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A Case Report - Physiotherapy Rehabilitation in a Chronic Ataxic Stroke Patient

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Abstract

Introduction: The cerebellum is primarily responsible for coordination, balance, and muscle control. Cerebellar infarction or haemorrhage can lead to an acute onset of cerebellar dysfunction. The dysfunction often leads to ataxia, which is defined as impaired coordination of voluntary muscle movements.

Case Presentation: A 54-year-old male rickshaw driver presented with difficulties in walking and transferring, as well as multiple episodes of falling. He also experienced challenges with activities of daily living, such as bathing, dressing, and eating, following a cerebrovascular accident around 7 years ago.

Intervention: Intervention was given 1.5 hours per day,5 days a week, for 8 weeks. Intervention includes education sessions, static and dynamic balance training, quasi-mobile task, body weight support treadmill training, stair gait training, slope walking, transfer activity, and task-specific training.

Outcomes: After the 8 weeks of intervention, the FIM score improved from 83 to 105, the BBS score improved from 26 to 36, and the ISS score increased from 74 to 83. The time taken to complete the 5 Times Sit to Stand Test decreased from 1.26 minutes to 40 seconds, and the number of falls reduced from 3 to 0. Retention of the exercise effect was also seen in follow-ups (1-2 months).

Conclusion: A tailor-made, goal-oriented physical therapy intervention including education, counselling sessions, and exercises designed and implemented based on the principles of motor control, motor learning, and neuroplasticity will provide recovery even in chronic ataxic stroke patients.

Key words: Chronic stroke, cerebellar ataxia, rehabilitation, balance, gait.

Introduction

The cerebellum is primarily responsible for coordination, balance, and muscle control. Cerebellar infarction or hemorrhage often leads to ataxia, which is defined as impaired coordination of voluntary muscle movements.(1)

Cerebellar infarcts account for only about 2% of all strokes.(2) Ataxia is a notable consequence and

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may present with symptoms including dysmetria, dysarthria, hypotonia, the rebound phenomenon, and nystagmus. Gait ataxia is specifically characterized by patterns such as stumbling, irregular foot placement, large steps, a wide base of support, and abnormal joint torque.(3)

Cerebellar stroke leads to increased postural sway and poorly coordinated postural responses during volitional movements. Gait variability is a common characteristic, resulting from a combination of balance impairments, inter-limb incoordination, and a lack of coordination between postural activity and leg movement. These intrinsic balance problems contribute to a high incidence of injurious falls.(4)

Ataxic hemiparesis and related syndromes present distinct rehabilitation needs—such as balance, coordination, and gait training—that are not fully addressed by standard stroke protocols. Rehabilitation protocols for chronic ataxic stroke are underrepresented in the literature. Most studies focus on general stroke or ataxia from other causes, leaving a gap in practical, detailed guidance for clinicians treating chronic ataxic stroke.By documenting novel or tailored interventions, case reports can highlight effective approaches, inform future clinical trials, and contribute to the development of standardized protocols. (5)(6)(7)

Case reports provide in-depth accounts of individualized rehabilitation strategies, including the rationale, progression, and outcomes of specific protocols. This helps clinicians understand how to apply principles like motor learning and neural plasticity in real-world settings. (7)

The purpose of this case report is to provide an effective and comprehensive assessment and management strategy for individuals with chronic cerebellar stroke.

Patient Information

Case Description

A 54-year-old male patient from Samarkha, Anand, came to us with complaints of difficulty walking and transferring, along with multiple episodes of falling. He also experiences challenges in performing daily living activities such as bathing, dressing, and eating following a cerebrovascular accident in 2017 (over 7 years ago).

History

In July 2017, while driving a rickshaw in the morning, he suddenly felt tingling all over his body and had difficulty steering. He was taken to a local physician, who referred him to a multispecialty hospital. He was admitted for one and a half days, during which necessary investigations were conducted. Following this, he was transferred to a tertiary care hospital, where he spent 10 days in the ICU and another 10 days inthe general ward. He was unconscious for the first four days of his stay. There, he received appropriate medical and physiotherapy care.

After being discharged, he began physiotherapy management and achieved independent standing for one minute in three years. He managed to walk a few steps with a walkerfive years after the incident. Due to financial constraints, he had irregular physiotherapy sessions. Now that the patient has received monetary aid, he would like to continue physiotherapy at our department.

Diagnostic Imaging

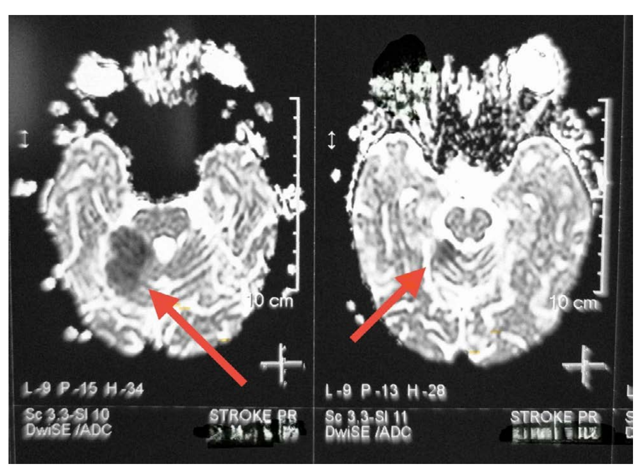

Figure: -1 MRI of the patient

The figure shows a left cerebellar ischemic lesion.

Clinical Findings

Patient consent was obtained before conducting the study. The patient was informed about all procedures and was made aware that participation was voluntary; he could withdraw from the study at any time.

The patient demonstrated normal cognition and metacognition, with stable vital signs. He has had a history of hypertension for 8 to 9 years, which is currently well-managed with medication. There were no other comorbidities noted. His general appearance was good, with a BMI of 27.3 kg/m^2. He was enthusiastic, but his speech lacked affection, and there was mild slownesspresent.Effective two-way Communication was intact. All cranial nerves were functioning properly, and there were no sensory or perceptual impairments. Upon observation, the patient exhibited a flexed posture and required assistance from one person, along with the use of a walker for locomotion. Examination revealed increased muscle tone in all four limbs. Reflexes were exaggerated (grade 3+), except for the calf muscle, which was graded at 1+ bilaterally. Range of motion (ROM) for all joints was within functional limits. The upper limbs appear minimally affected, allowing the patient to perform all self-care activities independently, though he was having mild difficulty opening his hands. Thus, he was functionally independent. As it was not the concern of the patient, the primary focus of management was on improving balance and gait.

The assessments included the Berg Balance Scale (BBS), the Timed Up and Go (TUG) test, the 5 Time Sit to Stand test, the 10-meter walk test (both with and without a walker), the 6-minute walking distance test, the Functional Independence Measure (FIM), and the Indian Stroke Scale (ISS).

The Berg Balance Scale was used to evaluate both static and dynamic balance through fourteen components, yielding a total score of 26 out of 56. The BBS assesses various tasks such as standing up from a sitting position, balancing on one foot, and reaching forward while standing.(8)

The Functional Independence Measure (FIM) is a seven-level ordinal scale comprising 18 items across six domains: self-care, sphincter control, mobility, locomotion, communication, and social cognition. It is commonly used to assess a patient's functional independence and level of disability.(9) The total FIM score for this patient was 83.

The Indian Stroke Scale (ISS) measures the limitations in daily activities experienced by stroke patients in India. The total ISS score for this patient was 74 out of 105.

The Indian Stroke Scale (ISS) is a culturally tailored, patient-reported outcome measure designed to assess functional participation in daily activities among stroke survivors in India. Developed by Dr. Prakash V. and colleagues, the ISS consists of 25 items that cover various domains such as mobility, self-care, domestic life, and social participation, reflecting the unique socio-cultural context of Indian patients.(10)

The Trunk Impairment Scale (TIS) evaluates static and dynamic sitting balance as well as trunk coordination while seated.It evaluates three main components: static sitting balance, dynamic sitting balance, and trunk coordination. Each item on the TIS is scored on an ordinal scale, with total scores ranging from 0 to 23, where higher scores indicate better trunk function.(11) The patient's total score was 11 out of 23.

The patient took 1 minute and 26 seconds to complete the Five Times Sit to Stand Test, a useful assessment tool for evaluating the ability to transition between sitting and standing. Performance on this test depends on lower-limb strength and balance control.(12)

The patient covered a distance of 40 meters using a walker during the Six-Minute Walk Test. This test is a widely recognized assessment tool in stroke rehabilitation, measuring functional mobility, endurance, and cardiovascular fitness. It is sensitive to changes in functional status, making it valuable for monitoring rehabilitation progress and evaluating the effectiveness of interventions.(13)

The 10-Meter Walk Test measures the time required to walk a defined distance, assessing walking speed in meters per second. For this patient, the time taken was 1 minute and 6 seconds with a walker and 3 minutes and 8 seconds without a walker. The 10-Meter Walk Test is widely used to evaluate walking speed and functional mobility in stroke patients, providing insights into gait performance and endurance.[14]

Additionally, we asked the patient about the number of falls he experienced in the past month, and they reported three falls.

Therapeutic Intervention

Physiotherapy management was provided for 1.5 hours per day. Three to four minutes of rest were given as and when needed by the patient, 5 days a week, for 8 weeks. Progressions were made every one to two weeks as necessary, according to the therapist's judgment, to keep the activities challenging. The physiotherapy sessions were conducted by an experienced neuro-physiotherapist.

After two months, the patient was advised to continue exercising at homeand with progression at their own pace, as the patient could not continue sessions due to socioeconomic reasons,and was assessed again after one and two months.

Table No. 1. Physiotherapy Management

(BWSTT- Body weight support treadmill training)

Goal	Intervention	Description	Progression	Dosage
Education/ counseling	One-to-one interaction with a neuro-physiotherapist	The therapist provided education about the condition, recovery, and prognosis. The patient was encouraged to ask any questions he had during the counseling session, and they were comprehensively answered by the therapist.	-	5 - 20 min once every 2 weeks
Static balance	Standing	Standing on a variable surface With open and closed eyes. With a different base of support	By reducing the base of support and closing the eye	10 mins
Dynamic balance	Quasi mobile task – reach out in sitting and standing with Head movement, Upper limb movement, trunk movements	Functional movement relevant to the patient was performed, like reaching out for a bottle, or jar, or clothes in a standing position And in sitting, shifting a bottle or a 1-2 kg bag, and manipulating heavier objects weighing 3 to 5 kg.	Increasing the distance to reach, and increasing the weight of the object	20 mins
	Reactive balance control	Perturbation in standing with and without eyesclosed.	Increasing intensity and force of perturbation	5 mins
	Transfer training	Sit to stand from a variable surface of variable heights.	By reducing the height	5 mins

Continue....

Gait training	BWSTT	BWSTT with lifting 20 % body weight	Increasing speed on the Treadmill	10 mins on alternate sessions for 1 month
	Stair gait training	With railing assistance and minimal assistance or supervision	Increasing number of stairs	5 mins
	Slope walking	Reverse slope walking with railing assistance under supervision	Reducing the assistance of the railing and increasing speed	10 min
Indoor Walking	Transfer activity	With the use of crutches and minimal assistance, the patient was prompted to get up, walk, and then sit down in a simulated environment similar to his home.	Reducing assistance and increasing speed	10 mins on alternate days
Improve upper extremity functions	Task-specific Training	For Bathing, eating, dressing, wearing, and removing clothes	Increasing complexity of the task as per task performance and analysis	20 mins

Outcomes and Follow-Up

Table No. 2. Here, all the assessments of the patient were given from baseline to follow-up month, including monthly assessment data

(BBS-Berg balance scale, ISS-Indian stroke scale, 6MWT-6-Minute walk test, FIM-Functional Independence Measures, TIS-Trunk Impairment Scale, 5TSTS-5-TimeSit-to-Stand, 10MWT- 10-Meter walk test)

Time	BBS	ISS	6MWT with walker (Meter)	FIM	TIS	5TSTS (min)	10 MWT (Min)	10 MWT (min)	NUMBER OF FALLS
Baseline	26	74	40	83	11	1.26	1.06	3.08	3
1 month	31	81	50	104	13	0.49	1.05	2.27	0
2 months	36	83	63	105	13	0.40	0.50	2.40	0
3 months (follow-up 1)	36	80	55	105	13	0.45	0.59	3	0
4 months (follow-up 2)	36	80	65	105	13	0.40	0.55	2.50	0

At 1 and 2 months (During and post-rehabilitation)

In comparison with the baseline data, there was a significant improvement in balance. The Berg Balance Scale (BBS) score increased from 26 at baseline to 36 out of 56 after 2 months. Additionally, the Indian Stroke Scale (ISS) score rose from 74 to 83. There was an improvement in 6MWT distance, increasing from 40 meters to 63 meters; however, this improvement was not statistically significant, as the Minimal Clinically Important Difference (MCID) for 6MWT is 44 meters. [14]

The Functional Independence Measure (FIM) also showed significant improvement, increasing from 83 to 105 after 2 months, exceeding the MCID value for stroke, which is 22.[15]

Trunk function demonstrated a slight increase; the Trunk Impairment Scale (TIS) score went from 11 to 13, but this change was clinically insignificant.[16]

The performance on the 5-time sit-to-stand test improved drastically, reducing from 1.26 minutes to only 40 seconds after 2 months.

In the 10-meter walk test, the baseline times were 1.6 minutes with a walker and 3.8 minutes without a walker. After 2 months, these improved to 0.50 minutes with a walker and 2.40 minutes without.

Lastly, the number of falls significantly decreased, going from 3 times at baseline to 0 times after 2 months of treatment.

At 3 and 4 months (Follow-up)

By the third month, the patient was not exercising regularly, leading to a decline in his condition and some unchanged parameters. The Berg Balance Scale (BBS) score remained the same as the previous month at 36/56. However, the Indian Stroke Scale(ISS) score decreased from 83 to 80, and the distance for 6MWT also reduced from 63 meters to 55 meters. The Functional Independence Measure (FIM) score remained unchanged at 105-126, indicating no progress. There was no improvement in the Trunk Impairment Scale (TIS), which stayed at 13. The time for the Five Times Sit-to-Stand (5TSTS) test increased by 0.5 minutes, and the time for the 10-meter walk test also increased. The number of falls remained unchanged at 0, consistent with the previous month.

Recognizing the importance of consistent treatment, we provided education to the patient and encouraged him to do regular exercise. By the fourth follow-up month, all parameters were closer to those recorded in the second month.

Discussion

This case report demonstrates that two months of intensive, goal-oriented functional rehabilitation significantly improves the patient's condition.

Research has highlighted the importance of education and counseling as key components in neurorehabilitation management.[17] Education was provided to the patient and caregiversregarding the importance of healthcare management, lifestyle behavior changes, and self-monitoring

The case also demonstrates a significant improvement in balance, as measured by the Berg Balance Scale (BBS) and the Trunk Impairment Scale (TIS), following balance training.A systematic review indicates that exercise therapy, including balance training, leads to gains in balance capacity.Such interventions can foster meaningful neurological adaptations. Engaging in repetitive balance tasks promotes neuroplastic changes in the brain, facilitating motor relearning and improved coordination. [18]

Perturbation-based balance training (PBT) has been shown to enhance balance by improving reactive balance control and reducing the risk of falls. Itdecreases the number of compensatory steps taken in response to perturbations, indicating improved stability and balance control.[19]

Our balance training also included Task-specific training that closely mimics real-life balance challenges, which enhances the transfer of training effects to daily activities, ultimately improving overall functional mobility.[20] Task-oriented training (TOT) incorporates timed mobility and dynamic balance activities based on daily life demands,significantly improving balance. This approach promotes neuroplasticity, enhances motor control, and facilitates functional task performance. [(21)(22)]

Our patient showed substantial improvement in gait and dynamic balance through gait training with BWSTT, stair gait training, slope training, and task-oriented transfer training. This method enhances gait parameters by improving walking speed, endurance, and balance.[(23)]

Overground gait training enhances coordination and control, leading to improved ambulation. It significantly increases walking speed, endurance, and functional mobility.[(23)]

Walking backward requires greater postural control and proprioceptive feedback, which can enhance balance, stability, and overall gait performance. It significantly improves gait speed, stride length, cadence, and balance in chronic stroke patients due to the increased demand for postural control and coordination during this activity.[(24)]

We also provided stair gait training, as itreduces fall incidents and improvesthe ability to perform independent activities. It enhances walking ability and shows positive results in the swing phase of walking.[(25)]

The patient received 20 minutes of Task-Oriented Training (TOT) for bathing, eating, and dressing. TOT has been shown to improve functional outcomes in chronic stroke patients by enhancing neuroplasticity, motor control, and daily activity performance, ultimately promoting greater independence.[(26)]

Improvements were observed at both the 1-month and 2-month follow-ups. But at 1st follow-up,some amount of reduction in a few outcome measures was seen, so educationwas provided to improve adherence to exercise. By the 2nd follow-up, the patient demonstrated significant recovery and maintained functional status. A recent review has alsosuggested that integrating psychosocial education into rehabilitation programs can enhance adherence and overall results.[(27)]

Conclusion

This case report highlights that intensive, goal-oriented functional rehabilitation over two months can lead to significant improvements in patient outcomes, particularly in balance, gait, and functional mobility. The targeted use of balance training, task-oriented therapy, and gait-related interventions facilitated meaningful neuroplastic changes and enhanced motor relearning, resulting in improved independence in daily life activities. Incorporating education, counselling, and psychosocial interventions proved essential for fostering adherence and sustaining gains throughout the rehabilitation process. These findings underscore the importance of tailor-made, goal-oriented neurorehabilitation strategies in promoting recovery for chronic stroke patients.

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Conflicts of Interest Statement

We declare that there are no conflicts of interest related to this article / study. All findings, conclusions, and recommendations are made objectively and impartially.

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Patient Navigators in Home Health: Enhancing Community Engagement, Rehabilitation and Addressing Social Determinants of Health in Older Adults

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Abstract

Social isolation and limited community engagement are critical challenges faced by home-bound older adults, resulting in decline in functional mobility, nutrition, and decreased access to care. This commentary highlights the potential role of trained patient navigators in the home health setting to address these social determinants of health. In particular, patient navigators can strengthen access to rehabilitation services such as physiotherapy (PT) and occupational therapy (OT), ensuring timely initiation, adherence, and continuity of care. Patient navigators can help bridge critical service gaps and enhance overall well-being in aging populations by assessing patient's physical, mental, and social needs and connecting them to healthcare, rehabilitation and community resources.

Keywords: home health, navigators, community, social determinants

Impact of Isolation and Disconnection

Social isolation can lead to the feelings of loneliness and depression which can affect motivation to participate in exercise, mood, appetite and overall well-being.

An individual's health is affected by the social and environmental conditions in which they live, work and breathe. People are increasingly feeling lonely especially after Covid-19pandemic[1]. Lack of motivation can result in decreased physical activity and weakness. Over-time, this can lead to gait instabilities, poor posture, decreased endurance and falls[2].

Community engagement is a critical social determinant of health. It refers to active participation and integration of organizations, individuals and communities with the sole purpose of improving the well-being and health of society as a whole.

One of the benefits of living in a community is that it boosts mental acuity. Interactions with individuals and connecting socially for participation in activities can stimulate cognitive abilities. Home-bound patients who do not have access to these engagements become susceptible to cognitive impairments. They can have difficulty in making decisions ultimately affecting their ability to perform tasks independently.

Nutrition is another area of concern for the home-bound. Consuming packaged and processed foods is a precursor to chronic debilitating medical conditions. In a study published by Cambridge University Press, dietary specific social groups

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had positive impact on healthy eating habits of community dwelling middle and older aged individuals[3]. Home-bound patients who have limited or no access to community-based transportation or healthcare services can suffer from delayed treatments or unmanaged medical conditions only worsening their functional limitations.

For the home-bound older adults, lack of community engagement can cause social isolation, functional decline and reduced or delayed access to care negatively affecting their quality of life. Trained patient navigators can fill the gap by assessing financial, social and physical needs of such patients and connecting them to community and healthcare resources. For rehabilitation professionals, these factors compound to increase fall risk, deconditioning, and decline in activities of daily living (ADLs), highlighting the need for navigators to ensure timely referral to physiotherapy and occupational therapy services.

History of Patient Navigation

Dr. Harold Freeman established the concept of patient navigation in 1990 at Harlem Hospital after the American Cancer Society conducted national hearings about barriers that low-income cancer patients faced when accessing timely medical care[4]. Dr. Freeman's program addressed financial barriers and access challenges and health system literacy problems to achieve better patient results and survival statistics. Currently, patient navigators provide their services not only for cancer care, but also for chronic disease management, transitional care and community-based healthcare delivery to reduce health disparities in various population groups[5].

Patient Navigator Models

The healthcare system implements multiple patient navigation models which addresses different healthcare needs. Traditional models use trained community health workers as lay navigators to connect patients with healthcare services while building trust and improving accessibility for marginalized populations[6]. Professional navigator models utilize nurses and social workers to provide clinical guidance and care coordination services for patients with complex medical or psychosocial requirements[7].

The hybrid and matrix models use both lay and professional navigators at different points in the care process to achieve maximum benefits from community outreach and high-acuity case management through multidisciplinary teams that receive cross-training to help patients obtain education and prevention services and treatment and support services[8]. The combination of technological advancements has led to the development of AI-assisted navigation systems which automate intake procedures and triage functions and follow-up processes while providing personalized support to decrease staff burnout in high-demand or resource-constrained settings[9]. The evolving engagement models enhance patient-centered care through better access and care coordination and higher satisfaction and improved health outcomes for different population groups.

Rehabilitation-oriented navigation models are beginning to emerge, where navigators coordinate PT and OT referrals, track functional progress, and support adherence to exercise programs post-discharge.

Patient Navigators in Rehabilitation: Linking Physiotherapy and Occupational Therapy

Older adults need rehabilitation through physiotherapy and occupational therapy to preserve their independence and functional abilities. Patient navigators can serve as essential figures who help older adults access rehabilitation services and maintain proper adherence to their treatment plans.

Patient navigators canassist patients start their rehabilitation process on time while maintaining continuous care through scheduling appointments with physiotherapists and occupational therapists. The navigators can explain the importance of rehabilitation services to patients and their caregivers while assisting them in developing recovery targets that both parties find important[10]. They can evaluate physical disabilities and home safety conditions and social barriers to provide assistance with medical equipment and transportation services and home improvement needs. The patient navigators can connect patients to home-based therapy services after hospitalization by ensuring a smooth transition and fighting for post-discharge rehabilitation support.

The medical field now acknowledges occupational therapists as expert patient navigators who perform functional assessments and deliver education to patients and their families while fighting for fair treatment[11]. The implementation of patient navigation services within rehabilitation programs leads to better patient participation rates while decreasing abandonment rates and enabling patients to recover their mobility and independence and self-care abilities. This creates a bridge between acute hospital care, home health rehabilitation, and community-based wellness programs. Patient navigators link older adults to medical care and rehabilitation professionals which enhances their chances of complete recovery through physical and cognitive and psychosocial restoration while providing comprehensive home-based care.

Training Pathways and Cost

Patient navigator training programs now follow structured competency-based models which serve both community health workers and licensed professionals. The core training programs teach essential competencies which include healthcare system navigation alongside communication skills and motivational interviewing and ethical practices. Future training modules can include functional assessment and rehabilitation care pathways and PT/OT interventions to enhance navigators' ability to support rehabilitation adherence.

Training delivery methods span from brief courses to extensive blended programs and their expenses depend on accessible resources. The training programs in high-income nations such as USA require official certification but low- and middle-income countries deliver practical cost-effective methods which match their healthcare requirements. For India and similar contexts, scalable and affordable training modules that integrate rehabilitation awareness would be crucial, as they can equip navigators to connect patients with physiotherapy and occupational therapy services, community-based fall prevention programs, and assistive technology support.

Navigators in Low-Resource Settings

Patient navigation implementation in low-resource settings demands customized approaches that match local conditions and available resources and address the specific requirements of marginalized communities[12]. In rehabilitation, this often includes limited access to PT/OT clinics, lack of adaptive equipment, or absence of structured fall-prevention programs. Navigators can help bridge these gaps by connecting patients to locally available rehab resources or low-cost community programs.

Recent case studies show these strategies being used in various settings. A rural district hospital in Nepal used patient navigation by employing local community members and creating visual navigation cues and making navigators an integral part of the care team's management and communication systems[13]. The approach enhanced patient satisfaction and strengthened marginalized patients while remaining practical for areas with limited health literacy and infrastructure. On another front, a United States hospital program trained bilingual lay navigators to assist underserved populations with post-emergency department follow-up through regular telephone communication and tailored appointment reminders and strong community resource linkage. The results showed better patient-provider communication and improved care adherence[14]. Another international scoping review demonstrated that community-sourced navigators enhanced healthcare access because they shared geographic and cultural ties with their service population while showing that navigator selection transparency and community alignment remain essential for success in low-income and under-resourced settings[15].

Challenges and Barriers

Despite their promise, patient navigation programs encounter multiple ongoing barriers which affect their operational success and long-term maintenance. The main challenge for navigation initiatives stems from unstable grant funding because they lack sustainable reimbursement systems which makes their financial stability uncertain[16]. The financial constraints directly impact the ability to maintain ongoing programs and deliver trained staff and high-quality services.

Another obstacle to success includes unclear roles and inconsistent standards because different organizations implement various responsibilities and protocols for their navigators. The inconsistent approaches between organizations create difficulties in team coordination and healthcare team integration and make it challenging to assess and replicate successful programs across different scales[17]. Burnout and workload challenges is yet another challenge that result in exhaustion among navigators and decreased job satisfaction and potential staff departures[18].

From a rehabilitation perspective, barriers include limited insurance to no coverage for PT/OT, transportation challenges to outpatient clinics, and lack of awareness among patients about the importance of ongoing rehab. Navigators could address these gaps by advocating for coverage, coordinating transportation, and reinforcing the role of PT/OT in recovery.

Unreliable internet connections, inconsistent electronic health record usage and limited digital device availability particularly in rural and low-resource settings where patient and healthcare provider access are difficult make communication difficult and stressful. Collectively, these obstacles demonstrate why patient navigation requires structural investments together with standardized professional standards and supportive systems to improve patient care.

The Case for Patient Navigators in home health

Currently, patient navigators have been playing a vital role in cancer care, ambulatory care and other transitional care settings[19]. They are vital for timely access to healthcare services from diagnosis to completion of care. I believe trained patient navigators for community dwelling elderly and home-bound patients can be pivotal in addressing the health outcomes. They would be trained professionals who are able to navigate the complex healthcare settings and bridge the gap between home-bound patients and the appropriate medical care.

They would assist the community members by assessing their specific health and rehabilitation needs including the social, mental and physical factors affecting them and their health conditions. They would also assess their financial and employment status and ability to afford health insurance and healthy meals. Based on this assessment, they would provide referral to the available healthcare resources, physiotherapy and occupational therapy, support groups, food banks, local healthcare communities, preventive measures and lifestyle changes. Trained patient navigators would have wealth of information to connect individuals with clinics, hospital providers and specialists. Additionally, they can refer patients for financial assistance, social services, housing resources and specific organizations that address the most basic needs and social determinants of health such as food, water, sanitation, pest control, transportation and housing.

Conclusion

Patient navigators would be involved with the individual from admission until their discharge from services. They would be able to advocate on behalf of their patients to receive timely care which includes setting up medical appointments, ensuring appropriate mode of transportation and assisting patients with insurance or financial issues. Their role bridges the gap between physical therapy, community services, and healthcare systems. When integrated into rehabilitation care, navigators can support PT and OT referrals, reduce abandonment of therapy, and ultimately preserve mobility, independence, and quality of life for older adults.

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Conflict of Interest: Nil

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Short Term Effects of Hypopressive Breathing Technique and Conventional Therapy on Pelvic Floor Dysfunction, Anxiety and Quality of Life in Post-Operative Hysterectomy

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Abstract

Background: Hysterectomy is the partial or total surgical removal of the uterus. The symptoms of post-operative hysterectomy include pelvic floor dysfunction, urinary incontinence, anxiety and decreased quality of life. Hypopressive breathing exercises activate deep muscles in the abdomen and pelvic floor. This technique has shown significantly reduced Pelvic floor dysfunction symptoms and enhanced quality of life in women with Pelvic dysfunction, Pelvic organ prolapse & Urinary incontinence. But till date, very few studies focused on postoperative hysterectomy women.

Objective: To compare the effectiveness of hypopressive breathing technique and conventional therapy on pelvic floor dysfunction, anxiety and quality of life in postoperative hysterectomy.

Methods: In this Quasi-experimental study, 128 post operative hysterectomy subjects were obtained from the Department of obstetrics and gynaecology. They were assigned into 2 groups based on convenience sampling, Group A (hypopressive breathing technique with conventional therapy) and Group B (conventional therapy). The eligible subjects were assessed by pelvic floor dysfunction inventory questionnaire (PFDI-20), Hamilton anxiety rating scale (HARS) and WHO quality-of-life questionnaire (QOL). After 2 weeks the post test was done. Data were analyzed using paired – t test, Independent – t test, Wilcoxon signed rank test and Mann Whitney U test.

Results: Both groups showed significant within-group improvements in all outcome measures ($p < 0.05$). Group A's WHO-QOL improved from 56.33 ± 8.21 to 80.14 ± 12.93, and Group B's from 59.19 ± 10.00 to 77.28 ± 15.17. No statistically significant between-group difference was observed ($p > 0.05$), though Group A demonstrated higher mean improvements in pelvic floor function and anxiety reduction.

Conclusion: Hypopressive breathing technique along with conventional therapy showed significant reduction in symptoms of pelvic floor dysfunction, anxiety and improvement in quality of life within the group but there was no significant difference between the groups on post-operative hysterectomy women.

Keywords: Hysterectomy, Hypopressive breathing technique, Pelvic floor dysfunction, Anxiety, Quality of life.

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Back Ground

Hysterectomy is the partial or total surgical removal of the uterus, and with age-specific prevalence of 0.36% among women aged 15-29; 3.59% among women aged 30-39; and 9.20% among women 40-49 years[1]. Hysterectomy is most commonly observed in women aged 45 to 59 years and is more prevalent among married women[1]. The major indication of hysterectomy is abnormal uterine bleeding which is due to myomas and adenomyosis. Other causes which leadto hysterectomy are dysfunctional vaginal bleeding (41.7%), endometriosis (3%), and uterine prolapse (18.2%) [1].

Hysterectomy can be performed in various ways, including: (a) vaginal hysterectomy, (b) laparoscopic hysterectomy, (c) abdominal hysterectomy, and (d) total hysterectomy[9]. Among these, laparoscopic hysterectomy is the most commonly performed procedure. Minor complications associated with hysterectomy include fever, bleeding, and infection. Potential adverse effects include pelvic floor dysfunction, depression, anxiety, urinary tract infections, urinary incontinence, and sexual dysfunction.

Pelvic floor dysfunction can manifest as increased activity (hypertonicity), decreased activity (hypotonicity), or poor coordination of the pelvic floor muscles. When these muscles fail to function properly, individuals may experience distressing symptoms such as urinary incontinence, faecal incontinence, pelvic organ prolapse, and sexual dysfunction. The impact of PFD can significantly affect the quality of life across four dimensions: physical, psychological, social, and financial. Hypotonic pelvic floor muscles may result in symptoms like urinary incontinence and a sensation of heaviness in the vagina[11]. Conversely, hypertonic pelvic floor muscles can lead to constipation, urinary retention, tailbone pain, and bladder pain.

The risk of depression and anxiety is higher among women with gynaecological surgeries because of associated with an uncertain future. However, hospitalization for surgery is associated with increased anxiety and negative effects on postoperative recovery and preoperative anxiety has different impacts on postoperative pain[6]. Disruptions in luteinizing hormone (LH) and oestrogen regulation after a hysterectomy is considered to be the major mechanism that causes these patients to experience increased depression risk. Women who underwent oophorectomy alongside hysterectomy exhibited higher anxiety-related scores, lower scores in sexual function, and weaker partner relationship. These procedures collectively contributed to an increased risk of depression[10].

The traditional exercise regimen prescribed for patients recovering from a hysterectomy includes a range of targeted movements designed to aid in rehabilitation and enhance overall physical well-being. These exercises typically encompass ankle pumps and rotations to improve circulation and prevent stiffness, active calf stretches to maintain flexibility, and Kegel exercises to strengthen the pelvic floor muscles. Deep breathing exercises are included to promote relaxation and optimize respiratory function. Additionally, alternate knee bending helps to maintain joint mobility, while static straight leg raises (SLR) focus on strengthening the lower extremities. Movements such as the posterior pelvic tilt and pelvic rotation are incorporated to improve core stability and support the recovery of pelvic region functionality. Together, this comprehensive program addresses multiple aspects of post-surgical recovery, fostering strength, mobility, and overall health.

Hypopressive breathing exercises involve the reflex activation of the pelvic floor muscles through specific postures and breathing techniques[3]. There are 33 documented Hypopressive postures, performed in various positions such as standing, kneeling, quadruped, sitting, and supine. During the Hypopressivemaneuver, the patient fully exhales to elevate the diaphragm, closes the glottis, and expands the rib cage and abdomen to reduce intra-abdominal pressure. This reduction in pressure triggers the automatic activation of postural muscles, including the pelvic floor muscles (PFMs), by combining apnea with changes in intra-abdominal pressure[13].

Hypopressive breathing exercises are designed to engage and activate the core muscles while simultaneously strengthening the pelvic floor[4,5]. These exercises focus on improving the function and tone of the muscles that support the abdomen and pelvis, by using controlled breathing techniques that emphasize breath retention and specific body postures. This combination of breathing and positioning works to increase muscle activation in the core and pelvic region, contributing to enhanced stability, strength, and overall pelvic health. These exercises involve a combination of breath holds and specific postures that create a vacuum effect in the abdomen. The technique focuses on expanding the ribcage laterally while pulling the abdomen inward[3,4,5].

The Hypopressive breathing technique has demonstrated significant benefits in alleviating symptoms of pelvic floor dysfunction (PFD) while improving the quality of life for women experiencing conditions such as pelvic organ prolapse and urinary incontinence. Despite these promising outcomes, there remains a notable gap in research specifically addressing its application and benefits for women recovering from hysterectomy surgery. To date, only a limited number of studies have explored the potential role of Hypopressive breathing techniques in supporting postoperative recovery in this population, highlighting the need for further investigation in this area.

Thus, the present study is therefore undertaken to examine the short-term effect of Hypopressive breathing technique and conventional therapy on pelvic floor dysfunction, anxiety and quality of life in patients who underwent hysterectomy.

Hypotheses

Null Hypothesis (H_0)- There will be no significant improvement in pelvic floor muscle function, reduction in anxiety and in improving quality of life following Hypopressive breathing technique.

Alternative Hypothesis (H_a)-There will be a significant improvement in pelvic floor muscle function, reduction in anxiety and in improving quality of life following Hypopressive breathing technique.

Material and Methods

Materials

Couch, Foot stool, Pillows for support and bed spread & Questionnaires for assessing pelvic floor dysfunction, anxiety, and quality of life.

Methodolohy

Study Design: A Quasi-experimental study - pre and post design.

Study Setting: Department of Obstetrics and Gynaecology, PSG Hospitals,Peelamedu, Coimbatore.

Human Participation Protection: The study was reviewed and approved by Institutional Human Ethics Committee at PSG IMSR, Coimbatore. (PSG/IHEC/2023/Appr/Exp/318)

Study Duration: 13 months (During the period between 27, November 2023 – 27, December 2024)

Population: 128 (sample size calculated using G*power 3.1.9.7 software)

Sampling Method: Sampling method by Convenience sampling method

Randomization was not feasible due to the clinical setup and availability of patients within the same postoperative ward, where ethical and logistical constraints limited random allocation. Thus, a quasi-experimental design with convenience sampling was selected to ensure feasibility while maintaining internal validity.

Treatment Duration

GROUP A(n=64)	**GROUP B**(n=64)
Hypopressive breathing exercise[3,4] & conventional therapy	Conventional therapy
Hypopressive exercise for 10 minutes and conventional therapy for 55 minutes **Treatment duration on POD 2:** 65 minutes per session, 2 times a day which is given for alternate days for 2 weeks.	Conventional therapy for 55 minutes **Treatment duration on POD 2:** 55 minutes per session, 2 times a day which is given for alternate days for 2 weeks.

The two-week intervention period was chosen to coincide with the immediate postoperative phase, during which pelvic floor reactivation and anxiety management are essential for optimal recovery. Extended intervention periods were not feasible due to early hospital discharge of the patient.

Criteria for Sample Selection

Inclusion Criteria:

- Females between 35-50 years
- Hysterectomy (vaginal and laparoscopic)
- Pelvic Floor Dysfunction grading (score 16-34)
- Hamilton Anxiety Rating Scale (score from severe – very severe)
- Pain score ranges from mild to moderate
- Informed consent and subjects willing to participate in the study.

Exclusion Criteria

- Urinary tract infection immediately after surgery
- Neurological disease
- Uncontrolled Hypertension
- Hiatal hernia
- Cardio respiratory disease

Instruments and Tools for Data Collection

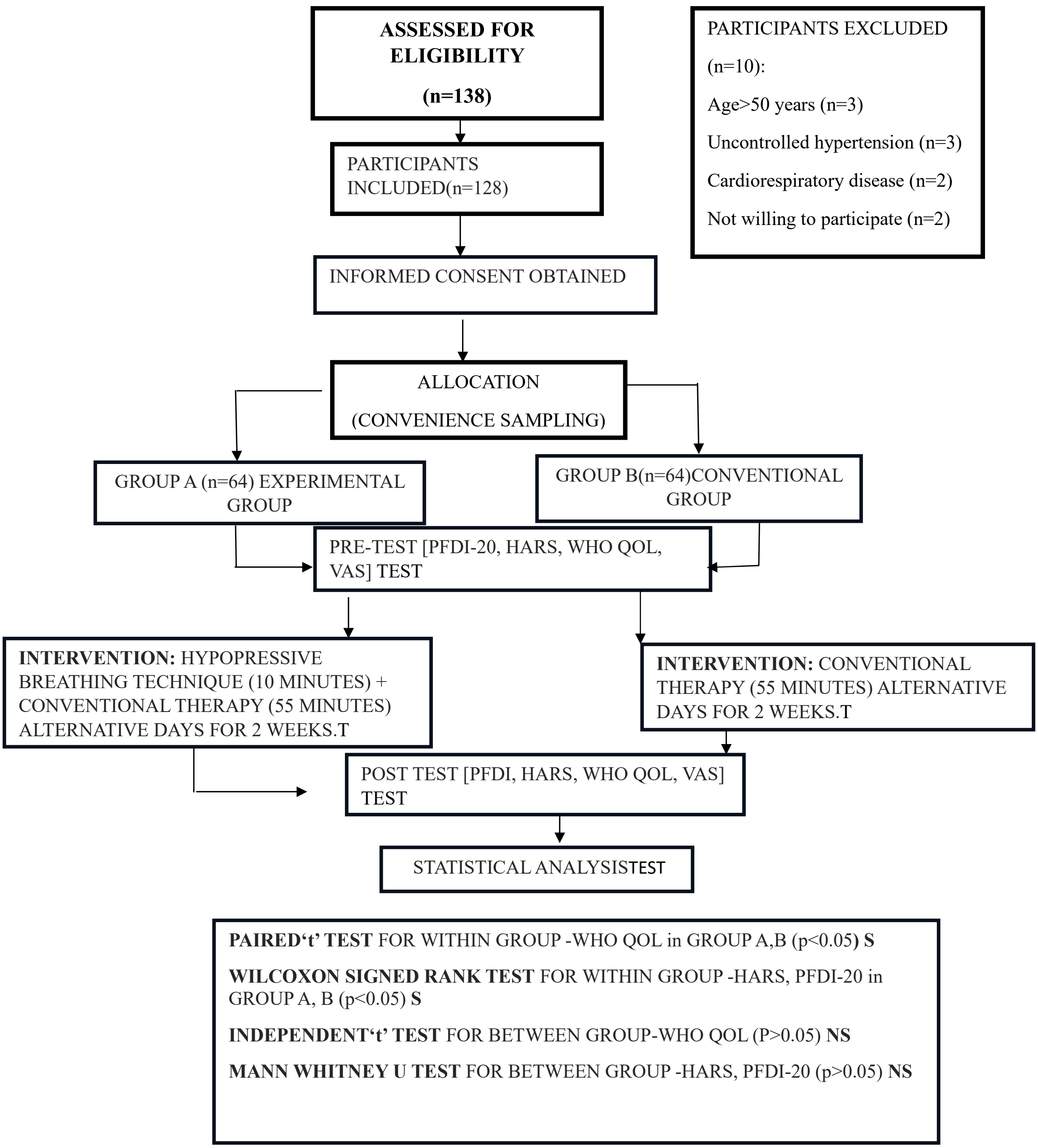
- Pelvic floor distress inventory questionnaire (PFDI-20) to assess pelvic floor muscle strength.
- Hamilton anxiety rating scale to rule out the anxiety the patient experienced.
- WHO Quality of life (WHO QOL) to evaluate the well-being of the patient.
- Visual analogue scale (VAS) to grade the pain.

Technique of Data Collection

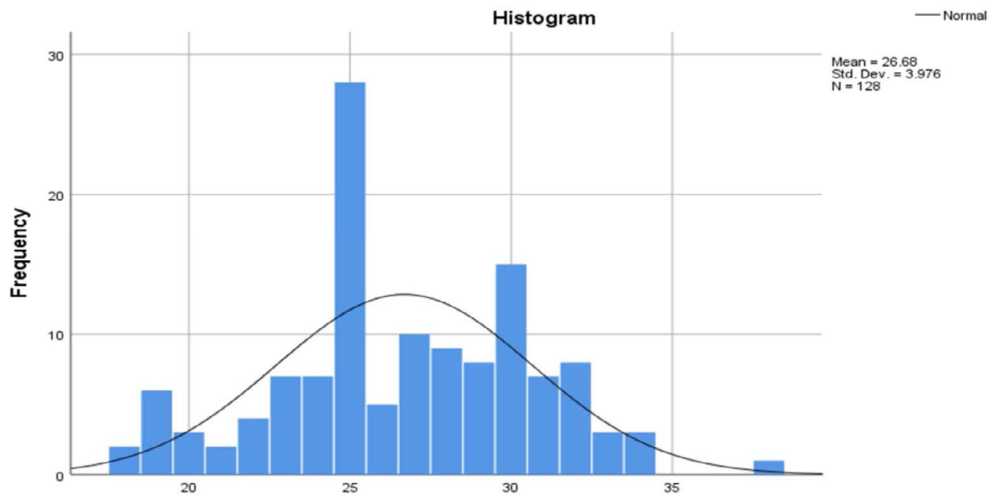
128 subjects who had undergone hysterectomy were obtained from the Department of obstetrics and gynaecology, based on inclusion and exclusion criteria. The informed consent was obtained from them. They were assigned into two groups based on convenience sampling, Group A (Hypopressive breathing technique with conventional therapy) and Group B (conventional therapy). The eligible subjects were assessed for pelvic floor dysfunction by pelvic floor dysfunction inventory questionnaire (PFDI-20), anxiety by Hamilton anxiety rating scale, quality of life by WHO quality-of-life questionnaire (WHO QOL) and Pain by visual analogue scale (VAS). After 2 weeks the post test was done. Data was collected and analysed by using Paired'ť' test & Independent 't' test for normally distributed variables and Wilcoxon signed rank test & Mann Whitney U test for non-normally distributed variables.

