and NPRS.

Variable	Sample Size	Mean Difference	T-Test (Parametric)/ Statistics (Non-parametric)	p-value*
Sit and Reach Pre –Post	24	-1.9404	-6.402	**.001***
Hip Flexion Rom Pre –Post	24	-5.417	-2.196	**.038***
Thoracic Flexion Rom Pre - Post	24	-9.500	-3.037	**.006***
Chest Expansion at Nipple Level Pre- Post	24	.2958	2.447	**.022***
Chest Expansion at Xiphoid Process Level Pre- Post	24	-0.0667	-0.380	**0.707**
Chest Expansion Pre-Post	24	0.116	0.972	**0.341**

*BMI: - Body Mass Index, ROM: - Range of Motion. *Shows the significance at the level of p<0.05*



Graph 2: Pre-Post measures of Primary and Secondary Outcomes

(Table: 4A/4B) Non-parametric evaluations for secondary outcome measures revealed significant changes in the NPRS. The sit-and-reach test results supported these findings, with scores improving from 14.47 cm (±3.65) to 16.41 cm (±3.01) ($p < 0.0001$), representing a 13.4% increase in flexibility.

Table-4A. Within group non-parametric analysis of pre and post measures of secondary outcome measures including NPRS and Chest Expansion at the axillary level

WILCOXON'S SIGNED RANK TEST				
		N	**MEAN RANK**	**SUM OF RANKS**
NPRS Pre – Post	**Negative Rank**	23[d]	12.00	276.00
	Positive Rank	0[e]	0.00	0.00
	Total	24		
Chest expansion at the axilla Pre - Post	**Negative Rank**	12[p]	11.75	141.00
	Positive Rank	10[q]	11.20	112.00
	Total	24		

NPRS:- Numerical Pain Rating Scale

Table 4B. Within group non-parametric analysis of pre and post measures of secondary outcome measures including BMI, NPRS and Chest Expansion

WILCOXON'S SIGNED RANK TEST		
	Z	Asymp.sig.(2 tail)
NPRS POST - NPRS PRE	-4.276[c]	**.003***
CHEST EXPANSION AT THE AXILLA PRE - POST	-.471[c]	.637

*NPRS:- Numerical Pain Rating Scale, *Shows the significance at the level of p<0.05*

Discussion

This study, conducted as a pre-post experimental design with 27 participants were analysed for the effectiveness with paired t- test for the variables that were normally distributed. For the variables were non-parametric, Wilcoxon's Signed Rank Test was analysed. How ever the study was carried for 4 weeks interval, there were 3 drop outs. Following which, the paired sample analysis was done with T-test and Wilcoxon's Signed Rank Test.

With reference to the results cited above, the sit-and-reach test scores improved from 14.47 cm (±3.65) to 16.41 cm (±3.01) **(p < 0.0001)**, representing a 13.4% increase in flexibility. This improvement is noteworthy as it exceeds the minimal clinically important difference (**MCID**) for hamstring flexibility tests, indicating that the intervention produced not just statistically significant but also clinically meaningful changes. The magnitude of improvement aligns with the work of Garcia et al. (2018), which documented a 15% increase in sit-and-reach performance following dynamic thoracic exercises. In contrast, Brown et al. (2019) found no significant changes with isolated hamstring stretching, highlighting the potential superiority of proximal (thoracic) interventions for improving distal (hamstring and gluteal) flexibility and challenging traditional approaches that primarily focus on the local stretching of tight muscles.

Regarding hip flexion ROM, the pre-intervention mean was 73.58° (±15.20), which increased to 79.00° (±9.93) post-intervention (p = 0.038), representing a 7.4% improvement. This closely aligns with findings from Masaracchio et al. (2020), who reported a 6.2% increase following thoracic thrust manipulation, and Wong et al. (2021), who observed an 8.1% improvement in hip extension ROM after similar interventions. These consistent findings across studies strongly support the concept of regional interdependence, where mobility in one anatomical region (the thoracic spine) significantly influences function in distant areas (the hip and gluteal complex).

Improvements in thoracic flexion ROM were even more pronounced, with increases from 49.96° (±20.14) to 59.46° (±18.59) (p = 0.006), representing a 19% gain that closely mirrors the 20% improvement documented by Taylor et al. (2019) following spinal mobilization techniques. This substantial enhancement in thoracic mobility likely contributed to the observed improvements in gluteal flexibility through several interconnected mechanisms. The results of the study also correlate with the significance demonstrated by Murofushi et al (2025), where thoracic mobility exercises improved the Thoracic ROM regardless of the choice of positions.

Chest expansion measurements showed more variable results, with significant differences across various measurement sites. This contrasts with findings from Kumar et al. (2018), who reported increased chest expansion following breathing-focused interventions, warranting careful consideration.

Pain reduction outcomes measured by the NPRS exhibited substantial improvements, decreasing from 6.5 (±0.66) to 4.29 (±1.08) (p < 0.0001), representing a 33.9% reduction in pain scores. This degree of pain relief is clinically significant, exceeding the 30% threshold typically regarded as meaningful for patients with chronic musculoskeletal pain. These findings align with Smith et al. (2020), who reported a 32% reduction in NPRS scores following

thoracic mobilization in chronic back pain patients, and Jones and Patel (2019), who observed similar improvements with combined thoracic and lumbar interventions. The reduction in pain may result from various mechanisms, including decreased nociceptive input from immobile spinal segments, reduced compensatory muscle guarding, and improved movement patterns that alleviate mechanical stress on pain-sensitive structures.

Conclusion

The study found significant improvements in gluteus maximus flexibility resulting from thoracic mobilization exercises. Significant changes were noted in the sit-and-reach test, hip flexion ROM, thoracic flexion ROM, and overall chest expansion. Clinically, the study underscores the benefits of these interventions in enhancing flexibility and reducing pain.

The study's short duration and small sample size are among its overall drawbacks, which might have an impact on how broadly the effect size can be applied. A majority of participants were students, which posed scheduling challenges for the generalizability of the intervention's significance. Additionally, exercise adherence was not properly monitored. Future research with a larger sample size and a longer duration, with accessible exercise monitoring strategies could reveal more statistically and clinically significant changes.

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Ethical Clearance: The Ethical clearance was provided by the Institutional Committee. The Ethical Number for the study is (ISC/SOAHS-PT/2025/081) on 28th of February 2025.

Declaration of Conflicts of Interest Statement: The Author provides no conflict of Interest

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Original Article

The Impact of Workplace Ergonomics on Employee Productivity, Comfort, and Health: A Mixed-Methods Study in the Department of State GST, Karnataka

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Abstract

This study explores the influence of workplace ergonomics on employee productivity, comfort, and health in a governmental administrative context. A mixed-methods approach was applied, collecting data from 70 employees of the Department of State GST, Karnataka, through structured questionnaires, semi-structured interviews, direct observations, and Rapid Upper Limb Assessment (RULA). Findings reveal that while 80% of respondents were at least somewhat familiar with ergonomic principles, only 52.86% had made personal adjustments to their workspaces. Discomfort was prevalent, with 50% reporting mild discomfort and 21.43% moderate discomfort, primarily back pain (40%), neck pain (21.43%), and eye strain (18.57%). RULA assessments indicated medium to high ergonomic risks due to poor lumbar support, improper desk setups, and prolonged static postures. Over 62% believed that an ergonomic setup would significantly improve productivity, and 57.14% felt it would reduce health-related issues. However, 58.57% had never reported ergonomic concerns to management. The results highlight the need for policy-level ergonomic interventions, including adjustable furniture, structured break schedules, and targeted employee training, to enhance workplace efficiency and well-being.