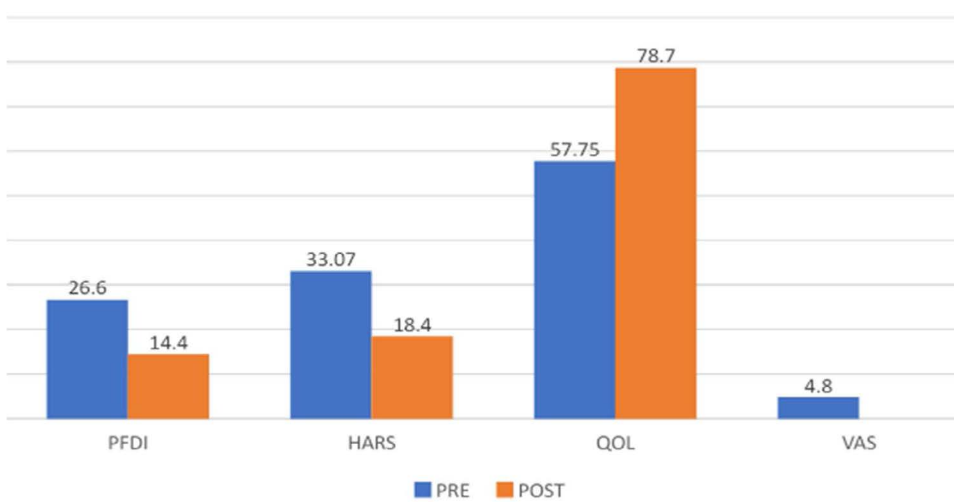
SCHEMATIC REPRESENTATION OF FLOW OF THE STUDY

POST-OPERATIVE HYSTERECTOMY WOMEN

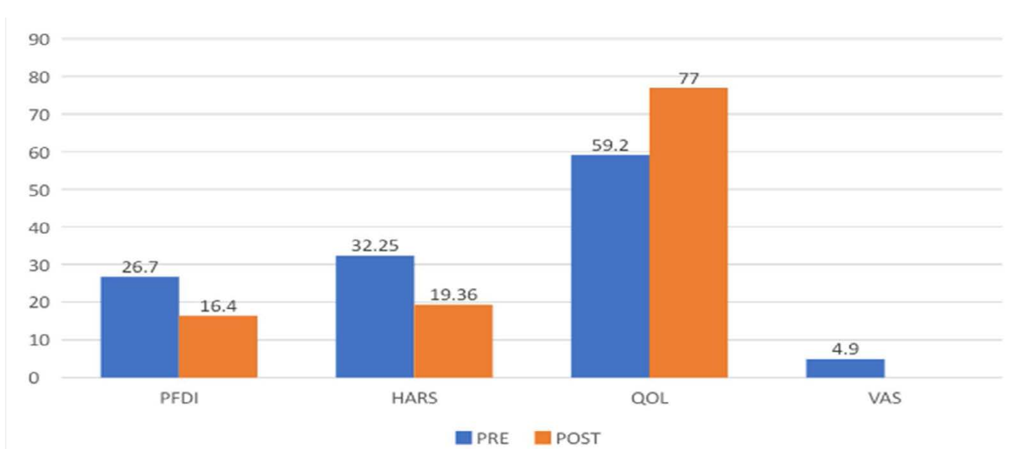


HISTOGRAM

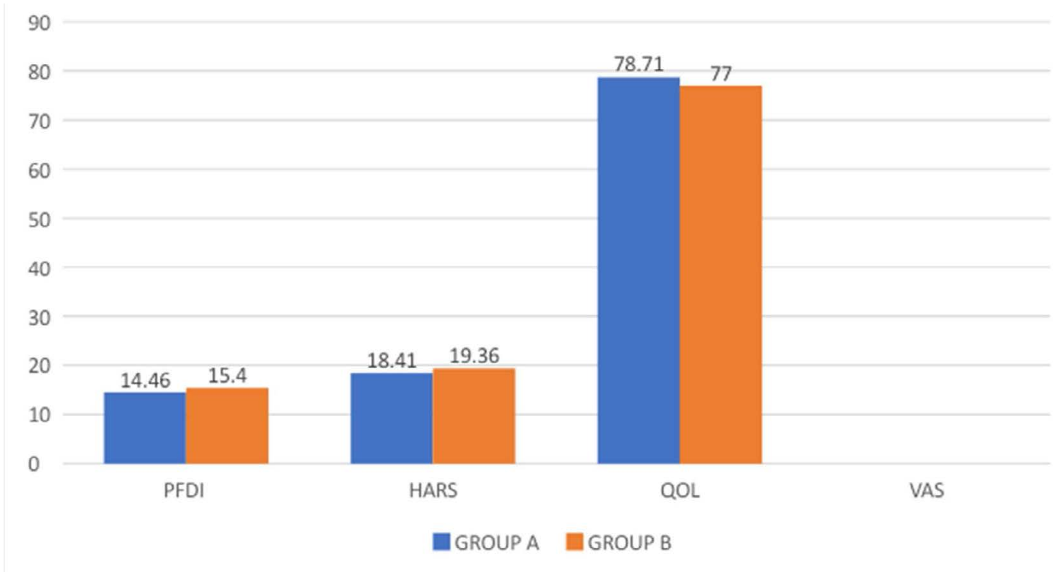




GRAPH 1: Within Group Analysis of Pfdi-20, Hars, Who Qol and Vas in Group A



GRAPH 2: Within Group Analysis of Pfdi-20, Hars, Who Qol and Vas in Group B



GRAPH 3: Between Group Analysis of Pfdi-20, Hars,Who Qol and Vas of Group A & Group B

Results

A total of 128 post-operative hysterectomy women participated in the study, with 64 subjects in Group A (Hypopressive breathing technique with conventional therapy) and 64 subjects in Group B (conventional therapy alone).

Demographic Characteristics

The majority of participants were aged between 46–50 years (51.6%), followed by 41–45 years (37.5%). Abnormal uterine bleeding was the most common indication for hysterectomy (54.7%). Total laparoscopic hysterectomy with or without bilateral salpingo-oophorectomy was the most frequently performed surgical procedure (55.4%). The demographic distribution was comparable between both groups (Table 1).

Table 1. Demographic Characteristics of Participants (n = 128)

Variable	Category	n (%)
Age (years)	35–40	14 (10.9)
	41–45	48 (37.5)
	46–50	66 (51.6)
Indication for Surgery	Abnormal uterine bleeding	70 (54.7)
	Multiple fibroids	25 (19.5)
	Leiomyoma	11 (8.6)
	Dysmenorrhoea	7 (5.5)
	UV prolapse	6 (4.6)
	Others	9 (7.1)

Continue....

Type of Surgery	TLH ± BSO	71 (55.4)
	TAH ± BSO	38 (29.7)
	Vaginal/Robotic	19 (14.9)

TLH – Total laparoscopic hysterectomy; TAH – Total abdominal hysterectomy; BSO – Bilateral salpingo-oophorectomy

Distribution of Outcome Measures

Normality testing revealed that WHO Quality of Life (WHO-QOL) scores were normally distributed ($p > 0.05$), while Pelvic Floor Distress Inventory-20 (PFDI-20), Hamilton Anxiety Rating Scale (HARS), and Visual Analogue Scale (VAS) scores were not normally distributed ($p < 0.05$). Accordingly, parametric tests were used for WHO-QOL, and non-parametric tests were applied for PFDI-20, HARS, and VAS (Table 2).

Table 2. Distribution and Normality of Outcome Measures (n = 128)

Outcome measure	Mean ± SD	Normality (p value)
PFDI-20	14.46 ± 3.90	<0.001*
HARS	18.41 ± 5.41	<0.001*
WHO-QOL	78.71 ± 12.84	0.200
VAS	0.00 ± 0.00	<0.001*

Shapiro–Wilk test; *p < 0.05 indicates non-normal distribution

Within-Group Analysis

Quality of Life (WHO-QOL)

Within-group analysis using the paired t-test showed a statistically significant improvement in WHO-QOL scores in both groups following the two-week intervention. Group A demonstrated an increase in mean WHO-QOL scores from 56.33 ± 8.22 to 80.14 ± 12.93 ($p < 0.05$). Similarly, Group B showed an improvement from 59.19 ± 10.00 to 77.28 ± 15.17 ($p < 0.05$) (Table 3).

Table 3. Within-Group Comparison of WHO-QOL Scores (Paired t-test)

Group	Pre-test Mean ± SD	Post-test Mean ± SD	Mean difference	p value
Group A	56.33 ± 8.22	80.14 ± 12.93	23.81	0.037*
Group B	59.19 ± 10.00	77.28 ± 15.17	17.99	<0.001*

p < 0.05 statistically significant

Pelvic Floor Dysfunction, Anxiety, and Pain

Wilcoxon signed-rank test analysis revealed statistically significant improvements in PFDI-20, HARS, and VAS scores in both groups following intervention ($p < 0.05$). This indicates that both hypopressive breathing combined with conventional therapy and conventional therapy alone were effective in reducing pelvic floor dysfunction symptoms, anxiety levels, and pain in post-operative hysterectomy women (Table 4).

Table 4. Within-Group Comparison of PFDI-20, HARS and VAS (Wilcoxon Signed Rank Test)

Outcome	Group A p value	Group B p value
PFDI-20	<0.001*	<0.001*
HARS	<0.001*	<0.001*
VAS	<0.001*	<0.001*

p < 0.05 statistically significant

Between-Group Analysis

Between-group comparison of post-test WHO-QOL scores using the independent t-test showed no statistically significant difference between Group A and Group B ($p > 0.05$) (Table 5).

Table 5. Between-Group Comparison of WHO-QOL Post-test Scores (Independent t-test)

Group	Mean ± SD	Mean difference	p value
Group A	80.14 ± 12.99	2.86	0.254
Group B	77.28 ± 15.17		

p > 0.05 – Not statistically significant

Similarly, Mann–Whitney U test analysis demonstrated no statistically significant differences between the groups for post-test PFDI-20, HARS, and VAS scores ($p > 0.05$) (Table 6).

Table 6. Between-Group Comparison of PFDI-20, HARS and VAS Post-test Scores (Mann–Whitney U Test)

Outcome	Group A Mean Rank	Group B Mean Rank	p value
PFDI-20	58.84	70.16	0.082
HARS	60.07	68.93	0.175
VAS	64.50	64.50	1.000

p > 0.05 – Not statistically significant

Both intervention protocols resulted in significant improvements within groups across all outcome measures. However, no statistically significant differences were observed between Group A and Group B at post-test. Despite the lack of statistical significance, Group A consistently demonstrated greater mean improvements in pelvic floor function, anxiety reduction, pain, and quality of life compared to Group B.

Discussion

The purpose of this Quasi Experimental study was to determine the short-term effects of Hypopressive breathing technique on symptoms of pelvic floor dysfunction, anxiety, and quality of life in women after hysterectomy.

Out of the 138 samples evaluated for the study, 128 patients who fulfilled the inclusion criteria took part. The age group with the highest prevalence in this study was 46–50 years old, followed by 41–45 years old. In accordance with this study, dysmenorrhea, numerous fibroids, leiomyoma of the uterus, and abnormal uterine bleeding were the most common reasons for hysterectomy. The most commonly carried out surgical procedures in this study were total laparoscopic hysterectomy with bilateral salphingo-oopherectomy and total abdominal hysterectomy with bilateral salphingo-oopherectomy.

The Hypopressive breathing technique is designed to trigger a reflexive activation of the pelvic floor muscles through specific adjustments in posture and breathing patterns. This method was found to generate a substantially higher intravaginal force compared to voluntary pelvic floor muscle contractions. Notably, the Hypopressivemaneuver, which combines apnea (breath-holding) with a rib cage lift, elicited a significantly greater intravaginal closure force. This suggests that the technique effectively stimulates pelvic floor muscle contraction, surpassing the activation required merely to counteract gravitational forces and stabilize the pelvic and abdominal regions. The interplay between breath control and postural modifications appears to enhance the engagement of these muscle groups, contributing to their strengthening and functional improvement[2].

During the Hypopressive exercise, the neuromuscular activation of the pelvic floor and abdominal muscles is likely driven by the need to stabilize the lumbopelvic region. In this study, it was observed that the specific posture adopted during the Hypopressive exercise inherently stimulated the pelvic floor muscles, the rectus abdominis, and the lateral abdominal wall muscles. This activation appears to be influenced by intra-abdominal pressure, which plays a critical role in maintaining spinal stability. Furthermore, the deliberate effort to decrease intra-abdominal pressure—achieved through techniques such as expanding the rib cage while maintaining the Hypopressive posture—may lead to a compensatory response. This response involves increased engagement of the abdominal and pelvic floor muscles to support stabilization and maintain proper alignment during the exercise[2].

The benefits of Hypopressive abdominal breathing exercise protocols can be viewed as an intervention that attempts to maintain or improve the overall psychophysical condition, the proper functioning of an overloaded body, or full recovery following illnesses, injuries, or respiratory fatigue states, according to earlier research on the subject conducted by Maria del Carmen Herena-Funes[20]. Hypopressive breathing technique could help women maintain their physical condition and general wellness. These findings were in accordance with our research, which revealed that post-operative hysterectomy women's quality of life significantly improved.

This study shows that there was a significant reduction in pelvic floor dysfunction after performing Hypopressive exercise with a significant value of $p<0.05$ when comparing pre-test and post-test in Group AHypopressive breathing exercise. This was supported by Beatriz Navario Brazalaz, et al., (2020) who concluded that pelvic floor muscles, abdominals, gluteal, and adductor muscles are activated during the performance of Hypopressive breathing exercise[3]. Jyothi Parlae, et al., (2021) also showed the reduction of symptoms in pelvic organ prolapse Grade (1 & 2) with help of Hypopressive breathing exercise[2].

This study also shows that there was significant reduction in the anxiety with a significant value $p<0.05$ after performing Hypopressive breathing exercise. These findings came in the same line with Wafaa Mostafa Ahmed Gamil, etal., (2022) who revealed that early ambulation and deep breathing exercise among the women undergoing abdominal hysterectomy may serve as an effective intervention to improve pain, minimizing anxiety and enhance of physiological outcome mainly oxygen saturation which helps in promoting patient's relaxation and enhance the post operative recovery and tissue healing[7].

In this study, there was also a significant improvement in quality of life with $p<0.05$, when performing within the group analysis after performing Hypopressive breathing exercise. It was supported by a case report which was conducted in 2021 by Neha N. Bhagdewani, et al., who emphasized the effect of combination of different exercises for pelvic floor muscles allowing the patients to recover early and return to daily activities[21].

Thus, with the reference to the statistical analysis done from the collected data, there was a significant reduction in symptoms of pelvic floor dysfunction, anxiety and pain and improvement in quality of life within the group analysis in Group A and B and there was no significant difference between the group analyses.

Although between-group differences were statistically non-significant, the greater mean improvement in the hypopressive group indicates potential clinical relevance. In early post-hysterectomy rehabilitation, small functional and psychological gains can expedite recovery, improve confidence, and enhance patient adherence. The non-significance might be attributed to short intervention duration, limited sample heterogeneity, and the quasi-experimental design rather than a lack of physiological effect.

Limitations

- This study was limited by the absence of randomization and short-term intervention, which restricts long-term interpretation
- External factors (visitors time, immediately after food intake) extended the time taken for each sample
- The participants found it uncomfortable to answer a few of the questions asked in Hamilton Anxiety Rating Scale and WHO Quality of Life questionnaires since they had questions about their personal life.
- There was delay in picking up the call by the patient for tele-rehabilitation.
- The participant's capacity of understanding exercise has some influence on performance.
- The participant's motivation for carrying out the exercises would have a distinct impact on the effects.
- The use of self-reported questionnaires may introduce response bias.
- The study sample was confined to a single hospital, limiting generalizability.

Suggestions

- Adherence to exercise program in home setting can be assessed in the future studies
- Preoperative assessment can be added in future studies.
- Along with Hypopressive breathing technique, other pelvic floor strengthening techniques can be included in the protocol for better results.
- Future research could look into whether scheduling periodic follow-up of treatment sessions would improve benefits obtained.
- Future research should employ randomized controlled trials with extended follow-up, larger sample sizes, and combined pelvic floor strengthening strategies to confirm these findings.

Conclusion

- The study was conducted to compare the effect of Hypopressive breathing technique along with conventional therapy on pelvic floor dysfunction, anxiety and quality of life in post-operative hysterectomy.
- With the reference to the statistical analysis done from the collected data of Pelvic floor dysfunction inventory questionnaire, Hamilton anxiety rating scale, quality of life questionnaire and visual analogue scale there was a significant reduction in symptoms of pelvic floor dysfunction, anxiety and pain and improvement in quality of life within the groups and there was no significant difference between the groups in post-operative hysterectomy women. But, when comparing the post-test mean values, Group A (Hypopressive breathing technique along with conventional therapy) shows higher improvement than the Group B (Conventional therapy).

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The Effectiveness of Cognitive Behavioral Therapy (CBT) and Recreational Activities on Psychological Morbidities and Quality of Life (QOL) in Traumatic Spinal Cord Injury: A Pilot Study an Original Research Article

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Abstract

Background: Spinal Cord Injury (SCI) presents with life changing consequences altering the physical, social, vocational aspects of a person at the same time leading to multiple psychological morbidities. Depression, anxiety, and Post Traumatic Stress are the three most common psychological issues seen in SCI population. Alterations to basic physiologic functions, intense emotions, disruption of social relationships, and barriers to participating in their usual activities – leads to a compromise in their Quality of Life (QoL). Cognitive Behavioral Therapy(CBT) administered along with recreational activities could prove to an effective mode of intervention for better mental health and QoL of traumatic SCI patients.

Objectives: To evaluate, as a pilot feasibility study, the preliminary effects of CBT combined with recreational activities on stress, anxiety, depression, and QoL in patients with traumatic SCI.

Study Design: Pilot pre–post feasibility study

Methods: A total of 30 subjects were taken for the study as per the inclusion criteria, outcome measures used were DASS-21 and WHOQOL-BREF. Total duration of therapy was 6 weeks. 1 session for 2 hours per week was taken for initial 3 weeks. In the last 3 weeks 2 sessions per week for 2 hours duration was administered. Each session was followed by 15 minutes of recreational activities. Therapy was administered in a group mode.

Results: Wilcoxon signed rank test revealed that there was preliminary improvement in DASS scores post intervention (Z= -4.183, p=<0.001). Similarly, a statistically significant increase in QoL was seen post intervention (Z= -4.375, p= <0.001).

Conclusions: Administration of CBT along with recreational activities to subjects with Depression, Anxiety and Stress and reduced QoL post traumatic SCI appears feasible and shows promise as an intervention; results are preliminary and will inform a larger definitive trial.

Key Words: Spinal Cord Injury, Post Traumatic Stress Disorder, Cognitive Behavioral Therapy, Quality of Life.

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Introduction

Traumatic SCI is a sudden and life-altering occurrence that profoundly affects an individual's health, capabilities, involvement in society, and overall well-being. Typically deemed as a permanent condition, any potential recovery of function is largely constrained to the initial two years after the injury. Beyond this timeframe, significant improvements in functional abilities are rare, leading to mostly minor changes, but there can be enduring effects on one's quality of life and mental health.[1] SCI involves not only severe physical, social, but also psychological consequences.[2] SCI population has higher incidences of psychological morbidities when compared with the general population.[3] The prevalence of depression is notably higher, nearly twice as much, within the population of individuals with SCI when compared to the general population.[4] While this heightened incidence has traditionally been attributed to the psychological, economic, and social challenges inherent to SCI. More than half of the considerable number of individuals undergoing rehabilitation after experiencing a SCI encountered difficulties related to anxiety and somatization, which involves physical symptoms arising from psychological distress.[5] Post-Traumatic Stress Disorder (PTSD) represents another commonly observed health issue among individuals with SCI, with its occurrence ranging in prevalence from 7% to 44%.[6] Thus, Depression, anxiety, and PTSD have become the three most common psychological morbidities in the SCI population.[7] QoL is a term used to evaluate individuals' wellbeing in a wide range of contexts. For patients with SCI, achieving a satisfactory QoL is a primary goal of treatment and rehabilitation.[8] Individuals who sustain SCI must adjust immediately to a new way of life that is often characterized by significant physical limitations, alterations to basic physiologic functions, intense emotions, disruption of social relationships, and barriers to participating in their usual activities – essentially, every possible area compromising quality of life (QoL).[9] CBT is a structured, short termed, present oriented psychotherapy directed toward solving current problems and modifying dysfunctional (inaccurate and/or unhelpful) thinking and behaviour[10] Individuals who experience high levels of anxiety and depression can benefit significantly from therapies such as CBT. In fact, research suggests that individuals with SCI can be `immunized' against anxiety and depression if CBT is provided early on in their rehabilitation following injury. Levels of recreational activities significantly decreases post injury; multiple studies have been carried out to see whether there exists any correlation between recreational activity indulgence and QoL in SCI patients. Given the exploratory nature of this research, the present work was conceived as a pilot study to assess feasibility, acceptability, and to generate preliminary effect-size estimates for planning a larger, adequately powered trail.

Rationale

Psychological morbidities are common after SCI. A meta-analysis reported the point prevalence of diagnosed depression to be approximately 22% (95% CI 18.7–26.3).[11] Clinically significant anxiety symptoms have also been documented in SCI cohorts, with some studies reporting rates as high as 40–45%.[12] Given this high burden, psychological interventions are an important component of SCI care. Evidence-based reviews indicate that CBT is a promising approach for improving depression, anxiety, adjustment and coping after SCI,[13,14] with group and individualized CBT trials reporting improvements in mood and psychosocial functioning.[15] In recognition of these findings, recent psychosocial care standards and regional SCI guidelines recommend routine psychological assessment and the provision of evidence-based treatments, including CBT, as part of the multidisciplinary rehabilitation pathway.[16] Combining CBT with structured recreational activities may therefore address both symptom reduction and broader QoLr outcomes, and testing that combination in SCI patients could support a validated treatment protocol for psychological morbidities in this population.

Methodology

STUDY DESIGN: Pilot pre–post feasibility study

STUDY POPULATION: Spinal Cord Injury Patients (Traumatic onset with all levels of lesions)

STUDY PLACE: Occupational Therapy Department, Swami Vivekanand National Institute of Rehabilitation Training and research (SVNIRTAR), Olatpur, Cuttack.

SAMPLE SIZE: 30

SAMPLING METHOD: Random Sampling

DURATION OF THE STUDY: From Oct 2021 to June 2023.

Inclusion Criteria

1. Traumatic SCI patients (ASIA- A to D)
2. Age: 18 to 60 years
3. Both male and female.
4. Subjects having Mild to severe depression, anxiety and stress on

   Depression, Anxiety, and Stress Scale–21 (DASS 21)
5. Subjects able to read and write in at least one Indian language.

Exclusion Criteria

1. Non- Traumatic Spinal Cord injury
2. Subjects having DASS 21 score for Depression less than 9, Anxiety less than 7, Stress less than 14.
3. Currently under any other psychotherapeutic treatment.
4. Taking antidepressants/mood stabilizers in the last 2 months prior to inclusion in the study
5. Acute suicidal ideations

Screening Tools

1. Medical Records and History taking
2. ASIA Impairment Scale
3. Depression, Anxiety, and Stress Scale–21

Outcome Measures

1. Depression, Anxiety, and Stress Scale–21
2. World Health Organization Quality of Life – BREF Scale

Data Collection

SCI patients were identified, and the ASIA Scale was used to confirm their diagnosis. All levels of injury and all grades on the ASIA Scale were considered for inclusion in the study. Prior consent was obtained from the patients. Subjects meeting the predefined inclusion criteria were enrolled. The study's objectives and procedures were explained to the patients, demographic data and basic medical history were recorded.

The DASS-21 (Depression, Anxiety, and Stress Scale - 21 items) was administered to the patients. Those scoring within the criteria for mild to extremely severe depression, anxiety, stress, or a combination of these conditions were included in the study. Additionally, the WHOQOL-BREF scale was used to assess the participants' quality of life. Data was collected using these scales before and after the intervention.

The intervention utilized the FEAR Model of CBT (Stephen Lenz) Permission was obtained from the author, and A permission was taken from Texas A&M University, United States, to access and utilize the original manual for the intervention.

A total of 30 subjects were taken for the study and were administered with the CBT protocol for a period of 6 weeks. 1 session for 2 hours per week for initial 3 weeks. In the last 3 weeks 2 sessions per week for 2 hours duration was administered. Every CBT session was followed by 15 minutes of recreation-based activities.

CBT Protocol

Time	Technique/ Protocol
Week 1	Introduction to relationships between Situations, feelings and thoughts. Building a Therapeutic Relationship
Week 2	Identifying venerable thoughts and associated feelings. Working on the cognitive model- identifying Automatic thoughts and beliefs of the client.
Week 3	Identifying negative automatic thoughts and using coping self-talks. Challenging Automatic Thoughts
Week 4	Introducing problem solving strategies and informed decision making as attitudes and actions for self-help
Week 5	Incorporating CBT techniques into daily routine and lifestyle. Deep Breathing Progressive Relaxation Meditation techniques
Week 6	Termination of treatment, evaluating treatment gains and developing future skills

Patients were engaged in board games like carom board, story narration, ball catch and throw (those with required physical capabilities) and charades as a form of recreation-based intervention activities.

Results

A total of 30 patients participated in the study, 23 Males and 7 females. The age range of the patients was 34.60 $\pm$ 4.6. 10 patients were ASIA D, 11 patients were ASIA C, 4 patients were ASIA B and 5 patients were ASIA A.

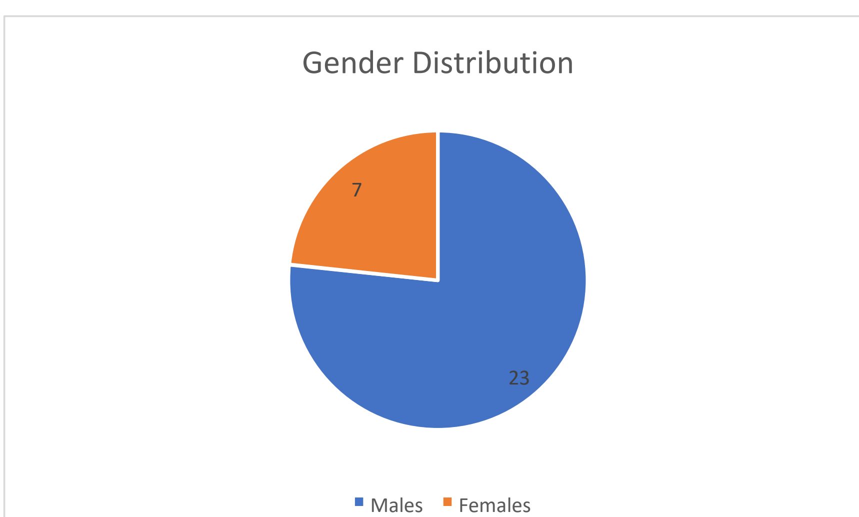

Figure 1: Shows the gender distribution of the SCI population.

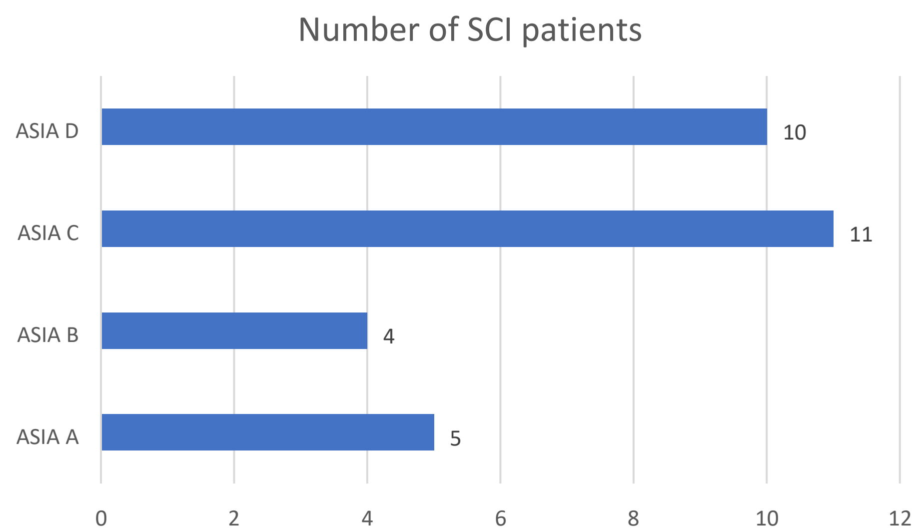

Figure: 2 depicts the distribution of SCI patients according to the ASIA Scale.

A Wilcoxon signed rank test was administered which revealed that the scores of the DASS-21 scale were significantly lower after the intervention (Md= 58.5 N=30) as compared to before the intervention (Md = 65 N=30), Z= -4.183, p< 0.001 and with a large effect size of r = 0.55.

Analysis for improvement in DASS-21 Scores			
PRE-TEST MEAN	**POST-TEST MEAN**	**Asymptotic Sig. (p)**	**Test statistic (Z)**
62.1 $\pm$ 17.35	58.96 $\pm$ 17.27	<0.001	-4.183

Figure 3: Shows the pretest- posttest analysis. It is observed that there is a statistically significant improvement in the DASS-21 scores post intervention.

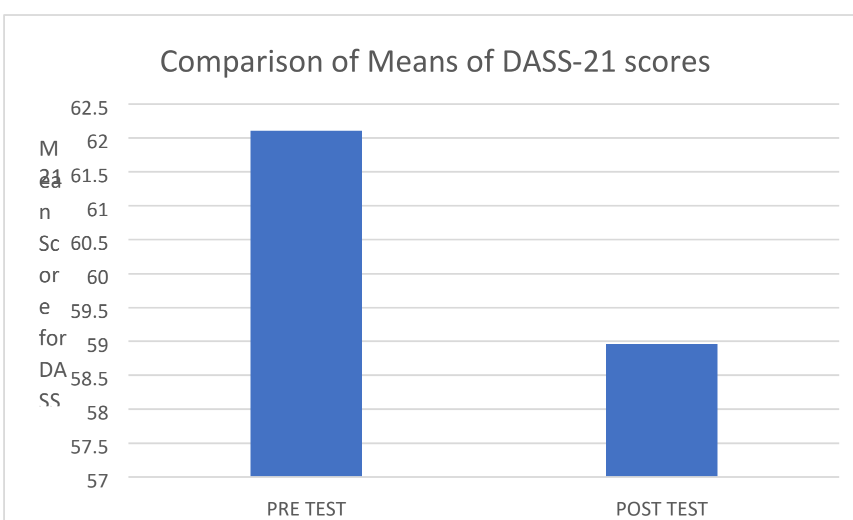

Figure: 4 depicts the graphical representation of pre and post test mean DASS-21 scores. There is a decrease in the mean score post intervention.

Wilcoxon test was further administered to evaluate whether there were any changes post CBT in the Quality of life of SCI patients. The tests revealed a statistically significant increase in QoL post intervention Z= -4.375 p< 0.001 and with a large effect size of r = 0.56.

Analysis for improvement in QoL Scores			
PRE-TEST MEAN	**POST-TEST MEAN**	**Asymptotic Sig. (p)**	**Test statistic (Z)**
40.81 $\pm$ 10.62	48.95 $\pm$ 11.25	<0.001	-4.375

Figure: 5 shows the pretest- posttest analysis. It is observed that there is a statistically significant improvement in the QoL scores post intervention.

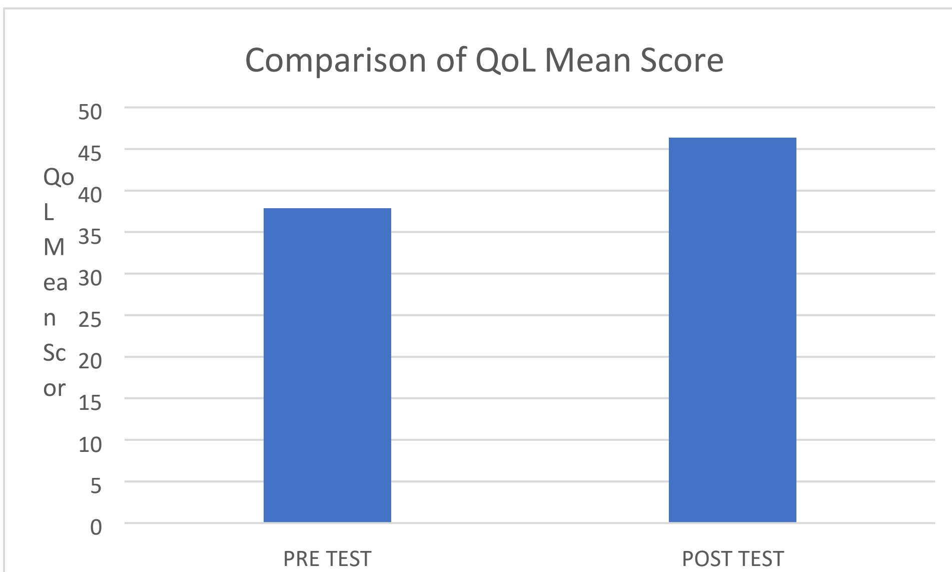

Figure: 6 the graphical representation of pre and post-test mean QoL scores. There is an increase in the mean score post intervention

Given the pilot nature of the study, analyses emphasize effect sizes and confidence intervals alongside descriptive statistics, with hypothesis testing interpreted cautiously.

Discussion

A longitudinal cohort study conducted in the United States reported that psychological morbidities were present in **59.1% of adults with spinal cord injury**, compared to **30.9% among matched controls without SCI,** indicating a substantially higher burden of mental health disorders—including anxiety, depression, post-traumatic stress disorder, and mood disturbances—within the SCI population.[17] There is a requirement for clinical initiatives aimed at enhancing mental health assessments and implementing specific interventions to lower the likelihood of psychological health problems emerging among those with traumatic SCIs[18] While factors like the level of spinal cord lesion, age, age at the time of injury, sex, time since injury, and completeness of the lesion have shown inconsistent links to lower QoL) among individuals with spinal cord injuries (SCI), certain negative psychological states and the intensity of pain have demonstrated a consistent impact on QoL.[19] The CBT model proposes that psychopathology is the product of faulty information processing that manifests itself in distorted and dysfunctional thinking, which directly leads to negative emotions and maladaptive behaviours. Thus, the CBT therapist works with the patient to identify evaluate and then modify distorted cognitions to produce more realistic and adaptive evaluations.According to a recent scoping review by Shu-Hua Yang et al CBT is the most commonly used psychological intervention in SCI and may be effective in improving symptoms of depression, coping and adjustment in adults following SCI. However, it mentioned that more elaborate and multifaceted cognitive behaviour interventions, especially to strengthen self-identity and to inspire patients' hope, is a requirement for the future.[20] The present study incorporates recreation-based activities and CBT protocol together as recreational activities are known to be associated with enhancing QoL in normal population.[21] The use of recreational activities for promoting mental health especially in neurological conditions has not been widely studied in the past thus paving way for further scope of research with isolated intervention. The results indicated that there was statistically significant improvement in Depression, Anxiety and Stress Scores post intervention, similar results were seen for Quality of life of SCI patients. The mean domain score of the four domains of WHOQoL were calculated and it was seen that the Physical domain of WHOQoL showed the most improvement post intervention followed by the Social Relationship domain, psychological domain and Environmental domain. For DASS-21 the mean improvement in scores was the most for the Depression subset followed by the Anxiety Subset and Stress Subset. Psychotherapies such as interpersonal therapy, problem-solving therapy, Mindfulness Based Cognitive Therapy, Mindfulness Based Stress Reduction, Dialectical Behavioral Therapy, Acceptance and Commitment Therapy and Yoga are widely in use for multiple psychological morbidities post neurological conditions, however the effectiveness of each of these in isolation or in combination on specific subsets of psychological conditions would be an interesting topic of exploration for the future.

Conclusion

The present study suggests that CBT combined with recreational activities is feasible and shows promise in reducing psychological morbidities and improving QoL in SCI patients. These findings are preliminary and support the need for a larger, adequately powered randomized trial. A deeper understanding of the mechanisms of these psychotherapeutic interventions would help occupational therapists to build a better understanding of specific interventional strategies in patients of Traumatic Spinal Cord Injury with psychological morbidities and decreased QoL.

Limitations & Future Recomendations

1. **Small sample size:** The limited number of participants is consistent with the pilot design; hence, the study was not powered to draw definitive conclusions about efficacy.
2. **Single-center study:** Conducted at one rehabilitation institute, which may restrict generalizability of results to other settings or populations.
3. **Short intervention and follow-up period:** The six-week duration did not allow assessment of long-term effects or sustainability of improvements.
4. **No control group:** Absence of a comparison group makes it difficult to rule out natural recovery or placebo effects.
5. **Heterogeneity of participants:** Variations in injury level, completeness, and duration since injury were not controlled and may have influenced outcomes.
6. **Future direction:** Larger, multi-centre randomized controlled trials with longer follow-up are recommended to validate and extend these preliminary findings.

Ethical Considerations

The study was conducted in accordance with the **Declaration of Helsinki**. Although formal approval from an Institutional Ethics Committee (IEC) could not be obtained due to the absence of an external or university-level IEC at the **National Institute for Rehabilitation Training and Research (NIRTAR), Odisha**, the research was reviewed and approved by the **Internal Scientific Committee** (Approval dated **4 January 2024**, Ref. No. [MOT/08/2021].

All participants provided **written informed consent**, and confidentiality was maintained throughout. The **CBT intervention** was administered by the first author, **Lakshita Jaya**, **Occupational Therapist**, JLN Medical College and Hospital, Ajmer, who holds a **Master's in Occupational Therapy (Neurological Rehabilitation)** with formal training in **CBT and Cognitive Rehabilitation**, including a **15-hour certified course on Essentials of CBT**.

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Conflicts of Interest Statement: No conflict of interest involved**.**

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Parent Perspectives on Telehealth Education for Pediatric Rehabilitation

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Abstract

This research study aimed to address the current knowledge gap by qualitatively assessing what parents need for telehealth education programming to be accessible, useful, and beneficial for their families. Interviews and online surveys were utilized to acquire qualitative data over the course of one year. Three themes emerged: current resource utilization, desired resources, and educational supports and barriers. Parents used various online resources primarily to connect with other caregivers and to enhance their child's skill sets. The subjects desired easy-to-use resources, session notes with visuals, and online forums for support. Consistent communication and resources from pediatric rehabilitation therapists were greatly valued. Future research should evaluate the efficacy of educational programming developed based on the recommendations provided.

Keywords: Children, family-centered care, rehabilitation, qualitative

Introduction

Telehealth education and service delivery are emerging areas of practice within rehabilitation.[1-3] Telehealth services have been found to promote greater participation due to convenience, specifically elimination of travel time and scheduling flexibility.[4-8] For pediatric rehabilitation, telehealth offerings have been found to be effective for meeting therapeutic goals.[9-12] Rehabilitation therapists have also reported success with 77% of therapists approving of telehealth programming and 78% supporting its permanent use.[13]

Telehealth education and service delivery may be an appropriate option for use in rehabilitation, particularly in addressing common challenges in the pediatric setting.[14-15] Family-centered practice, which is most supported through home-based services, can be fostered through telehealth services.[16] Additionally, telehealth education has been shown to improve therapeutic outcomes and carryover of recommendations at home.[6,17]

When considering the appropriateness of telehealth offerings, benefits must be weighed against their limitations. It is known that virtual services cannot replace evaluation or treatment techniques that require a hands-on approach from a trained practitioner.[15] Telehealth utilization also requires parents and practitioners to be proficient in technology.[14] Technology is becoming increasingly

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ubiquitous, eliminating skill and availability as barriers; however, some experts caution that technology is already being used excessively and should be used more judiciously.[18]

Currently, many telehealth offerings are left to the discretion of individual practitioners, guided solely by their own expertise and self-taught technical skills.[19] As such, there is a great disparity in the availability and quality of resources.[18]

This study aimed to address the current gap in knowledge by qualitatively assessing what parents need for virtual education programming to be accessible, useful, and advantageous for their families. This research study aimed to answer the question, "What do parents need from virtual education services?" The results from this study add to the understanding of how virtual education can be developed and utilized by rehabilitative professionals to benefit families and promote the carryover of therapeutic strategies at home.

Methods

After receiving Institutional Review Board approvals, this research study first employed semi-structured interviews to collect data from parents of children who received pediatric occupational therapy (OT) services. Parents were recruited via virtual flyers on social media platforms and physical flyers dispersed in pediatric outpatient clinics in Florida. Interviews were conducted both virtually and in-person, recorded, and transcribed by the primary investigators.

After the initial round of interviews, it was noted that early intervention was not represented. A second round of interviews were conducted to address this disparity. Due to difficulty with recruitment, the interview questions were adapted to an open-response Google Form format.

The interviews and Google Form survey consisted of nine open-ended questions as illustrated in Figure 1. Questions underwent expert review by four Doctors of OT to diminish potential bias before administration. The interviews lasted approximately 10 to 20 minutes and were conducted via Microsoft Teams, with no identifying information shared to ensure confidentiality was maintained. All interviews, both virtual and in-person, were audio-recorded and transcribed verbatim and analyzed along with the Google Form survey responses.

Figure 1

Nine Open-Ended Questions

1. How do you use online resources (websites, apps, blogs, Facebook groups, etc.) to help your child?
2. What online resources (websites, apps, blogs, Facebook groups, etc.) do you use to help your child?
3. Why do you use those online resources (websites, apps, blogs, Facebook groups, etc.) to help your child?
4. If an online website was made to support you as the caregiver of your child what would it look like?
5. If an online website was made to support you as the caregiver of your child what would it include?
6. What other resources do you use to help your child?
7. Where do you find those resources?
8. What helps you carryover what was done in therapy at home?
9. What does not help you carryover what was done in therapy at home?