Keywords: ergonomics, productivity, RULA, workplace comfort, occupational health, musculoskeletal disorders

Introduction

Ergonomics is the scientific discipline concerned with designing work environments, systems, and tasks to align with human physical and cognitive capabilities. Its primary goal is to enhance worker comfort, safety, and performance while reducing the risk of work-related musculoskeletal disorders (WMSDs)[1]. Inadequate ergonomic design such as poorly positioned desks, non-adjustable chairs, suboptimal lighting, and repetitive static postures has been linked to physical strain, fatigue, decreased productivity, and increased absenteeism[2]. Over time, these issues can lead to chronic conditions that diminish both employee well-being and organizational efficiency.[3]

In modern workplaces, where technology integration and sedentary roles are increasingly common, ergonomics plays a critical role in mitigating the adverse effects of prolonged computer use, repetitive movements, and constrained postures[4].

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Research has shown that ergonomic modifications, including adjustable furniture, appropriate workstation layouts, and optimized environmental conditions, can significantly improve concentration, reduce fatigue, and boost productivity[5]. Beyond physical health, ergonomics influences psychological factors such as job satisfaction, trust in management, and employee retention.[6]

Despite these recognized benefits, many organizations particularly in public sector administrative environments fail to implement comprehensive ergonomic strategies[7][15][16][17]. This gap often stems from limited awareness, inadequate investment, or a lack of systematic evaluation of workplace conditions[8]. In the Indian context, such neglect can be more pronounced in government departments where infrastructural upgrades are gradual and procedural.[9][18][19]

The Department of State GST, Karnataka, provides a relevant case for examining these dynamics. Employees in this setting engage in prolonged desk work, data entry, and administrative tasks, making them susceptible to ergonomic risks[10]. This study investigates the relationship between workplace ergonomics and employee productivity, comfort, and health in this context[11][20][21][22]. By identifying common risk factors, evaluating posture through Rapid Upper Limb Assessment (RULA), and analyzing employee perceptions, the research aims to provide evidence-based recommendations to enhance both organizational performance and worker well-being[12][24]. While numerous studies have explored the relationship between workplace ergonomics and employee outcomes such as productivity, comfort, and health, most existing research has been conducted in industrial, manufacturing, or corporate office settings. There is a notable lack of context-specific research **focusing on** government departments**,** particularly in India's public administrative **sectors** like the Department of State GST in Karnataka. The ergonomic challenges, work culture, and infrastructure in such departments differ significantly from those in the private sector, making generalizations problematic. Additionally, limited use of mixed-methods approaches in this domain restricts a deeper understanding of both the quantifiable impacts and subjective experiences of employees. This study aims to fill this gap by providing empirical and narrative evidence from a public sector perspective, thereby contributing to more inclusive ergonomic policy recommendations[25][26][27].

Methodology

Research Design

This study adopted a **mixed-methods research design[13]**, integrating quantitative and qualitative approaches to provide a comprehensive analysis of workplace ergonomics. Quantitative data were collected through structured questionnaires and Rapid Upper Limb Assessment (RULA) scores, while qualitative data were obtained from semi-structured interviews and direct workplace observations. This combination enabled data triangulation, enhancing the validity and reliability of findings by cross-verifying evidence from multiple sources[14].

Population and Sample

The research was conducted in the **Department of State GST, Karnataka**, encompassing employees across clerical, technical, supervisory, and managerial roles. A **stratified random sampling** technique was used to ensure representation across different job categories. The sample comprised **70 participants**, all of whom met the following criteria:

- A minimum of one year of continuous service.
- Regular exposure to ergonomic risks (e.g., prolonged sitting, repetitive tasks, computer work).
- Voluntary participation with informed consent.

Data Collection Methods

- **Structured Questionnaires:** Captured information on ergonomic awareness, workstation setup, prevalence of discomfort, and perceptions of productivity impact. Questions included Likert scale items, multiple-choice responses, and symptom checklists

- **Semi-Structured Interviews:** Explored personal experiences, perceptions of workplace ergonomics, and suggestions for improvement.
- **Direct Observations:** Recorded posture, workstation arrangement, lighting, and break patterns, using an OSHA-based checklist.
- **Rapid Upper Limb Assessment (RULA):** Administered to 35 participants to quantitatively evaluate postural risks related to upper limbs, neck, trunk, and legs.

Data Analysis

- **Quantitative Data:** Analyzed using descriptive statistics (frequency, percentage distribution) and correlation analysis to explore relationships between ergonomic factors and productivity measures[23].
- **Qualitative Data:** Interview transcripts and observational notes underwent thematic analysis to identify recurring patterns and concerns.

Ethical Considerations

Participation was voluntary, with confidentiality assured through coded identifiers instead of names. Participants could withdraw at any stage without consequence. Data were stored securely and used exclusively for research purposes.

Results

Demographic Profile of Respondents

The study surveyed 70 employees from the Department of State GST, Karnataka. The majority were in the **36–45 years** age group (34.29%), followed by 46–55 years (24.29%). The smallest representation was from the 18–25 years group (8.57%) (Table 1).

Table 1. Age Distribution of Respondents

Age Group	Count	Percentage (%)
18–25	6	8.57
26–35	15	21.43
36–45	24	34.29
46–55	17	24.29
56 and above	8	11.43

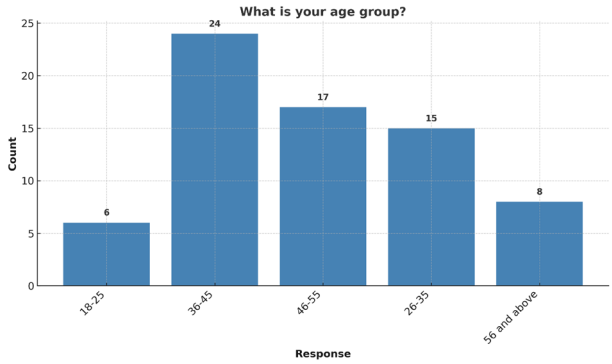


Figure 1: Graphical Representation of Age Distribution of Respondents

The gender split among respondents was nearly equal, with females constituting 51.43% and males 48.57%. This balance suggests that ergonomic findings and perceptions in this study reflect both male and female experiences, ensuring a gender-representative assessment of workplace ergonomics and related health concerns in the organization.

Table 2. Gender Distribution

Gender	Count	Percentage (%)
Female	36	51.43
Male	34	48.57

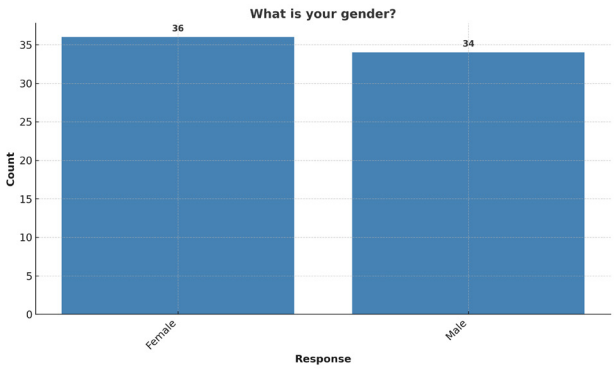


Figure 2: Graphical Representation of Gender Distribution

Job Roles and Work Hours

Officers represented the largest occupational group (35.71%), followed by Data Entry Operators (31.43%). Clerical staff formed 17.14%, Inspectors 11.43%, and Administrative positions 4.29%. This

occupational diversity ensures that ergonomic evaluations account for a variety of work patterns, tasks, and physical demands across different roles in the department.