The inclusion criteria for participating was being the parent of a child younger than 18 years of age who receives OT services at a rate of at least one weekly session and has access to a technological device (i.e., computer, phone, or tablet). Participants were excluded from participating in this study if they had experience working as an occupational therapist or a certified occupational therapy assistant (COTA) or if the child had been receiving OT services for less than one month.

Following the collection of data, two researchers reviewed the audio recording, transcripts, and field notes independently to hand code. Thematic analysis method was utilized to analyze the data.[20] The researchers independently identified recurring terms, general topics, and feelings to determine themes from the interviews and surveys.[21] After independently reviewing the data, the investigators discussed the themes that emerged from the wording and perception of parents' responses to reach a consensus.[22]

Results

Thirty-four individuals expressed interest in participating; however, only 18 met the inclusion criteria. A total of 18 interviews and online surveys were completed to acquire qualitative data over the course of one year. The majority of participants were female (83%). Of the participants, nine reported their child received services in an outpatient setting, eight reported their child received services in the natural environment (e.g., home), and one reported their child received services at school. The participants had children between the ages of 0 to 11 years old receiving services at the time of the interviews and surveys. Three themes emerged from the data: current resource utilization, desired resources, and carryover supports and barriers.

Current Resource Utilization

Subjects articulated the educational resources they used, described how they utilized those resources, and provided rationale for why they chose those resources. Subjects utilized resources such as search engines (e.g., Google), social media (e.g., Facebook groups), educational programming (e.g., ABC Mouse), and YouTube. When asked how resources were found, Participant #7 stated, "I search online for all." Other participants agreed, and Participant #5 said that they specifically used YouTube to conduct searches. Participants also reported therapists, family members, and doctors to be their main sources of how resources were found (#1, #3, #5). Participants #6 and #8 were outliers, reporting that they used "mostly books" recommended by their child's therapist and pediatrician.

Participants described how they utilized their resources. Participant #10 explained that when trying to find resources to help their child, "I usually just do a, you know, generic Google search and see where the information leads me from there." Participant #4 elaborated, "Whenever I go and look these things up, half the time I do get the right answer."

When asked why they use online resources, parents expressed their desire to help their children succeed. Participant #5 stated they were motivated by the "zeal to help" their child. Participant #1 said, "I have a lot of motivation to help my son be successful." Participants also reported seeking a sense of camaraderie when faced with similar situations. For instance, Participant #5 responded that they utilize resources "to help and learn from others' experiences on how they care for their child." They stated that their decision was made due to the overwhelming nature of therapeutic recommendations. Participant #6 elaborated, "I just focus on what the therapist says."

Desired Resources

Subjects described specific features and content that would be beneficial. Desired features included "user friendly" and "interactive" components (#2, #5, #10). Participant #4 reported wanting a "search bar or somewhere where you can put in like your kid's, maybe like, a diagnosis…or typing my kid is hyper, out of focus, or sensory needs and it pulls up, you know, things that you could do for the hyper, the focus, and sensory stuff." Having easy-to-utilize resources was also important because "We're given a lot of information, and it's all helpful but a lot to remember" (Participant #4). Participants #6 and #9 desired a resource that provides video and written materials to appeal to parents' unique learning styles (e.g., auditory, visual).

Fifty percent of participants responded requesting a "forum" or parent blog and believed it would be beneficial. Participant #5 elaborated, wanting access to "reviews of other parents with descriptions of what their child has been going through, for how long, and what improvements have been made/shown by using the education provided." Participants detailed the importance of having help from professionals for a forum. Participants stated that "having constant aid from a professional" in a forum would be beneficial for all users (Participant #5).

Subjects described the content they would like to include in a virtual education resource. Responses included step-by-step guides for skill development, explanations of developmental milestones, descriptions of therapeutic techniques in non-specialist terms, and creative ideas for activities parents can do at home with their children. Participant #4 reported wanting "something that gives you the definition for the words that you need to know, an explanation that anyone can understand." Specific skills that were requested included reflex integration, coordination, and visual memory activities (#1), potty training guides (#2), diagnosis and prognosis (#10), and "what is going on in therapy" (#5, #6, and #9). Ninety percent of participants reported that they would like content to be organized by skill rather than age. Participant #8 disagreed with the majority, stating "I want to refer to the age groups ahead of where my child is to see what they are working towards."

Subjects also suggested that receiving session notes with visuals and easy-to-understand videos would assist in the home implementation of therapy practices. Participant #1 stated that having videos of therapy techniques would be beneficial because "it is information overload at times… then you go home and you forget". Only three participants reported that they "don't know" or were "not sure" what they would like a new parent education resource to resemble or include.

Supports and Barriers

Subjects described the supports and barriers they encountered when utilizing educational resources. Regarding supports, parents reported success with demonstration, handouts, and follow-up. One participant noted the therapist's demonstration of certain skills/techniques, such as "brushing and compressions" to have supported her ability to carryover because OT had "given me the tools I need to help him exercise his muscles in the right way" (#4). When asked what helps them carryover what is done in therapy at home, Participant #6 reported, "the ease of the techniques shown and how I can do them in everyday routines." To effectively carryover the recommendations at home, parents responded that they found it helpful to focus on specific strategies, utilize easy-to-follow techniques, and maintain consistent communication with their child's therapist(s). Overall, parents reported positive feelings regarding telehealth education.

Subjects also reported barriers with some of the information they received. Participant #4 reported that her child's therapist provided age-appropriate checklists and "to tell you the truth, I've gone through lists and lists. Most of them work, but 55% of the time they don't because he's just not there yet." Subjects also noted that therapists tended to provide verbal feedback at the end of sessions, which could be challenging to recall. When using other sources not provided by their child's therapist (e.g., social media groups), parents were concerned about the potential for misinformation or recommendations that could be harmful to their children. They reported difficulty with determining the validity of the overabundant information available.

Discussion

The findings, which support the use of telehealth resources, were congruent with previous research. Previous studies found both parents and therapists had positive opinions of telehealth education delivery models.[8,13,17] Telehealth delivery for parental education has also been found to be effective for pediatrics, echoing the sentiments of this study's subjects.[6]

The results from this study add to the understanding of how telehealth educational content can be developed and utilized by rehabilitative professionals to benefit families and promote the carryover of therapeutic strategies at home. Based on the results, it is recommended that information be created for specific diagnoses, challenges (e.g., picky eating), and skills (e.g., potty training) as milestone/age-appropriate information may not be applicable for parents of children with developmental delays.

Information should be presented in multiple formats to meet different learning styles, be simplified to be accessible to parents with minimal medical knowledge and promote positive parenting strategies.[23] Therapist-moderated parent forums may also be appropriate to encourage supportive relationships and address any misinformation.

This study had the unique advantage of having a diverse group of subjects, even though the majority resided in Florida. For instance, two participants were fathers; a population frequently neglected.[24-25] The study also had a decent sample size for a qualitative study with participants who provided quality, elaborative data.

This study lacked a quantitative component that could be evaluated with statistical analysis. Likewise, since a questionnaire did not exist prior to this study, one had to be created based on feedback from content experts. This study was also limited to Florida, which may limit its generalizability to other countries with different healthcare systems.

Future studies may use a larger, more diverse sample size to elaborate on the findings of this study. Telehealth content made from this study's recommendations should be assessed for efficacy. Additionally, new content should be qualitatively assessed for continued improvement of telehealth service delivery.

Conclusions

This research study aimed to address the current knowledge gap by qualitatively assessing what parents need for telehealth education programming to be accessible, useful, and beneficial for their families. Qualitative data from 18 parents of children receiving therapy services revealed three themes: current resource utilization, desired resources,and finallyeducational supports and barriers. Parents used various online resources primarily to connect with other caregivers and to enhance their child's skill sets. The subjects desired easy-to-use resources, session notes with visuals, and online forums for support. Consistent communication and resources from pediatric rehabilitation therapists were greatly valued. Telehealth content generated from these findings should be evaluated by future research.

Declaration

There are no funding sources to disclose. The authors received institutional review board (IRB) approvals from Gannon University (#GUIRB-2023-3-7075 and #GUIRB-2024-1-7207) on 3/22/2023 and 7/22/2024, prior to the commencement of this study. The authors declare no competing interests.

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The Impact of Obesity on Deep Neck Flexor Endurance among College Students in Chennai: A Cross-Sectional Study

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Abstract

Background: Obesity is an epidemic that impacts individuals across all age groups, from children and adolescents to adults and the elderly. The purpose of this study is to assess the relationship betweenobesity and deep neck flexor endurance a mong college students.

Methodology: A cross-sectional study was conducted on obese college students without neck pain. The measure of obesity used was the Asian Body Mass Index (BMI) classification, and muscular endurance was assessed using the Deep Neck Flexor Endurance Test (DNFET). Relationships were explored through Pearson's correlation coefficient (r) analysis.

Results: A total of 100 (60 male, 40 female) obese college students were enrolled. These college students had a significantly reduced DNFE. The correlationr value for males and femaleswas-0.822 and -0.762, so there is strong negative correlation.
Conclusion: Obese college students exhibit a lack of deep neck muscle endurance, which may increase the risk of developing neck muscle injuries.

Keywords: Deep Neck Flexor Endurance, Obesity, collegiate students, BMI, DNFE hold time.

Introduction

Obesity is a root cause of major health issues in modern society and has become an epidemic disease due to the lack of conscientious health habits and lifestyle modifications. Nowadays, with an increase in computer-related work and prolonged working hours, an inactive lifestyle has led to consequences such as altered eating, insufficient sleep, lack of exercise, and changes in physical activity patterns. Obesity is a state in which excessive deposition of body fat occurs when there is a decrease in energy

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expenditure compared to the amount of food intake. This results in an increase in calorie storage and stimulates the consumption of unhealthy, high-calorie foods[1].

The World Health Organization (WHO) reported in 2021 that the global prevalence of obesity has nearly tripled since 1975. More than 1.9 billion adults worldwide are overweight, and over 650 million of them are classified as obese[2]. Obesity is now recognized as a major public health concern with serious consequences for both individuals and society[3]. It is a well-established risk factor for several non-communicable diseases, including cardiovascular disease, diabetes, musculoskeletal disorders, and various cancers[4,5]. In addition, increasing levels of obesity have been linked to reduced physical fitness, particularly in domains such as muscular endurance, strength, and flexibility, which may contribute to a higher risk of head, neck, and whiplash-related injuries[6–9].

Excess body weight also places mechanical strain on the musculoskeletal system, commonly leading to discomfort in the neck, lower back, and knees[10,11]. Weakness in the neck flexor muscles has been associated with reduced strength and endurance, muscle atrophy, fatty infiltration, and abnormal activation patterns, all of which can compromise cervical stability and increase the likelihood of musculoskeletal problems[12]. Muscular endurance is defined as the ability of a muscle group to sustain repeated contractions or maintain a position over time. In the cervical region, the deep neck flexor muscles are essential for stabilizing the head and cervical spine against gravity. Reduced endurance of these muscles can result in cervical deformities, postural imbalances, and functional limitations. The DNFET is a reliable, simple, and non-invasive method for evaluating the endurance of these muscles and their contribution to cervical spine stability[13–18].

With obesity becoming increasingly common among young adults, particularly college students, it is important to understand its impact on neck flexor endurance. Previous studies in India have estimated the prevalence of obesity in this group at approximately 10.7%, a trend often linked to sedentary behavior, low physical activity, and academic pressures[19]. The present study examines the relationship between obesity and deep neck flexor endurance in college students and determines the average DNFE hold times in this population.

Materials and Methods

Study Design

A cross-sectional study

Study Setting

The study was conducted at SRM Institute of Science and Technology (SRMIST), Chennai, Tamil Nadu, a multidisciplinary university offering programs in engineering, medicine, health sciences, management, and humanities.

Participants

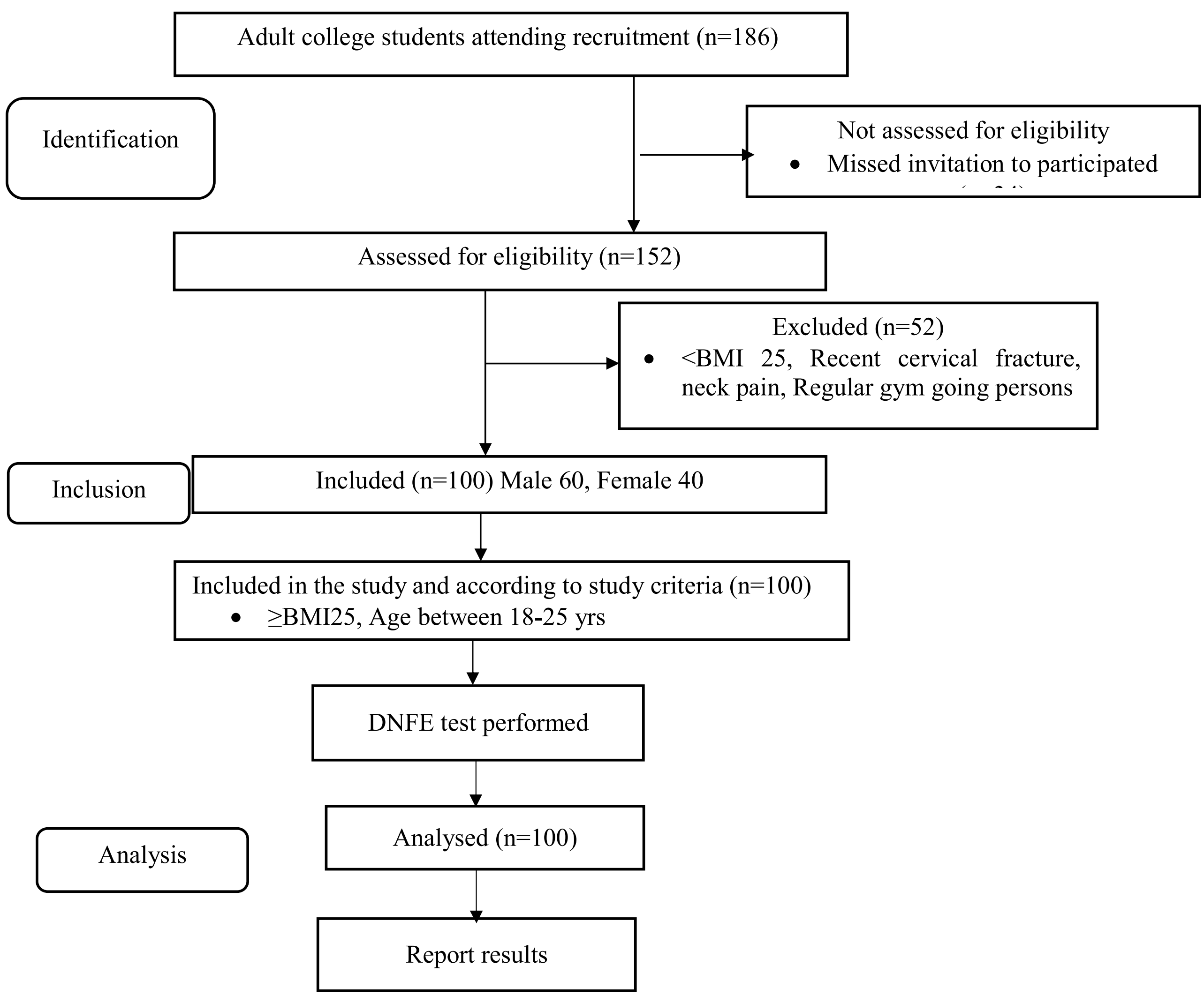
College students aged 18–25 years with a Body Mass Index (BMI) greater than 25, as per the Asian BMI classification, were included. Participants were required to be free of current neck pain and able to lie in the supine position for at least 30 minutes. Exclusion criteria included a recent history of neck or thoracic pain, cervical fractures, frequent headaches, regular gym training, diagnosed myopathies, cervical spine deformities, neurological conditions, or any muscular or connective tissue disorders. All criteria were based on self-reported medical history. A purposive sampling method was used to recruit eligible participants.

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee of SRM College of Physiotherapy, Chennai (Approval No. IEC.0050). Written informed consent was collected from all participants before enrolment.

Dnfet Procedure

The DNFET is the most widely utilised clinical test for assessing the endurance of the deep neck flexors[20,21]. Based on the eligibility, 100 asymptomatic college students were included in the study (refer flowchart 1). The participants lay on their backs in a hook lying position (head straight, knees bent, and both feet resting on the couch), with their hands placed on their abdomen region. Individuals who experienced difficulty lying flat on the couch due to excess kyphosis were provided with a conventional sandbag to comfortably support their head and neck. Subjects were instructed to tuck their chin in as much as possible in an isometric stance and were asked to maintain the position for as long as they could. They were then told to lift their head and neck approximately 2.5 cm off the couch while keeping the chin tucked. The analyst maintained the width by stacking his index and middle fingers, kept in contact with the subject's head in the back part of the occipital. Simultaneously, in this position, the analyst drew a line up to 1 cm across two approximated horizontal skin folds along the subject's anterior-lateral side of the neck with an erasable marker[21], as shown in figures 1 and 2.



A flowchart 1showing the steps involved in this study.

Figure 1

Figure 1: The tester places their hand palm down beneath the subject's occiput and crosses their index finger across their middle finger dorsally. The subject's anterior-lateral neck is shown by the arrow by a line drawn across two approximation skin folds.

Figure 2

Figure 2: A supine, hook-lying position was used to perform the DNF endurance test for this study.

During the DNFET, subjects were requested to follow commands from the examiner, such as "Lift your head and pull your chin maximally." They were instructed to keep their heads in direct contact with the examiner's fingers at all times. Subjects were permitted to maintain touch with the analyst's fingers without putting any weight on their heads by lifting the head and maintaining the tucked chin posture. A stopwatch was used to measure the time of holding in that position. Subjects were required to remain supine for the entire experiment. After the evaluation, subjects were given five minutes of free time to relax. During this rest time, they were told not to raise their heads or get out of bed, but they were permitted to gently rotate their neck as long as there was no discomfort[20].

The subjects were asked to maintain the position as much as they could, and a stopwatch was used to measure the time of holding in that position. Subjects were tested twice with a 5-minute break between the tests to allow muscle recovery. Two scores were recorded, and the best one was used for statistical analysis. To account for the high experience curve linked with the DNFET, the measurement was only carried out twice. Each time, the maximal attained time was noted. Time recording for each trial started, and if a mistake occurred during the trial time, the individual's posture was rectified by verbal commands. The countdown on the stopwatch commenced as soon as the individuals elevated their heads and ceased if any one of the following four criteria ruled out and lasted longer than one second.

While performing the DNFET, it was observed that there is a possibility of one error lasting longer than one second out of the following four scenarios:(1).The moment when the subject's chin could no longer be tucked in, and the vertical cross line in the skin fold disappears, not in contact with the neck line due to the loss of chin tuck.(2).When the evaluator's stacked finger perceives the weight of the subject's head rested on it for more than 1 second.(3).When the subjects lifted their head without holding, the evaluator observed that they were unable to maintain contact with the crossed finger.(4).When the subjects were unwilling to continue the procedure.The subject was given verbal guidance by the assessor at the time of the error on how to fix it. The measurer stops the measurement and records the timings if an error happens twice[22].

Statistical Analysis

Data were analysed using IBM Statistical Package for the Social Sciences (SPSS) software, version 23. Based on normality,Pearson's correlation method was employed to assess the association between obesity, measured by BMI and DNF Endurance among college students, with a significance level set at $P < 0.05$.Additionally, a simple linear regression analysis was conducted to further explore the relationship between BMI and DNF Endurance. The findings from both correlation and regression analyses contribute to a comprehensive understanding of the potential impact of BMI on DNF Endurance.

Results

A total of 100 participants (male-60, female-40) were included in this study. Table 2 shows the mean and standard deviation value of age,height, weight,BMI are 19.79±1.73 years, 168.27±8.93(cm), 80.63±11.58(kg) and28.5±3.5 kg/m^2.

Table 2. Sociodemographic characteristics of persons with obesity among collegiate students in Chennai, (N=100).

Variables	n	Age (y)*	Weight (kg)*	Height (cm)*	BMI (kg/m^2)*
Entire sample	100	19.79±1.73	80.63±11.58	168.27±8.93	28.5±3.5
Male	60	19.42±1.86	86.68±10.31	173.28±6.94	28.99±4.02
Female	40	20.35±1.33	71.55±6.23	160.75±5.75	27.76±2.24

n = number of subjects per group; y = year; cm = centimetre; kg=kilogram; BMI= body mass index; * Mean ± standard deviation.

Table 3 demonstrates a significant negative correlation between BMI and DNFE in the entire sample. A Pearson correlation analysis revealed a noteworthy negative association between BMI and DNF endurance in the entire sample ($r = -0.440$, $p < 0.001$). Among male participants, the correlation was even more pronounced ($r = -0.822$, $p < 0.001$), signifying a stronger negative relationship between BMI and DNF endurance. Similarly, for female participants, the correlation was significant ($r = -0.762$, $p < 0.001$), indicating that higher BMI is associated with reduced DNF endurance in both genders. Figure 3 shows the negative relationship between BMI and DNF endurance.

Table 3. Relationship between BMI and deep neck flexor endurance in persons with obesity among collegiate students in Chennai, (N=100).

Variable	n	Mean±SD		r	Beta Coefficient	SE	*p* value
		BMI (kg/m^2)	DNFE (s)				
Entire sample	100	28.5±3.5	20±3.1	-0.440	-0.396	0.082	<0.001
Male	60	30±4	21.9±2.5	-0.822	-0.505	0.046	<0.001
Female	40	27.8±2.2	17.4±1.8	-0.762	-0.610	0.084	<0.001

$p < 0.05$; SD- standard deviation; BMI- body mass index; DNFE-deep neck flexor endurance; s-seconds; r- pearson correlation coefficient; SE- standard error;

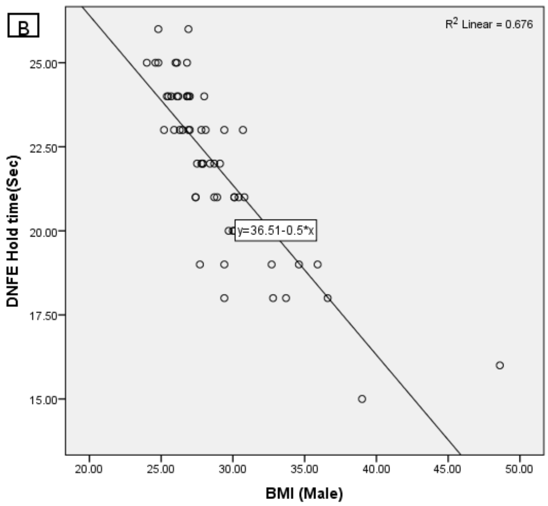


Figure 3.A

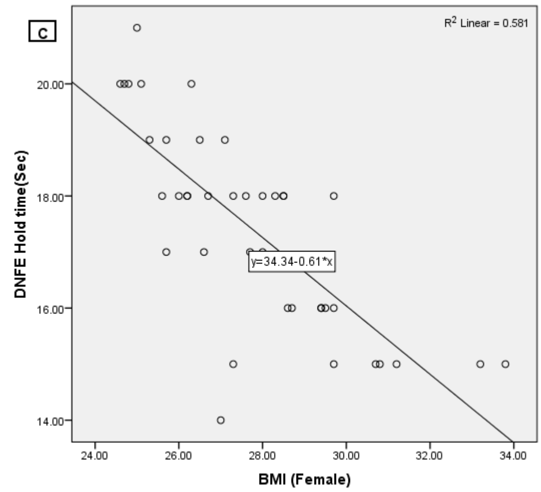


Figure 3.B

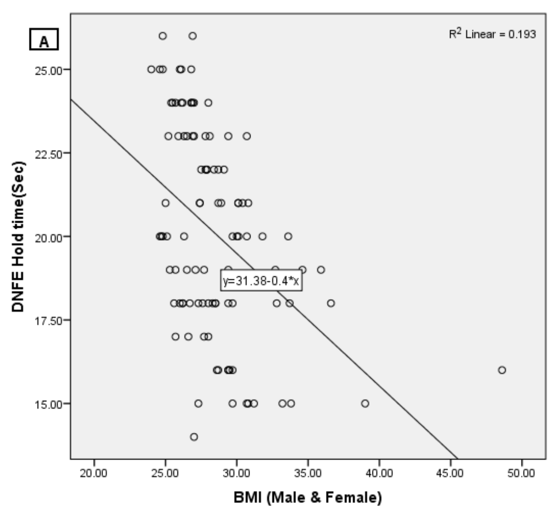


Figure 3.C

Figure 3: The scatterplots (Figure3.A, 3.B, and 3.C) visually depict the relationship between BMI and DNF endurance across the entire sample, male and female participants, respectively.

The regression analysis indicated a significant negative association between BMI and deep neck flexor (DNF) endurance. Overall, BMI was a significant predictor of DNF endurance, with a negative beta coefficient (β = –0.396, SE = 0.082, p <.001), suggesting that for every one-unit increase in BMI, DNF endurance decreased by approximately 0.40 seconds on average.When analysed by sex, BMI remained a significant negative predictor of DNF endurance. Among males, the regression model showed a beta coefficient of β = –0.822 (SE = 0.505, p <.001), indicating that each one-unit increase in BMI was associated with a reduction of 0.82 seconds in DNF endurance. Similarly, for females, the beta coefficient was β = –0.762 (SE = 0.610, p <.001), reflecting an average decrease of 0.76 seconds in DNF endurance for every unit increase in BMI.

Discussion

This study was conducted to evaluate the relationship between obesity and DNFE in college students and to establish the average hold times on the DNFET in this population. The endurance of the cervical flexor muscles plays a key role in maintaining cervical spine stability, and any reduction in their function may disrupt the balance between the anterior and posterior stabilizing muscles of the neck. The DNFET is a simple, reliable, and cost-effective clinical test for assessing craniocervical flexor performance and is valuable in both the prevention and management of neck pain. The results of this study indicate that obesity is significantly associated with reduced deep neck flexor endurance among college students.

The present study found that obese college students demonstrated markedly lower DNFE compared to values reported in earlier research on healthy populations[20,21]. The mean DNFE hold time was 21.9 seconds in males and 17.4 seconds in females. A statistically significant negative correlation (r = –0.440) was observed between BMI and DNFE in both sexes, indicating that higher BMI is associated with reduced endurance capacity of the deep neck flexors.These findings align with previous evidence suggesting that obesity adversely affects musculoskeletal performance. Oliveira et al.[23] and Watson et al.[24] reported that poor biomechanical adaptation in posture and physical performance contributes to the development of neck pain in obese individuals. Similarly, Jarman et al.[20] demonstrated that higher fat composition and BMI are linked to diminished muscular endurance in the back and core, further supporting the inverse association between BMI and DNFE identified in the current study.

When compared with endurance values in non-obese populations, the reduced hold times in the present study are evident. Domenech et al.[25] reported DNFE hold times of 39.1 ± 20.0 seconds in males and 29.3 seconds in females among healthy adults aged 20–80 years, while Jarman et al. found hold times of 35.5 seconds in males and 31.8 seconds in females among adolescents and young adults. These values are considerably higher than those observed in our obese college cohort. Furthermore, Zele et al.[26] reported decreased neck flexor and extensor endurance in cigarette-smoking students, highlighting the influence of lifestyle-related factors on cervical muscle function.Taken together, the present study extends prior findings by specifically examining the impact of obesity on DNFE in college students, confirming that higher BMI is associated with significantly reduced neck muscle endurance.

When correlating obesity and DNFE separately for male and female students, there is a strong negative correlation. However, when correlating obesity and DNFE for overall subjects without gender differences, there is a moderate negative correlation, possibly due to shorter hold times for females. The study underscores the negative association between Deep Neck Flexor Endurance and obesity among college students, suggesting that females with higher BMI may be more prone to neck pain compared to males with similar BMI.Clinical implications include regular assessment of DNFE in patients with neck pain to identify reduced neck flexor endurance. If endurance is found to be low, endurance training can be incorporated along with conventional physiotherapy. Collins et al.,[27] and Kim et al.,[28] recommend training neck flexion performance to improve neck muscle strength and prevent injuries.

The study has limitations, including gender distribution inequality in sampling, a smaller sample size, and not accounting for age-related differences, physical activity levels, and body fat percentage in obese individuals related to neck muscle endurance. Future studies with larger participants and interventions, including endurance training for individuals with low DNFE and neck pain, are recommended.

Conclusion

The study concludes that obese college students exhibit significantly lower deep neck flexor muscle endurance. This reduced endurance may contribute to an increased risk of developing neck muscle strain, fatigue-related injuries, and forward head posture over time.Early interventions focusing on weight management, postural correction, and physical activity are recommended to prevent neck-relatedmusculoskeletal issues in this population.

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Awareness and Utilization of Government's Educational Schemes Amongst People with Locomotor Disabilities

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Abstract

Background: Education plays an essential role in promoting independence, confidence, and social participation among people with locomotor disabilities. The Government of India has introduced several educational schemes to support this group and ensure equal learning opportunities. However, awareness and use of these schemes may differ based on individual, social, or environmental factors. Assessing how far these initiatives are known and used by people with locomotor disabilities is important for identifying practical gaps and improving inclusion in education.

Methods: A descriptive cross-sectional study was carried out among fifty-five people with locomotor disabilities aged 18 to 30 years. Participants were selected through purposive sampling from hospitals, outpatient departments, and non-governmental organizations. Data was collected using a validated self-structured questionnaire focusing on awareness, utilization, and perceived barriers related to government educational schemes. Descriptive statistics were used for analysis.

Conclusion: Among the participants, 29.09% were aware of government educational schemes, while 70.91% were unaware, and out of those who were aware only 6.25% had ever utilized any scheme. Awareness was relatively higher among graduates and those with paraplegia or cerebral palsy. The main barriers included lack of clear information, difficulty understanding eligibility, and complicated application processes. Strengthening awareness activities, simplifying procedures, and involving rehabilitation professionals in guidance can improve access and participation, helping people with locomotor disabilities benefit fully from available educational opportunities.

Keywords: Locomotor disability, Government educational schemes, Awareness, Utilization, Inclusive education, Rehabilitation

Introduction

Disability is a global public health concern, affecting over 1.3 billion people, or approximately 16% of the world's population, according to the World Health Organization (2001).[1] Among various forms, locomotor disabilities particularly affect an individual's ability to move independently

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and participate fully in everyday activities. These limitations often influence access to education, employment, and social engagement, thereby affecting overall quality of life. In developing countries, insufficient infrastructural support, limited accessibility, and socio-environmental challenges further restrict opportunities for people with disabilities to achieve their full potential.[2][3]

In India, the 2011 Census reported that 2.21% of the population lives with disabilities, with locomotor disability being the most prevalent category. [1] The Government of India has introduced several educational schemes and inclusive policies under initiatives like the Rights of Persons with Disabilities Act (2016) and Samagra Shiksha Abhiyan to promote equal learning opportunities. However, the actual reach and utilization of these schemes remain uncertain, particularly among people with locomotor disabilities. [4-8]

Physiotherapy, being a profession that emphasizes a holistic approach to health. It plays a vital role beyond rehabilitation—by promoting functional independence, community participation, and educational inclusion.[9] Understanding the awareness and utilization of such schemes is therefore essential to guide physiotherapists and policymakers in developing targeted awareness and referral strategies. This study aims to assess the awareness and utilization of government educational schemes among people with locomotor disabilities.

Material and Methods

Study Design and Setting

A cross-sectional descriptive study was conducted to assess the awareness and utilization of government educational schemes amongst people with locomotor disabilities. The study was carried out at Sancheti Institute for Orthopedics & Rehabilitation College of Physiotherapy, Pune, Maharashtra, during the period of 6 months April-October 2025. Ethical approval was obtained from the Institutional Ethics Committee of Sancheti Institute for Orthopedics & Rehabilitation College of Physiotherapy. (Approval No: IEC-SIOR/Agenda 086)

Participants

A total of 55 participants with locomotor disabilities were recruited using Purposive sampling. Inclusion criteria were individuals aged 18-30 years, diagnosed with locomotor disability, and willing to participate. Participants with cognitive, hearing, vision impairments that prevented informed consent or questionnaire completion were excluded.

Data Collection Tools

Data were collected using a structured questionnaire developed specifically for this study. It included sections on participants' demographic details, type and duration of disability, awareness of government educational schemes, actual utilization, and barriers faced in accessing these schemes. The tool was face validated by experts in Community Physiotherapy. The experts evaluated the questionnaire to ensure it appropriately measured the intended variables, was suitable for the participants, and aligned with its purpose. The tool was finalized after subjective assessment, confirming that the items were relevant, clear, unambiguous, and reasonable for accurately capturing the required information.

Procedure

Participants were selected based on predefined inclusion and exclusion criteria, written informed consent was obtained from all participants prior to data collection. The aim and significance of the study, along with its potential relevance in future, were explained to each participant. Data were collected using a self-designed, face- and content-validated questionnaire. Participants' responses were recorded through face-to-face interviews at the study site, and in cases where in-person meetings were not feasible, telephonic interviews were conducted to ensure complete participation.

Data Analysis

Collected data were entered into Microsoft Excel and analyzed using descriptive statistics. Percentages and frequencies were calculated to summarize demographic characteristics, awareness levels, and utilization of schemes.

Results and Discussion

A total of 55 participants with locomotor disabilities were included in the study (Table 1). Among them, 16 participants (29.09%) reported being aware of government educational scheme, while 39 participants (70.91%) were unaware (Figure 1). Figure 2 indicates that only a limited number of participants were aware of specific government educational schemes. Out of those who were aware, only 6.25% had ever utilized any scheme (Figure 3).

Table 1: Demographics Characteristics of Participants (n=55)

Characteristics	Category	Number (n)	Percentage (%)
Age(years)	18-20	18	32.73%
	21-25	19	34.55%
	26-30	18	32.73%
Type of locomotor disability	Cerebral Palsy	20	36.36%
	Paraplegia	13	23.64%
	Polio	13	23.64%
	Amputation	9	16.36%

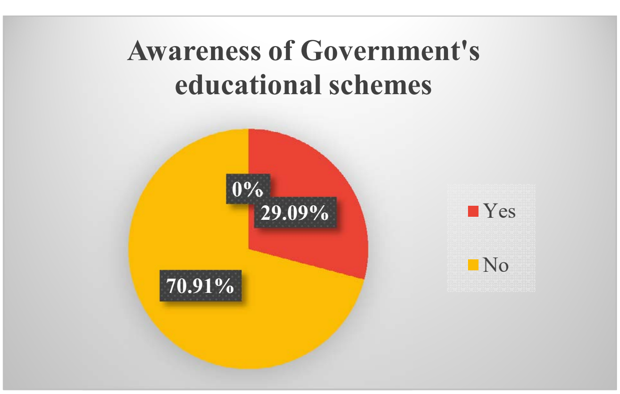

Figure 1: Shows awareness of government's educational schemes

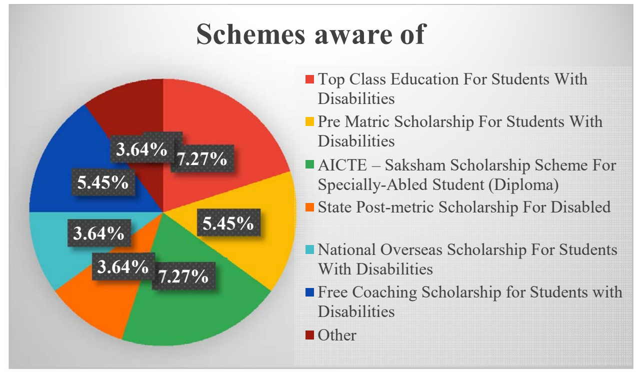

Figure 2: Schemes that are aware of by the participant

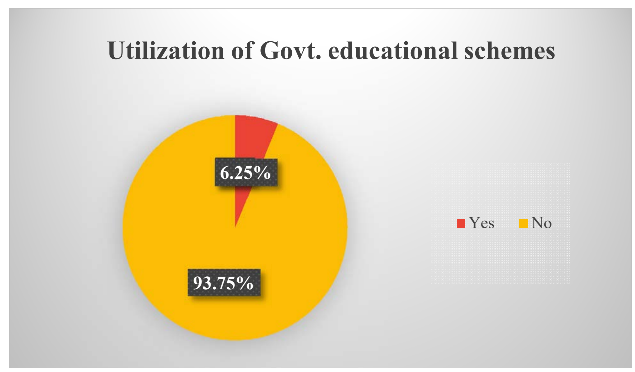

Figure 3: Utilization of Government Educational Schemes by Participants

When analyzed by type of disability, awareness was highest among participants with paraplegia (5 out of 13; 38.46%), followed by cerebral palsy (7 out of 20; 35.0%), and lowest among participants with polio (3 out of 13; 23.08%) and amputation (1 out of 9; 11.11%). Utilization of schemes was minimal across all disability types, with only one participant with cerebral palsy reporting utilization. Figure 4 demonstrates that non-utilization of government educational schemes was primarily due to insufficient information, unclear eligibility criteria, and procedural difficulties, highlighting significant systemic barriers that restrict access.

Regarding the source of information, participants primarily reported receiving awareness through family and friends (56.25%), followed by social media or online sources (31.25%), and NGOs (18.75%) (Figure 5).

Figure 4: Reasons for Non-Utilization of Government Educational Schemes

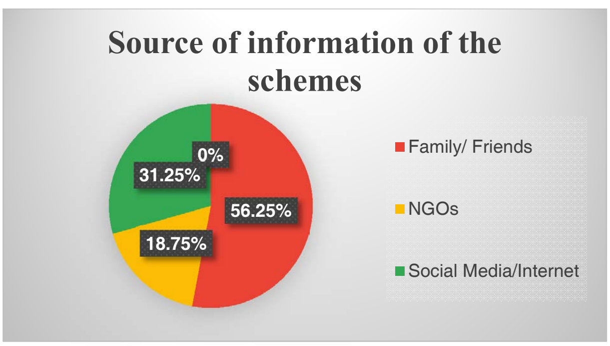

Figure 5: Shows the sources from which participants received information about government educational schemes.

Majority of the participants were students (60%), followed by employed individuals (20%) (Figure 6).

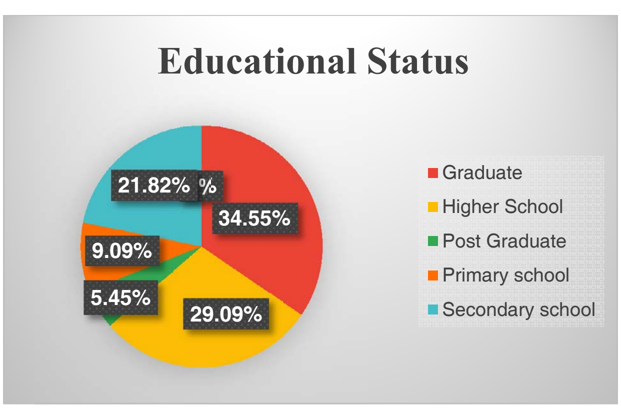

Figure 6: Educational status of Participants

This figure shows that 70.91% participants are not aware and 29.09% are aware of Government's educational schemes.

This figure shows the awareness regarding various educational schemes provided by government.

This figure shows that only 6.25% of the participants have utilized government educational schemes.

This figure shows reasons for not utilizing educational schemes provided by government.

The majority reported learning about the schemes through family/ friends, followed by social media and NGO

This figure illustrates the varying levels of education attained by the participants in the study.

Discussion

In the vast pool of literature we explored, we searched extensively using keywords such as Locomotor disability, Government educational schemes, Awareness, Utilization, Inclusive education, Rehabilitation. The present study assessed awareness and utilization of government educational schemes among people with locomotor disabilities.When awareness was examined based on the type of locomotor disability, it was found that 38.46% of individuals with paraplegia, 35% with cerebral palsy, 23.08% with polio, and only 11.11% of those with amputation were aware of the available government educational schemes. These findings indicate a significant gap between policy intent and public understanding, suggesting that dissemination of information and implementation at the ground level remain insufficient.

Latha and Vakkil (2013) found that awareness and utilization of government schemes among physically challenged students were generally average, with higher awareness observed in urban areas and among students with educated parents. This highlights the influence of socio-economic factors, which aligns with the present study's findings of significant gaps in awareness and utilization among people with locomotor disabilities.[10]

Verma and Chohan (2025) reported limited awareness of government schemes among women with locomotor disabilities, emphasizing that higher educational attainment was associated with better knowledge. This aligns with the current study, where most participants who were aware of schemes had higher education, reinforcing the role of education in empowering persons with disabilities to access welfare programs.[11]

Variations in awareness among different disability types may be attributed to differences in mobility, dependence, and institutional engagement. Participants with paraplegia and cerebral palsy, who are more likely to attend rehabilitation centers or physiotherapy units, demonstrated higher awareness, whereas those with polio or amputations had fewer structured touchpoints, limiting exposure to scheme information. Pal et al. (2000) similarly emphasized that social isolation and limited outreach services hinder the flow of disability-related information, particularly in rural and semi-urban areas.[12]

Underutilization of schemes observed in this study mirrors findings from Angothu et al. (2022) and Kashyap et al. (2012), who reported low enrollment in disability programs due to procedural complexity, unclear eligibility criteria, and limited publicity.[13-14] Ojha (2023) further highlighted gaps in coordination and monitoring, noting that many beneficiaries remain unaware of programs and frontline officials often lack clarity on documentation requirements. Together, these findings suggest that awareness alone is insufficient; practical accessibility remains a major barrier.[15]

The present findings align with Fernández-Batanero et al. (2022), who reported that students with disabilities face barriers such as inadequate institutional support, attitudinal challenges, and limited accessibility.[2] Similarly, in this study, participants reported difficulties in accessing information and guidance about government educational schemes, highlighting that systemic and informational barriers impede inclusion not only in higher education but also in broader educational and welfare contexts.

Participants in the current study primarily learned about schemes through informal sources such as NGOs or social media, consistent with Pal et al. (2000)[12], who emphasized the intermediary role of non-governmental organizations in bridging communication gaps. While NGOs are important, structured government-led awareness campaigns, community outreach, and accessible digital platforms are essential to ensure equitable dissemination of information.

Conclusion

The conclusion of this study points to an ongoing gap between the availability of government educational schemes and their actual accessibility for people with locomotor disabilities. It also emphasizes the importance of better implementation, clearer communication of information, and stronger institutional support to ensure that these schemes genuinely provide equal educational opportunities. Barriers such as inadequate dissemination of information, complex procedures, and limited institutional engagement impede effective utilization.