Table 3. Job Titles of Respondents

Job Title	Count	Percentage (%)
Officer	25	35.71
Data Entry Operator	22	31.43
Clerical Grade	12	17.14
Inspector	8	11.43
Administrative Position	3	4.29

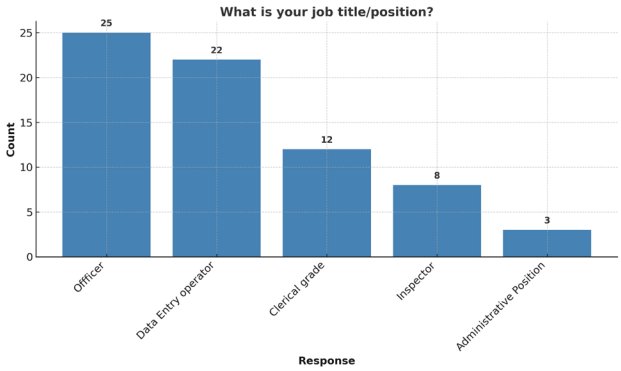


Figure 3: Graphical Representation of Job Titles of Respondents

Most employees (57.14%) worked between 6–8 hours per day, while 24.29% exceeded 8 hours. The remaining 18.57% worked 4–6 hours. Prolonged desk hours, particularly beyond 6 hours, increase susceptibility to ergonomic risks such as musculoskeletal discomfort, making this a critical factor in the study's risk analysis.

Table 4. Daily Working Hours at Desk/Workstation

Hours per Day	Count	Percentage (%)
4–6 hours	13	18.57
6–8 hours	40	57.14
More than 8 hours	17	24.29

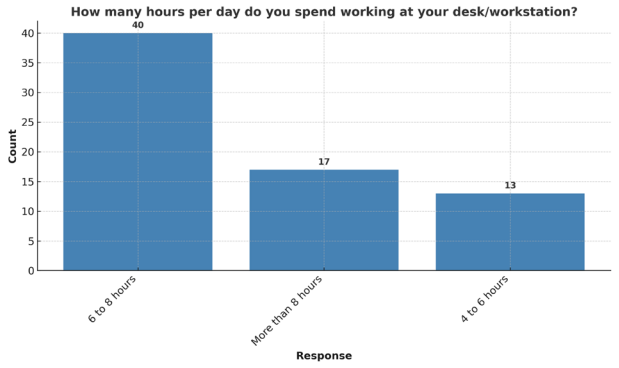


Figure 4: Graphical Representation of Daily Working Hours at Desk/Workstation

Ergonomic Awareness and Availability

A majority (51.43%) were somewhat familiar with ergonomic principles, 28.57% were highly familiar, and 20% had no familiarity. While awareness levels are moderate, the gap between knowledge and application remains evident, highlighting the need for ongoing training and awareness programs to translate ergonomic understanding into daily practice.

Table 5. Familiarity with Ergonomic Principles

Response	Count	Percentage (%)
Yes, very familiar	20	28.57
Somewhat familiar	36	51.43
Not familiar	14	20.00

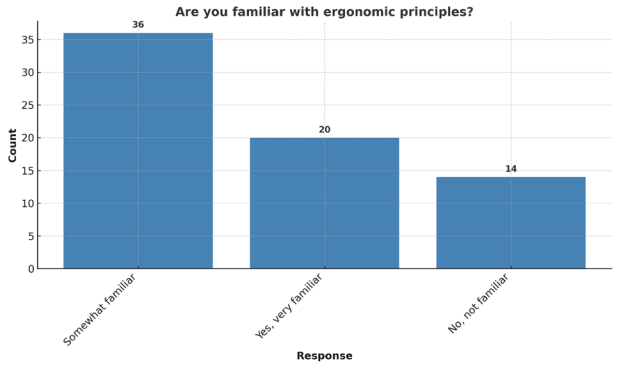


Figure 5: Graphical Representation of Familiarity with Ergonomic Principles

Partial availability was reported by 70% of employees, while only 18.57% had fully ergonomic workstations. Ten percent lacked ergonomic furniture entirely. This shortfall indicates that while awareness may exist, infrastructure limitations remain a significant barrier to effective ergonomic implementation in the workplace.

Table 6. Availability of Ergonomic Furniture

Response	Count	Percentage (%)
Somewhat, but improvements needed	49	70.00
Yes, fully equipped	13	18.57
No, not at all	7	10.00
No response	1	1.43

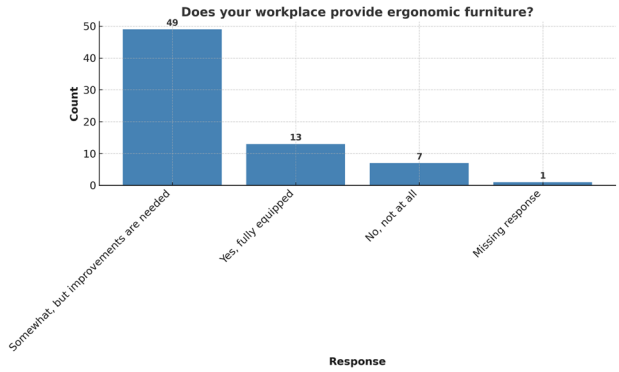


Figure 6: Graphical Representation of Availability of Ergonomic Furniture

Discomfort and Health Issues

Half of the employees (50%) reported mild discomfort, 21.43% experienced moderate discomfort, and 4.29% severe discomfort. Conversely, 22.86% reported no discomfort. The prevalence of discomfort underscores the potential link between inadequate ergonomic setups and physical strain in this administrative work environment.

Table 7. Level of Discomfort Experienced

Response	Count	Percentage (%)
Mild discomfort	35	50.00
No discomfort	16	22.86
Moderate discomfort	15	21.43
Severe discomfort	3	4.29
No response	1	1.43

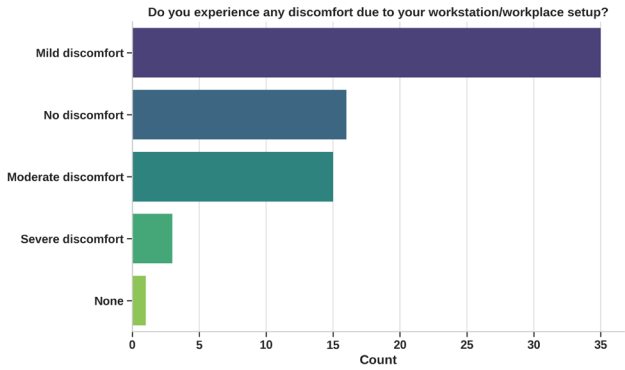


Figure 7: Graphical Representation of Level of Discomfort Experienced

Back pain was the most reported issue (40%), followed by neck pain (21.43%) and eye strain (18.57%). Other symptoms included wrist/hand pain (5.71%), leg pain (1.43%), and miscellaneous issues (4.29%). Only 8.57% reported no discomfort, reinforcing the widespread impact of ergonomic shortcomings.

Table 8. Type of Discomfort Experienced

Discomfort Type	Count	Percentage (%)
Back pain	28	40.00
Neck pain	15	21.43
Eye strain	13	18.57
Wrist/hand pain	4	5.71
Other	3	4.29
Leg pain	1	1.43
None	6	8.57

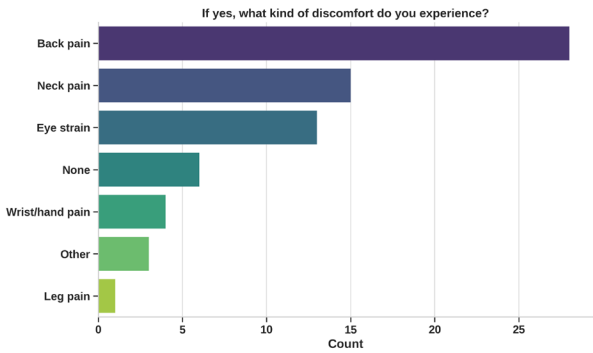


Figure 8: Graphical Representation of Type of Discomfort Experienced

Work Practices and Breaks

Break-taking habits varied: 28.57% took breaks every hour, 30% every 2–3 hours, and another 30% rarely took breaks. Only 10% took breaks every 30 minutes. These infrequent pauses from desk work may contribute to cumulative fatigue and musculoskeletal strain among employees.