Higher awareness among participants with greater educational attainment or more frequent interaction with rehabilitation centers highlights the role of education and institutional support in bridging information gaps.

This study adds novel evidence by specifically examining awareness and utilization patterns across different types of locomotor disabilities, revealing disparities likely influenced by mobility, social engagement, and access to support services.

Although sex and gender were not the primary focus of this study, differences in awareness and access to schemes may exist across socio-demographic groups, highlighting the need for further research to explore these variations. The study was limited by its geographic scope and reliance on a self-made questionnaire, which may not capture the full range of participants' experiences.

The findings have important implications for policy, clinical practice, and research. Strengthening awareness campaigns through schools, community centers, healthcare facilities, and digital platforms can improve reach. Simplifying application procedures and aligning scheme benefits with the actual needs of the target population may enhance utilization. Rehabilitation professionals, including physiotherapists, can play a pivotal role in guiding beneficiaries and facilitating access. Future studies could explore inter-sectoral collaborations, the role of technology in increasing accessibility, and long-term evaluations of policy interventions on scheme uptake.

Overall, this study underscores the persistent gap between policy intent and practical implementation, emphasizing that targeted, multi-level strategies are essential to ensure that persons with locomotor disabilities are empowered to fully access educational opportunities and social welfare benefits.

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Ethical Clearance/Statement of Ethics: The study was approved by the Institutional Ethics Committee of Sancheti Institute for Orthopaedics and Rehabilitation College of Physiotherapy. The ethical approval reference number is IEC-SIOR/Agenda 086.

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

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Effectiveness of Plantar Flexor and Intrinsic Foot Muscle Exercises in Knee Osteoarthritis: A Randomized Controlled Trial

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Abstract

Background*:* Knee osteoarthritis (KOA) is a common degenerative disorder, often aggravated by obesity, malalignment, and inactivity. While most rehabilitation targets proximal muscles, foot and ankle function—essential for shock absorption, postural control, and gait—remains overlooked. This gap highlights the need for a more integrated approach addressing both proximal and distal components of the lower limb.

Objectives*:* To evaluate the added benefit of foot and ankle exercises in KOA rehabilitation.

Methods*:* Eighty participants were randomized into two groups. Group A received exercises for foot intrinsic and plantar flexors along with quadriceps, hamstrings, and hip abductors. Group B performed only proximal muscle exercises. Knee Osteoarthritis Outcome Scores were recorded at baseline and after six weeks.

Results*:* Both groups improved significantly (overall posttest Mean = 48.42, SD = 12.45; $p < 0.05$). Group A achieved greater gains across all KOOS subscales (Mean = 59.86, SD = 12.58; $p < 0.05$).

Conclusion*:* Incorporating foot and ankle exercises enhances KOA rehabilitation, supporting a kinetic-chain approach.

Keywords*:* Exercise therapy, foot intrinsic, osteoarthritis, plantar flexors, toe intrinsics

Introduction

Knee osteoarthritis (KOA) is the most common and rapidly progressing form of arthritis [1], marked by cartilage degeneration, subchondral bone changes, and inflammation causing pain, stiffness, muscle weakness, reduced mobility, and functional decline [2,3]

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Osteoarthritis (OA), affecting the tibiofemoral and patellofemoral joints, is classified as primary (systemic/local factors) or secondary (identifiable causes)[3,4]. Key risk factors include age, genetics, obesity, trauma, repetitive stress, lifestyle, structural abnormalities, and systemic diseases [4,5]

A systematic review and meta-analysis reported thatknee OA is more common in women and increases with age, affecting 22.9% of people over 40 years. In 2020, there were 654 million cases worldwide, with 19.2% prevalence in Asia. [6]

According to the Kellgren-Lawrence classification, the prevalence of OA in India is 28.7%, higher in women (31.6%) than men (28.1%). Elevated BMI, sedentary lifestyle, and use of Western toilets are key contributing factors [7]

Subchondral bone changes may precede cartilage loss in OA. Reduced blood supply triggers osteoblasts to send signals that harm cartilage, and exosomes promote cartilage breakdown.Senescent chondrocytes release pro-inflammatory SASP factors (TGF-β,IL-6), promoting chronic inflammation and degradation [8-10]

Kinematic changes KOA increase peak knee adduction moments (KAM) and reduce knee flexion moments (KFM), indicating greater medial joint loading and OA progression [9]. Cartilage damage disrupts smooth motion, and repetitive loading worsens pain, inflammation, and discomfort [10,11]

Conventional OA management encompasses medications, surgery, and non-pharmacological approaches. Among the latter, exercises are widely used as it is safer than medication and enhances both function and overall health [11]

Conventional KOA rehabilitation targets hip abductors, quadriceps, and hamstrings [12,13], but often overlooks the foot and ankle's role in the kinetic chain.

Recent research emphasizes the importance of plantar flexors and intrinsic foot muscles in shock absorption, posture, and gait. Weakness in these muscles can disrupt mechanics, increase knee joint stress, and limit the effectiveness of proximal-focused rehab alone [14]

This gap in current clinical practice underscores the need for a comprehensive, integrated approach that addresses both proximal and distal components of the lower limb. Hence, this study aims to compare the effectiveness of two exercise regimens: one combining exercises for the hip abductors, quadriceps, and hamstrings with plantar flexors and intrinsic foot muscles, and another using conventional proximal-focused exercises alone. Outcomes will be assessed with KOOS to evaluate added benefits of foot and ankle training.

Methodology

This single-blinded randomized controlled trial was conducted at a tertiary care center in Dharwad, Karnataka, India, from April 2024 to May 2025. Ethical approval was obtained (SDMIEC/2024/715), and the trial was preregistered (CTRI/2024/10/075245). The study followed CONSORT 2025 guidelines.

A total of 93 patients presenting with knee pain were screened. Inclusion criteria were individuals aged ≥40 years [15], of any gender, with clinical and radiographic evidence of medial tibiofemoral OA in unilateral or bilateral knee/s [11, 16], Kellgren–Lawrence grades 1–3[14]. Exclusion criteria included inflammatory or infective arthritis, OA of the hip, ankle, or foot, prior knee or hip surgery, taken intra-articular injections within the past 6 months, neurological disorders affecting the lower limbs, or deformities of the affected limb(s). Written informed consent was obtained from all participants after they were fully informed about the study.

Sample size

The prevalence of osteoarthritis in India is approximately 39%, with 83% attributed to knee osteoarthritis (KOA). Using the formula $4pq/L^2$ (p = 83%, q = 17%, L = 10%), and a 5% alpha error, the calculated sample size was 80, divided equally into two groups of 40 participants each.

Randomization and Blinding

The participants' demographic data were taken and assessed. Of 93 participants, 80 met the criteria and were randomized (1:1) into Group A (experimental, n = 40) and Group B (control, n = 40) using a concealed envelope method by an independent third party, ensuring allocation blinding (Figure 1).

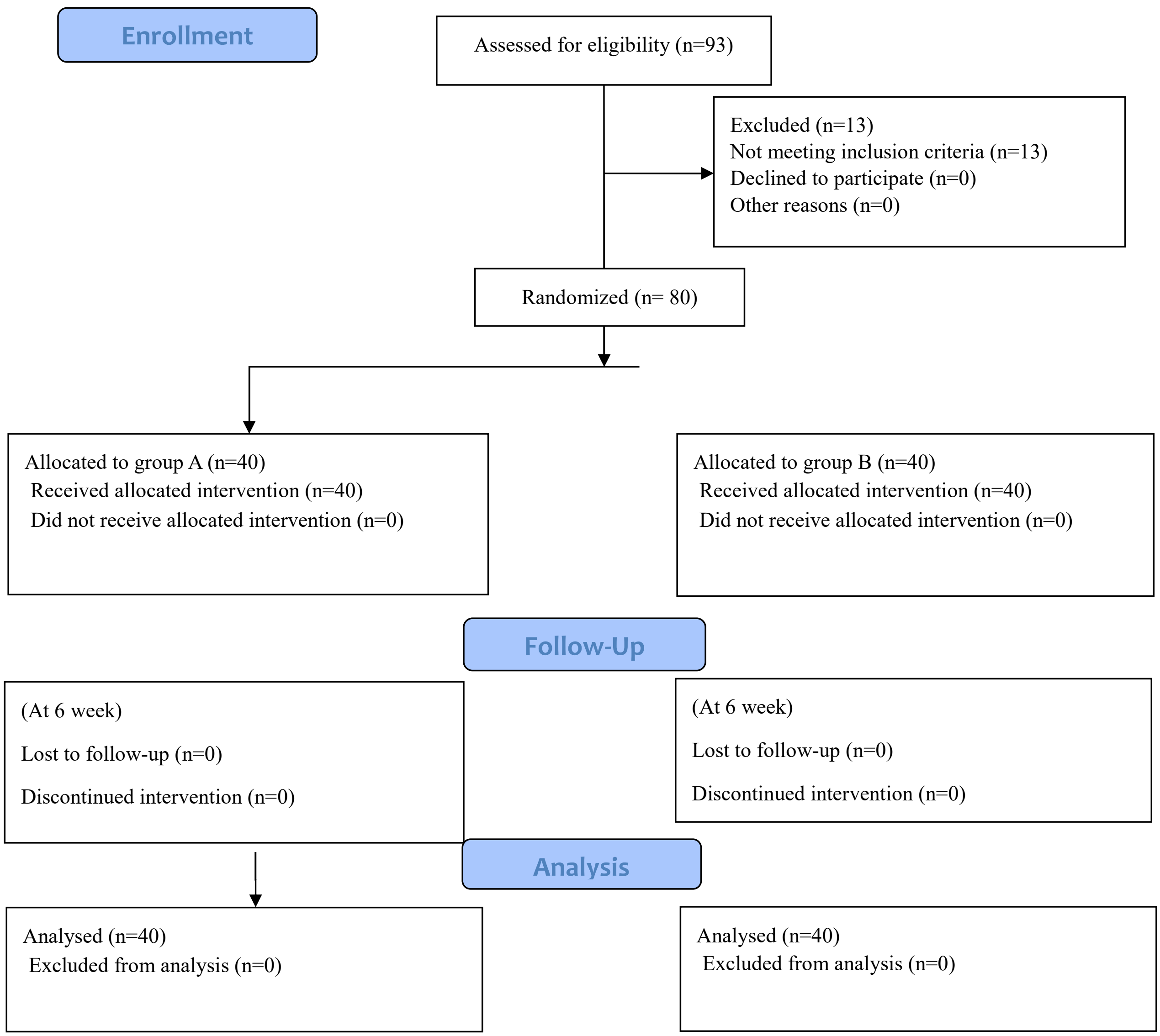

Figure 1. CONSORT flowchart

Interventions

Group A: - plantar flexors and intrinsic muscles of the foot exercise training along with hamstrings, quadriceps, and hip abductors.

Group B: - hip abductors, quadriceps, hamstrings training.

Exercise Protocol for Group A (Figures 2 to 6)

The exercise regimen was customized, with distinct sets and repetitions for every muscle that were increased weekly with a 1-minute rest between sets.

Figure 2: Hip Abductor Training Exercise

Figure 3: Quadriceps Training Exercise

Figure 4: Hamstring Training Exercise

Figure 5: Plantar Flexors Training Exercise (5a, 5b)

Figure 6: Foot Intrinsics Exercise Training

1st week:

Hip abductors- 10x2

Quadriceps- 20x2

Hamstrings- 20x2

Plantar flexors- 20x2

Intrinsics- 30secs x2 (curling and releasing the toes for 30 secs into 2 sets)

2nd week:

Hip abductors- 15x2

Quadriceps- 30x2

Hamstrings- 30x2

Plantar flexors- 30x2

Intrinsics- 45secs x2

3rd week:

Hip abductors- 15x2

Quadriceps- 40x2

Hamstrings- 40x2

Plantar flexors- 40x2

Intrinsics- 1 min x2

4th week:

Hip abductors- 20x2

Quadriceps- 50x2

Hamstrings- 50x2

Plantar flexors- 50x2

Intrinsics- 1 min x3

5th week: Half kg of external resistance was added for hip abductors, quadriceps, hamstrings and 100 grams was added for intrinsics

Hip abductors- 10x2

Quadriceps- 20x2

Hamstrings- 20x2

Plantar flexors- 20x2

Intrinsics- 1 min x3

6th week: 1 kg of external resistance was added for hip abductors, quadriceps, hamstrings and 200 grams was added for intrinsics

Hip abductors- 10x2

Quadriceps- 20x2

Hamstrings- 20x2

Plantar flexors- 20x2

Intrinsics-1 min x3

Exercise Protocol for Group B (Figures 2 to 4)

The protocol is the same as experimental group for the Hip abductors, quadriceps, and hamstrings.

A compliance sheet was given to every subject, where he/she had to tick, as they performed the exercises. Patients were followed once a week.

Each muscle group was performed 5 days a week. Hence, a total of 90 sessions were carried out for 30 minutes. A minimum of 45 sessions was considered for evaluating the participant.

Outcomes

The KOOS is a self-administered questionnaire consisting of 42 items; five domains. Scores for each domain are transformed to a 0–100 scale, with 100 indicating no problems [17]. Participants completed all domains at baseline and at the end of the 6th week.

Statistical Analysis

All analyses were conducted using SPSS version 23 (IBM, Armonk, NY, USA). Descriptive statistics included mean, standard deviation, frequencies, and percentages. Chi-square and independent t-tests assessed demographic differences. Normality was tested using the Shapiro-Wilk test, revealing a non-normal distribution. Therefore, Wilcoxon matched pairs test and Mann-Whitney U test were used for within- and between-group comparisons, respectively. A p-value <0.05 was considered statistically significant.

Results

Baseline data showed no significant differences between groups (Tables 1and 2). After 6 weeks of intervention, both groups showed significant improvements across all KOOS domains (p=0.0001*) [Table 3], with Group A demonstrating significantly greater improvement than Group B (p=0.0001*) [Table 4]. MCID values are Pain: 14.3-15.3, Symptoms: 14.1-15.6, ADL: 15.2-16.0, Sp/rec: 11.7-11.8 and QOL: 13.6[18]

Table 1. Comparison of gender distribution in both groups.

Gender	Group A	%	Group B	%	Total	%	P-value
Male	13	32.50	14	35.00	27	33.75	0.8131
Female	27	67.50	26	65.00	53	66.25	
Total	40	100.00	40	100.00	80	100.00	

Chi-square test, Group A- experimental group, Group B- control group

Table 2. Comparison of Group A and Group B with mean age by

Group	n	Mean	SD	SE	t-value	P-value
Group A	40	59.38	10.56	1.67	0.2397	0.8112
Group B	40	58.88	7.91	1.25		

Independent t test, Group A- experimental group, Group B-control group, SD- standard deviation, SE- standard error

Table 3. Within-Group Comparison of Pre-Test and Post-Test Scores of KOOS in Group A and Group B

KOOS Domains	Group	Time	Mean	SD	Mean Diff.	Effect Size	% of Effect	Z-value	p-value
Pain	A	Pretest	22.40	12.09					
		Posttest	68.78	12.15	46.37	3.84	207.02	5.43	0.0001*
	B	Pretest	21.63	8.97					

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		Posttest	38.73	11.50	17.09	1.91	79.01	5.44	0.0001*
Symptoms	A	Pretest	26.08	10.53					
		Posttest	57.42	11.50	31.34	2.98	120.19	5.51	0.0001*
	B	Pretest	24.59	7.74					
		Posttest	38.60	10.77	14.01	1.81	56.95	4.97	0.0001*
ADL	A	Pretest	18.80	7.68					
		Posttest	63.22	12.68	44.43	5.79	236.37	5.51	0.0000*
	B	Pretest	16.53	5.11					
		Posttest	35.35	11.73	18.82	3.68	113.87	4.81	0.0000*
SP/REC	A	Pretest	16.12	8.21					
		Posttest	49.06	15.19	32.93	4.01	204.24	5.44	0.0001*
	B	Pretest	15.30	10.86					
		Posttest	29.93	12.89	14.63	1.35	95.59	5.37	0.0001*
QOL	A	Pretest	32.69	10.13					
		Posttest	59.84	12.08	27.15	2.68	83.04	5.44	0.0001*
	B	Pretest	35.39	11.17					
		Posttest	43.28	14.04	7.89	0.71	22.29	4.56	0.0001*

Wilcoxon Matched Pairs Test, ADL = Activities of Daily Living, SP/REC = Sports/Recreation, QOL = Quality of Life, SD = standard deviation, Diff = difference, KOOS = Knee Injury and Osteoarthritis Outcome Score $p < 0.05$*

Table 4. Between-Group Comparison of Pre-Test and Post-Test Scores of KOOS in Group A and Group B

KOOS Domains	Time Point	Group A Mean ± SD	Mean Rank A	Group B Mean ± SD	Mean Rank B	Effect Size	Z-value	p-value
Pain	Pretest	22.40 ± 12.09	40.44	21.63 ± 8.97	40.56	0.07	0.0192	0.9846
	Posttest	69.78 ± 11.47	58.93	38.73 ± 11.50	22.08	2.70	7.0870	0.0001*
	Difference	47.37 ± 16.29	58.08	17.09 ± 9.03	22.93	2.39	6.7598	0.0001*

Continue....

Symptoms	Pretest	26.08 ± 10.53	40.93	24.59 ± 7.74	40.08	0.16	0.1588	0.8738
	Posttest	57.42 ± 11.50	54.93	38.60 ± 10.77	26.08	1.69	5.5474	0.0001*
	Difference	31.34 ± 12.86	55.16	14.01 ± 7.64	25.84	1.69	5.6388	0.0001*
ADL	Pretest	18.80 ± 7.68	42.23	16.53 ± 5.11	38.78	0.35	0.6591	0.5098
	Posttest	63.22 ± 12.68	57.69	35.35 ± 11.73	23.31	2.28	6.6107	0.0001*
	Difference	44.43 ± 14.75	57.01	18.82 ± 9.98	23.99	2.07	6.3509	0.0001*
SP/REC	Pretest	16.12 ± 8.21	40.73	15.30 ± 10.86	40.28	0.09	0.0818	0.9348
	Posttest	49.06 ± 15.19	53.24	29.93 ± 12.89	27.76	1.36	4.8979	0.0001*
	Difference	32.93 ± 15.24	54.28	14.63 ± 8.40	26.73	1.55	5.2972	0.0001*
QOL	Pretest	32.69 ± 10.13	40.14	35.39 ± 11.17	40.86	0.25	0.1347	0.8928
	Posttest	59.84 ± 12.08	52.85	43.28 ± 14.04	28.15	1.27	4.7487	0.0001*
	Difference	27.15 ± 12.80	56.65	7.89 ± 7.97	24.35	1.85	6.2113	0.0001*

Mann Witney U Test, ADL = Activities of Daily Living, SP/REC = Sports/Recreation, QOL = Quality of Life, SD = standard deviation, KOOS = Knee Injury and Osteoarthritis Outcome Score $p< 0.05$*

Discussion

The objective of the current study was to assess how a thorough lower limb training program affected people with KOA. The study consisted of 80 participants, randomly divided into two groups: the experimental and control group. Results demonstrated statistically significant improvements in both groups through within-group analysis, while between-group analysis favored the experimental group.

Frontal plane pelvic control during gait depends on the hip abductors, which prevent contralateral pelvic drop and trunk sway. In KOA, weak abductors cause pelvic instability, trunk lean, higher knee adduction moments, and medial knee overload [19] Training them improves lateral stability, reduces dynamic valgus, and enhances gait symmetry and confidence.

The quadriceps femoris stabilizes the knee during gait, working isometrically at heel strike, eccentrically to foot flat, and concentrically in mid-stance, with peak activity again in deceleration. In KOA, quadriceps weakness reduces shock absorption, stability, and eccentric control, impairing function. Dynamic quadriceps training improves knee control, load distribution, pain and mobility. [12,13].

The hamstrings stabilize the knee by acting eccentrically at heel strike, concentrically at toe-off and mid-swing, and eccentrically in deceleration. In KOA, weakness impairs tibial control, swing initiation, and stability, increasing anterior knee load. Eccentric training restores support, balance, gait stability, and efficiency [11,13].

The gastrocnemius, stabilizes the ankle during the foot flat and controls anterior tibial translation eccentrically in mid-stance. Its peak activity occurs during heel off, where it contracts concentrically, providing plantarflexion power for propulsion, and continues through toe-off before becoming inactive in swing phases. Originating from the femur, its activation also helps control anterior tibial glide, reducing shear forces in the tibiofemoral joint. In KOA, weak plantar flexors diminish eccentric control and push-off strength, contributing to poor gait mechanics and joint stress.[20]

The experimental group showed better dynamic knee stability in mid-to-terminal stance due to gastrocnemius training, which improved push-off timing and magnitude, reduced gait asymmetry, minimized compensatory hip/trunk movements, and absorbed impact after initial contact, lowering knee joint loads.

The soleus originates from the posterior fibular head and upper shaft, the tibialsoleal line, and the middle third of the medial tibial border, narrowing to join the calcaneal tendon. While its main role is ankle plantarflexion, it also influences knee biomechanics by modulating tibial rotation during gait.Its inferior part is deeply indented in the shape of a horseshoe with a medial and lateral border[21,22].

1. **Heel strike to mid-stance**: Soleus eccentrically controls tibial forward translation and internal rotation, preventing excess dorsiflexion and prolonged pronation that increase KAM and medial knee stress.
2. **Mid-stance to toe-off**: Soleus maintains eccentric control until heel-off, then switches to concentric action to drive plantarflexion, subtalar supination, and tibial external rotation.

The toe intrinsics, originating from the calcaneus and plantar fascia and inserting into the proximal phalanges and extensor hoods, play key roles in gait:

1. **Arch Support**: Maintain medial arch, limit pronation, and control tibial/femoral rotation. Weakness causes arch collapse, poor force transfer, longer stance, and medial knee overload.
2. **Midstance to Toe-off**: Stabilize MTPJs and activate the windlass mechanism, stiffening the arch for efficient push-off, better propulsion, and reduced hip/quadriceps strain.[14,20]

Knee OA reduces knee extension and propulsion, altering gait with weaker toe-off. Shortened stance time lowers toe intrinsic activation, leading to poor proprioception and balance. Training toe intrinsics improved toe clearance, reduced tripping risk, enhanced gait coordination, and lowered abnormal OA limb loading.

- A bottom-up biomechanical improvement throughout the lower leg is produced by the coordinated participation of these muscles:
- Initial Contact to Mid-Stance: Reduced excessive dorsiflexion due to improved soleus function minimizes knee overloading.
- From mid-stance to terminal stance, the gastrocnemius muscle helps stabilize the knee and facilitates effective forward propulsion
- Terminal Stance to Pre-Swing: The limb is ready for swing due to the toe intrinsics, which also provide final propulsion and strengthen arch mechanics.

The experimental group improved KOOS scores by enhancing gait mechanics and redistributing load, reducing knee stress. Gastro-soleus training boosted plantarflexion for smoother weight transfer and stronger push-off, while stronger toe intrinsics improved terminal stance stability, stride symmetry, and reduced fall risk[24,25]

In future longitudinal studies to evaluate the sustained effects of this expanded protocol over six months to one year can be conducted, biomechanical analysis techniques (such as EMG and gait analysis) can be used to clarify the physiological processes behind the noted functional gains.

The limitations of the study was theshort-term duration of the intervention limits the ability to assess the prolonged sustainability of the selected parameters. The study was conducted in a single-center setting, which may restrict the generalizability of findings to broader or more diverse populations.

Conclusion

The findings of this study provide compelling evidence for a holistic, kinetic-chain-focused rehabilitation strategy in managing KOA. The experimental group, which received additional foot and ankle exercises, outperformed the control group across all KOOS subscales. These benefits likely stem from improved gait mechanics, enhanced neuromuscular control, and reduced joint stress. This study advocates for shifting rehabilitation paradigms toward full-limb, multi-joint interventions that reflect the functional complexity of human movement.

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Name of the registry- Clinical Trials Registry-India (CTRI)

https://ctri.nic.in/Clinicaltrials/login.php (ctri.nic.in)

Conflicts of Interest- The authors declare no conflicts of interest related to this study.

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Burnout Syndrome Among Physiotherapists: An Exploratory Cross-Sectional Study from Delhi–NCR

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Abstract

Introduction: Burnout among physiotherapists has received limited attention in India, despite growing evidence of its impact on professional well-being and patient care.This study assessed the burnout levels and their associations with demographic and professional variables among physiotherapists practicing in the Delhi–NCR region.

Methodology: A cross-sectional survey was conducted among 140 practicing physiotherapists using the Maslach Burnout Inventory–Human Services Survey. Burnout levels across emotional exhaustion (EE), depersonalization (DP), and personal accomplishment (PA) subscales were categorized as low, moderate, or high. Associations with demographic and professional variables were analyzed using chi-square tests.

Results: Most participants demonstrated low burnout across all three domains. Emotional exhaustion was predominantly low (51%), while depersonalization (42% low; 37% high) and reduced personal accomplishment (38% low; 34% high) showed greater variability. Gender was significantly associated with personal accomplishment, with females reporting higher PA scores ($\chi^2 = 8.398$, $p = 0.015$).

Conclusion: Physiotherapists in Delhi–NCR exhibited relatively low emotional exhaustion but notable levels of depersonalization and reduced personal accomplishment, indicating emerging occupational strain. Compared with global estimates, emotional exhaustion appeared lower, while depersonalization and reduced personal accomplishment were higher. These findings highlight the need for early preventive measures and organizational strategies to promote physiotherapist well-being.

Keywords: Burnout, Physiotherapists, Maslach Burnout Inventory, Healthcare Worker, Delhi-NCR.

Introduction

Burnout is increasingly recognized as a serious occupational phenomenon resulting from chronic workplace stress[1]. It is characterized by three dimensions – emotional exhaustion, cynicism (depersonalization), and reduced professional efficacy – and in healthcare settings it can undermine

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both provider well-beingand patient care quality[2]. Healthcare workers face particularly high risk because of long hours, heavy workloads and high emotional demands. For example, about one-quarter of medical professionals globally report burnout symptoms[3]. The World Health Organization now classifies burnout as an "occupational phenomenon" (not a medical condition) and emphasizes that it arises when job stress exceeds coping resources[1].

Burnout has been extensively documented among physicians, nurses and allied health staff worldwide. Estimates suggest roughly 20–30% of hospital doctors and nurses meet criteria for high burnout in core domains[3], with risk factors including heavy caseloads, long hours and staffing shortages[4]. Younger age, female gender and difficult working conditions have consistently been associated with higher burnout rates[5].

Physiotherapists share many of the same stressors as other clinicians but have been less often studied. Recent reviews confirm that burnout levels in physiotherapy are substantial. In a 2024 meta-analysis of 5,984 physiotherapists across 17 countries, about one-fourth of physiotherapists reported high burnout symptoms, comparable to other health workers[2]. Notably, Venturini et al. observed that burnout symptoms tended to be more common in studies from developing countries, suggesting context-specific pressures.

In India, the literature on burnout in allied health professionals is sparse. A recent systematic review of Indian healthcare workers (doctors, nurses and allied staff) found that roughly one-quarter of respondents scored high on each major burnout domain[4]. The authors noted that burdens such as heavy patient loads and limited infrastructure likely fuel these rates[4]. To date, only a few small Indian studies have quantified burnout in physiotherapists. For example, Khan et al. (2020) reported that 40% of 100 physiotherapists in Jalgaon (Maharashtra) met criteria for moderately high burnout[6]. Similarly, a cross-sectional study conducted in Ahmedabad found a weak positive correlation between burnout syndrome severity and poor sleep quality among middle-aged physiotherapists working in academic, outpatient, and private clinic settings, highlighting the influence of workplace stressors on burnout in Indian physiotherapy practice[7].

Because existing evidence in India is limited and localized, especially outside Gujarat/Maharashtra, it remains unknown how burnout affects physiotherapists working in Delhi–NCR region. The current exploratory study therefore aims to fill this gap. We conducted a cross-sectional survey of practicing physiotherapists in Delhi-NCR. Using the Maslach Burnout Inventory, we aimed to estimate the distribution of burnout levels in this group and examine associations with demographic and professional variables. The study's research question was: What is the level of occupational burnout among physiotherapists in Delhi–NCR region, and which demographic or professional variables are associated with higher burnout levels? Insights from this research will help inform strategies to support physiotherapy professionals and mitigate burnout in the Indian healthcare system.

Methodology

Study design and setting

Anexploratory cross-sectional study was conducted among physiotherapists practicing in Delhi–NCR region between February and July 2025. A total of 140 practising physiotherapists participated in the study, working in a variety of clinical settings (hospitals, clinics, rehabilitation centre, and home care). Exclusion criteria were Physiotherapy students (not yet in clinical practice) and physiotherapists not currently practicing as a profession. Convenience sampling was used to recruit participants. Incomplete responses and those not meeting inclusion criteria were excluded.

Data Collection Procedure

Data were collected using a structured Google Form. The form consisted of an electronic informed consent statement, demographic and professional questions (age, gender, years of experience, and workplace type), and a self-assessment questionnaire adapted from items of the Maslach Burnout Inventory. Participation was voluntary and anonymous, and no personal identification information was collected. The data were compiled in Google Sheets and later transferred to Microsoft Excel and SPSS for analysis.

Outcome Measure

Burnout was assessed using a freely available burnout self-assessment questionnaire adapted from items of the Maslach Burnout Inventory[9]. The tool includes three sections that reflect emotional exhaustion, depersonalization, and personal accomplishment. Each item uses a 7-point frequency scale ranging from 0 ("Never") to 6 ("Every day"). Because this version is not the original copyrighted MBI-HSS, it should be considered an adaptation rather than the official instrument.

Scoring followed the interpretation guidelines provided in the tool:

- Emotional Exhaustion (≤17 low, 18–29 moderate, ≥30 high)
- Depersonalization (≤5 low, 6–11 moderate, ≥12 high)
- Personal Accomplishment (≥40 low burnout, 34–39 moderate, ≤33 high burnout)

Participation in the study was voluntary, and informed consent was obtained from all participants prior to data collection. The survey collected no identifiable personal information and involved no intervention or deception. The study adhered to the ethical principles outlined in the Declaration of Helsinki (2013 revision).

Data Analysis

Statistical analysis was performed using IBM SPSS Statistics (Version 27). Descriptive statistics including frequency, percentage, mean, and standard deviation were computed to summarize the demographic and professional variables as well as burnout levels. Burnout scores for each of the three MBI subscales were categorized into low, moderate, and high levels for comparison. The Chi-square test for association was applied to examine the relationship between burnout levels and selected demographic and professional variables such as gender, age, specialization, years of experience, and clinical setting. A p-value less than 0.05 was considered statistically significant.

Results

A total of 140 physiotherapists participated in the study. The demographic and professional characteristics of the participants are presented in Table 1. The majority of participants were female (74.3%) and below 26 years of age (70%). Most respondents were having less than 3 years of experience (75.7%)and were primarily employed in hospital settings (39.3%).

The mean and standard deviation for each burnout subscale are presented in Table 2.

Table 1. Sociodemographic and professional char-acteristics of participants (N = 140)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	36	25.7%
	Female	104	74.3%
Age group	<26 years	98	70.0%
	26–35 years	37	26.4%
	>35 years	5	3.6%
Specialization	Neurology	27	19.3%
	Orthopaedics	24	17.1%

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	Cardiopulmonary	6	4.3%
	Paediatrics	6	4.3%
	Sports	17	12.1%
	None	60	42.9%
Years of experience	1–3 years	106	75.7%
	3–10 years	27	19.3%
	>10 years	7	5.0%
Clinical setting	Hospital	55	39.3%
	Clinic	28	20.0%
	Rehabilitation centre	26	18.6%
	Home care	31	22.1%

Table 2. Mean and standard deviation of burnout subscale scores (N = 140)

Subscale	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Emotional Exhaustion (EE)	0	42	18.06	8.74
Depersonalization (DP)	0	31	9.58	7.36
Personal Achievement (PA)	14	48	35.41	8.31

Burnout Levels among Participants

Based on the predefined cut-off scores for the Maslach Burnout Inventory, 11.4% of participants exhibited high levels of Emotional Exhaustion, 37.9% moderate, and 50.7%low. For Depersonalization, 36.4% demonstrated high burnout, 21.4% moderate, and 42.1% low. In contrast, for Personal Accomplishment, 34.3% of the participants exhibited high levels burnout (low accomplishment), 27.9% reported moderate, and 37.9% exhibited low (refer to Figure 1).

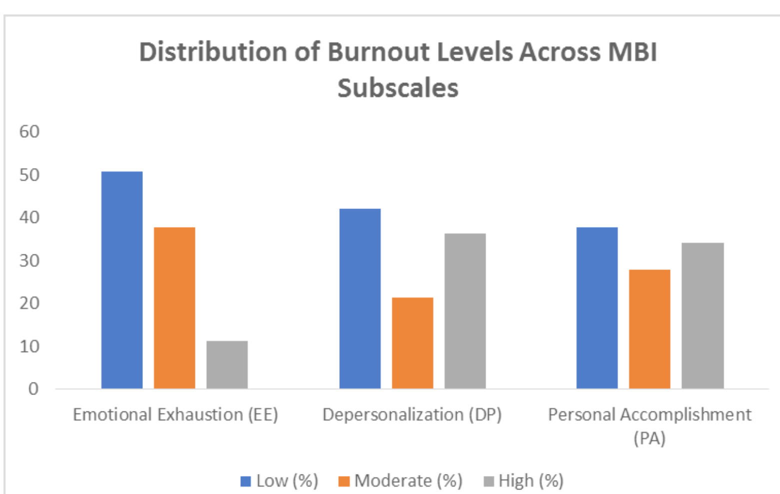

Figure 1: Distribution of burnout levels across the three subscales of the Maslach Burnout Inventory (N = 140)

Association Between Burnout Levels and Demographic and Professional Variables

The Chi-square test was applied to examine the association between the levels of burnout (low, moderate, high) in each MBI subscale and selected characteristics (gender, age group, years of experience, specialization, and clinical setting). No statistically significant associations were observed between Emotional Exhaustion and any variable (p>0.05) (Table 3). Similarly, Depersonalization did not show significant associations, although clinical setting approached significance (p = 0.065) (Table 4). A statistically significant association was observed between gender and Personal Accomplishment (χ^2 = 8.398, p = 0.015), with females reporting higher levels of personal accomplishment (Table 5).

Table 3. Association between emotional exhaustion(EE)levels and demographic and professional variables

Variable	Category	Low n(%)	Moderate n(%)	High n(%)	χ^2	p-value
Gender	Male	19 (52.8%)	13 (36.1%)	4 (11.1%)	.084	.959
	Female	52 (50.0%)	40 (38.5%)	12 (11.5%)		
Age group	<26 years	50 (51.0%)	38 (38.8%)	10 (10.2%)	2.898	.575
	26–35 years	17 (45.9%)	14 (37.8%)	6 (16.2%)		
	>35 years	4 (80.0%)	1 (20.0%)	0 (0.0%)		
Specialization	Neurology	12 (44.4%)	12 (44.4%)	3 (11.1%)	6.591	.763
	Orthopaedics	10 (41.7%)	12 (50.0%)	2 (8.3%)		
	Cardiopulmonary	2 (33.3%)	3 (50.0%)	1 (16.7%)		
	Paediatrics	4 (66.7%)	2 (33.3%)	0 (0.0%)		
	Sports	11 (64.7%)	5 (29.4%)	1 (5.9%)		
	None	32 (53.3%)	19 (31.7%)	9 (15.0%)		
Years of experience	1–3 years	50 (47.2%)	44 (41.5%)	12 (11.3%)	3.181	.528
	3–10 years	16 (59.3%)	8 (29.6%)	3 (11.1%)		
	>10 years	5 (71.4%)	1 (14.3%)	1 (14.3%)		
Clinical setting	Hospital	25 (45.5%)	23 (41.8%)	7 (12.7%)	4.276	.639
	Clinic	18 (64.3%)	8 (28.6%)	2 (7.1%)		
	Rehabilitation centre	15 (57.7%)	8 (30.8%)	3 (11.5%)		
	Home care	13 (41.9%)	14 (45.2%)	4 (12.9%)		

Table 4. Association between depersonalization(DP) levels and demographic and professional variables

Variable	Category	Low n(%)	Moderate n(%)	High n(%)	χ^2	p-value
Gender	Male	15 (41.7%)	5 (13.9%)	16 (44.4%)	2.143	.342
	Female	52 (42.3%)	40 (24.0%)	12 (33.7%)		

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Age group	<26 years	39 (39.8%)	22 (22.4%)	37 (37.8%)	3.889	.421
	26–35 years	16 (43.2%)	7 (18.9%)	14 (37.8%)		
	>35 years	4 (80.0%)	1 (20.0%)	0 (0.0%)		
Specialization	Neurology	11 (40.7%)	4 (14.8%)	12 (44.4%)	6.714	.752
	Orthopaedics	9 (37.5%)	8 (33.3%)	7 (29.2%)		
	Cardiopulmonary	2 (33.3%)	1 (16.7%)	3 (50.0%)		
	Paediatrics	4 (66.7%)	0 (0.0%)	2 (33.3%)		
	Sports	9 (52.9%)	3 (17.6%)	5 (29.4%)		
	None	24 (40.0%)	14 (23.3%)	22 (36.7%)		
Years of experience	1–3 years	42 (48.6%)	20 (18.9%)	44 (41.5%)	7.084	.132
	3–10 years	12 (44.4%)	9 (33.3%)	6 (22.2%)		
	>10 years	5 (71.4%)	1 (14.3%)	1 (14.3%)		
Clinical setting	Hospital	22 (40.0%)	12 (21.8%)	21 (38.2%)	11.848	.065
	Clinic	19 (67.9%)	5 (17.9%)	4 (14.3%)		
	Rehabilitation centre	8 (30.8%)	7 (26.9%)	11 (42.3%)		
	Home care	10 (32.3%)	6 (19.4%)	15 (48.4%)		

Table 5. Association between personal accomplishment levels(PA) and demographic and professional variables

Variable	Category	Low n(%)	Moderate n(%)	High n(%)	χ^2	p-value
Gender	Male	20 (55.6%)	10 (27.8%)	6 (16.7%)	8.398	.015*
	Female	33 (31.7%)	29 (27.9%)	42 (40.4%)		
Age group	<26 years	33 (33.7%)	29 (29.6%)	36 (36.7%)	5.388	.250
	26–35 years	16 (43.2%)	9 (24.3%)	12 (32.4%)		
	>35 years	4 (80.0%)	1 (20.0%)	0 (0.0%)		
Specialization	Neurology	13 (48.1%)	6 (22.2%)	8 (29.6%)	9.708	.466
	Orthopaedics	7 (29.2%)	8 (33.3%)	9 (37.5%)		
	Cardiopulmonary	2 (33.3%)	1 (16.7%)	3 (50.0%)		
	Paediatrics	3 (50.0%)	0 (0.0%)	3 (50.0%)		
	Sports	8 (47.1%)	7 (41.2%)	2 (11.8%)		
	None	20 (33.3%)	17 (28.3%)	23 (38.3%)		

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Years of experience	1–3 years	36 (34.0%)	31 (29.2%)	39 (36.8%)	5.802	.214
	3–10 years	12 (44.4%)	6 (22.2%)	9 (33.3%)		
	>10 years	5 (71.4%)	2 (28.6%)	0 (0.0%)		
Clinical setting	Hospital	22 (40.0%)	14 (25.5%)	19 (34.5%)	8.364	.213
	Clinic	14 (50.0%)	4 (14.3%)	10 (35.7%)		
	Rehabilitation centre	5 (19.2%)	10 (38.5%)	11 (42.3%)		
	Home care	12 (38.7%)	11 (35.5%)	8 (25.8%)		

Overall, the findings indicate that participants experienced predominantly moderateburnout across all three domains. Demographic and Professional Variables showed minimal influence, except for gender differences in personal accomplishment.

Discussion

In this study of 140 Indian physiotherapists, burnout levels were predominantly low across the three Maslach subscales, although variation was evident between domains. Most participants scored low on emotional exhaustion (EE), indicating generally good emotional well-being. However, a notable proportion showed higher burnout on depersonalization (DP) and low personal accomplishment (PA) subscales—suggesting that, while therapists were not emotionally drained, some experienced emotional distancing or reduced professional fulfilment. Only about 11% had high emotional exhaustion (EE), whereas 36% had high depersonalization (DP) and 34% had high (i.e. low personal accomplishment) burnout.

In comparison, a recent meta-analysis of 5984 physiotherapists worldwide found that roughly 27% had high EE, 23% had high DP, and 25% had low personal accomplishment[2]. In an Indian context, Kesarwani et al. (2020) meta-analyzed healthcare workers and found pooled burnout rates of about 24–27% in each MBI domain[4]. Hence, our participants exhibited relatively lower high-EE but somewhat higher DP and low-PA rates than the pooled international averages.

The only significant association observed was between gender and personal accomplishment, with female therapists reporting higher scores (lower burnout) than males, consistent with previous findings[5], while men had higher depersonalization (and no gender difference in exhaustion). Similarly, Corrado et al. found that male therapists in an Italian sample experienced greater depersonalization than their female counterparts[11]. Kesarwani et al. noted female gender as a general risk factor for burnout in Indian healthcare workers[4], although that meta did not report PA specifically. The gender gap in personal accomplishment may stem from differing social roles and work experiences, with men tending toward greater depersonalization and women maintaining higher professional efficacy[12]. In our cohort no gender differences emerged for exhaustion or depersonalization.

Apart from gender, no other variables (age, specialization, experience, setting) showed significant associations. This partly contrasts with other studies: younger and less experienced physiotherapists often report greater burnout[13]. For example, Scutter &Goold (1995) emphasized that new graduates had unusually high exhaustion[13], and Lee (2021) found therapists in their 20s had higher burnout scores than older colleagues[5]. In our sample, however, 70% were under 26 years and 75% had <3 years' experience, so limited variability may have obscured age effects.

Similarly, no specialization differences were found here, although previous research suggests that field of practice can influence burnout levels.

Corrado et al. reported lower accomplishment among neurological therapists[11]. WhileCelik and Sezgin (2025) found orthopaedic physiotherapists showed the highest personal accomplishment and neurology/paediatrics specialists greater exhaustion and depersonalization[14]. These discrepancies could reflect cultural or work environment differences, as well as sample characteristics (our cohort was predominantly young and female).

Participants in home-care and rehabilitation settings showed slightly higher depersonalization, though not statistically significant. In contrast, Donohoe et al. (1993) reported moderate burnout among inpatient rehabilitation therapists[15], while U.S. data show greater emotional exhaustion in home health care[16]. Conversely, private or outpatient settings appear protective—Polish physiotherapists in private clinics reported significantly lower burnout than those in public institutions[17]. Overall, burnout tends to be higher in high-demand settings and lower in private practice.

Practical Implications

Although overall burnout was low, the elevated proportion of participants showing high DP or low PA warrants attention. As Venturini et al. note, burnout "can negatively impact both staff well-being and the quality of care delivered to patients"[2]. Burnout arises when chronic job stress exceeds coping capacity, driven by workload, staffing issues, and patient demands[4,5]. The Job Demands–Resources model emphasizes enhancing job resources—such as autonomy, competence, and respect—to buffer burnout[18]. More broadly, organizational strategies are warranted. Skamagki et al. recommend systemic changes such as "robust support systems, flexible working conditions, and opportunities for professional development" to mitigate burnout[19].

Limitations and Future Directions

This study has several limitations. As a cross-sectional design, it cannot establish causal relationships between variables; longitudinal research is needed to examine how burnout evolves over time among physiotherapists. Self-reported MBI data may be subject to response or social desirability bias, and cultural influences could have affected how burnout symptoms were perceived or expressed. Moreover, the predominance of young, early-career, and female participants may limit generalizability to older or more diverse populations. The convenience sampling and restricted geographical coverage constrain external validity. Additionally, important contextual variables—such as workload, work environment, personality traits, coping strategies, and mental health—were not assessed and could have provided deeper insights.

Future research should involve larger samples of physiotherapists to assess the generalizability of findings. Qualitative studies could explore contextual influences, such as perceived support or workplace discrimination, underlying gender and age differences. Intervention studies are warranted to test strategies suggested by the job demands-resources framework (e.g. autonomy-enhancing programs, respect-building initiatives[18]. Finally, examining the impact of interventions on patient care quality and therapist retention will help translate findings into practice.

Conclusion

The present study found that the majority of physiotherapists practicing in Delhi–NCR region demonstrated low levels of burnout across all three Maslach subscales. Emotional exhaustion was predominantly low, whereas depersonalization and reduced personal accomplishment showed a more varied distribution, with a considerable proportion experiencing high burnout in these domains. Compared with the global estimates from recent meta-analysis, the present cohort exhibited relatively lower emotional exhaustion but comparable levels of depersonalization and reduced personal accomplishment. Gender emerged as the only significant factor associated with burnout, with females reporting higher personal accomplishment. Although severe burnout was uncommon, the coexistence of elevated depersonalization and diminished personal accomplishment indicates emerging occupational strain and warrants further investigation through larger, multi-centre studies.

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Ethical Clearance: The study involved voluntary, anonymous participation of physiotherapists through an online questionnaire. No personally identifiable data were collected. The study complied with the ethical principles of the Declaration of Helsinki (2013 revision). Formal institutional ethical approval was not required as per local and national research guidelines for minimal-risk survey studies.

Declaration of Conflicts of Interest Statement: The authors report no conflicts of interest.

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Efficacy of Therapeutic Ultrasound vs Myofascial Release in Treating Trigger Points of Myofascial Pain Syndrome: A Comparative Study

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Abstract

Background: Myofascial Pain Syndrome (MPS) is a highly prevalent condition, reported in 85% of patients with chronic pain complaints, and disproportionately affects women (64.3%) compared to men (35.7%). To evaluate treatment efficacy for MPS, a pre-post experimental comparative study was conducted, recruiting 30 subjects diagnosed with myofascial trigger points (MTrPs) who were randomly divided into two groups.Subjects received 12 treatment sessions on alternate days. The Ultrasound group (Group A) was treated with a continuous mode for 5-7 minutes, while the Myofascial Release group (Group B) received manual therapy over the trigger points until the therapist noted a reduction in tissue resistance. Outcome measures used were the Visual Analog Scale (VAS)in terms of pain and Palpable Muscle Spasm Degree (PMSD) in terms of spasm.

Aim of the Study: To compare the efficacy of Therapeutic Ultrasound versusMyofascial release in reducing pain and spasmassociated with Myofascial Pain Syndrome over the trigger point region.

Materials and Methods: This study employed ultrasound application and myofascial release, and subjects were randomly assigned to two groups.Outcome measures used were the Visual Analogue Scale (VAS) subjectively in terms of pain and the Palpable Muscle Spasm Degree (PMSD) objectively in terms of spasm.

Key Results: The pre-mean VAS of Group A was 7.73±0.704, and the post-mean VAS was 2.07±0.594. The pre-mean PMSD was 1.87±0.576, and the post-mean PMSD was 1.00±0.926. For Group B, the pre-mean VAS was 8.33±0.816, and the post-mean VAS was 2.40±0.910. The pre-mean PMSD was 2.13±0.640, and the post-mean PMSD was 0.600±0.910. The “P” value was <0.001. A weekly comparison of the mean VAS level in both groups was 4.60±0.138, with a “P” value of <0.001, which showed significant improvement across all 12 sessions (4 weeks).

Conclusion: This study statistically validated that both Therapeutic Ultrasound and hands-on manual therapy (Myofascial Release) were equally effective in reducing pain and spasm among the student population with active MTrPs. However,

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the clinical assessment suggested that Myofascial Release might be superior, offering more effective pain relief and spasm reduction within a shorter duration, in addition to being cost-effective, non-invasive, and providing immediate ymptomatic relief.

Keywords: Myofascial Pain Syndrome (MPS), Myofascial Trigger Point (MTrP), Ultrasound, Myofascial release, Visual Analog Scale (VAS), Palpable Muscle Spasm Degree (PMSD).

Introduction

Myofascial Pain Syndrome (MPS) is a complex musculoskeletal condition characterised by the presence of trigger points (TrPs) within skeletal muscle and its surrounding fascia. These TrPs are localised, hyper-irritable spots described as palpable, taut bands, nodes, or knots that are tender and painful when pressure is applied.[1] According to the recent surveys, the prevalence of MPS is about 85% in patients complaining of chronic pain.[2] Trigger points are most frequently identified in high-stress muscles such as the trapezius, levator scapulae, scalene, and infraspinatus. They are categorised based on their origin as active trigger Points, which cause pain even when the patient is at rest, contributing significantly to chronic pain complaints, and the Latent Trigger Points, which cause pain or other MPS symptoms only when direct manual pressure is applied. Other types include Primary/ Secondary Trigger Points reflecting their initial cause or development in response to other problems.[3,4]

Patients typically report chronic or acute symptoms, including a dull aching or sharp, stabbing pain, alongside associated issues like stiffness, muscle spasms, and a limited range of movement (ROM) in the affected area.[5]

MPS primarily develops due to chronic overuse or overstress of muscle groups and prolonged maintenance of abnormal or awkward postures.[6] These factors cause certain muscles, particularly the parascapular muscles like the Upper Trapezius, Rhomboids, and Levator Scapulae, to remain in a shortened or contracted state, leading to the formation of the taut band or knot.[7-8]

Diagnosis relies on a physical examination, where the therapist's palpation confirms the presence of the characteristic rope-like nodule, taut band, or irritable point, correlating with the patient's complaints of pain, stiffness, and restricted ROM.

Treatment protocols are divided into two main categories: Invasive and Non-invasive Techniques. Invasive Techniques primarily include dry needling, which involves inserting a thin needle into the trigger point to elicit a twitch response and relieve tension.[9-10]

Non-Invasive Techniques encompasses a wide variety of physiotherapeutic approaches, including Manual therapy techniques and Electrotherapy Modalities. Manual therapy techniques include Myofascial Release (MFR), Spray and Stretch, Ischemic compression, Deep Transverse Friction Massage(DTFM),Multiple trigger point release massagesand Kinesio Taping.[11-13] Electrotherapy modalities include Faradic stimulation, Mechanical Vibration, Ultrasound, Microwaves, Interferential therapy (IFT), Extracorporeal shock wave therapy, Low-level laser therapy, Magnetic coil stimulation, and Transcutaneous Electrical Nerve Stimulation. Other techniques includeThermotherapy (hot packs), Stretching, and strengthening exercises. [14-17]

Therapeutic Ultrasound, uses sound waves to create thermal and non-thermal effects. The thermal effect increases the elasticity of collagen fibres, which helps reduce pain and stiffness by decreasing muscle spasms and improving local blood circulation. It provides controlled deep heat in continuous mode to the targeted muscle/fascia, which is difficult to replicate with superficial heat or manual friction. This heat is crucial for increasing the extensibility of collagen fibres in the muscle and fascia, breaking the pain-spasm-pain cycle, and reducing muscle spasms deep within the trigger point structure.

Non-Thermal Effect of ultrasound, especially in pulsed mode, uses acoustic streaming and cavitation to mechanically stimulate cellular activity. This promotes tissue healing and repair by activating mechanoreceptors in fibroblasts. This is a unique bio-mechanical effect not shared by manual techniques.

These Microcirculatory Effects (thermal and non-thermal) combine to promote vasodilation and increased local blood circulation to the ischemic core of the trigger point, aiding in the washout of metabolic waste products and chemical irritants hypothesised to sustain the trigger point.[18]

Myofascial Release (MFR) is a manual, hands-on technique where sustained, gentle pressure is applied to areas of fascial restriction. The goal is to stretch and release the tightened fascia, allowing the structure to become pliable and soft, thereby reducing pain and improving restricted movement. The therapist locates the taut band, applies sustained, thumb pressure from the origin of the muscle and strokes toward the insertion of the muscle. The key manoeuvre is strumming, where the thumb finger pulls perpendicularly across the muscle fibres over the TrPs.[19]

Despite the wide use of various physiotherapy protocols, such as MWD, IFT, TENS, Ultrasound, and manual techniques like Deep Transverse Friction Massage (DTFM) and Ischemic Compressionto inactivate trigger points, some previous research has been inconclusive regarding functional improvements post-treatment. Crucially, there is a recognised insufficient evidence base comparing the outcomes of manual (like MFR) versus electrotherapeutic (like Ultrasound) approaches for TrPs treatment.

Therefore, the specific objective of this study was to directly evaluate and compare the effectiveness of Therapeutic Ultrasound versus Myofascial Release in managing trigger points located in the Upper Trapezius, Rhomboids, and Levator Scapulae muscles.

The use of Therapeutic Ultrasound (US) as a single modality, rather than in combination with manual techniques, is justified by the fundamental objective of this comparative interventional study to isolate and quantify the distinct therapeutic effects of two dissimilar approaches: a mechanical electrotherapy (US) versus a manual therapy (MFR). While clinical practice often combines modalities, such amalgamation renders it difficult to determine the specific contribution of each intervention to patient outcome. By administering US as a standalone treatment, we aim to validate its unique physiological mechanisms,specifically, its controlled deep thermal effect on collagen extensibility and its non-thermal cellular effects (acoustic streaming and cavitation) that promote tissue repair, without the confounding influence of simultaneous manual stimulation. This methodological rigour is essential to address the recognised gaps in the literature and provide evidence-based guidance on the independent efficacy of US for the deactivation of Myofascial Trigger Points.[20-24]

Materials & Methods

The study was conducted in the Department of Physiotherapy. It was a pre- and Post-Experimental Comparative Study. The sample population consisted of college-going students who screened positive for the trigger point. The study included a total of 30 subjects, and the duration wasset for four weeks.

Participants - Eligibility

Inclusive Criteria

Subjects were included if they were aged 18-23 years, reported pain greater than “6” on the VAS, and presented with more than one demonstrable active triggerpoint on palpationin the neck and upper back area(Upper Trapezius, Rhomboids, Levator scapulae).

Exclusive Criteria:

Subjects were excluded if they had cervical radiculopathy, skin allergies, any history of trauma to the upper back and trunk area, or a permanent tattoo in the cervical and shoulder area. Additionally, subjects with a history of high-velocity neck or shoulder injury were excluded.

Materials Used

The materials used includ0ed an Ultrasound machine, ultrasonic gel, and cotton.

Data Collection

Subjects were randomly selected and screened for trigger points.All data were collected after informed consent was obtained from the subjects. The consent also included permission to use their data and photographs for presentation and publication purposes.Physical examination findings were noted in individual case sheets.

Interventions

Procedure

All 30 subjects who met the inclusioncriteria were randomly allocated into two groups: one group receivedTherapeutic Ultrasound,and the other group receivedMyofascial release, respectively.

Group -A

Subjects in Group A received only Ultrasound therapyfor trigger points. The ultrasound was administered at 1MHz frequency, 3 days a week on alternate days for 4 weeks, using a continuous mode with a treatment duration of about 5-7 minutes.It was given to the upper trapezius, levator scapulae, and rhomboids.

Group-B:

Subjects in Group B were treated with the only Myofascial release technique. This technique was applied "3" days a week on alternate days for "4" weeks. The myofascial release was specifically given to the upper trapezius, levator scapulae, and rhomboids.This deep tissue technique targets trigger points (TrPs) and taut bands in the Upper Trapezius, Levator Scapulae and Rhomboid muscles.The therapist locates the taut band, applies sustained, thumb pressure from the origin and strokes toward the insertion of the muscle. The key manoeuvre is strumming,where the thumb finger pulls perpendicularly across the muscle fibres over the TrPs.

Outcome Measures

Measurements were obtained on two occasions: pre-intervention and post-intervention.

Visual Analog Scale (VAS)

The Visual Analogue Scale (VAS) is a psychometric instrument where a patient marks their subjective symptom intensity, such as pain, from "no pain" to "worst possible pain," yielding a score from 0 to 10.

Palpable Muscle Spasm Degree (PMSD)

Grading of PMSD objectively by the therapist palpating over the trigger point area

0 Nospasm

1. Medium-gradespasm
2. Spasmis strongerthanmediumgrade,butdoes notlimitthe jointrangeofmovement
3. Sever espasmlimiting joint range of movement
4. Severes pasm accompanied by postural deviation

Statistical Analysis

The data wereanalysedby using the Statistical Package for the Social Sciences Computer Program(SPSS) software in this study.

Demographic variables(age) were analysed by using descriptive statistics. Paired t-tests were used to compare pre- & post-VAS within each group, while independent t-tests were used for comparison between the groups. All data were expressed as Mean ± Standard deviation, with statistical significance set at $p<0.05$.

Result

Table 1 presents the descriptive statistics for the 30 subjects, indicating a mean age of 20.5 ± 1.72 years, with ages ranging from 18 to 23 years.

Table 1: Demographic Variables (Descriptive Statistics) (N=30)

Variable	Minimum	Maximum	Mean
Age in Years	18	23	20±1.72

Table 2 presents the pre- and post-intervention VAS and PMSD values for Group 1 and Group 2. In Group 1, the pre-intervention mean VAS was 7.73±0.704, decreasing to a post-intervention mean VAS of 2.07±0.594. For Group 2, the pre-intervention mean VAS was 8.33±0.816, decreasing to a post-intervention mean VAS of 2.40±0.910.

Table 2. Clinical Variables Analysis (Outcome Measures Within Group)

GROUPS	Pre-VAS	Post-VAS	Pre-PMSD	Post-PMSD	"p" Value
Group-1	7.73±0.704	2.07±0.594	1.87±0.576	1.00±0.926	<0.001
Group-2	8.33±0.816	2.40±0.910	2.13±0.640	0.600±0.910	<0.001

Regarding PMSD values, Group 1 showed a pre-intervention mean of 1.87±0.576, which decreased to a post-intervention mean of 1.00±0.926. In Group 2, the pre-intervention mean PMSD was 2.13±0.640, decreasing to a post-intervention mean of 0.600±0.910. A p-value of <0.001 was observed for all variables presented in the table.

Table 3 presents the post-intervention changes in VAS and PMSD between the groups. The post-intervention mean VAS was 2.07±0.594 in Group 1 and 2.40±0.910 in Group 2. The post-intervention mean PMSD level was 1.00±0.926 in Group 1 and 0.600±0.910 in Group 2. The p-value for VAS was 0.245, and for PMSDit was 0.243.

Table 3. Between-Group Analysis

VARIABLE	Group-1	Group-2	"P" Value
VAS	2.07±0.594	2.40±0.910	0.245
PMSD	1.00±0.926	0.600±0.910	0.243

Discussion

This experimental comparative study evaluated the effects of Ultrasound and Myofascial release on trigger points in the upper trapezius, levator scapulae, and rhomboids. The primary outcome measures for this study were pain, assessed with VAS, and spasm, measured using the Muscle Spasm Degree (PMSD). This study intentionally included a greater proportion of female participants than male participants for myofascial pain syndrome (MPS) trigger point analysis, recognising the significantly higher prevalence of MPS in women, estimated at 64.3% in women versus35.7% in men, as a primary justification for prioritising the most affected population. This strategic enrollment ratio is further supported by the established finding that women generally exhibit greater pain sensitivity and lower pain tolerance thresholds than men, potentially leading to more pronounced clinical presentations of trigger points. Furthermore, the modulating influence of female sex hormones on pain perception and chronic pain conditions is a key factor, as hormonal fluctuations have been implicated in the development and exacerbation of MPS. Crucially, the practical observations during the initial screening phase of this research validated this approach and predominantly identified women meeting the criteria for MPS trigger points compared to men, ultimately reinforcing the decision to enrol a larger female cohort to ensure the study's findings are robust and clinically relevant to the majority of MPS sufferers.

In one group, to treat the myofascial trigger points, 1MHz Ultrasound was used in a continuous mode for 5-7 minutes per session on 15 patients. Ultrasound is a non-invasive and commonly used modality with both thermal and non-thermal effects. Its thermal effect enhances the flexibility of collagen fibres, which contributes to decreased stiffness, reduced muscle spasms and pain, and improved blood circulation. The non-thermal effects of Ultrasound produce a segmental analgesic effect, and also 1 MHz therapeutic ultrasound improves cell replication by using non-thermal, mechanical effects (like acoustic streaming and cavitation) to activate cellular mechanoreceptors, which stimulate proliferation pathways in fibroblasts and other repair cells for enhanced tissue healing. The study conducted by Kavadar et al. investigated the same dosage and frequency of Ultrasound on upper trapezius trigger points and found a significant improvement in pain, as measured with VAS and Algometer. Similarly, the studies conducted by Chiarelli et al., Houghton et al., and Mc Milan et al. found that Ultrasound therapy is highly effective in treating pain, promoting tissue healing, and improving overall musculoskeletal function. The current study compared the changes in pain and stiffness as measured by VAS and PMSDbefore and after 12 sessions of Ultrasound treatment on the myofascial trigger points, and found a significant improvement in VASand PMSD within both groups after the intervention.

The second group received the Myofascial release technique on their myofascial trigger points. Myofascial release is a hands-on soft tissue technique that directly applies force to the involved fascia, loosening tightened structures caused by overuse or stress, thereby relieving symptoms.The therapist locates the taut band, applies sustained, thumb pressure from the origin of the muscleand strokes toward the insertion of the muscle. The key manoeuvre is strumming, where the thumb finger pulls perpendicularly across the muscle fibres over the TrPs.

The study conducted by Werenski J et al. found that applying an appropriate myofascial technique can be a very effective therapy for myofascial pain, and it has shown a decrease in pain and an increase in range of motion for the joint acted on by the affected muscle. The study conducted by Zutshi et al. showed that myofascial release shows greater improvement in pain and pressure threshold.

Upon comparing both groups statistically, there was no significant difference, indicating that both treatments were equally effective.

Conclusion

This present study validated and concluded that both Ultrasound and hands-on manual therapy (Myofascial release) were equally effective in reducing pain and spasm statistically in the student population with active Myofascial Trigger Points (MTrPs). But clinically, myofascial release seems to be more effective in pain relief as well as reducing spasm within a short period, while also being cost-effective, non-invasive, and providing symptomatic relief.

The study uses a small and specific student population, which restricts the generalizability of the findings to broader demographics. Despite the statistical significance achieved, the small sample size (30 subjects) limits the statistical power. Furthermore, while two measures were utilised, the reliance on the subjective Visual Analogue Scale (VAS) for pain and the therapist's perceptual judgment for the Palpable Muscle Spasm Degree (PMSD) introduces potential measurement subjectivity and inter-rater variability. Crucially, the lack of any long-term follow-up means the duration of the pain and spasm relief cannot be ascertained, and the inability to blind the therapist to the manual intervention (Myofascial Release) creates a potential performance bias.

To address these shortcomings, future research should prioritise recruiting a larger, more diverse cohort encompassing various age groups and occupations to enhance external validity. To strengthen the findings, future studies should incorporate a true control or sham group to isolate the specific effects of the therapeutic interventions. Utilising more objective outcome measures, such as pressure algometry or surface electromyography (sEMG), is recommended to provide quantifiable data on muscle spasm and pain thresholds, reducing reliance on subjective assessment and finally, implementing a longitudinal follow-up period.

It is necessary to evaluate the sustained efficacy and recurrence rates of MPS after the treatments, alongside a formal cost-effectiveness analysis to quantitatively support the clinical observation that Myofascial Release is cost-effective.

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Assessment of Fall Risk Using a Self-Structured Questionnaire Among Community-Dwelling Elderly: A Validation Study

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Abstract

Background: Falls among the elderly remain a growing public health concern, affecting one-third of community-dwelling older adults annually[1]. While brief, practical screening tools are needed, rigorous validation approaches are essential before clinical implementation.

Objectives: (1) To evaluate the internal consistency and test-retest reliability of a self-structured Fall Risk Assessment Questionnaire (FRSQ) in community-dwelling elderly. (2) To examine its correlation with the Falls Efficacy Scale-International (FES-I) as a measure of concurrent validity. (3) To transparently report study design limitations and outline future validation directions.

Methods: A cross-sectional descriptive study enrolled 201 community-dwelling elderly (age ≥60 years) from Ahilyanagar, Maharashtra, India. Statistical analysis included Cronbach's alpha, Intraclass Correlation Coefficient (ICC), Pearson correlation, one-way ANOVA, and 95% confidence intervals.

Results: The FRSQ demonstrated excellent internal consistency (Cronbach's $\alpha = 0.83$; 95% CI: 0.80--0.86) and test-retest reliability over 2 weeks (ICC = 0.92; 95% CI: 0.89--0.94). Strong positive correlation with FES-I ($r = 0.78$; $p < 0.001$; 95% CI: 0.71--0.84) supported concurrent validity. Risk categorization: Low risk (0--5) = 125 participants (62.2%), Moderate risk (6--10) = 56 participants (27.9%), High risk (≥11) = 20 participants (10.0%). One-way ANOVA demonstrated significant group differences ($F = 1247.8$, $p < 0.001$).

Conclusion: The FRSQ demonstrates strong internal consistency, test-retest stability, and correlation with fall-related concern. However, the cross-sectional design limits conclusions regarding predictive validity. Prospective cohort studies examining prediction of actual falls are essential before clinical implementation.

Keywords: Fall risk assessment, questionnaire validation, psychometric properties, elderly, community-dwelling, reliability, validity

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Introduction

Falls among community-dwelling older adults represent a substantial personal, social, and economic burden globally. The World Health Organization identifies falls as the second leading cause of unintentional injury death among adults aged 60+ years[1]. Approximately 30% of adults aged 65 years and older experience at least one fall annually, with prevalence rising to 40% in those aged 80 years and above[2,3].

Public Health Significance

Falls carry both immediate and long-term consequences. Acute complications include fractures, head injuries, and soft tissue trauma. Long-term sequelae include functional decline, loss of independence, psychological distress, reduced quality of life, and depression[4,5]. The burden is particularly acute in resource-limited healthcare settings, where access to specialized geriatric services remains limited[7]. In India, demographic transitions toward an aging population create urgent need for efficient, scalable, and culturally appropriate screening approaches.

Current Assessment Approaches and Gaps

Standardized fall risk assessment instruments include the Berg Balance Scale (BBS), Timed Up and Go (TUG), and Falls Efficacy Scale-International (FES-I)[9,10,11]. While these tools demonstrate robust psychometric properties, they often require specialized equipment, trained administrators, or significant time investment[12,13]. These requirements limit practical applicability in community settings, particularly primary healthcare facilities typical in resource-limited regions.

There remains unmet need for brief, practical, self-administered screening questionnaires accessible to non-specialist healthcare providers. Community screening instruments enable population-level identification of high-risk individuals and facilitate targeted intervention allocation[6,8].

Questionnaire Development Framework

Rigorous instrument development requires systematic progression through evidence-based phases: (1) item generation and content validity, (2) preliminary psychometric validation, (3) reliability assessment, (4) concurrent/construct validity, (5) predictive validity testing, (6) multi-sample validation, (7) diagnostic accuracy evaluation, and (8) clinical responsiveness[12,13]. The present manuscript reports findings addressing phases 3 and 4 (reliability and concurrent validity) in a single geographic sample.

Study Rationale and Objectives

Our research team developed a self-structured Fall Risk Assessment Questionnaire (FRSQ) incorporating both intrinsic (individual physiological) and extrinsic (environmental) fall risk factors[14,15]. A preliminary feasibility study demonstrated acceptable internal consistency. The current investigation expands upon preliminary findings through substantially increased sample size (n = 201), rigorous statistical validation with confidence intervals, and transparent delineation of study limitations.

Primary Objectives

1. To evaluate internal consistency reliability using Cronbach's alpha coefficient
2. To assess test-retest reliability over 2-week interval using Intraclass Correlation Coefficient (ICC)
3. To examine concurrent validity through correlation with Falls Efficacy Scale-International (FES-I)

Secondary Objectives

1. To characterize item-level performance and identify prevalent fall risk domains
2. To describe risk stratification across low, moderate, and high-risk categories
3. To transparently identify study limitations and prerequisites for clinical implementation

Methods

Study Design and Setting

A cross-sectional descriptive design was employed. Data collection occurred across urban and semiurban community settings in Ahilyanagar, Maharashtra, India, between October 12, 2025 and December 2, 2025. Study sites included community health centers and senior citizen community groups.

Ethical Approval

This investigation was approved by the Institutional Ethics Committee of Dr. Vithalrao Vikhe Patil Foundation's College of Physiotherapy, Ahilyanagar (Reference: 787; dated 09/10/2025). All procedures complied with the Declaration of Helsinki. Written informed consent was obtained from all participants. Participant confidentiality was maintained through pseudonymized study identifiers.

Study Participants

Inclusion Criteria: Age ≥60 years; community-dwelling; cognitively intact (Mini-Cog score ≥3 or MMSE ≥24); ability to understand questionnaires in English or Marathi; written informed consent provided.

Exclusion Criteria: Severe neurological or psychiatric conditions materially affecting comprehension; terminal illness; significant communication impairment; acute illness on assessment day; unable to provide informed consent.

A total of 201 eligible participants were recruited using convenience and purposive sampling with deliberate attention to demographic diversity. However, convenience sampling and restriction to a single geographic region limit generalizability beyond this population.

Questionnaire Development

Instrument Development Methodology

1. Literature Synthesis: Comprehensive review of fall risk literature (PubMed, Google Scholar, 2015--2024) identifying validated fall risk domains
2. Expert Panel Consultation: Input from 5 physiotherapy faculty members specializing in geriatric rehabilitation
3. Qualitative Preliminary Work: Focus group discussions (n=8) with community-dwelling elderly exploring perceived fall risk factors
4. Item Generation: 15 candidate items generated covering intrinsic and extrinsic factors
5. Content Validity Review: Items reviewed for clarity, relevance, and comprehensiveness, resulting in 11-item instrument
6. Preliminary Feasibility Testing: Pilot (n=30) confirmed item clarity, completion time (<10 minutes), and acceptable internal consistency (α=0.78)

Acknowledgment: Formal quantitative content validity assessment (e.g., Content Validity Index) was not systematically conducted and is recommended as a future research priority.

Assessment Instruments

Fall Risk Assessment Questionnaire (FRSQ)

The FRSQ comprises 11 items assessing intrinsic and extrinsic fall risk factors[14,15]:

Intrinsic Items (5 items)

1. Balance difficulties when standing or walking
2. Muscle weakness or loss of strength
3. Foot problems (pain, deformity, sensation loss)
4. Visual problems (blurred vision, poor sight)
5. Cognitive issues or memory problems

Extrinsic Items (6 items)

6. Floor navigation hazards (uneven surfaces, obstacles)
7. Environmental hazards (slippery areas, narrow passages)
8. Stair safety concerns
9. Poor lighting in home environment
10. Inadequate furniture for support
11. Medication effects on balance or dizziness

Scoring: Each item rated on 3-point scale: 0 = No/ minimal risk, 1 = Moderate risk, 2 = High risk. Total possible score range: 0--22.

Risk Categorization: Low Risk: 0--5 points; Moderate Risk: 6--10 points; High Risk: ≥11 points. These cutoffs represent statistically meaningful stratification rather than externally validated or prospectively predictive thresholds.

Falls Efficacy Scale-International (FES-I)

The FES-I is a validated 16-item instrument measuring concern and self-efficacy regarding falls during activities of daily living[11]. Items rated 1--4 (very confident to not confident at all). Total score range: 16--64, with higher scores indicating greater fall-related concern.

Important Distinction: The FES-I measures fear of falling and perceived self-efficacy—constructs related but distinct from actual fall incidence[16,17].

Data Collection Procedures

All participants completed the FRSQ and FES-I under direct supervision of trained research personnel. Demographic information was collected: age, gender, comorbidities, and self-reported fall history.

Test-Retest Reliability Assessment: A subset of 40 consecutive participants (approximately 20%) was re-administered the FRSQ after 2 weeks using identical procedures to assess temporal stability.

Missing Data: Complete data were obtained from all 201 participants; no missing values were present.

Statistical Analysis

All analyses were conducted using SPSS Version 26 and GraphPad InStat Version 3.10. Significance level was set at $p < 0.05$ (two-tailed).

Descriptive Statistics

Mean, standard deviation, median, interquartile range, and skewness were calculated for both FRSQ and FES-I total scores. Item-level descriptive statistics and endorsement rates were computed.

Reliability Assessment

Internal Consistency: Cronbach's alpha coefficient was calculated. Interpretation: $\alpha < 0.70$ (unacceptable), 0.70--0.79 (acceptable), 0.80--0.89 (excellent), ≥0.90 (potentially redundant)[12,13]. 95% confidence intervals were calculated using bias-corrected bootstrap methods.

Test-Retest Reliability: ICC (model 3,1—two-way mixed effects, absolute agreement) was computed for 40 participants completing reassessment after 2 weeks. Interpretation: ICC < 0.70 (unacceptable), 0.70--0.89 (acceptable), ≥0.90 (excellent)[12].

Item-Total Correlations: Pearson correlation between individual item score and total score (excluding that item) was calculated. Items with $r < 0.30$ suggest poor correlation.

Normality Testing

Kolmogorov-Smirnov and Shapiro-Wilk tests assessed whether distributions approximated normality. Histograms and Q-Q plots were visually inspected, justifying parametric approaches.

Validity Assessment

Concurrent Validity: Pearson's product-moment correlation coefficient (r) was calculated between FRSQ and FES-I scores[11,16]. Interpretation: $r < 0.30$ (weak), 0.30--0.70 (moderate), >0.70 (strong). 95% confidence intervals were calculated using Fisher's z-transformation.

Important Clarification: The FRSQ was correlated with FES-I (fear of falling/fall self-efficacy) as concurrent validity—confirming both instruments measure related subjective constructs. This does not constitute validation against actual observed falls.

Group Comparisons

One-way ANOVA compared mean FRSQ scores across three risk categories. Post-hoc Tukey HSD tests were applied. Effect size (partial eta-squared, η^2p) was calculated.

Methodological Note: Risk categories were created from the same questionnaire used for comparison, so significant group differences are mathematically expected by design rather than representing independent validation.

Statistical Power Analysis

Post-hoc power analysis using G*Power Version 3.1 determined achieved statistical power for detecting Pearson correlations of $r \geq 0.30$ at $\alpha = 0.05$ with n = 201.

Confidence Intervals

95% confidence intervals were calculated for all primary statistics: Cronbach's alpha, ICC, correlation coefficients, and group means.

Results

Participant Characteristics

Table 1. Demographic Characteristics of Study Participants (n=201)

Characteristic	n	%
Gender		
Male	94	46.8
Female	107	53.2
Age Groups (years)		
60--69	124	61.7
70--79	61	30.3
≥80	16	8.0
Comorbidities		
Hypertension	57	28.4
Diabetes Mellitus	38	18.9
Osteoarthritis	31	15.4
No Comorbidities	118	58.7

Two hundred one participants completed the study (94 male, 107 female). Mean age was 68.2 ± 5.9 years (range: 60--88 years). Comorbidity prevalence: 41.3% reported at least one chronic condition, with hypertension (28.4%), diabetes mellitus (18.9%), and osteoarthritis (15.4%) most common.

Descriptive Statistics

Table 2. Descriptive Statistics for FRSQ and FES-I Scores

Statistic	FRSQ	FES-I
Mean ± SD	5.14 ± 4.17	30.91 ± 9.22
Median (IQR)	4.0 (1.0--8.0)	29.0 (24.0--37.0)
Range	0--18	16--58
25th Percentile	1.0	24.0
75th Percentile	8.0	37.0
Skewness	1.02	0.93

Item-Level Analysis

Table 3. Item-Level Performance Characteristics for FRSQ (n=201)

FRSQ Item	Mean ± SD	Endor-sement (%)	Item-Total r
Intrinsic Factors			
Balance Difficulties	0.87 ± 0.68	61.2	0.64
Muscle Weakness	0.95 ± 0.72	68.7	0.71
Foot Problems	1.02 ± 0.60	66.1	0.58
Visual Problems	0.55 ± 0.70	43.3	0.52
Cognitive Issues	0.20 ± 0.45	16.9	0.31
Extrinsic Factors			
Floor Navigation	0.60 ± 0.71	41.8	0.49
Environmental Hazards	0.33 ± 0.59	24.4	0.42
Stair Safety	0.77 ± 0.65	57.7	0.55
Poor Lighting	0.29 ± 0.52	22.9	0.38
Furniture Support	0.41 ± 0.60	30.8	0.45
Medication Effects	0.19 ± 0.44	14.9	0.29

All items demonstrated acceptable item-total correlation (r ≥ 0.29). Muscle weakness and balance difficulties demonstrated strongest correlations, suggesting these domains are most central to the overall construct.

Risk Categorization

Participants were stratified: Low Risk (0--5 points): 125 participants (62.2%); Moderate Risk (6--10 points): 56 participants (27.9%); High Risk (≥11 points): 20 participants (10.0%).

Normality Testing

Kolmogorov-Smirnov and Shapiro-Wilk tests indicated both score distributions approximated normality (FRSQ: p = 0.07, p = 0.08; FES-I: p = 0.21, p = 0.11), supporting parametric methods.

Reliability Assessment

Internal Consistency: Cronbach's alpha = 0.83 (95% CI: 0.80--0.86), classified as excellent internal consistency (α ≥ 0.80)[12,13]. The alpha indicates FRSQ items are substantially intercorrelated and measure a consistent underlying construct.

Test-Retest Reliability: ICC (3,1) = 0.92 (95% CI: 0.89--0.94) for 40 participants over 2 weeks, classified as excellent (ICC ≥ 0.90)[12]. This indicates strong temporal stability when administered at different time points under stable conditions.

Concurrent Validity

FRSQ vs. FES-I Correlation: Pearson's r = 0.78 (p < 0.001); 95% CI: [0.71--0.84], classified as strong positive correlation[11,16,17].

Interpretation: The strong correlation indicates individuals with higher FRSQ scores (greater self-assessed fall risk) tend to have higher FES-I scores (greater fall-related concern). This convergence supports concurrent validity as a measure of subjectively perceived fall risk.

Critical Clarification: This correlation demonstrates both instruments measure related subjective constructs (perceived fall risk, fear of falling). It does not constitute evidence that the FRSQ predicts actual future fall incidence.

Group Comparisons

Table 4. FRSQ Scores Across Risk Categories

Risk Category	n	Mean ± SD	95% CI	Range
Low (0--5)	125	2.10 ± 1.53	[1.84--2.36]	0--5
Moderate (6--10)	56	7.32 ± 1.26	[6.98--7.62]	6--10
High (≥11)	20	13.5 ± 1.89	[12.68--14.32]	11--18

ANOVA Results: F-value: 1247.8; p-value: <0.001; Partial η^2: 0.92 (very large effect size). Post-hoc Tukey HSD tests: All pairwise comparisons significant at p < 0.001, indicating the FRSQ reliably differentiates between three risk categories.

Methodological Caveat: Risk categories were derived from the same FRSQ used in analysis. Significant results are mathematically expected by design and demonstrate internal consistency but do not independently validate the instrument against external criteria.

Statistical Power

Post-hoc power analysis: With n = 201, α = 0.05, achieved power = 0.98 for detecting correlations of r ≥ 0.30. This exceeds conventional threshold of 0.80, indicating adequate sample size.

Discussion

Summary of Key Findings

This cross-sectional study examined internal consistency reliability, test-retest stability, and concurrent validity of a self-structured FRSQ in

201 community-dwelling elderly from a single geographic region. Primary findings include: (1) excellent internal consistency (α = 0.83); (2) excellent test-retest reliability (ICC = 0.92); (3) strong correlation with FES-I (r = 0.78); (4) reliable risk stratification; and (5) adequate statistical power (0.98).

Interpretation of Reliability Findings

Internal Consistency: Cronbach's alpha of 0.83 exceeds thresholds for excellent internal consistency[12,13]. Item-total correlations ranged from 0.29 to 0.71, with muscle weakness (r = 0.71) and balance difficulties (r = 0.64) showing strongest associations.

Test-Retest Reliability: ICC of 0.92 indicates excellent temporal stability over 2-week interval[12], supporting measurement stability appropriate for screening application.

Concurrent Validity with FES-I

The strong FRSQ-FES-I correlation (r = 0.78) demonstrates both instruments measure related subjective constructs—perceived fall risk, fall-related concern, and self-efficacy[11,16,17]. This convergent validity supports the construct validity of the FRSQ.

Critical Distinction: The correlation reflects convergence on subjective dimensions. Both assess participant self-perception rather than objective fall risk or actual fall incidence. High FES-I scores (indicating fear) may occur in individuals without substantial objective fall risk. The FRSQ should not be interpreted as a validated predictor of future falls until prospective cohort studies are conducted.

Risk Stratification and Item-Level Insights

The FRSQ effectively differentiated three risk categories with very large effect size (η^2 = 0.92). Among intrinsic factors, muscle weakness (68.7%), balance difficulties (61.2%), and foot problems (66.1%) were most prevalent—all domains amenable to physiotherapeutic intervention[18,19]. Among extrinsic factors, stair safety concerns (57.7%) and floor navigation hazards (41.8%) predominated.

Practical Feasibility

The FRSQ demonstrated excellent practical feasibility: rapid administration (<10 minutes); 100% completion rate; no missing data; accessibility across diverse literacy backgrounds; no requirement for specialized equipment. These characteristics distinguish the FRSQ from more resource-intensive instruments[9,10,11].

Study Limitations

Cross-Sectional Design: This design provides data at a single time point, precluding examination of predictive validity or causal relationships. The design supports internal consistency and test-retest reliability but does NOT support ability to predict actual future falls.

Sampling and Generalizability: Convenience sampling from single geographic region (Ahilyanagar, Maharashtra) restricts generalizability. Study sample reflects relatively healthy, community-dwelling elderly (mean age 68.2 years; 58.7% free of comorbidities) from urban/semiurban settings. Results may not generalize to rural populations, highly cognitively impaired populations, or other geographic regions.

Correlation with FES-I: Correlation demonstrates convergence on subjective fall concern but does not constitute validation against actual fall incidence. The FRSQ should not be interpreted as having established predictive validity.

Group Comparisons: Risk categories created from FRSQ items used in subsequent ANOVA. Significant differences are mathematically expected by design and confirm internal consistency but do not independently validate against external criteria.

Limited Scope: This study addresses internal consistency, test-retest reliability, and concurrent validity. It does NOT provide evidence regarding predictive validity, diagnostic accuracy, discriminative validity, responsiveness, or multi-population validity.

Content Validity: Formal quantitative content validity assessment (e.g., Content Validity Index) was not systematically conducted and is recommended for future research.

Roadmap for Future Research

Priority 1: Prospective Predictive Validity Studies: Prospective cohort designs following participants 6--12 months with objective fall outcome measurement; ROC curve analysis establishing diagnostic cutoffs; calculation of sensitivity, specificity, positive/negative predictive values[14,20].

Priority 2: Content Validity Formalization: Systematic Content Validity Index study with expert panels; quantitative assessment of item relevance and comprehensiveness[12,13].

Priority 3: Factor Structure and Construct Validation: Confirmatory factor analysis testing underlying dimensional structure; Item Response Theory analysis[13].

Priority 4: Multi-Population Validation: Replication across diverse Indian geographic regions; validation in rural populations; cross-cultural validation in other South Asian populations.

Priority 5: Intervention Responsiveness: Randomized controlled trials of community-based falls prevention interventions incorporating FRSQ; assessment of sensitivity to clinically meaningful change; comparative effectiveness against established instruments[6,18,19].

Priority 6: Diagnostic Accuracy: Validation against detailed geriatric fall risk assessment by specialists; establishment of agreement between FRSQ categorization and comprehensive clinical evaluation.

Appropriate Current Role of the FRSQ

Appropriate Uses (Current Evidence): Screening for perceived fall risk domains in community-dwelling elderly; rapid identification of individuals with self-reported fall-related concerns; practical tool for community health workers; research instrument for group-level description; foundation for hypothesis generation.

NOT Yet Supported (Requires Future Evidence): Clinical screening to predict actual future falls; substitute for comprehensive geriatric fall risk assessment; diagnostic instrument for identifying "true" high-risk individuals; basis for individual clinical decision-making; large-scale public health implementation.

Conclusion

The self-structured Fall Risk Assessment Questionnaire demonstrates strong internal consistency (Cronbach's $\alpha = 0.83$), excellent test-retest reliability (ICC = 0.92), and strong correlation with Falls Efficacy Scale-International ($r = 0.78$) in 201 community-dwelling elderly from a single geographic region. These psychometric properties support the FRSQ's utility as a brief, practical screening instrument for identifying fall risk domains among community-dwelling elderly within this population.

However, the cross-sectional design substantially limits supportable conclusions. The study demonstrates measurement reliability and correlation with subjective fall concern but does not provide evidence regarding predictive validity, real-world screening effectiveness, or readiness for clinical implementation.

Future research priorities include: (1) prospective predictive validity through cohort studies with objective fall outcome measurement; (2) formalized content validity assessment; (3) factor structure confirmation; (4) validation across broader geographic regions and diverse populations; (5) diagnostic accuracy establishment; and (6) intervention responsiveness in clinical trials.