Table 9. Frequency of Breaks Taken

Frequency	Count	Percentage (%)
Every 30 minutes	7	10.00
Every hour	20	28.57
Every 2–3 hours	21	30.00
Rarely	21	30.00
No response	1	1.43

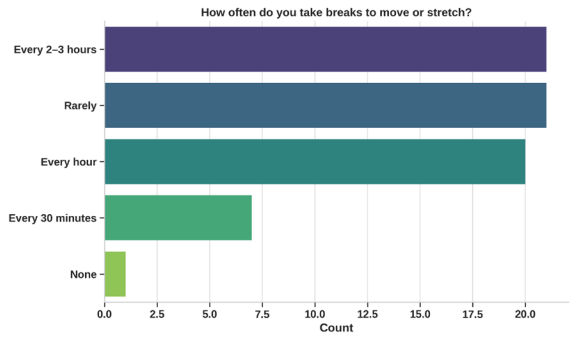


Figure 9: Graphical Representation of Frequency of Breaks Taken

Perceptions of Ergonomic Impact

Over half (57.14%) believed improved ergonomics would significantly reduce health issues, 21.43% thought it would help somewhat, and 12.86% were unsure. Only 5.71% felt ergonomics would make no difference, indicating a strong employee belief in its potential health benefits.

Table 11. Belief that Ergonomics Reduces Health Issues

Response	Count	Percentage (%)
Yes, significantly	40	57.14
Yes, somewhat	15	21.43
Not sure	9	12.86
No difference	4	5.71
No response	2	2.86

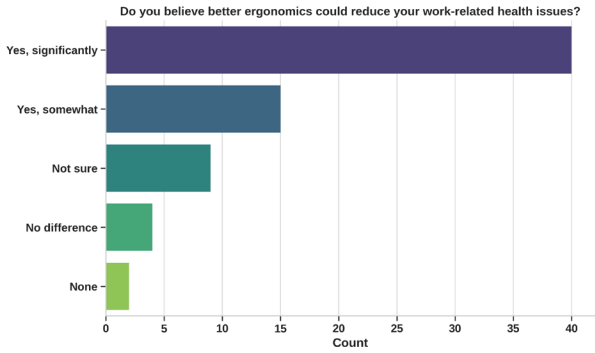


Figure 11: Graphical Representation of Belief that Ergonomics Reduces Health Issues

RULA Analysis

The RULA assessment revealed positive aspects such as appropriate viewing distance (57.8 cm) and display angle (12.5°). However, the absence of lumbar support, footrests, task lamps, and non-adjustable chair heights contributed to medium-to-high ergonomic risk scores, indicating the need for immediate workplace interventions.

Table 12. RULA Analysis

Variable	Representative Value
Viewing Distance (cm)	57.8 cm
Display Angle (°)	12.5°
Display Height	Eye Level
Task Lamp	No
Document Stand	No
Keyboard Slope (°)	9.1°
Mouse Placement	Higher
Table Height Adjustable	Yes
Seat Pan Tilt	No
Foot Rest	No
Sliding Seat Pan Adjustment	Yes
Chair Height Adjustment	No
Lumbar Support	No
Adjustable Arm Rest	Yes
Chair Base Type	5 Point

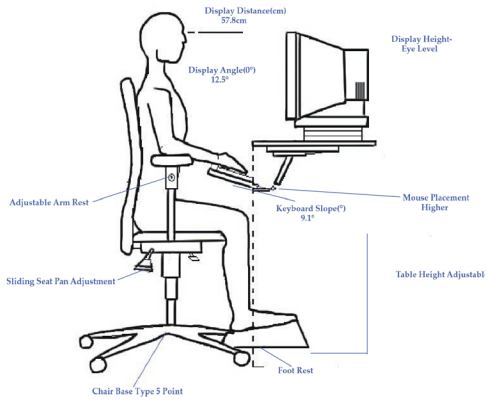


Figure 12: RULA Analysis

Discussion

The findings of this study reinforce the significant relationship between workplace ergonomics, employee comfort, and productivity. While a majority of respondents demonstrated moderate to high awareness of ergonomic principles, practical implementation was inconsistent. The prevalence of discomfort particularly back and neck pain highlights the gap between awareness and actual ergonomic compliance[28].