In its current form, the FRSQ is appropriately deployed as a research instrument and community discussion facilitator regarding fall risk perception. It is not yet ready for recommendation as a substitute for comprehensive geriatric fall risk assessment. With completion of identified research priorities, the FRSQ has potential to become a valuable tool for community-based falls prevention initiatives in resource-limited settings.

Conflict of Interest: The authors declare that they have no conflict of interest related to this study.

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Comparison of the Lifestyle of Young Female Athletes with and without Dysmenorrhea

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Abstract

Dysmenorrhea is painful cramps of the uterus during menstrual cycle. This study examined the prevalence of dysmenorrhea among female athletes and compared the lifestyle of athletes with dysmenorrhea to those without dysmenorrhea. 200 young female athletes participated in the study, out of which 83.5% athletes experienced dysmenorrhea. By using lifestyle questionnaire, findings indicated that only 30% of women without dysmenorrhea had a poor personal relationships and poor work satisfaction as compared to 62.27% population with dysmenorrhea. Most athletes with dysmenorrhea reduced their physical activity (78.44%) during menses. 72.72% of athletes without dysmenorrhea had normal eating habits whereas athletes with dysmenorrhea had irregular meal times or used to skip their meals.By using personal-social questionnaire, findings indicated that most of the female athletes with dysmenorrhea hadeffect on physical functioning (68.26%), body pain (91.61%), vitality (64.67%), social functioning (68.26%), mental health (60.28%) and general health (65.26%). It is concluded that dysmenorrhea influences competitor's quality of life, social conduct, dietary patterns, and their productive tasks. To prevent or reduce the incidence of dysmenorrhea, comprehensive lifestyle assessment, preventive health intervention, knowledge and awareness should be raised in female athletes through proper lifestyle education and health promotion measures.

Keywords: Dysmenorrhea, Lifestyle, Prevalence,Young female athletes

Introduction

Dysmenorrhea is derived from the Greek words "dys" which means problematic or difficult, "meno" which means month, and "rrhea" which means stream or flow [1]. It is a gynecological condition that affects more than 50% of females[2].

Dysmenorrhea is characterized by crampy pelvic pain beginning shortly before or at the onset of menses and lasting 1–3 days[3]. Some 2–4 days before menstruation begins, prostaglandins proceed into the uterine muscle where they build up quickly at menstrual onset and act as smooth muscle contractors that aid in the expulsion of the endometrium [4].

Depending on the degree of pain experienced, dysmenorrhea can be classified as mild, moderate, or severe [5]. Mainly dysmenorrhea is of two types primary and secondary. Primary dysmenorrhea is

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one of the common complaints in young females and is defined as painful menstruation in absence of pelvic pathology [6,7]. Secondary dysmenorrhea is the pain of menstruation resulting from underlying pelvic pathologies [8]. Asymptomatic females do not have endometrialproduction of prostaglandins whereas females with primary dysmenorrhea have greater endometrial production of prostaglandins [9].

Primary dysmenorrhea occurs when the ovulation cycle is fully established which is 1 to 2 years after menarche [10]. It occurs when the production of endometrial prostanoids is increased or unbalanced during the menstruation cycle. Menstrual pain is common in young females in their teens and early adult life, and it affects around three-quarters of all females during their reproductive life [11]. The characteristic symptoms of Primary dysmenorrhea are colicky and cramps spasms of pain below the belly button, occur within 8–72 hours of the menstruation cycle, and peaking as menstrual flow increases within the first few days [12]. 60% to 90% is the overall prevalence of primary dysmenorrhea among adolescent girls and decreases with age[5]. The symptoms such as diarrhea, dizziness, nausea, tiredness, vomiting, irritability, and headache are also seen. These symptoms appear during or before menstruation and remain for up to three days after menstruation, with the intensity diminishing after the first day [13].

Smoking, alcohol consumption, abnormal menstrual flow, low body mass index, previous sanitization, psychological irritation, genetic effect, and premature menarche are the factors that influence the severity of dysmenorrhea [14, 15]. Smokers are more likely than nonsmokers to experience dysmenorrhea and lengthy, heavy menstrual periods [16]. Alcohol, coffee, and smoking have all been linked to dysmenorrhea, although the evidence is generally contradictory or inconclusive (14). The NSAIDs which are popular treatment for dysmenorrheal have various well-known adverse effects like nausea, breast soreness, and intermenstrual hemorrhage, dizziness, sleepiness, hearing and vision problems, and so on [17].

Lifestyle includes changeable and controllable behaviors that affect the individual's health either negatively or positively [18]. The World Health Organization defines health as the existence of physical, mental, and social well-being in addition to the absence of sickness, physical and mental weakness [19]. Quality of life is defined as individual perception, experiences, beliefs, and expectations based on the subjective phenomenon [20].

Long menstrual cycles, early menarche, poor sleep hygiene, a family history of dysmenorrhea, specific eating habits, alcohol and caffeine intake, lack of exercise, cigarette smoking, obesity, and having a stressful lifestyle are all risks factors for primary dysmenorrhea episodes [21-23]. According to recent research, one's lifestyle might cause tension and anxiety, as well as mental pressures that worsen dysmenorrhea[24].

Given the prevalence of dysmenorrhea and its significant effects on personal and social quality of life, as well as public acceptance of new lifestyle trends, knowledge of exercise and diet-related methods for dysmenorrhea management can be gained by comparing the lifestyles of athletes with and without dysmenorrhea. Some of the studies that have been carried out on this issue have shown unsatisfactory findings. As a result, this research was carried out to look at the link between lifestyle and dysmenorrhea in young female athletes in order to promote lifestyleimprovement therapies for these athletes.

Materials and Methods

This was a cross-sectional survey study conducted on young female athletes of Punjabi University Patiala, Punjab (India) selected through convenient random sampling. 200 young female athletes(either state, national or international level) having more than one year of experience in the age group of 18-35 years were included.Female athletes of school, college and district level as well as those with any gynecological disorders were excluded. The research proposal was approved by the Institutional Ethical Committee (IEC). Each participant was explained in detail the purpose, aim, objectives and risks associated with the study and thereafter their written consent was obtained. The tool used was a questionnaire which consisted of questions related to the severityof dysmenorrhea, lifestyle, and personal-social domain[23, 25]. The items included were age at menarche, presence and absence of dysmenorrhea, its duration, irregularity, symptoms experienced during menstruation, family history, sickness absenteeism & quality of life-related (QoL) questions. QoL questionnaire used is reliable and valid [26]. Dataanalysis included mean, standard deviation and percentage analysis using SPSS version 20.

Results

The descriptive analysis, carried out in the present study, suggested that the mean age ofthe respondents was 21.84 (±1.81 SD)years. Theirbody weight was in normal range as the mean value of BMI was 22.44 kg/m^2. 74% of female athletes were of national-level, 17% state level and 9% of international level. Most often,the duration ofathletic experience was more than 7 years.

The prevalence of dysmenorrhea in young female athletes is 83.5%in the present study (Figure 1). 28.5% of the young female athletes, in the current study,had their onset of menarche at the age of 16 to 17 years, but 46% of athletes at the age of 14to 15 yearswhereas 18.5% of athletes at the age of 18 to 19 years.Thus, most of them had the history of delayed menarche.

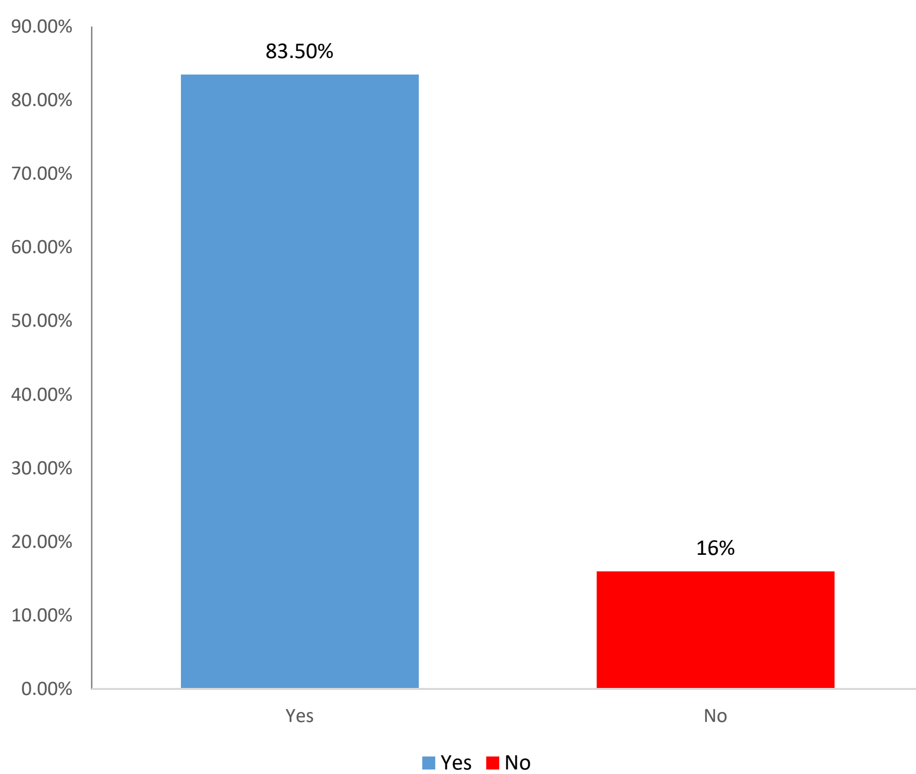

Figure 1: Distribution of young female athletes according to the experience of dysmenorrhea

The eating habits of athletes are presented in Figure 2 & Table 1. Only 9.09% of the female athletes without dysmenorrhea were obese, while 22.75% of female athletes with dysmenorrheawere obese as shown in Table 2.

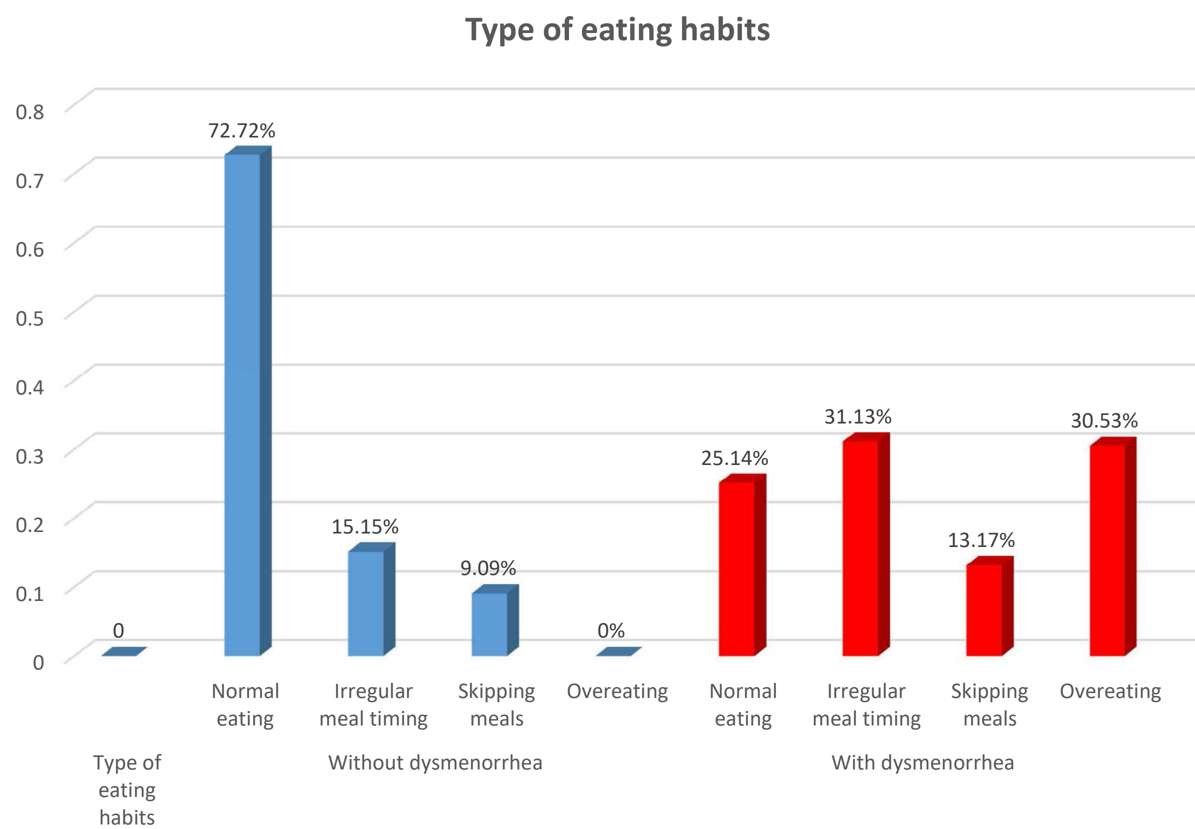

Figure 2: Comparison of the type of eating habits among respondents

Table 1. Comparison of having caffeinated drinks among female athletes

Caffeine containing drinks	Athletes without dysmenorrhea			Athletes with dysmenorrhea		
Tea	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**
Frequency	18	15	33	102	65	167
Percentage	54.54	45.45	100	61.07	38.92	100
Coffee	**Yes**	**No**		**Yes**	**No**	
Frequency	19	14	33	131	36	167
Percentage	57.57	42.42	100	78.44	21.55	100
Coke	**Yes**	**No**		**Yes**	**No**	
Frequency	8	25	33	75	92	167
Percentage	24.24	75.75	100	44.91	55.08	100

Table 2. Comparison of intake of chocolate and obesity among female athletes

	Athletes without dysmenorrhea			**Athletes with dysmenorrhea**		
Chocolate	**Yes**	**No**	**Total**	**Yes**	**No**	**Total**
Frequency	20	13	33	130	37	167
Percentage	60.60	39.39	100	77.84	22.15	100
Obese	**Yes**	**No**		**Yes**	**No**	
Frequency	3	30	33	38	129	167
Percentage	9.09	90.90	100	22.75	77.24	100

Table 3 presents the comparison of the lifestyle of athletes with and without dysmenorrhea.It was seen that only 30.30% of the athletes without dysmenorrhea had poor personal relationshipand poor work satisfaction.

Table 3. Comparison oflifestyle among female athletes

Poor personal relationship	Athletes without dysmenorrhea			Athletes with dysmenorrhea		
	Yes	No	Total	Yes	No	Total
Frequency	10	23	33	104	63	167
Percentage	30.30	69.69	100	62.27	37.27	100
Poor work satisfaction	**Yes**	**No**		**Yes**	**No**	
Frequency	10	23	33	88	79	167
Percentage	30.30	69.69	100	52.69	47.30	100
Decreases confidence	**Yes**	**No**		**Yes**	**No**	
Frequency	12	21	33	102	65	167
Percentage	36.36	63.63	100	61.07	38.92	100

Figure 3 suggeststhat 54.54% athletes without dysmenorrhea reduced their physical activity during menses whereas frequency of such athletes with dysmenorrhea was much greater (78.44%). With respect to type of physical activity, most of the females without dysmenorrhea used to perform jogging during the menses while athletes with dysmenorrhea preferred walking during menses.It was discouraging to observe that a handful of respondents were involved in yoga practice (Table 4). Additionally, absent from work during menses and the comparison of the domains status of the respondents is shown in Figure 4 and Table 5 respectively.

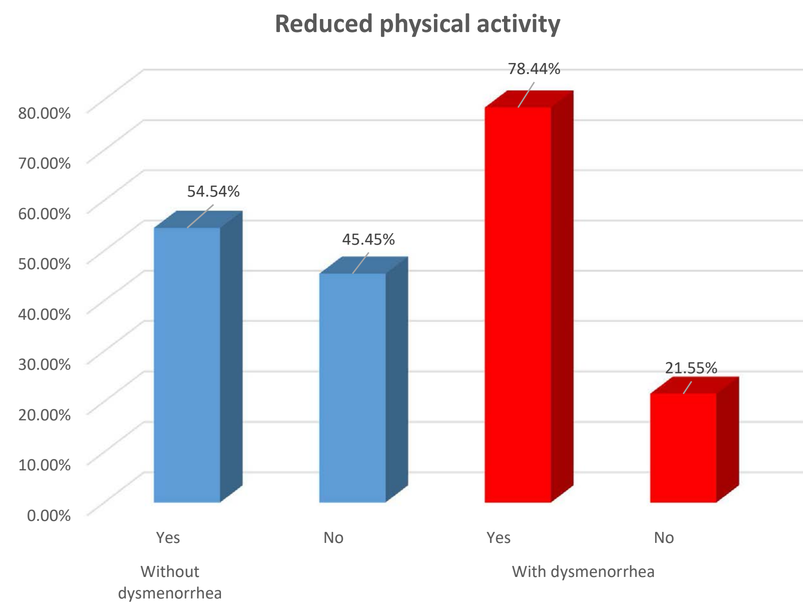

Figure 3: Comparison of the reduced physical activity in respondents

Table 4. Comparison of type of physical activity among female athletes

Type of physical activity	Athletes without dysmenorrhea					Athletes with dysmenorrhea				
	Dancing	Jogging	Walking	Yoga	Total	Dancing	Jogging	Walking	Yoga	Total
Frequency	7	18	6	3	33	44	50	58	15	167
Percentage	21.21	54.54	15.15	9.09	100	26.34	29.94	34.73	8.98	100

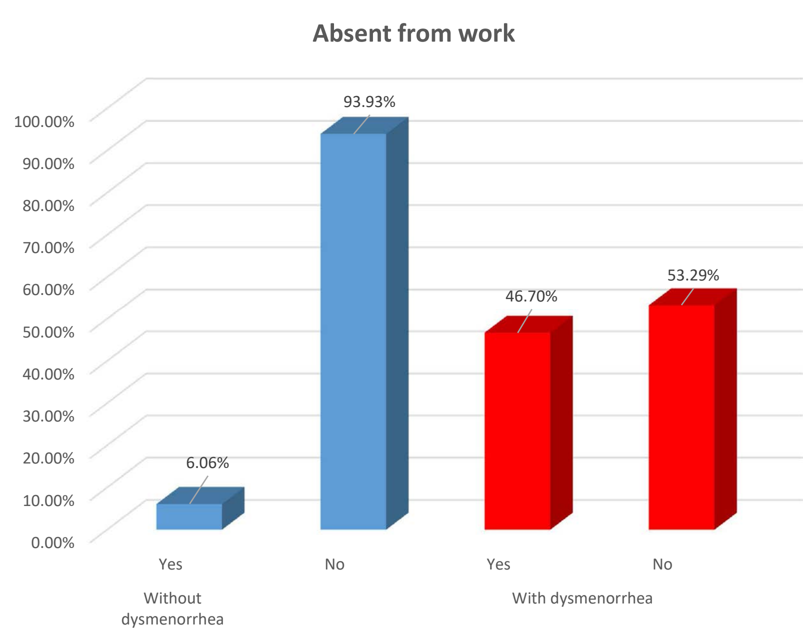

Figure 4: Comparison of absence from work during menses in respondents

Table 5. Comparison of the domains status among female athletes

Disturb physical functioning	**Athletes without dysmenorrhea**			**Athletes with dysmenorrhea**		
	Yes	**No**	**Total**	**Yes**	**No**	**Total**
Frequency	12	21	33	114	53	167
Percentage	36.36	63.63	100	68.26	31.73	100
Body pain	**Yes**	**No**		**Yes**	**No**	
Frequency	20	13	33	153	14	167
Percentage	60.60	39.39	100	91.61	8.38	100
Affectvitality	**Yes**	**No**		**Yes**	**No**	
Frequency	10	23	33	108	59	167
Percentage	30.30	69.69	100	64.67	35.32	100
Affect social functioning	**Yes**	**No**		**Yes**	**No**	
Frequency	7	26	33	114	53	167
Percentage	21.21	78.78	100	68.26	31.73	100
Affect mental health	**Yes**	**No**		**Yes**	**No**	
Frequency	9	24	33	99	68	167
Percentage	27.27	72.72	100	59.28	40.71	100
Affect general health	**Yes**	**No**		**Yes**	**No**	
Frequency	4	29	33	109	58	167
Percentage	12.12	87.87	100	65.26	34.73	100

Discussion

The findings of present study show that 50% of the female athletes had delayed menarche which was supported by a prior study in which the players of different sports like swimmers, gymnasts and tennis players also experienced delayed menarche [(27)]. The interval between the age at maximal peak velocity of height and the age at menarche was used to scientifically establish the delayed menarche of female athletes.The UK reference data is almost 20 years old, therefore this may no longer reflect contemporary menarche ages.

In the present study, a very high percentage of female athletes i.e. 83.5% experienced dysmenorrhea which was similar to a study conducted on University students in Turkey with 85.7% of dysmenorrhea [(28)]. There are various studies where prevalence of dysmenorrhea ranged from 16% to 91%. The smaller prevalence of 16% of dysmenorrhea was found in a study conducted on Japanese women aged between 18-51 years which may be attributed to the study's short duration (1 month) andpossible underreporting of moderate menstrual discomfort [(29)] whereas other studies reported higher prevalence [(30-33)]. In the present study, it was found that 66.2% of athletes with dysmenorrhea described their pain as severe and moderate, in line with the study conducted on Canadian women[34].

In the current study, various factorslike diet, physical activity, stress, and social interactions influenced dysmenorrhea in both the groups. It was noted that dysmenorrhea was less severe when athletes had a good dietary level. Also the eating habits were compared and it was discovered that athletes with dysmenorrhea had poor eating habits, missed their meals, and had inconsistent meal timings, all of which had an impact on their lifestyle, practice, and injury risk.The majority of female students (52.6%) who consistently ate breakfast had a lower proportion of having primary dysmenorrhea than those who skipped breakfast, according to the findings of one study. Female college students who ate breakfast seldom had a 0.02 times greater incidence of primary dysmenorrhea than those who ate breakfast often [35]. It is backed up by a study where it was found that eating a regular breakfast is a key sign of a healthy lifestyle and has a positive impact on physical and psychological well-being [18].

In the present study, it was also discovered that athletes without dysmenorrhea had better personal connections, job satisfaction, confidence, and focus levels, and were less likely to miss practice than athletes with dysmenorrhea. This is supported by another study done on Spanish female university students where it was found that females with dysmenorrhea experienced lower quality of life[33]. Severe dysmenorrheic pain reducedQoL in women with dysmenorrhea, compared with their own pain-free follicular phase and compared withcontrols in a study conducted on women [36]. A previous studysuggested that primary dysmenorrhea was a leading cause of absenteeism in colleges and had negative effects on young girls' quality of life, but primary and secondary dysmenorrhea were not differentiated[37]. Dysmenorrhea is a disorder that causes persistent pelvic discomfort and has serious physical, emotional, and financial consequences for people [32]. In the present study athletes with dysmenorrhea, had lower scores on social dimensions such as social functioning, vitality, bodily pain, physical functioning, mental health, and overall health which is supported by a similar study where women with menstrual symptoms had significantly lower scores for all domains of the SF-36[37]. Absenteeism (28-48%) and perceived quality of life losses are common among adolescent females due to dysmenorrhea illness. Dysmenorrhea is the leading cause of time missed from work and education in the United States [38]. Dysmenorrhea had negatively impacted their quality of life, job, and psychological well-being.

As per the present study, athletes with more practice hours had less severe dysmenorrhea than those with less practice hours. The symptoms of dysmenorrhea are thought to be alleviated by exercise. The findings are supported by astudywhere exercise was commonly promoted as a therapy for menstrual cramps; it may intervene through increased blood flow, improved metabolism, stimulation of beta-endorphins, and stress reduction [39]. Another potential reason is that aerobic exercise works by diverting blood away from the viscera, resulting in reduced blood congestion in the pelvic region during menstruation [40]. Sports club activity levels were found to be inversely associated with the prevalence of severe dysmenorrhea in a study conducted on Japanese female junior high school students[41]. Exercise was found to be most effective in the prevention of dysmenorrhea when it began before the first menstruation and remained a fixed part of the adult's lifestyle [42].

Thus, it can be stated that the prevalence of dysmenorrhea among females was higher and young female athletes with dysmenorrhea had poor dietary and lifestyle habits than athletes without dysmenorrhea. Therefore, healthy nutrition habits should be adopted to alleviate everyday stress and manage immune system changes. Recreational activities like listening to music, meditation, and aerobic exercisecan be utilized by females from the beginning to improve their quality of life.

Conclusion

The findings of the present study concluded that more than half of the female athletes experienced dysmenorrhea.Young female athletes with dysmenorrhea had poor eating habits as compared to their peers without dysmenorrhea. It was also revealed that athletes with dysmenorrhea experienced poor personal relationships, poor work satisfaction and loss of concentration, decreased confidence, and absence from work in comparison to females without dysmenorrhea.

Ethical Approval

The study was approved by Departmental Research Board (DRB) via reference number 1168M/PT and Institutional Ethical Committee (IEC) of Punjabi University, Patiala via number 4/35/IEC/PUP/2022.

Limitations

The sample size was small and the study was conducted in a small geographical area which can't be generalized to entire population.

The sample was selected through convenient sampling which could result in selection bias.

Recommendations

The future study can be conducted on a larger sample to generalize the results to entire population. The effect of additional factors like training intensities can also be considered.

Disclosure Statement

- No potential conflict of interest was reported by the author(s).
- Data availability statement
- The data that support the findings of this study are available from the corresponding author, upon reasonable request.
- Additional information

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The Effect of Seat Surface Inclination on Postural Control and Upper Extremity Function in Children with Cerebral Palsy- A Crossover Study

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Abstract

Background: Children with cerebral palsy spend prolonged periods in sitting, particularly in school settings. Adaptive seating, including seat surface inclination, may influence postural control and upper extremity function.

Methods: A cross-over study was conducted on 25 children with spastic cerebral palsy (8–13 years). Postural control and upper extremity function were assessed using the Sitting Assessment Scale, Seated Postural Control Measure, Functional Assessment Battery Tool, and ABILHAND-Kids Questionnaire under neutral, anterior, and posterior seat inclination conditions.

Results: Significant differences were observed across seating conditions in postural control, alignment, and selected upper extremity functional outcomes ($p < 0.05$).

Conclusion: A 10° seat inclination significantly influenced seated postural control and upper extremity function in children with spastic cerebral palsy.

Keywords: Cerebral palsy; postural control; upper extremity function; adaptive seating; seat inclination

Introduction

Cerebral palsy is a group of permanent disorders affecting the development of movement and posture, resulting in activity limitations and attributed to non-progressive disturbances in the developing fetal or infant brain.[1] In India, the pooled prevalence of cerebral palsy is reported as 2.95 per 1,000 children, while the global prevalence is approximately 2.11 per 1,000 live births.[2, 3] Cerebral palsy represents a heterogeneous group of motor disorders, most commonly classified by motor type and topographical distribution, with spastic cerebral palsy being the predominant form.[4-7]

Children with cerebral palsy frequently exhibit impairments in postural control due to muscle tightness, weakness, impaired selective motor control, and excessive co-contraction of antagonist muscles.[8-14] These impairments affect the ability to maintain and modify sitting posture and subsequently influence upper extremity function and participation in daily and school-related activities.[15,16]

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Upper extremity dysfunction in cerebral palsy arises from both motor and sensory impairments, including reduced strength, limited range of motion, spasticity, poor coordination, and deficits in proprioception and tactile perception.[17-21] These deficits contribute to limitations in reaching, grasping, manipulation, and functional task performance, leading to restricted participation across home, school, and community environments.[22-24]

Pelvic positioning and trunk alignment are critical for achieving a functional sitting posture necessary for optimal upper extremity performance. Adequate postural control provides proximal stability, enabling improved distal upper limb mobility. Modifications in seating systems can alter pelvic and trunk orientation relative to gravity, thereby enhancing postural stability and functional arm use.[25-32]

Children with cerebral palsy spend a substantial amount of time in sitting, particularly in school settings, making adaptive seating strategies an important component of intervention. Anterior and posterior seat inclinations are commonly used to promote postural stability and functional performance.[33-34] Anterior seat inclination encourages anterior pelvic tilt and upright sitting posture, potentially enhancing upper limb function, whereas posterior seat inclination may increase stability by preventing forward sliding but can also increase postural effort.[35-38]

Previous studies have reported variable effects of seat inclination based on cerebral palsy subtype and angle of inclination. Seat inclinations around 10° have been associated with improved postural stability and reaching performance, while steeper inclinations appear to offer limited additional benefit.[39, 40] However, comparative evidence examining the effects of both anterior and posterior seat inclination on postural control and upper extremity function remains limited.

Therefore, the present study aimed to evaluate the effect of **anterior and posterior seat surface inclination** on seated postural control and upper extremity functional performance in children with spastic cerebral palsy.

Objective of the Study

To evaluate the effect of seat surface inclination on postural control and upper extremity function in children with cerebral palsy.

Materials and Methods

Ethical clearance was obtained from the Institutional Ethics Committee prior to the commencement of the study.

A total of 39 children with spastic cerebral palsy were screened for eligibility. Of these, 28 participants who met the selection criteria were recruited using a convenience sampling method from special schools and rehabilitation centers. Children aged 8–13 years diagnosed with spastic cerebral palsy (unilateral or bilateral), classified under the Manual Ability Classification System (MACS) levels I–III, able to understand and follow verbal commands, and having a passive hip flexion range of motion of 90° ± 10° (measured using a goniometer) were included.

Participants were excluded if they had severe visual impairment; upper extremity deformities involving the shoulder, elbow, or wrist; restricted shoulder range of motion (shoulder flexion or abduction <120°); fixed trunk deformities such as kyphosis or scoliosis or a positive Adam's forward bend test; or hip pain ≥5 on the Numerical Rating Scale (NRS-11).

A patient information sheet, informed consent form, informed assent form, and videography consent form were provided to the parent or class teacher of each participant, and written informed consent was obtained prior to participation.

This study employed a cross-over design, wherein each participant was exposed to both anterior and posterior seat inclinations using a custom-built foam wedge of 10°. A 15-minute familiarization period was provided for each seating condition, and outcome measures were recorded during each condition. A washout period of 30 minutes was allowed between seating conditions to minimize potential carry-over effects.

Assessments were conducted with participants seated on a standard chair with armrests, backrest, and footrest using the Sitting Assessment Scale, Seated Postural Control Measure, Functional Assessment Battery Tool, and ABILHAND-Kids Questionnaire.

Although 28 participants were initially recruited, complete data across all seating conditions were available for 25 participants only. Participants with incomplete assessment data or inability to complete both seating conditions as per the crossover protocol were excluded from the final analysis to ensure the integrity of within-subject comparisons.

Statistical Analysis

Statistical analysis was performed using SPSS version 28.0, with data from 25 participants analyzed according to the within-subject comparisons planned for the cross-over design. Sitting Assessment Scale scores were analyzed using Fisher's Exact Test; Seated Postural Control Measure, ABILHAND-Kids Questionnaire, and Functional Assessment Battery activities 1 and 7 were analyzed using repeated measures ANOVA; and Functional Assessment Battery activities 2–6 were analyzed using the Friedman test, with Bonferroni and Wilcoxon signed-rank tests applied for post-hoc analysis as appropriate. A p-value < 0.05 was considered statistically significant.

Results

Table 1: Demographic characteristics of subjects (n=25)

Characteristics	Frequency	%
Age- mean ± SD	11.72 ± 1.77	
Gender- Male	16	64
Gender- Female	9	36

All participants demonstrated good head control across seating conditions. Trunk control was predominantly good across positions, while foot, arm, and hand functions showed variation across normal, anterior, and posterior seating conditions (Table 2).

Table 2. Sitting Assessment Scale- Frequency and percentage of normal, anterior and posterior seat inclinations

		Normal		Anterior		Posterior	
		Frequency	%	Frequency	%	Frequency	%
Head control	Good	25	100	25	100	25	100
Trunk control	Fair	2	9.5	2	9.5	2	9.5
	Good	19	90.5	19	90.5	19	90.5
Foot control	Poor	0	0	0	0	1	4.8
	Fair	3	14.3	1	4.8	8	38.1
	Good	18	85.7	20	95.2	12	57.1
Arm function	Fair	12	57.1	9	42.9	11	52.4
	Good	9	42.9	12	57.1	10	47.6
Hand function	Fair	21	100	3	14.3	10	47.6
	Good	0	0	18	85.7	11	52.4

Significant associations between seating condition and trunk control and arm function were identified (Table 3)

Table 3. Comparison of trunk control, arm function, hand function, foot control between normal and anterior seats

		Anterior				Fisher's Exact Test	p value
		Fair		Good			
		N	%	N	%		
Trunk control (Normal)	Fair	2	100	0	0	0.003	**0.005***
	Good	0	0	19	100		
Arm function (Normal)	Fair	9	100	3	25	0.001	**0.001***
	Good	0	0	9	75		
Hand function (Normal)	Fair	3	100	18	100	--	--
Foot control (Normal)	Fair	1	100	2	10	0.143	0.143
	Good	0	0	18	90		

(* Significant)

Significant associations between seating condition and trunk control and arm function were identified (Table 4).

Table 4. Comparison of trunk control, arm function, hand function between normal and posterior seats

		Posterior				Fisher's Exact Test	p value
		Fair		Good			
		N	%	n	%		
Trunk control (Normal)	Fair	2	100	0	0	0.003	**0.005***
	Good	0	0	19	100		
Arm function (Normal)	Fair	10	90.9	2	20	0.002	**0.002***
	Good	1	9.1	8	80		
Hand function (Normal)	Fair	10	100	11	100	--	--

(* Significant)

A significant association between seating condition and foot control was identified (Table 5).

Table 5. Comparison of foot control betweenthe seats

		Posterior						Likelihood ratio	p value
		Poor		Fair		Good			
		N	%	n	%	N	%		
Foot control (Normal)	Fair	1	100	1	12.5	1	8.3	4.312	0.116
	Good	0	0	7	87.5	11	91.7		
Foot control (Anterior)	Fair	1	100	0	0	0	0	8.041	**0.018***
	Good	0	0	8	100	12	100		

(* Significant)

Significant associations between seating condition and trunk control and arm function were identified (Table 6).

Table 6. Comparison of trunk control, arm function, hand function between anterior and posterior seats

		Posterior				Fisher's Exact Test	p value
		Fair		Good			
		N	%	n	%		
Trunk control (Anterior)	Fair	2	100	0	0	0.003	**0.005***
	Good	0	0	19	100		
Arm function (Anterior)	Fair	9	81.8	0	0	0.0002	**< 0.001***
	Good	2	18.2	10	100		
Hand function (Anterior)	Fair	3	30	0	0	0.090	0.090
	Good	7	70	11	100		

(* Significant)

Significant differences in the alignment and functional sections were identified across seating conditions (Table 7).

Table 7. SPCM scale- Comparison of Level of Sitting Scale (LSS), alignment section, functional sectionaccording to the seats

		Mean	S.D.	"F'	p value
LSS	Normal	7.38	0.67	3.1	0.056
	Anterior	7.33	0.66		
	Posterior	7.10	0.62		
Alignment section	Normal	64.14	2.35	**38.057**	**< 0.001***
	Anterior	61.71	3.00		
	Posterior	57.95	3.63		
Functional section	Normal	42.29	1.15	**18.135**	< 0.001*
	Anterior	43.38	1.60		
	Posterior	41.95	1.16		

(* Significant)

Significant differences in the alignment and functional sections were identified across seating conditions (Table 8).

Table 8. Pairwise comparison of alignment section and functional section

Domain	Seat Comparison	Mean Difference	*p* value
Alignment	Normal vs Anterior	2.43	**0.014***
	Normal vs Posterior	6.19	**< 0.001***
	Anterior vs Posterior	3.76	< 0.001*
Functional	Normal vs Anterior	−1.10	**0.003***
	Normal vs Posterior	0.33	0.389
	Anterior vs Posterior	1.43	< 0.001*

(* Significant)

No significant differences were identified in overhead, forward, or sideways reaching across seating conditions (Table 9).

Table 9. Functional assessment battery- Comparison of overhead, forward, sideway according to the seats

		Mean	S.D.	"F'	p value
Overhead	Normal	55.33	6.78	0.235	0.792
	Anterior	56.07	7.33		
	Posterior	55.48	6.56		
Forward	Normal	53.14	6.58	2.536	0.107
	Anterior	56.00	7.24		
	Posterior	53.38	7.17		
Sideway	Normal	52.81	6.45	3.575	0.056
	Anterior	54.90	6.20		
	Posterior	53.24	6.14		

Significant differences were identified in Activities 4–6 across seating conditions (Table 10).

Table 10. Comparison of activity 2, 3, 4, 5 & 6according to the seats

Activity (sec)	Seat Comparison	Median	IQR	Friedman's ANOVA	p value
Activity 2	Normal	25	15.5 to 30	2.620	0.270
	Anterior	24	13.5 to 29		
	Posterior	22	13 to 29.5		
Activity 3	Normal	47	32.5 to 58	6.317	0.051
	Anterior	37	24 to 56		
	Posterior	45	28.5 to 55.5		
Activity 4	Normal	31	22.5 to 48.5	6.872	**0.032***
	Anterior	25	21 to 40		
	Posterior	32	19.5 to 37.5		
Activity 5	Normal	191.4	128.7 to 246	13.238	**0.001***
	Anterior	146.4	105 to 229.2		
	Posterior	180.6	93.6 to 231.6		
Activity 6	Normal	369	226.2 to 690	10.289	**0.006***
	Anterior	321	143.1 to 593.4		
	Posterior	327.6	137.4 to 627.6		

(* Significant)

Significant differences were identified in Activities 4–6 across seating conditions (Table 11).

Table 11. Pairwise comparison of activity 4, 5 and 6

Activity (sec)	Seat Comparison	Z value	*p* value
Activity 4	Normal vs Anterior	−2.529	**0.011***
	Normal vs Posterior	−2.265	**0.024***
	Anterior vs Posterior	−1.157	0.247
Activity 5	Normal vs Anterior	−3.181	**0.001***
	Normal vs Posterior	−1.930	0.054
	Anterior vs Posterior	−2.068	**0.039***
Activity 6	Normal vs Anterior	−3.319	**0.001***
	Normal vs Posterior	−2.798	**0.005***
	Anterior vs Posterior	−0.952	0.341

(* Significant)

Activity 7 differed significantly across seating conditions (Table 12).

Table 12. Comparison of activity 7according to the seats

		Mean	S.D.	"F'	p value
Activity 7 (Distance in Cm)	Normal	217.29	88.74	5.437	**0.019***
	Anterior	245.38	90.10		
	Posterior	235.62	93.44		

(* Significant)

Activity 7 differed significantly between neutral and anterior seating (Table 13).

Table 13. Pairwise comparison of activity 7

Activity 7 (Distance in Cm)		Mean Difference	p value
Normal	Anterior	-28.10	**0.031***
	Posterior	-18.33	0.255
Anterior	Posterior	9.76	0.169

(* Significant)

ABILHAND-Kids scores differed significantly across seating conditions (Table 14).

Table 14. Comparison of ABILHAND kids questionnaire according to the seats

		Mean	S.D.	"F'	p value
ABILHAND kids questionnaire	Normal	34.52	5.83	27.386	**< 0.001***
	Anterior	35.90	5.66		
	Posterior	33.67	6.19		

(* Significant)

Significant post-hoc differences were observed in ABILHAND-Kids scores (Table 15).

Table 15. Pairwise comparison of ABILHAND kid's questionnaire

ABILHAND kids questionnaire		Mean Difference	p value
Normal	Anterior	-1.38	**< 0.001***
	Posterior	0.86	**0.036***
Anterior	Posterior	2.24	**< 0.001***

(* Significant)

Results

Twenty-five children with spastic cerebral palsy participated in the study (mean age 11.72 ± 1.77 years; 64% male); baseline characteristics are presented in Table 1. Significant differences were observed in trunk, arm, hand, and foot control on the Sitting Assessment Scale and in the alignment and functional sections of the Seated Postural Control Measure across seating conditions (Tables 2–8). No significant differences were found in overhead, forward, or sideways reaching (Table 9); however, Functional Assessment Battery activities 4–7 and ABILHAND-Kids Questionnaire scores differed significantly across seating conditions (Tables 10–15).

Discussion

The present study examined the effect of anterior and posterior seat inclination on postural control and upper extremity function in children with spastic cerebral palsy. The findings demonstrated that seat inclination was associated with significant differences in seated postural control and selected upper extremity functional tasks.

Postural Control and Seat Inclination

The results indicated significant differences in postural control across seating conditions, as reflected by the Sitting Assessment Scale and Seated Postural Control Measure. Improvements in trunk control and arm function were observed with seat inclination, particularly with anterior seating. Anterior seat inclination promotes an upright sitting posture by facilitating anterior pelvic tilt and reducing slouched sitting, which may enhance proximal stability. In contrast, foot control was reduced in posterior seat inclination, possibly due to decreased weight-bearing through the feet.

The Seated Postural Control Measure demonstrated significant differences in both alignment and functional sections across seating conditions. Functional performance appeared more favourable in anterior and neutral seating, while alignment scores were relatively better in neutral seating. These findings suggest that seat inclination influences pelvic and trunk alignment, which in turn affects postural stability during sitting.

Previous studies have reported similar findings. Cherng et al. reported improved postural stability with anterior seat inclination, attributed to increased weight-bearing through the feet. Hadders-Algra et al. observed improved postural control and reaching performance with forward seat inclination in children with unilateral spastic cerebral palsy, while horizontal seating was more beneficial for children with bilateral involvement. The present study similarly found anterior seat inclination to be associated with better postural stability, particularly in children with milder involvement.

Upper Extremity Function and Seat Inclination

Significant differences were observed in selected upper extremity functional tasks across seating conditions. Functional Assessment Battery activities involving fine motor skills, bimanual coordination, and visual-motor integration demonstrated improved performance with anterior and neutral seating compared to posterior seating. Activity 7 (throwing a ball) showed greater throwing distance in anterior seating, which may be attributed to improved trunk alignment, increased sitting height, and better lower limb support.

These findings are consistent with previous reports indicating faster task performance and improved reaching efficiency with anterior seat inclination compared to posterior inclination. The present study also demonstrated that time-based functional tasks were performed more efficiently in anterior and neutral seating conditions.

Several factors may have influenced task performance, including prior experience with functional activities, attention, motivation, fatigue, and fear associated with task execution. Additionally, many participants were classified as GMFCS levels I–II and had limited experience with wheelchair use, which may have affected scores related to wheelchair-based functional components.

Overall, anterior seat inclination may be beneficial for postural control and upper extremity function in children with spastic cerebral palsy.

Limitations

The lengthy assessment protocol may have influenced performance due to fatigue and variable engagement. In addition, the predominance of participants classified as GMFCS levels I–II, with limited wheelchair experience, may have affected functional section scores of the Seated Postural Control Measure.