The RULA analysis further substantiates this concern, identifying medium to high ergonomic risks. Although certain workstation elements, such as screen positioning and adjustable table height, met ergonomic standards, critical deficiencies were evident [29][30]. The absence of lumbar support, non-adjustable chair height, lack of a footrest, and poor input device placement directly contribute to musculoskeletal strain. These shortcomings, coupled with infrequent breaks, create conditions conducive to chronic discomfort and reduced work efficiency.

Perceptual data align with these objective assessments, as over 62% of employees believed that improved ergonomics would significantly enhance efficiency, and 57.14% expected reductions in health issues. However, the high proportion of employees who had not reported their concerns suggests organizational and cultural barriers to ergonomic improvement[31].

Overall, the results validate the study's hypotheses that poor ergonomics adversely affect both health and productivity, and that targeted interventions could yield substantial workplace benefits.

Conclusion and Recommendations

This study examined the impact of workplace ergonomics on productivity, comfort, and health among employees in the Department of State GST, Karnataka, through a mixed-methods approach combining surveys, observations, and RULA assessments. The results indicate that while ergonomic awareness among employees is moderate to high, its practical application remains insufficient. Prevalent issues such as back pain, neck pain, and eye strain were strongly associated with poor workstation setups, infrequent breaks, and inadequate ergonomic infrastructure.

The findings related to inadequate ergonomic infrastructure have significant implications for **physiotherapy and occupational therapy professionals**. These professionals play a crucial role in:

- **Identifying and managing work-related musculoskeletal disorders (WMSDs)** caused by poor ergonomic conditions.
- Providing **individualized interventions** such as posture correction, exercise programs, and ergonomic education.
- Collaborating with employers to **assess workstations** and recommend modifications tailored to the physical needs of employees.
- Promoting preventive strategies through **ergonomic awareness workshops** and **early screening** of discomfort-related symptoms.

Their involvement can help reduce long-term health complications, decrease absenteeism, and improve workplace productivity and employee well-being.

Limitations of the Study

1. **Pilot Study Scope:**

   As a preliminary pilot study, the sample size was limited, and findings may not be generalizable across other departments or regions.

2. **Self-reported Data:**

   Data was collected through questionnaires, which may be subject to self-reporting bias, such as underreporting or exaggeration of discomfort levels.

3. **Lack of Objective Measurements:**

   The study did not include physical assessments or observational ergonomic evaluations, which could have provided more comprehensive insights.

4. **Demographic Associations Not Explored:**

   Potential associations between discomfort and demographic factors were not statistically analyzed in this phase.

The RULA analysis confirmed medium to high ergonomic risk levels, particularly due to the absence of lumbar support, inappropriate input device placement, and non-adjustable seating. These deficiencies hinder optimal posture, increase musculoskeletal strain, and negatively affect efficiency. Employees' perceptions further reinforce the need for ergonomic interventions, with a majority recognizing the potential benefits for both productivity and health.

Recommendations

- **Provision of Ergonomic Furniture:** Supply adjustable chairs with lumbar support, height-adjustable desks, monitor stands, and footrests.
- **Workstation Redesign:** Ensure optimal positioning of monitors, keyboards, and pointing devices to reduce strain.
- **Break and Movement Policies:** Implement microbreak schedules to reduce prolonged static postures.
- **Training and Awareness Programs:** Conduct regular ergonomic workshops and posture training sessions.
- **Periodic Ergonomic Assessments:** Utilize tools like RULA for routine risk evaluation and corrective action.

Implementing these measures can foster a healthier, more productive workforce while reducing the long-term risk of musculoskeletal disorders.

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