Future Recommendations

Seat inclination may be considered as an adjunct to improve functional activity performance in children with spastic cerebral palsy.

Clinical Implications

Given that children with cerebral palsy spend considerable time in sitting, particularly in school settings, a custom-built foam wedge with a 10° anterior or posterior seat inclination may be considered during functional activities to facilitate postural control and upper extremity function.

Conclusion

Anterior and posterior seat inclinations were associated with statistically significant differences in postural control and upper extremity function, as reflected by improvements in SAS, SPCM, selected Functional Assessment Battery activities (4–7), and ABILHAND-Kids Questionnaire scores in children with spastic cerebral palsy.

Ethical Clearance: Ethical clearance for this study was obtained from the Institutional Ethics Committee of The Oxford College of Physiotherapy. Approval was granted as per reference number TOCPTRBERS001/2022 dated 06 January 2022.

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Assessing the Knowledge and Utilization of the International Classification of Functioning, Disability, and Health (ICF) among Pediatric Physiotherapists: A Questionnaire Based Cross-Sectional Study

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Abstract

Background: The International Classification of Functioning, Disability and Health (ICF), developed by WHO, offers a standardized, biopsychosocial framework to assess health and functioning. Its Pediatric version International Classification of Functioning, Disability and Health for Children and Youth (ICF-CY), addresses developmental aspects specific to children. Although it aids clinical decision-making and outcome evaluation in pediatric physiotherapy, its integration into routine clinical practice is still not widespread.This limited adoption may be due to factors such as lack of awareness, training, and perceived complexity in applying the framework in everyday practice.The objective the study is to assess the level of knowledge and utilization of the International Classification of Functioning, Disability, and Health (ICF) among pediatric physiotherapists.

Methods: A cross-sectional study was conducted among 95 pediatric physiotherapists practicing in Bangalore, Karnataka. Participants were selected based on inclusion criteria using purposive sampling. A structured questionnaire was used to assess knowledge and utilization of the ICF.

Conclusion: Among 95 pediatric physiotherapists surveyed, 55.8% demonstrated average knowledge of the ICF, 27.4% had good knowledge, and 16.8% showed below average knowledge. The study highlights the pediatric physiotherapists have average knowledge of the ICF, with limited good understanding and a notable portion showing below average knowledge. These findings emphasize the need for enhanced training to improve ICF use in clinical practice and support better patient outcomes.

Keywords: ICF, International Classification of Functioning, Disability and Health, Physiotherapy, Pediatric Physiotherapy, Knowledge.

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Introduction

The International Classification of Functioning, Disability and Health describes people's and communities' health and health-related conditions in a consistent and standardized manner[1]. In May 2001 the World Health Assembly accepted International Classification of Functioning, Disability and Health (ICF) as a component of World Health Organization (WHO) international classification[2]. ICF is a multidimensional model that can be used for all individual despite of their health conditions[3].

One of the primary objectives of the ICF is to make study results comparable at the national and international levels by using numerical codes as a common language for healthcare professionals to explain how people with a health condition function. There are 1495 numeric codes in the ICF. The extensive scope of ICF has led to the development of so-called core sets. Core sets are of two types; comprehensive core sets and brief core sets[3].

The ICF gives detailed classifications of disability and ability in the areas of body functions, body structures, activities, participation and environmental factors. Aspects of functioning for each of these elements are explained in a hierarchical category with four levels of increasing detail and also, they are denoted by unique alphanumeric codes[4]. Body structures represent anatomical parts and organs of the body, whereas body functions reflect physiological functions of the human body. Activities are tasks that a person performs on their own. Participation is the practice of individual getting involved in various aspects of life including their jobs, hobbies, families, communities and studies. Environmental factors include the physical, psychological and social environments in which an individual lives or performs their activities. Personal factors refer to the way an individual experiences a specific health condition[5].

The International Classification of functioning, disability and health- children and youth (ICF-CY) version, is an expanded version of ICF that places a special focus on the behavioural, educational and developmental aspects of children and youth[6]. With the help of the ICF-CY version, children's environments and functions can be explored and documented in innovative ways[7]. Both ICF and ICF-CY are universal in that they can be used to characterize functioning of all people, not only those with disabilities[7]. Documenting children's participation in daily life is the primary goal of the ICF-CY classification[7].

The ICF has been more used to classify outcomes for various pediatric disorders[8]. The ICF can help families and healthcare professionals have an explanation about different objectives in pediatrics rehabilitation which can help them understand priorities[9]. Relationships between impairments in body functions and structures, activities, participation, and environmental factors are essential for understanding the health and development of those with cerebral palsy throughout their lives[10]. Using ICF framework, gives a uniquely broad overview of the preschool motor functioning of children born very preterm. A greater number of pediatric disorders, such as, cerebral palsy, developmental coordination disorder, congenital hemiplegia and traumatic brain injury are having their outcomes categorized using the ICF[8]. Also, the crutches and ankle-foot orthoses' impact in improving gait and walking results at ICF body functions and structures level[11].

As the integrated model proposed by the ICF includes equally essential biological, social and individual view-points that may prevent the progress of health or disease, the ICF-classified data can help health professionals in clinical practice in thinking clinically and making decisions[1]. The ICF highlights the need for many health care professionals and serve as an ideal model for approaching health and healthcare. As a result, it motivates healthcare professionals to think about the health concerns that support their area of expertise. In this way, by providing a universal language and framework for health and functioning, the ICF facilitates better communication among healthcare professionals during patient assessment[5]. This study aims to evaluate how well pediatric physiotherapists understand and use the International Classification of Functioning, Disability, and Health (ICF). By identifying gaps in knowledge and application, it seeks to improve the quality of care for children. The findings can inform.

Material and Methods

Study Design: Cross-sectional study

Study Setting: Physiotherapist working at various clinics atBangalore

Source of Data: Bangalore

Inclusion Criteria

- Physiotherapists currently working with children.
- Physiotherapists those who were practicing in Bangalore.

Exclusion Criteria

- Physiotherapists with less than one year of experience in pediatrics.

Sampling Method: Purposive sampling

Sample Size: 95 paediatric physiotherapists

Materials: Questionnaire

Method of Data Collection:

After obtaining SRB approval and Ethical clearance, all procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/ or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards participants who fulfil the eligibility criteria were included in the study, the study was conducted among pediatric physiotherapists in and around Bangalore, Karnataka. The participant is selected by purposive sampling method. 162 participants were approached and screened directly in person. In which, 95 participants were selected who met the inclusion criteria. The study was explained to the participant through the participant information sheet, it was given and signature was obtained with the informed consent of the participants for their voluntary participation by the principal investigator. Later the participants were given a questionnaire for assessing the knowledge and utilization of International Classification of Functioning, Disability and Health (ICF) among pediatric physiotherapists. The questionnaire consists of three sections with total 16 questions. Approximately 10-15 minutes were required to answer the questions. In case, the participant doesn't understand any question, the principal investigator explained the questions. The questionnaire was given to the participant only when they are free and available so as not to disrupt their clinical time and other daily activities. The data was collected within three months. All the data was collected anonymously to protect the participants privacy. After completion, the questionnaires and informed consent was handed back to the researcher. The participant was commended and thanked for their time, Following the data collection statistical analysis was conducted. Interpretation of data was done. After analysing, the data was interpreted and the final report was prepared.

Statistical Analysis

Data collected through the questionnaire were analysed using **jamovi version 2.6.26**. Descriptive statistics were computed to summarize participants' demographic characteristics, as well as their levels of knowledge and utilization of the International Classification of Functioning, Disability, and Health (ICF). Measures of central tendency (mean, median) and dispersion (standard deviation, interquartile range) were used for continuous variables, while frequencies and percentages were reported for categorical variables.

Results

A total of 95 pediatric physiotherapists participated in the study. The majority were female (65.30%), and the highest level of education reported was a bachelor's degree who practice in pediatric clinical setups, which accounted for 82.10% of the respondents. Most participants reported practicing primarily in clinical settings (57.90%), indicating that the ICF framework is being considered within routine clinical care. The demographic characteristics shown in Table. 1. Participants' knowledge of the International Classification of Functioning, Disability, and Health (ICF) was assessed through a questionnaire designed to evaluate their understanding of key concepts and practical applications related to pediatric physiotherapy. The questions covered fundamental aspects such as the meaning of the acronym, components of the ICF, relevant screening tools for gross motor skills, outcome measures specific to pediatric conditions like cerebral palsy, and ICF-based intervention strategies. Table 2. summarizes the frequency and percentage of correct and incorrect responses for each question.

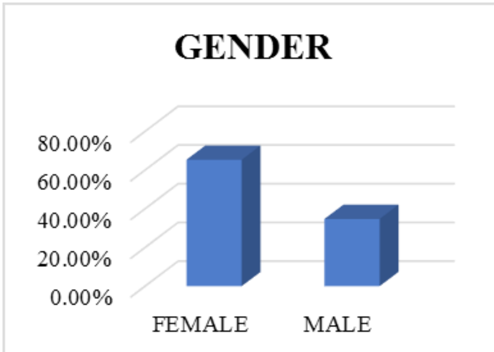
Table 1. Demographic characteristics and percentages of total

Demographic characteristics	Counts	% of Total	Cumulative %
Gender			
FEMALE	62	65.30%	65.30%
MALE	33	34.70%	100.00%
Frequencies of Highest degree			
Master's Degree	16	16.80%	16.80%
Bachelor's Degree	78	82.10%	98.90%
Doctoral degree	1	1.10%	100.00%
Frequencies of Where do you act professionally			
Clinics	55	57.90%	57.90%
Hospital	36	37.90%	95.80%
Patient's house	2	2.10%	97.90%
University or college	2	2.10%	100.00%
Frequencies of How long have you been working in pediatric clinical setups?			
More than 4 years	12	12.60%	12.60%
2 years	37	38.90%	51.60%
1 year	44	46.30%	97.90%
3 years	2	2.10%	100.00%
Frequencies of Do you know ICF?			
Yes	80	84.20%	84.20%
No	15	15.80%	100.00%
Frequencies of When was your first contact with the ICF?			
Clinical Practice	28	29.50%	29.50%
Graduation	44	46.30%	75.80%
Masters or Doctorate	6	6.30%	82.10%
Never	17	17.90%	100.00%

Continue....

Frequencies of In which area, do you use ICF?			
Clinic	60	63.20%	63.20%
Research	11	11.60%	74.70%
I do not use	24	25.30%	100.00%
Frequencies of How important do you think it is to use ICF-based outcome measure			
Very important	64	67.40%	67.40%
Somewhat important	26	27.40%	94.70%
Not very important	5	5.30%	100.00%
Questions		**Counts**	**% of Total**
Q1. What is the meaning of the acronym "ICF"?			
Correct answer		90	94.70%
Wrong answer		5	5.30%
Q2. Among the options below, which is not a component of International Classification of Functioning, Disability and Health (ICF)?			
Correct answer		52	54.70%
Wrong answer		43	45.30%
Q3. What screening tool would you use to assess the gross motor skills of a pediatric patient, specifically, to evaluate their ability to perform physical activities such as running, jumping, and balancing?			
Correct answer		68	71.60%
Wrong answer		27	28.40%
Q4. Which of the following outcome measures assesses gross motor function in children with cerebral palsy, based on the International Classification of Functioning, Disability and Health component of Activities?			
Correct answer		70	73.70%
Wrong answer		25	26.30%
Q5. A pediatric physiotherapist is working with a child who has difficulty with self-care activities due to limited upper limb function. What International Classification of Functioning, Disability and Health -based intervention would be most appropriate?			
Correct answer		49	51.60%
Wrong answer		46	48.40%
Q6. Which International Classification of Functioning, Disability and Health (ICF) component addresses the child's ability to perform daily activities, such as dressing and feeding?			
Correct answer		67	70.50%
Wrong answer		28	29.50%

Table 2. Frequency and percentage of correct and incorrect responses for each question.



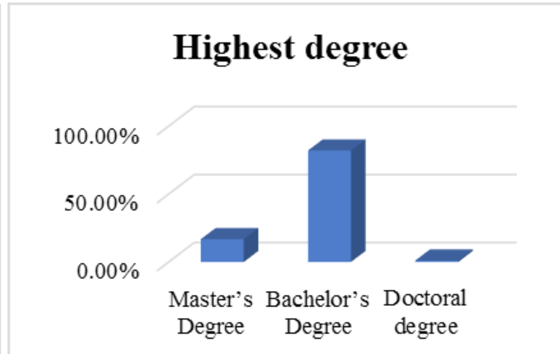
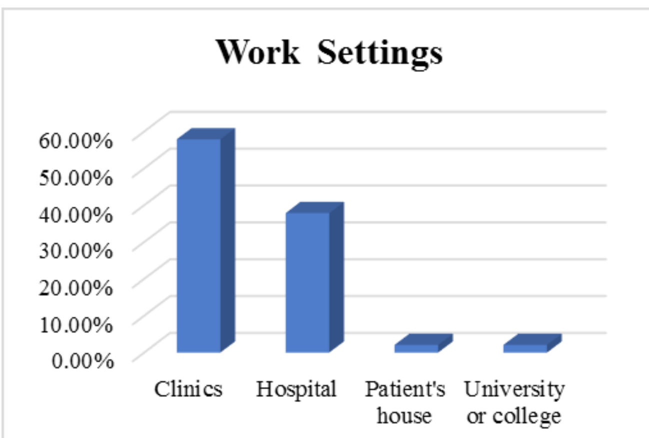


Figure 1: Frequencies of gender and highest degree



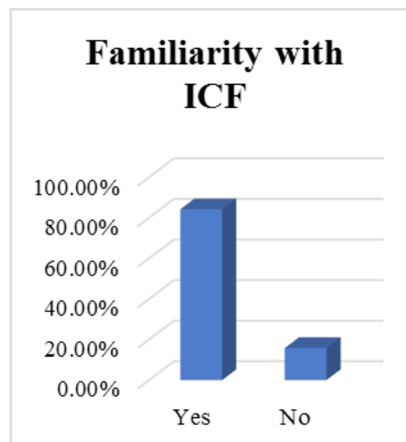


Figure 2: Frequencies of work setting and familiarity with ICF

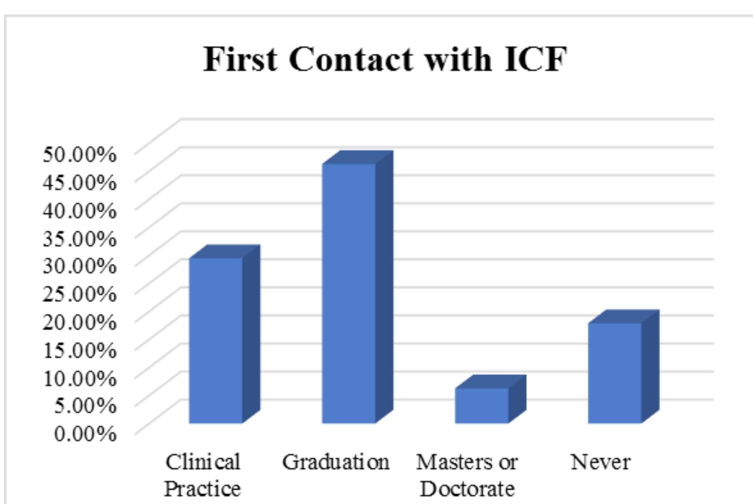


Figure 3. Frequencies of First Contact with ICF

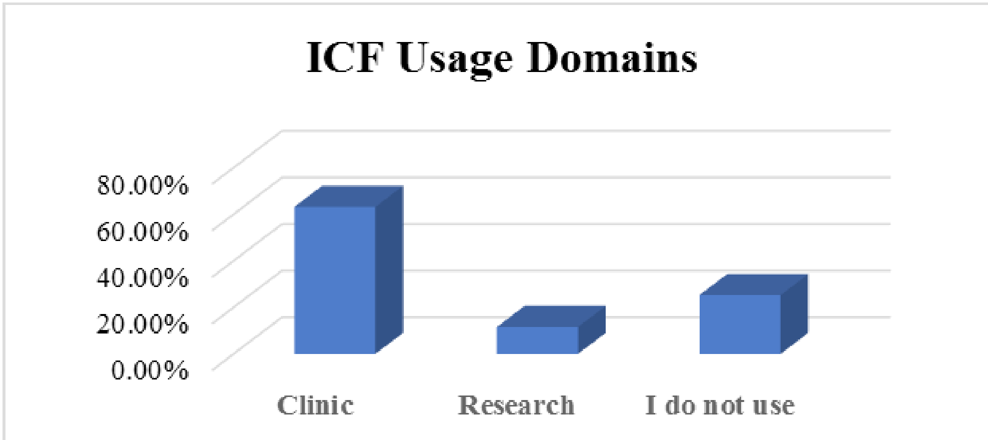


Figure 4: Frequencies of ICF Usage Domains

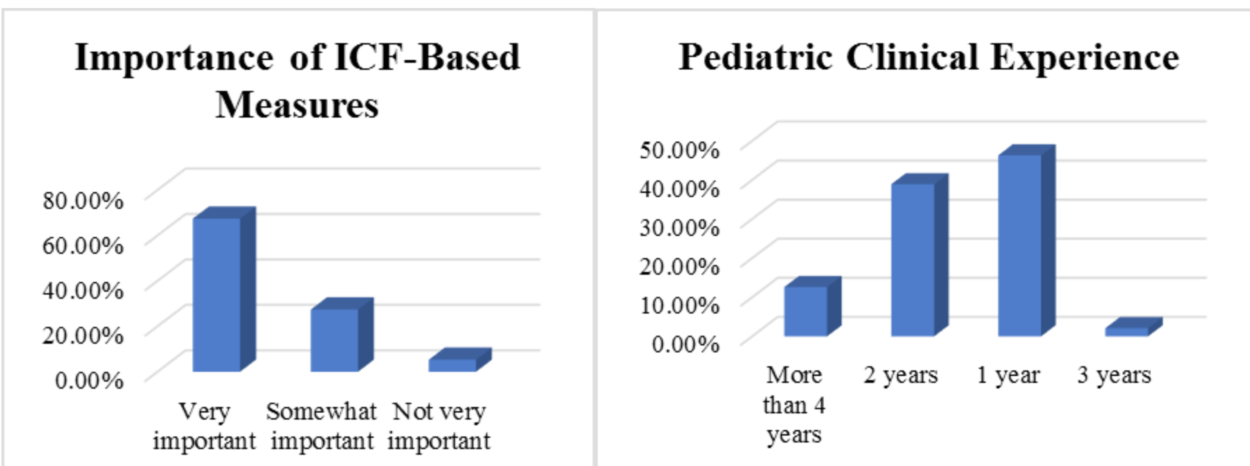


Figure 5: Frequencies of Importance of ICF-Based Measures and Pediatric Clinical Experience

The overall knowledge of the International Classification of Functioning, Disability, and Health (ICF) among pediatric physiotherapists was categorized into three levels: below average, average, and good knowledge. As shown in figure 8, the majority of participants (55.8%) demonstrated average knowledge of the ICF framework. Approximately 27.4% of respondents showed good knowledge, indicating a strong understanding of the concepts and applications of ICF in pediatric physiotherapy. Meanwhile, 16.8% of participants were classified as having below average knowledge.

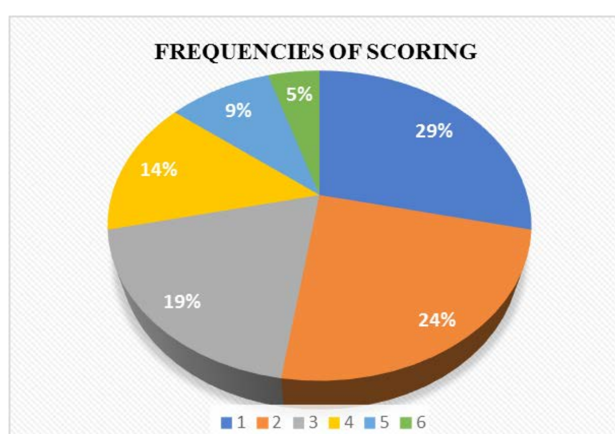


Figure 6: Frequencies of scoring

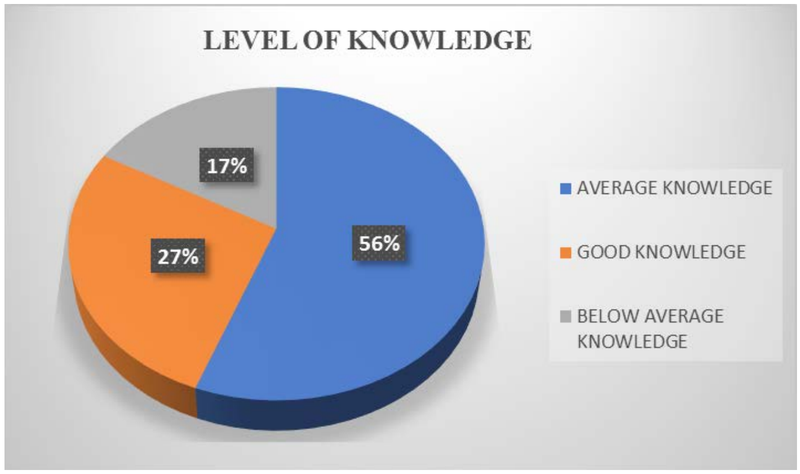


Figure 7: Level of Knowledge

Measures of central tendency (mean, median) and dispersion (standard deviation, interquartile range) are shown in table 3.

Table 3. Measure of central tendency and dispersion

Central Tendency and Dispersion	Q1	Q2	Q3	Q4	Q5	Q6	Scoring
Mean	0.947	0.547	0.284	0.737	0.484	0.705	3.71
Median	1	1	0	1	0	1	4
Standard deviation	0.224	0.5	0.453	0.443	0.502	0.458	1.29
IQR	0	1	1	1	1	1	2

Discussion

Using a questionnaire based cross-sectional study, this study is among the first to examine pediatric physiotherapists' knowledge and utilization of the international classification of Functioning, Disability and health (ICF). The ICF is still largely underutilized in clinical practice, although it has been recognized and recommended by national and international organizations including the world health organization (WHO) and professional regulatory bodies[12]. The gap was evident in our results, which indicate that while more than half of pediatric physiotherapists reported to be familiar with the ICF, but there is limited implementation of the tool into daily practice.

Although the ICF is designed to be a universal framework for health and disability, it is relevant across professions and sectors including health, education, insurance, and social policy—it is often incorrectly perceived as being the exclusive domain of rehabilitation professionals. In this study, we focused specifically pediatric physiotherapists because their work requires an extensive understanding of child development, functioning and disabilities. The ICF is therefore particularly relevant in this area. However, our findings indicate a gap between theoretical knowledge and practical application, consistent with findings from previous studies in other contexts[13,14].

Furthermore, over 84.20% of respondents stated that they were aware of the ICF and only 57.90%

reported using it in their clinical pediatric practice. This is in accordance with findings from other countries, including research from Canada and Israel, which similarly reported that high awareness but low practical implementation among rehabilitation professionals[13,14]. These results demonstrate that familiarity with the ICF does not always translate to application[14,15].

One important finding from this study is that many physiotherapists initially came inro touch with the ICF during their undergraduate studies, while others experienced it later on in their postgraduate studies. However, a sizable percentage reported no exposure to the ICF at all, especially those who finished their training prior to its international adoption in 2001. This suggests a persistent lack of training and education in ICF at the academic and professional development levels[16].

By itself, pediatric physical therapy requires an individualized, family-centred and developmental approach. By providing a common language and framework to direct assessment, goal setting, intervention planning and outcome evaluation, the biopsychosocial model promoted by the ICF could enhance these approaches[17]. The adoption of ICF framework has been limited by barriers like its complexity, lack of training, time constraints, and the perception that it is difficult in busy clinical settings. The medical model's continued dominance in many clinical and educational setting contributes to these challenges and may be a factor in difficulty or opposition to a more comprehensive biopsychosocial paradigm[18].

Our research also showed that 25.30% of physiotherapists do not use ICF, although believing it is feasible. The gap probably reflects structural problems as well as unfamiliarity, such as a lack of institutional support, inadequate continuing education, and absence of user-friendly tools to facilitate ICF coding and application in fast paced pediatric settings[19,20]. Therefore, initiates to make the ICF easier to implement, like targeted workshops, digital documentation tools, and mobile applications, may assist overcome this gap[20,21]. Furthermore, including the ICF more clearly into continuing professional development courses and undergraduate pediatric curricula might encourage both awareness and application[16,21].

The quality of care given to children is impacted by the non-utilization of the ICF because it limits a thorough understanding of the child's functional abilities, environmental barriers and social participation. The use of the ICF could improve interdisciplinary communication, guide individualized treatment planning, and strengthen pediatric physiotherapists' roles in educational and multidisciplinary settings. Additionally, it might support the cause of children with disabilities, particularly in areas like social services, education and inclusive policy making[13,21].

Conclusion

This study reveals that while the majority of pediatric physiotherapists possess an average level of knowledge regarding the International Classification of Functioning, Disability, and Health (ICF), only a limited proportion demonstrate good understanding of its concepts and clinical applications. The presence of a significant below average knowledge underscores the need for targeted educational programs and continuous professional development to enhance the effective utilization of the ICF framework in pediatric physiotherapy practice. Improving knowledge and competency in ICF is essential to promote comprehensive, standardized assessment and intervention, ultimately leading to better patient outcomes.

Limitations

A key limitation of this study is that it primarily measures self-reported knowledge and utilization of the ICF framework, which may not accurately reflect actual clinical practice or depth of understanding. Additionally, the study's cross-sectional design also restricts the ability to observe changes in knowledge or utilization over time.

Recommendations

- Based on the finding that a significant number of pediatric physiotherapists have average or below-average knowledge of the ICF, institutions and professional bodies should design targeted educational interventions and workshops, and integrate ICF training modules into Continuing Professional Development (CPD) requirements to improve understanding, ensure sustained learning, and enhance the practical application of the ICF framework in clinical practice.
- Advocate for healthcare facilities and rehabilitation centers to embed the ICF framework into patient documentation systems and care protocols to promote consistent use in clinical practice.
- Conduct follow-up studies to assess whether targeted interventions lead to improved knowledge and application of the ICF over time.
- Future studies should aim to include a larger and more diverse sample of pediatric physiotherapists across different regions and healthcare settings to enhance generalizability.

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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-1/2024/323.

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

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Epidemiological Trends of Knee Disorders in Rural India: A Retrospective Review from a Tertiary Care Knee Pain Clinic- An Observational Study

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Abstract

Background: Knee pain is one of the most prevalent musculoskeletal complaints globally, particularly affecting individuals in rural and labor-intensive settings. Despite its widespread occurrence, epidemiological data from rural India remain limited. This study aimed to analyse the demographic and clinical trends of knee disorders among patients attending a Knee Clinic at a tertiary care hospital serving a predominantly rural population, to identify the prevalence and pattern of traumatic and non-traumatic knee disorders, to assess demographic characteristics, and to explore contributing occupational and lifestyle factors.

Methods: A retrospective observational study was conducted using registry data from 4,485 patients who visited the Physiotherapy Department of Vitthalrao Vikhe Patil Memorial Hospital, Ahmednagar, between January 2023 and June 2025. Data were categorized into traumatic and non-traumatic knee conditions and analyzed based on gender, diagnosis, and type of injury.

Results: Of the total patients, 58% were male and 42% female. Non-traumatic conditions accounted for a larger proportion, with osteoarthritis (74.9%) being the most common diagnosis, followed by patellofemoral pain syndrome (16.6%). Among traumatic injuries, ACL injuries (44%) were the most prevalent, followed by joint effusion (21%) and meniscal injuries (11%). The patterns observed suggest occupational overuse, biomechanical stress, and delayed access to care as major contributing factors.

Conclusion: The study highlights a significant burden of both degenerative and traumatic knee conditions in rural populations. It underscores the need for early screening, structured physiotherapy, ergonomic education, and improved access to rehabilitation. The Knee Clinic model proves to be an effective multidisciplinary framework for the timely management of knee disorders in resource-constrained settings.

Keywords: Knee pain, osteoarthritis, ACL injury, rural healthcare, knee clinic, physiotherapy, musculoskeletal disorders, epidemiology

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Introduction

Knee pain is one of the most prevalent musculoskeletal complaints encountered in clinical settings and a leading cause of physical disability worldwide. It significantly impairs mobility, restricts daily functioning, and affects the overall quality of life, particularly in adult and elderly populations. The condition is multifactorial, arising from both traumatic injuries and chronic degenerative changes. According to the World Health Organization (WHO), over 250 million individuals suffer from knee osteoarthritis, which is one of the most common causes of chronic joint pain and disability globally [(1)]. The burden of knee-related disorders is expected to escalate further due to increasing life expectancy, sedentary behavior, and rising obesity rates[(2)].

In India, the impact of knee disorders is disproportionately higher in rural areas, where healthcare access and awareness remain limited. Rural populations, which comprise nearly 65–70% of the country's demographic profile, face unique challenges that elevate their risk for both acute and chronic knee conditions. Most individuals in these settings are engaged in physically demanding occupations, such as agriculture, construction, and domestic labor, which require frequent squatting, prolonged standing, repetitive bending, lifting heavy objects, and walking long distances on uneven surfaces. These biomechanical stressors place significant load on the knee joint and accelerate wear and tear of articular cartilage and soft tissues [(3)].

Moreover, rural individuals often lack access to ergonomic education, proper footwear, and structured exercise, which further predisposes them to mechanical imbalances and joint degeneration. Inadequate dietary practices, combined with vitamin D and calcium deficiencies, are commonly reported in rural communities, contributing to poor bone health and reduced muscular support around the knee joint [(4)]. Compounded by delayed healthcare-seeking behaviour—often due to cultural beliefs, economic limitations, or geographical barriers—many individuals resort to traditional healing practices or over-the-counter pain medications, which may offer temporary relief but fail to address the underlying pathology [(5)].

Knee disorders can be broadly categorised into traumatic and non-traumatic etiologies. Traumatic knee injuries typically result from falls, accidents, sports injuries, or occupational hazards and may involve ligament tears (such as ACL/PCL injuries), meniscal tears, fractures, or dislocations [(6)]. Non-traumatic knee conditions, such as primary osteoarthritis, rheumatoid arthritis, patellofemoral pain syndrome, and tendinopathies, develop more gradually and are often influenced by aging, obesity, hormonal changes, inflammatory conditions, and mechanical malalignment [(7,8)].

The lifestyle in rural areas—characterized by high physical strain, low nutrition, poor rest, and a lack of preventive care—creates a fertile ground for the early onset and rapid progression of knee disorders. Yet, these conditions often remain undiagnosed until they reach an advanced stage. This gap highlights the urgent need for early screening, diagnosis, and intervention, particularly in rural healthcare systems [(9)].

Establishing dedicated Knee Clinics within tertiary care hospitals offers an organized and multidisciplinary platform for early identification and management of knee-related disorders. These clinics are crucial not only for accurate diagnosis using clinical and radiological evaluation but also for delivering physiotherapy, lifestyle advice, and surgical referrals when necessary. Importantly, early physiotherapy intervention—including strengthening of the quadriceps, hamstrings, and deep stabilizing muscles; posture and gait correction; ergonomic education; and weight management—can significantly delay the progression of degenerative changes, improve function, and reduce pain [(10,11)]. Studies have shown that early conservative management is both cost-effective and functionally beneficial, particularly in low-resource settings like rural India [(12)].

Tertiary care hospitals, especially those with specialized Knee Clinics, serve as referral hubs for a large number of such underserved patient. Most existing studies focus either on specific conditions like osteoarthritis or sports injuries in urban populations, leaving a significant void in the understanding of rural knee health trends [(6,13)].

This study is therefore needed to:

- Generate baseline data on the demographic and clinical characteristics of patients attending a tertiary care Knee Clinic.
- Highlight the burden of knee disorders in rural populations.
- Identify modifiable risk factors associated with both traumatic and non-traumatic knee conditions.
- Promote the integration of physiotherapy and early rehabilitation in routine knee care, especially for rural and underserved groups.

Aims & Objectives

1. To assess the demographic profile of patients (including age, gender, occupation, rural/ urban origin).
2. To determine the frequency and nature of common knee conditions in a tertiary care setting.
3. To provide recommendations for preventive care and rehabilitation strategies based on identified trends

Material & Method

- **Study design:** Retrospective observational study
- **Study setting:** Musculoskeletal Physiotherapy Outpatient Department, Vitthalrao Vikhe Patil Memorial Hospital, Ahilyanagar, India.
- **Sample size:** 4,485 patients
- **Study duration:**2.5 years

Inclusion Criteria

- Patients who visited the Knee Clinic / Physiotherapy OPD at Vitthalrao Vikhe Patil Memorial Hospital.
- Patients presenting with knee-related complaints (both traumatic and non-traumatic).
- Both male and female patients.
- Inpatients and outpatients referred from the Orthopaedics department or associated hospitals.
- Patients whose data were recorded in the physiotherapy knee clinic.
- Patients treated during the period January 2023 to June 2025.

Exclusion Criteria

- Patients with incomplete or missing data.
- Patients presenting with non-knee musculoskeletal conditions.
- Patients who did not attend the Knee Clinic / Physiotherapy Department.

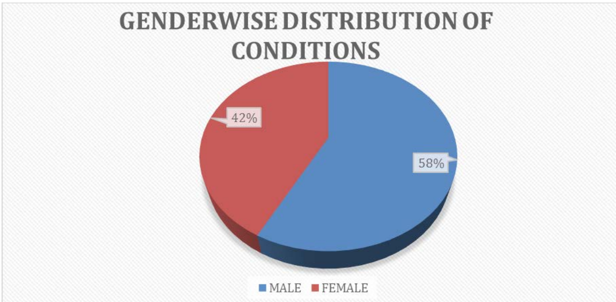
Procedure

Ethical clearance was firstly obtained from the institutional ethical committee (IEC). The data were derived from the daily patient registry of the physiotherapy department in a tertiary care hospital in Ahmednagar. The study population consisted of both in and outpatients who were referred to the musculoskeletal physiotherapy department by the orthopaedic department of Vikhe Patil Hospital and other hospitals in Ahilyanagar. Data collected from January 2023 to June 2025 in the monthly register of the Knee Clinic were segregated into traumatic and non-traumatic conditions. These conditions were represented in the form of a percentage based on each condition.

Result Analysis

The study was conducted to find out the Patients of the Knee Pain Clinic in the rural population of Ahilyanagar. Out of patients who visited a tertiary care hospital physiotherapy OPD were analyzed for their disorders and analysis was done for the percentage of trend for a specific condition.

Condition wise analysis of trends of musculoskeletal disorder in 2 years 6 months: (JAN 2023-JUNE 2025)



Gender	Number of Cases (n)	Percentage (%)
Male	2601	58
Female	1884	42
Total	4485	100

The gender-wise distribution of conditions among the study participants is illustrated in pie chart. Of the total individuals, 58% (n = 2,621) were male and 42% (n = 1,923) were female. This indicates that males constituted a greater proportion of the reported conditions compared to females.

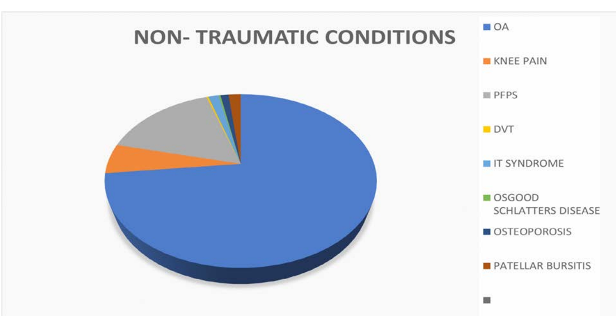


Figure 1: Pie chart Of Non -Traumatic Conditions

Table 1. Non - Traumatic Conditions

Condition	Number of Cases (n)	Percentage (%)
OA (Osteoarthritis)	1,707	74.9
PFPS	379	16.6
Chondromalacia patellae	129	5.7
Patellar Bursitis	41	1.8
Osteoporosis	27	1.2
IT Syndrome	35	1.5
DVT	6	0.3
Osgood Schlatter's Disease	6	0.3
Total	**2,330**	100

The distribution of non-traumatic knee conditions among the study participants is presented in Table X and Figure X. Osteoarthritis (OA) was the most prevalent condition, observed in 1,707 individuals (74.9%), followed by patellofemoral pain syndrome (PFPS) in 379 individuals (16.6%) and non-specific knee pain in 129 individuals (5.7%). Less common conditions included patellar bursitis (1.8%), iliotibial band (IT) syndrome (1.5%), osteoporosis (1.2%), deep vein thrombosis (DVT) (0.3%), and Osgood Schlatter's disease (0.3%).

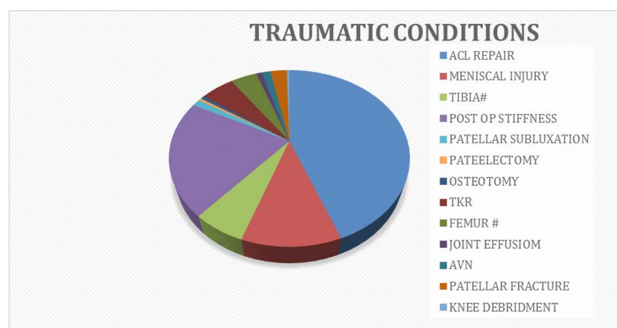


Figure 2: PiechartOf Traumatic Conditions

Table 2. Traumatic Condition

Condition	Number of Cases (n)	Percentage (%)
ACL Repair	978	44
Joint Effusion	471	21
Meniscal Injury	248	11
Tibia Fracture (Tibia#)	133	6
Osteotomy	117	5
Total Knee Replacement	94	4
Patellar Fracture	32	1

Continue....

AVN (Avascular Necrosis)	20	1
Femur Fracture (Femur#)	15	1
Patellar Subluxation	28	1
Knee Debridement	10	<1
Patellectomy	9	<1
Total	2,155	100

The distribution of traumatic knee conditions among the study participants is shown in Figure X. The most common traumatic condition was **anterior cruciate ligament (ACL) repair**, accounting for 978 cases (44%). This was followed by **meniscal injury** (248 cases, 11%), **tibia fracture (Tibia#)** (133 cases, 6%), and **joint effusion** (471 cases, 21%). Other less frequent conditions included **total knee replacement (TKR)** (94 cases, 4%), **osteotomy** (117 cases, 5%), **patellectomy** (9 cases, <1%), **patellar subluxation** (28 cases, 1%), **femur fracture (Femur#)** (15 cases, 1%), **avascular necrosis (AVN)** (20 cases, 1%), **patellar fracture** (32 cases, 1%), and **knee debridement** (10 cases, <1%).

Discussion

This retrospective observational study analyzes trends, prevalence, and demographic patterns of knee disorders in a rural tertiary care hospital in India. Data from over 4,400 patients across 30 months reveal a rising burden of degenerative and traumatic knee conditions, with osteoarthritis and anterior cruciate ligament injuries being most prevalent.

Burden of Osteoarthritis and Non-Traumatic Conditions

The most striking observation in this study is the overwhelming predominance of non-traumatic knee disorders, with OA alone accounting for nearly 75% of these cases. This trend is consistent with recent global projections by Katz et al., who estimate that the global burden of knee osteoarthritis is rising dramatically due to aging populations, obesity, and physical inactivity, especially in low- and middle-income countries [14]. In rural India, however, the risk profile is distinct. While obesity is emerging as a factor, the more prominent contributors include occupational strain, frequent squatting, heavy manual labor, and poor ergonomic awareness, which accelerate the degenerative process [15,16].

Our findings are supported by a rural Indian cohort study by Rani et al., which demonstrated that over 60% of adults with knee pain had radiological OA changes, many of them moderate to severe due to delayed healthcare-seeking behavior and reliance on non-allopathic treatments [17]. The role of micronutrient deficiencies, particularly of vitamin D and calcium, cannot be overlooked, as it exacerbates cartilage degradation and weakens musculoskeletal support [18].

Additionally, patellofemoral pain syndrome (PFPS) and non-specific anterior knee pain were found in a significant proportion of patients, particularly among younger and early middle-aged adults[19].

Traumatic Injuries: ACL Dominance and Occupational Hazards

Among the traumatic conditions, ACL injuries emerged as the leading cause, constituting 44% of trauma-related cases. This is particularly concerning as it reflects a shift in the injury demographic—from athletes to manual laborers, farmers, and industrial workers. These individuals are often exposed to uneven terrain, falls, rotational loading, and sudden directional changes without protective gear or training. The findings are in alignment with Chakravarti et al., who observed a rising incidence of ACL tears among young rural males involved in physical labor[20].

Joint effusion and meniscal injuries were the next most common findings and frequently coexisted with ligamentous injuries. Their presence indicates not only acute trauma but also inflammatory responses, chronic mechanical instability, or failed conservative management. Late-stage interventions such as total knee replacement (TKR) and osteotomy, while less frequent, represent the tip of an iceberg of neglected or mismanaged early cases, reinforcing the critical need for early rehabilitation protocols.

Sociocultural Determinants and Gender Disparity

The study shows a male predominance (58%); however, evidence suggests women—especially post-menopausal—are biologically more vulnerable to osteoarthritis progression due to hormonal influences on cartilage. The lower representation of women likely reflects gender disparities in health-seeking behaviour, driven by financial dependence, sociocultural norms, and delayed care[21]. This highlights significant hidden morbidity among rural women and underscores the need for gender-sensitive outreach and awareness programs

Rehabilitation Gaps and the Role of Knee Clinics

The high rates of both degenerative and traumatic knee conditions illustrate a dual burden that requires a comprehensive, structured approach to care. Studies by Goh et al. and Cavanaugh & Killian provide compelling evidence that early physiotherapy, including muscle strengthening, gait correction, neuromuscular re-education, and weight management, not only alleviates symptoms but also delays the need for surgical interventions [22,23]. In our study setting, the dedicated Knee Clinic model proved effective in facilitating coordinated care pathways—enabling diagnosis, conservative treatment, and surgical referrals under one roof.

This model aligns well with recent guidelines from the World Health Organisation, which advocate for multidisciplinary musculoskeletal care hubs that prioritise person-centred, timely, and equitable management of chronic conditions [24].

Limitations of The Study

- Being a **retrospective observational study**, causality between risk factors and outcomes cannot be established.
- The study was limited to patients presenting at a tertiary care hospital, and thus may not capture community-level prevalence or untreated cases.
- Data on certain variables such as BMI, socioeconomic status, and time to presentation were not available, which could have provided additional context to the findings.
- Follow-up outcomes of treatment and rehabilitation were not assessed in this study.

Future Scope of The Study

1. **Longitudinal Tracking:** Future studies can adopt a prospective cohort design to evaluate the long-term functional outcomes of patients attending the Knee Clinic, particularly those undergoing physiotherapy or surgical interventions.
2. **Community-Level Screening:** There is potential to extend this model to primary health centers and community outreach programs for early identification of high-risk individuals, especially women and elderly manual laborers.
3. **Integration with Digital Health Tools:** Mobile-based self-assessment apps and tele-rehabilitation platforms could be developed to expand access to physiotherapy services in remote rural areas.
4. **Inclusion of Biomechanical and Nutritional Parameters:** Future studies could incorporate biomechanical analysis (e.g., gait analysis, muscle strength testing) and nutritional assessments (vitamin D, calcium) to explore modifiable risk factors more deeply.
5. **Health Economics Analysis:** Evaluating the cost-effectiveness of early physiotherapy versus delayed surgical care can support health policy formulation and budget allocation.

Clinical Implications

1. **Early Physiotherapy Intervention:** The high prevalence of non-traumatic conditions

such as osteoarthritis and PFPS underscores the importance of early physiotherapeutic interventions like strengthening, joint mobilization, and neuromuscular training.

2. **Occupational Risk Assessment:** Given the strong association between manual labor and knee injuries, clinicians should incorporate occupational screening into the assessment process and offer tailored ergonomic advice.
3. **Multidisciplinary Management:** The Knee Clinic model facilitates integrated care through collaboration between orthopedic surgeons, physiotherapists, and rehabilitation specialists, enhancing treatment efficiency and patient compliance.
4. **Public Health Outreach:** The under representation of women and elderly individuals suggests the need for gender-sensitive and community-based awareness campaigns to improve healthcare utilization.
5. **Referral Guidelines:** Establishing standardized referral protocols for different severity levels of knee disorders will ensure timely escalation of care, especially for traumatic injuries requiring surgical evaluation.

Conclusion

- This study outlines the demographic and clinical patterns of knee disorders in a rural tertiary care knee clinic.
- Osteoarthritis was the most common non-traumatic condition, while ACL injuries predominated among traumatic cases.
- These patterns reflect the combined effects of degeneration and occupational stress.
- The findings highlight the importance of early diagnosis and structured physiotherapy.
- They also support the role of dedicated knee clinics and multidisciplinary care in improving outcomes.

Conflict of Interest: The authors declare that they have no competing interests.

Ethics Approval: The Research Ethics Committee of the DVVPFs COPT, Ahilyanagar approved this study.

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Severity and Functional Impact of Carpal Tunnel Symptoms in Relation to Mobile Device Usage

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Abstract

Background: Prolonged mobile device use may increase the risk of Carpal Tunnel Syndrome (CTS). This study explored the association between mobile usage patterns and CTS symptoms among college students.

Methods: Two hundred students (115 females, 85 males; mean age = 20.31 ± 1.53 years) participated. Mobile use was assessed via questionnaire, and CTS symptoms using the Boston Carpal Tunnel Questionnaire, Phalen's test, and Compression test.

Results: Most (94%) used smartphones for 4–6 hours daily; 12% showed CTS symptoms. CTS was significantly associated with device type (p = 0.021) and longer screen time.

Conclusion: Extended smartphone use was linked to higher CTS symptoms, emphasizing the need for awareness and preventive measures among students.

Keywords: Carpal Tunnel Syndrome, Mobile device use, Musculoskeletal health, College students, Phalen's test, Boston Carpal Tunnel Questionnaire

Introduction

Advances in information technology have made mobile devices essential to modern daily life.[1] Mobile deviceis defined as a hand-held portable device that has a display screen with touch input and a keyboard. At present, a wide range of mobile devices are available with varied application, including tablets, laptops, netbooks, and smartphones.[2] People are becoming increasingly dependent on these devices for many purposes such as E-learning, gaming, chatting, texting, internet browsing, watching videos and listening music.[3,4,5] Therefore, these devices have gained lot of popularity in all age groups especially among children and youth.[6] According to the available literature, India has become the second biggest smartphone market in terms of active users.[7]

Mobile devices are widely utilized by students to support their academic activities, offering immediate access to diverse educational resources. As a result, they have emerged as an essential learning tool, particularly for the younger

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generation.[8,9] The COVID-19 pandemic further accentuated this trend, as the shift to online learning significantly increased dependence on digital devices. Evidence indicates that average daily screen time among college students rose from 4.75 hours prior to the lockdown to 11.36 hours during the lockdown period.[10] The majority of students today possess and regularly use multiple mobile devices. One study reported that 87% of university students owned laptops, more than half possessed smartphones, and approximately 8% used iPads.[11] Therefore, addiction to these devices has increased substantially, specially of smartphone among students.[12] Excessive use of mobile devices has been associated with a deterioration in students' quality of life, manifesting as disrupted sleep patterns, poor eating habits, diminished energy levels, and compromised academic performance. Research further reveals that headaches, reduced concentration, memory impairment, hearing loss, and fatigue are attributable to smartphone usage.[13] Prolonged device interaction without adequate breaks can also result in repetitive strain injuries impacting the neck, shoulders, hands, and wrists.[14] Studies report that 50% of university students reported neck and shoulder pain[15], while29.2% of students noted thumb pain due to sustained smartphone use.[9] Prolonged improper hand positioning can impair microcirculation, reducing nutrient and oxygen supply to the muscles, which thus lead to decreased blood flow and early muscle fatigue.[14] Frequentuse of the devices, increases the risk of anatomical changes such as enlargement of the median nerve and subsequently impaired hand function and pinch strength.[16] These physiological alterations elevate the risk for carpal tunnel narrowing, predisposing individuals toCTS.[17,18,19] It is recognized as the most frequently reported entrapment neuropathy,[20] accounting for approximately 90% of all neuropathies,[21] and is estimated to affect 3–6% of the general population.[22] The syndrome is characterized by compression of the median nerve within the carpal tunnel at the wrist,[21] resulting in symptoms including numbness, tingling, pain, and weakness in the palmar aspects of the thumb, index, middle, and the radial side of the ring finger.[23]

Numerous studies have explored the impact of smartphone use on musculoskeletal pain and the incidence of CTS, with some also examining occupational risk factors. However, in India, research on the effects of excessive use of different mobile device on CTS especially among student population, remains limited. To the best of the current knowledge, no study has explored the relationship between the different types of mobile device use and the manifestation of CTS symptoms specifically in college students. Addressing this critical gap, the present study aims to provide foundational evidence to support early identificationenabling timely intervention strategies, thereby mitigating the risk of permanent nerve damage and functional impairment in this vulnerable group.

Methodology

Study Design

This observational study was conducted on male and female college students recruited from various colleges in Chandigarh, Mohali, and Panchkula. Ethical approval was obtained from the Institutional Ethics Committee of Saket College of Physiotherapy (Approval No. SCP/2022-23/557). A total of 200 participants were enrolled in the study using convenience sampling.

Sample Size

For samplesize calculation: -[24]

$$n = Z_{1-\alpha/2}^{2}\, p\,(1-p)/\, d^{2}$$

Where n = The minimum sample size

p = The presumed prevalence of the condition under the study (13.20%)[25]

$Z_{1-\alpha/2}$ = Is standard normal variate (at 5% type 1 error (P<0.05) it is 1.96.

d = Absolute error or precision and it is 5%

Thus, by using above formula the minimum sample size comes out to be 183. The sample used in the study was 200.

The study included undergraduate students aged 18–25 years of both genders who had been using mobile devices for at least 4 hours per day for more than one year and were willing to participate.[10,26-29] Participants were excluded if they had any inflammatory or neuromuscular conditions affecting the upper extremity, a history of hand or wrist fracture, previous hand or wrist surgery, congenital abnormalities, thoracic outlet syndrome, cervical radiculopathy, or diabetes mellitus.[5,16,26,30,31]

Procedure

Participants were informed about the purpose, procedure, and benefits of the study. Written informed consent was obtained from all participants prior to their enrolment in the study. Screening was conducted using an assessment proforma, and only those meeting the inclusion criteria were enrolled.

Self-Constructed Questionnaire for usage of Mobile Devices:

Data on mobile device usage were collected using a self-designed, interview-based questionnaire developed after a comprehensive literature review. It comprised two sections: demographic details and patterns of mobile device usage. The questionnaire underwent multiple rounds of pilot testing to refine content, grammar, and format based on participant's feedback. Following revisions, it was tested for validity and reliability before final implementation.[16,26,27,31]

For Validity and Reliability of The Questionnaire

The content validity of the self-constructed questionnaire was established through evaluation by a multidisciplinary panel of experts, including specialists in orthopaedics, physiotherapy, and engineering. Astudent representative was also included in the team, to ensure the instrument's clarity and relevance from the perspective of the target population. Recommendations from the panel were incorporated to develop the revised and finalized version of the questionnaire. To determine test-retest reliability, the finalized questionnaire was administered to the same 15 participants on two occasions spaced 10 days apart. The resulting reliability coefficient was high ($r = 0.911$, $p = 0.002$, $\alpha = 0.05$), demonstrating excellent reliability.

Screening for Carpal Tunnel Syndrome Symptoms

CTS screening was performed using the Boston Carpal Tunnel Syndrome Questionnaire (BCTQ) along with Phalen's test and the Carpal Tunnel Compression test.

Boston Carpal Tunnel Syndrome Questionnaire

The BCTQ is a self-administered tool assessing symptom severity and functional status in CTS. It includes an 11-item Symptom Severity Scale (SSS) and an 8-item Functional Status Scale (FSS), each rated on a 5-point scale (1=no symptoms/difficulty, 5 = worst symptoms/inability). Symptom scores are classified as asymptomatic (11), mild (12–22), moderate (23–33), severe (34–44), and very severe (45–55); functional scores as asymptomatic (8), mild (9–16), moderate (17–24), severe (25–32), and very severe (33–40).[32-34]

Physical Examination

Two provocative tests, Phalen's test and Carpal Tunnel Compression test, were performed to assess current wrist status.

Phalen's Test Procedure

The participant's wrist was placed in full (but not forced) flexion for up to 60 seconds. The test was considered positive if paraesthesia or numbness occurred in the median nerve distribution.[35]

Carpal Tunnel Compression Test Procedure

Tingling or abnormal sensation in the median nerve distribution of the hand within 30 seconds after pressure was applied by the examiner's thumb over the median nerve at the carpal tunnel was considered positive for carpal tunnel syndrome.[35]

Results

Data were analysed using SPSS version 20, with statistical significance set at $p < 0.05$. Descriptive statistics were presented through tables and graphs. The Pearson Chi-square test assessed associations between CTS symptoms and mobile device usage. Based on combined BCTQ scores and clinical tests (Phalen's and Compression), 12% (n = 24) of participants showed CTS symptoms.

According to the BCTQ SSS, 50.5% were asymptomatic, 48.5% had mild, and 1% had moderate symptoms. On the FSS, 59.5% reported no functional difficulty, 39% mild, and 1.5% moderate difficulty (Figure 3). Among symptomatic participants, the most common complaints were daytime pain (58.3%), numbness/tingling (50%), and difficulty in writing or gripping (41.6%). Other symptoms included nocturnal pain (29%) and hand weakness (20%).

CTS was slightly more prevalent in females (7%) than males (5%), with no significant gender difference ($\chi^2 = 0.008$, $p = 0.930$, Table-1). A significant association was observed between CTS and academic year ($p = 0.007$), with second-year students showing the highest prevalence (7.5%) and frequent device use. CTS was significantly correlated with musculoskeletal discomfort in the neck, shoulder, wrist, and hand. However, no association was found with total duration of mobile use ($p = 0.732$) (Table-1 and 2).

Table 1. Summarizes the distribution of CTS Symptoms across demographic variables, with chi-square values and p-values indicating the statistical significance of associations.

Variable		CTS		Total Frequency	Chi-Square Value	p-value
		Present	**Not Present**			
Gender	Male	10	75	85		
	Female	14	101	115	.008	.930
Dominant Hand	Right	24	169	193		
	Left	0	07	07	.989	.320
Academic Year	1st	4	54	58		
	2nd	15	48	63	12.170	**.007****
	3rd	4	57	61		
	4th	1	17	18		
Academic Stream	**Medical**	**10**	**112**	**122**		
	Non-Medical	**03**	**20**	**23**	**20.71**	.023*
	Other Streams	**11**	**44**	**55**		

*Statistically significant at $p < 0.05$

**Highly significant at $p < 0.01$

Table 2. Association between CTS Symptoms and Mobile Device Usage Variable among College Students.

Variable		CTS		Chi-Square Value	p-value
		Present	Not Present		
Type of mobile devices used most of the time	SmartPhone Laptop Tablet Notebook Any Other	20 04 0 0 0	168 05 02 01 0	9.711	.021*
Hand used most while operating mobile device	Right Left Sometimes both	17 0 07	140 05 31	2.370	.306
Duration of device use	1- 3 years 3 years - 5 years 5 years - 7 years More than 7 years	10 07 05 02	66 69 25 16	1.289	.732
AverageScreen Time/day	4 hours - 6 hours 6 hours-8 hours 8 hours - 10 hours More than 10 hours	09 08 05 02	114 40 12 10	8.672	.032*
Purpose for which mobile device usedmost of the time	Reading Texting Playing games Others	24 42 10 17	173 158 190 183	8.589	.198
Experience any pain while using mobile devices.	None Rarely Occasionally Frequently Always	01 15 03 04 01	70 87 13 05 01	20.646	.000**
Region of pain	Neck Shoulder Elbow Wrist Hand Other	04 05 01 14 07 01	57 13 06 13 16 13	2.462 4.663 0.036 46.94 8.364 0.336	0.117 0.031* 0.850 0.000** 0.004** 0.562

*Statistically significant at $p < 0.05$

**Highly significant at $p < 0.01$

Significant relationships were noted between CTS and average daily screen time ($p = 0.034$), duration of reading on mobile devices ($\chi^2 = 18.893$, p = 0.0002**), and the type of device used ($p = 0.021$), indicating that prolonged screen exposure and device ergonomics may contribute to symptom development (Table2 and 3).

Table 3. Association of CTS Symptoms with Duration of Reading, Texting, Gaming, and Leisure Activities among College Students.

Variable	Duration/day	CTS		Chi Square Value	p-value
		Present	Not Present		
Reading	0-1 hour 1-2 hours 3-4 hours 5-6 hours >6 hours No reading	08 08 03 03 0 02	28 83 53 07 04 01	18.893	.0002**
Texting	0-1 hour 1-2 hours 3-4 hours 5-6 hours >6 hours No texting	08 10 03 19 01 01	75 52 16 03 02 10	3.204	.669
Gaming	0-1 hour 1-2 hours 3-4 hours 5-6 hours >6 hours Not playing game	06 04 0 0 0 14	74 13 05 01 05 78	6.076	.299
Leisure Activities	0-1 hour 1-2 hours 3-4 hours 5-6 hours >6 hours No leisure time spent	4 10 6 3 0 1	62 65 31 5 3 10	8.377	0.137

***Statistically significant at p < 0.05**

****Highly significant at p < 0.01**

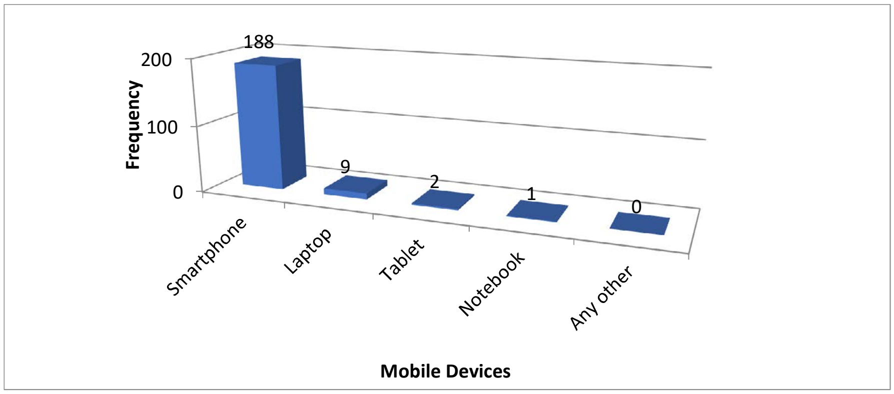

Figure 1: Represents the frequency of different mobile devices used most often by the participants.

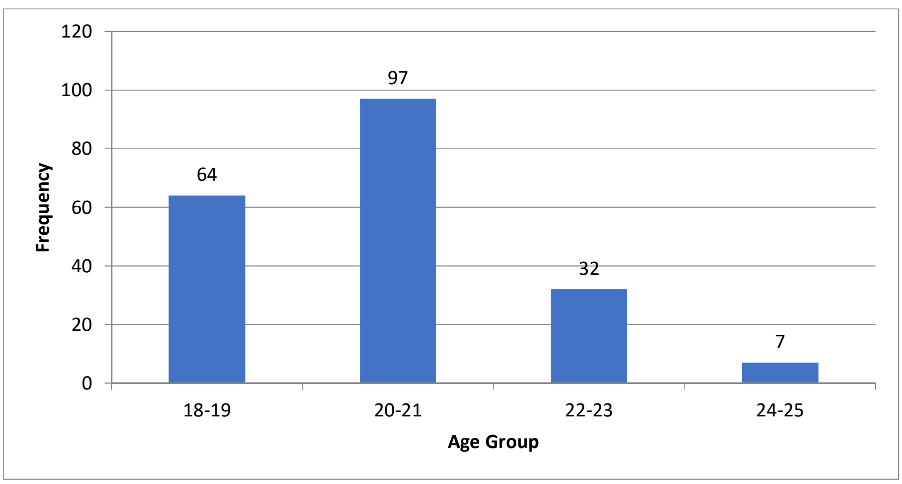

Figure 2: Distribution of Study Participants According to Age Group

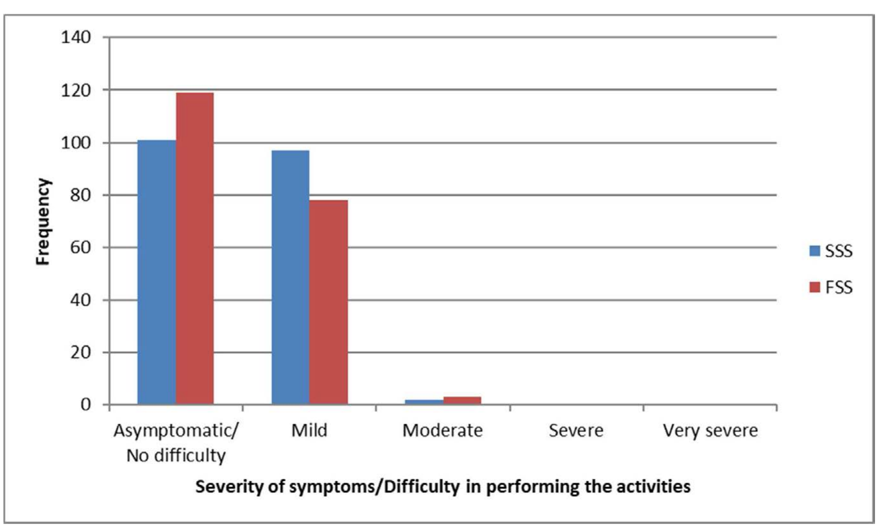

Figure 3: Represents the frequency of the participants based on the SSS and FSS.

Discussion

In this study12% of the participants demonstrated the symptoms suggestive of CTS. The prevalence was higher among females, which aligns with existing literature indicating that women are more predisposed to CTS due to anatomical characteristics, hormonal influences, and smaller carpal tunnel dimension.[36] Male and female smartphone users have different purposefor using their devices. Males use smartphones for more diverse range of activities, such as playing games and watching videos, females more likely use them for communication and social networking purpose.[37]Although most participants belonged to the younger age group (below 22 years), no significant association between age and CTS symptoms was found, consistent with earlier evidence showing CTS typically affects older adults. Previous studies found that CTS more commonly affects the older adults[38,39]. Age-related changes in the flexor retinaculum may have a role in the etiology of CTS.[39] If more samples with older age group were included in this study, then we would have found more comparable results in context to age.

Among the 24 participants (12%), slight daytime pain (58.3%) and slight numbness or tingling (50%) were the most common symptoms. A smaller proportion experienced medium pain (16.6%), severe tingling (12.5%), or weakness (8.3%). Functionally, mild to moderate difficulty was most frequently noted while writing, gripping a phone, performing household chores, and carrying a grocery basket. These findings correspond with previous research. Studies on dental students reported similar rates of pain and numbness,[40] while Feng et al. documented over 50% pain and 60% numbness among clinically diagnosed CTS cases, along with functional limitations in fine-motor tasks.[41] Andersen et al. also reported hand tingling among computer users.[42] In the present study, 14.5% had a positive Phalen's test and 12% had a positive compression test, supporting the presence of early CTS symptoms despite low severity on BCTQ.

Few studies globally have examined CTS prevalence among students. Behee et al. reported median nerve compression signs in 17% of college students,[43] while the general population shows CTS-related incidence ranging from 14.4% to 16.6%.[44] Correlation between CTS symptoms and the region of pain (shoulder, wrist and hand)waspresent in the current study. Our results were consistent with a survey study which found that daily use of a key board for more than 4 hours is associated with shoulder and wrist/hand pain[45]. Woo et al. revealed that 49.9% of respondents reported of having musculoskeletal complaints in one or more body regions and 84.9% reported of having symptoms at multiplesitesandreported that prevalence of wrist/hand pain in intensive electronic device users were significantly higher than non-intensive users.[14,15]

In the present study a significant association was found between CTS symptoms and academic year ($p = 0.007$), with the highest proportion of symptomatic individuals (7.5%) observed in the second year. They also reported the highest use of mobile devices for texting (9%) and watching videos (9%). Prolonged wrist extension, ulnar deviation, and repetitive movements such as typing or mouse use are known to increase median nerve strain across the carpal tunnel,[46] and maintaining the wrist in non-neutral positions has been shown to elevate CTS risk.[47] However, evidence regarding the influence of academic year on CTS remains limited. One study comparing first-year and fourth-year architecture students reported greater computer use among senior students due to drawing-related tasks,[48] contrasting with our findings. Therefore, while the current study suggests a possible association between academic year and CTS symptoms, this relationship cannot be conclusively established due to insufficient literature support. Further studies across diverse student populations are needed to clarify this pattern.

In this study, 94% of participants primarily used smartphones, consistent with findings from Karnataka where 90.5% of undergraduates reported smartphone use.[49] A significant association was found between CTS symptoms and the type of mobile device used ($p = 0.021$). Previous research similarly reported that using a smartphone for more than two hours daily was significantly linked to CTS development.[5] One study found no association between device type and CTS symptoms based on FSS scores,[50] suggesting that factors such as posture and duration of use may be more influential. Studies have shown that mobile devices often require users to maintain non-neutral wrist positions.[51] Differences in device size and weight further alter wrist angles,[14] and such sustained deviation increase carpal tunnel pressure, contributing to CTS risk.[52] These findings highlight the ergonomic impact of device characteristics on median nerve stress.

In the current study, correlation analysis showed no significant association between CTS symptoms and years of mobile device use (p = 0.732), possibly due to the relatively small number of long-term users in the sample. These findings align with a study which similarly reported no association between duration of device use and CTS incidence.[5] On the other hand, one study found a strong association between owning a smartphone for more than nine years and higher prevalence of wrist/hand and neck pain.[53] Another study reported that computer workers with over eight years of experience had a significantly greater risk of CTS compared to those with less than four years of experience.[47] Moreover, long-term electronic device use may contribute to enlargement of the median nerve cross-sectional area and thickening of flexor tendons within the carpal tunnel,[54,55] potentially increasing susceptibility to CTS.

In this study, a significant association was found between CTS symptoms and average daily screen time on mobile devices (p = 0.034). This is consistent with earlier findings showing that prolonged use of electronic devices is linked to increased wrist and hand discomfort and structural changes in the carpal tunnel that may predispose individuals to CTS. Studies have also reported that using a smartphone for four or more hours per day increases the likelihood of developing CTS, as repetitive thumb movements and sustained wrist flexion can irritate the median nerve.[54,55]

Among the participants, the most common mobile activities were watching videos (37%) and browsing the internet (23%). No correlation was observed between CTS symptoms and the primary purpose of mobile use (p = 1.98). However, time spent on reading showed a significant association with CTS symptoms (p = 0.002). This may be because fewer participants used their devices extensively for texting, gaming, or music. Existing research supports these findings, indicating that various smartphone activitiessuch as chatting, gaming, reading, or prolonged typingcan contribute to musculoskeletal strain[5]. Even short durations of smartphone use in a fixed posture have been shown to cause wrist fatigue. Repetitive thumb motions and prolonged flexed wrist positions may increase pressure within the carpal tunnel, tighten soft tissues, and place stress on the median nerve, thereby elevating the risk of CTS.[54,55]

Research has shown that prolonged use of mobile devices can negatively impact wrist and hand function. When individuals without symptoms are exposed to repetitive or sustained risk factors, they become more vulnerable to developing CTS symptoms over time.This may reduce students' study efficiency and overall quality of life. Increasing reliance on mobile devices and sedentary behaviour further compromises health, contributing to sleep disturbances, musculoskeletal disorders, and other related health problems. These issues can promote weight gain and obesity, which are additional risk factors for CTS.

Conclusion

The study revealed early CTS symptoms among college students, with smartphone use, device type, and extended daily screen time as key risk factors. Although symptoms were mild, they reflect early repetitive strain and median nerve stress. Ergonomic awareness, posture correction, and limiting screen exposure are vital preventive strategies to mitigate CTS risk in young users.

Limitations

Self-reported data may have introduced bias, and variations in device dimensions were not considered, which could affect hand posture and wrist strain. The cross-sectional design also limits causal interpretation.

Future Suggestions

Longitudinal studies with larger samples and electrophysiological confirmation are recommended to establish causality and guide evidence-based ergonomic interventions for preventing CTS.

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Conflicts of Interest Statement: NONE

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Prevalence of Musculoskeletal Pain and its Correlation with Quality of Life Among Healthcare College Staff Members: A Questionnaire Based Cross-Sectional Study

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Abstract

Background: Musculoskeletal pain (MSP) is a leading occupational health problem worldwide and a major contributor to disability and reduced work productivity. Academic staff in healthcare institutions are at increased risk due to prolonged teaching hours, static postures, and suboptimal ergonomics.

Objective: To determine the prevalence of MSP and its correlation with quality of life (QoL) among healthcare college staff members.

Design: Questionnaire-based cross-sectional study.

Methods: A questionnaire-based cross-sectional study was conducted among 66 healthcare college staff members in Bengaluru, Karnataka. MSP was assessed using the Nordic Musculoskeletal Questionnaire and QoL using the SF-36 Health Survey. Descriptive statistics, independent t-tests, and Spearman correlation were applied using SPSS v27.

Results: The prevalence of MSP was high, with the lower back (80.3%), neck (69.7%), and shoulders (39.4%) most affected. Low back pain was significantly associated with lower Physical Component Summary (p=0.002) and Mental Component Summary (p=0.006) scores. Shoulder pain was significantly correlated with MCS (p=0.016). PCS scores were significantly associated with Body Mass Index, daily computer use, and teaching hours, while MCS was associated with designation. A moderate positive correlation was observed between PCS and MCS (r=0.474, p<0.001).

Conclusion: MSP is highly prevalent among healthcare college staff and significantly impacts both physical and mental QoL. Ergonomic interventions and workplace wellness programs are recommended to mitigate risks.

Keywords: Musculoskeletal pain, Quality of life, SF-36, Healthcare staff, Occupational health, Cross-sectional study

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Introduction

Musculoskeletal pain (MSP) is defined by the International Association for the Study of Pain (IASP) as an unpleasant sensory and emotional experience associated with actual or potential tissue damage or characterized in terms of such damage[1,2]. Musculoskeletal pain is defined as pain that is associated with the musculoskeletal system which includes the muscles, bones, joints, ligaments and tendons. It typically functions as the body's warning sign, indicating the risk of tissue damage or occurrence of such damage and also signals the need for tissue healing and recovery[4-6]. MSP results from multiple contributing factors, including physical attributes (such as height, weight, and sex), occupational conditions (like repetitive use of certain body parts, poor posture, and lack of breaks), and socio psychological elements (including high work demands and stress) [8,13-17].

The World Health Organization (WHO) has recognized musculoskeletal disorders as a leading contributor to the global burden of disease, especially among the working population[7-10]. MSP is one of the most common health complaints globally, contributing significantly to disability, reduced work productivity due to substantial impact on quality of life, frequent sick leave, functional impairment, absenteeism and also representing a significant medical and socioeconomic concern [10-15]. It is observed in all the age groups, gender and social groups[5,12].

Among various professional groups, health-care workers are particularly vulnerable to musculoskeletal pain due to the combined physical and psychological demands of their dual roles in clinical practice and academia[6,13,18]. Academic professionals in healthcare institutions not only provide university level education and conduct research but are also responsible for generating new knowledge, which often involves physically and mentally demanding tasks. These include standing for long periods during lectures, maintaining static postures while using computers for publication, course preparation, and administrative duties, as well as coping with psychological stress related to academic advancement and professional expectations[13,19-21,25, 26].

Additionally, several preventable factors further contribute to the development of MSP among academic staff. These factors include high workload, excessive paperwork, class preparation and students' evaluation, lifting heavy load, fixed posture, anxiety level, low peer support and poor mental status [13,19-20]. These activities, especially when performed in ergonomically poor environments, can predispose individuals to chronic MSP. Moreover, the combination of occupational stress, high workload, and limited physical activity during working hours serves to increase the severity and persistence of musculoskeletal conditions in this population [13].

Despite growing interest in occupational health, healthcare college staff remain underrepresented in the literature, with most research focusing on clinical professionals such as nurses, physicians, and physiotherapists, while limited attention has been given to the unique occupational risks faced by academic staff and the impact of musculoskeletal pain on their quality of life [21].

This study is particularly important as musculoskeletal pain is a common issue in healthcare professionals, and its impact on quality of life is a growing concern. By focusing on healthcare college staff members, this research aims to fill a gap in the literature and provide insights into how these conditions affect their overall well-being.

Methods

Study Design

A questionnaire-based cross-sectional study.

Study Setting

This cross-sectional study was conducted between 13/01/2025 - 30/03/2025 in healthcare colleges (allied and non-allied) in Bengaluru, Karnataka.

Healthcare college – Manjunatha college of Physiotherapy, Shantidhama Group of Institution, Karnataka College.

Participants

A total of 66 healthcare college staff members were recruited through snowball sampling. Inclusion criteria were: Full-time academic faculty engaged in clinical postings of both genders with more than one year of work experience were included. Exclusion criteria : part-time faculty, diagnosed neurological or rheumatological disorders, orthopaedic deformities, or cancer.

Sampling

Snowball sampling was used. Sample size was estimated as 66 using a prevalence rate of 77.8%, 95% confidence interval, and 10% margin of error.

Ethical Considerations

The study received ethical clearance from the Institutional Ethics Committee of [Yenepoya deemed to be university, Deralakatte, Mangaluru, Karnataka 575018] with **Protocol number YEC-1/2024/318**. Written informed consent was obtained from all participants.

Procedure

Ethical approval was obtained from the Yenepoya (Deemed to be University) Ethics Committee. Participants also provided demographic data and completed the questionnaires in approximately 15–20 minutes. Assistance was provided where clarification was required.

Instrument

1. **Adopted Nordic Musculoskeletal Questionnaire** – to identify MSP prevalence and affected body regions (http://dx.doi.org/10.1097/MD.0000000000026176).
2. **Short Form-36 (SF-36)** – to assess Physical Component Summary (PCS) and Mental Component Summary (MCS) scores (doi:10.3389/fpubh.2022.810036).

Statistical Analysis

The statistical analysis, was done using SPSS (version 27) software. The continuous variables were summarised as mean (standard deviation). The categorical variables were summarised as frequency (percentage). In mean comparisons, the t-test was used for parametric variables while the Wilcoxon's test was used for non-parametric variables. The Shapiro -Wilk test for testing the normality of the data. For correlation between the Musculoskeletal pain and Quality of life i.e PCS and MCS component the Spearman's correlation was used.

Results

Participant Characteristics

A total of 66 healthcare college staff members participated in the study. The mean age was 28.11 ± 4.06 years, with a slightly higher proportion of females (51.5%) compared to males (48.5%). The majority were lecturers (59.1%) and had less than five years of academic experience (87.9%). Detailed demographic characteristics are presented in Table 1.

Table 1. Demographic data of participants (n=66)

DEMOGRAPHIC VARIABLES	Category	n(%)
AGE	<=25 years	13(19.7%)
	26-30 years	43(65.2%)
	>30 years	10(15.2%)
GENDER	female	34 (51.5%)
	male	32(48.5%)
DESIGNATION	Assistant professor	10 (15.2 %)
	Associate professor	2(3 %)
	Clinical instructor	5 (7.6 %)

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	Lecturer	39(59.1 %)
	Nursing Staff	1(1.5%)
	Tutor	9 (13.6%)
QUALIFICATION	BOT	4 (6.1%)
	BPT	3(4.5%)
	BSC ANAESTHESIA	2(3%)
	BSC MLT	2 (3%)
	BSC NURSING	7 (10.6%)
	BSCRADIATIONTECHNOLOGY	1 (1.5%)
	BSC RENAL DIALYSIS	1 (1.5%)
	MLT	1(1.5%)
	MOT	2(3%)
	MPT	22 (33.3%)
	MPT (CARDIO)	1 (1.5%)
	MPT (NEURO)	1 (1.5%)
	MPT (ORTHO)	1 (1.5%)
	MPT MSK	2 (3%)
	MSC IMAGING TECHNOLOGY	2(3%)
	MSC MLT	7 (10.6%)
	MSC NURSING	5 (7.6%)
	MSC RADIATION THERAPY	1(1.5%)
	MSC RESPIRATORY THERAPY	1 (1.5%)
WORKING IN THE ACADEMIC FIELD	Between 5-9 Years	8 (12.1%)
	Less than 5 Years	58(87.9%)
MARITAL STATUS	Married	12 (18.2%)
	Unmarried	54 (81.8%)
BMI	Normal	55 (83.3%)
	Obese	1 (1.5%)
	Overweight	6 (9.1%)
	Underweight	4 (6.1%)
SLEEPING PER DAY (HOURS)	< 6	23 (34.8%)
	7-8 hours	43 (65.2%)
POSITIONING	Sitting	28(42.4%)
	Standing	38 (57.6%)
TEACHING PER DAY(HOURS)	<1	7 (10.6%)
	1-2 HOURS	21 (31.8%)
	3-4 HOURS	32 (48.5%)
	>=5	6 (9.1%)
COMPUTER USE PER DAY (HOURS)	<1	13 (19.7%)
	1-2 HOURS	29 (43.9%)
	3-4 HOURS	14(21.2%)
	>=5	10 (15.2%)

Overall Scores and Pain Prevalence

Normative values for PCS and MCS are standardized to a mean of 50 with a standard deviation of 10. In the present study, the average PCS (Physical Component Summary) score was 59.88 ± 11.67, and the average MCS (Mental Component Summary) score was 58.01 ± 12.03 (Table 2), both of which were higher than the normative values.

Table 2. Variables with Mean (SD)

Variables	Mean ± SD
AGE	28.11 ± 4.06
PCS SCORE	59.88 ± 11.67
MCS SCORE	58.01 ± 12.03
LOW BACK PAIN	3.52 ± 3.11
NECK PAIN	2.71 ± 2.00
SHOULDER PAIN	1.88 ± 3.28

Comparison of QoL Scores by Pain Presence

Independent-samples t-tests showed that participants with low back pain had significantly lower PCS (p = 0.002) and MCS (p = 0.006) scores compared to those without low back pain. Shoulder pain was significantly associated with lower MCS scores (p = 0.016) but not PCS scores. Neck pain was not significantly associated with PCS or MCS scores (**Table 3**).

Table 3. Comparison of PCS and MCS scores among individuals with and without pain in specific body regions, using independent-samples t-tests.

Pain Site	Prevalence	Variable	Present (Mean ± SD)	Absent (Mean ± SD)	t-value	p-value
Low Back Pain	80.3%	PCS Score	58.38 ± 12.28	65.98 ± 5.83	3.255	0.002
		MCS Score	56.02 ± 12.10	66.10 ± 7.85	2.850	0.006
Neck Pain	69.7%	PCS Score	59.60 ± 12.63	60.52 ± 9.38	0.330	0.743
		MCS Score	57.16 ± 12.13	59.96 ± 11.86	0.867	0.389
Shoulder Pain	39.4%	PCS Score	56.33 ± 12.86	62.18 ± 10.35	1.945	0.058
		MCS Score	53.62 ± 10.43	60.86 ± 12.26	2.484	0.016

Correlation Analysis

Spearman's correlation revealed a moderate positive relationship between PCS and MCS scores (r = 0.474, p < 0.001). Low back pain was negatively correlated with both PCS (r = –0.398, p = 0.001) and MCS (r = –0.466, p < 0.001). Shoulder pain was negatively correlated with PCS (p = 0.024) and MCS (p = 0.007), while neck pain showed a significant negative correlation only with MCS (p = 0.004). Detailed correlation values are provided in Table 4.

Table 4. Spearman's correlation matrix for PCS, MCS, and pain sites

Variables	PCS Score	MCS Score	Low Back Pain	Neck Pain	Shoulder Pain
PCS Score	1.000				
MCS Score	**0.474** (*p*< 0.001)	1.000			
Low Back Pain	**–0.398** (*p* = 0.001)	**–0.466** (*p*< 0.001)	1.000		
Neck Pain	–0.172 (*p* = 0.167)	**–0.354** (*p* = 0.004)	**0.355** (*p* = 0.003)	1.000	
Shoulder Pain	–0.277 (*p* = 0.024)	**–0.331** (*p* = 0.007)	0.302 (*p* = 0.014)	0.313 (*p* = 0.011)	1.000

Associations with Demographic Variables

PCS scores were significantly associated with BMI (p = 0.0066), daily teaching hours (p = 0.0051), and computer use per day (p = 0.0054). MCS scores were significantly associated with designation (p = 0.017). No significant associations were observed for age, gender, marital status, or sleeping hours. These comparisons are summarised in **Table 5**.

Table 5. PCS and MCS scores by demographic variable

Demographic Variables	Category	Count	PCS Mean (SD)	p- value	MCS Mean (SD)	p-value
AGE	<=25 years	13	53.9423 (14.7088)	0.1943	52.587 (12.737)	0.243
	26-30 years	43	61.5762 (10.8248)		58.901 (12.015)	
	>30 years	10	60.2778 (9.1592)		61.2 (9.878)	
GENDER	female	34	59.0891 (11.3956)	0.1281	55.272 (11.699)	0.108
	male	32	60.7118 (12.085)		60.91 (11.868)	
DESIGNATION	Assistant professor	10	59.625 (12.7412)	0.7667	51.537 (11.536)	0.017*
	Associate professor	2	62.7083 (13.2583)		55.5 (5.127)	
	Clinical instructor	5	48.6667 (13.8251)		56.075 (13.662)	
	Lecturer	39	61.5527 (11.4011)		60.292 (11.751)	
	Nursing Staff	1	66.1111 (.)		56.875 (.)	
	Tutor	9	57.7932 (9.2396)		57.042 (13.811)	
WORKING IN THE ACADEMIC FIELD	Between 5-9 Years	8	61.9618 (10.5914)	0.0729	59.266 (9.539)	0.882
	Less than 5 Years	58	59.5881 (11.8702)		57.832 (12.394)	
MARITAL STATUS	Married	12	62.1644 (9.3892)	0.8848	62.594 (9.346)	0.354
	Unmarried	54	59.3673 (12.1389)		56.986 (12.391)	
BMI	Normal	55	60.8662 (11.1229)	0.0066*	59.743 (11.555)	0.284
	Obese	1	48.6111 (.)		40.5 (.)	
	Overweight	6	59.0741 (13.2012)		51.542 (7.871)	

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	Underweight	4	50.2778 (15.8207)		48.188 (16.107)	
SLEEPING PER DAY (HOURS)	< 6	23	58.43 (11.645)	0.5833	55.832 (12.653)	0.391
	7-8 hours	43	60.6492 (11.7505)		59.169 (11.668)	
POSITIONING	Sitting	28	58.9583 (12.2175)	0.7352	58 (13.62)	0.501
	Standing	38	60.5519 (11.3722)		58.01 (10.902)	
TEACHING PER DAY(HOURS)	<1	7	62.7183 (6.7452)	0.0051*	68.536 (16.911)	0.080
	1-2 HOURS	21	58.5979 (12.2941)		58.458 (12.043)	
	3-4 HOURS	32	62.4349 (11.1458)		55.754 (9.956)	
	>=5	6	47.3843 (9.7224)		56.146 (12.28)	
COMPUTER USE PER DAY (HOURS)	<1	13	58.7607 (13.4436)	0.0054*	58.385 (16.081)	0.195
	1-2 HOURS	29	62.9071 (10.7732)		59.078 (11.581)	
	3-4 HOURS	14	58.5714 (11.2767)		58.491 (10.931)	
	>=5	10	54.3611 (11.4214)		53.725 (9.268)	

Discussion

The present cross-sectional study aimed to assess the prevalence of musculoskeletal pain (MSP) and its correlation with the quality of life (QoL) among healthcare college staff members in Bangalore, Karnataka. The findings revealed a notably high prevalence of MSP, with the lower back (80.3%) being the most frequently affected region, followed by the neck (69.7%) and shoulders (39.4%). These results align with the previous studies conducted among faculty members and academic professionals globally, which consistently highlight the burden of MSP due to long teaching hours, static postures, and inadequate ergonomics[4–6, 10].

The high prevalence of low back pain in this study is consistent with findings reported by Aldhafian et al. (2021) and Arshad et al. (2021), who also identified the lower back as the most commonly affected site among faculty members[4, 13]. The results of the present study reinforce the idea that poor ergonomic practices and high workload contribute significantly to MSP.

A statistically significant negative correlation was observed between MSP and QoL scores. Participants reporting low back and shoulder pain had significantly lower PCS and MCS scores, indicating that MSP has a detrimental impact on both physical and mental health. This observation is supported by the work of Hashem et al. (2024), which emphasized that chronic musculoskeletal pain impairs daily function and well-being [5].

Additionally, significant associations were found between QoL (especially PCS scores) and work-related factors such as teaching hours, daily computer use, and body mass index (BMI). These findings suggest that longer periods of teaching or screen time and abnormal BMI may exacerbate MSP and thus reduce physical QoL. Such associations have been similarly documented in studies by Ozdinca et al. (2019) and Niciejewska et al. (2019), which highlighted the role of occupational demands and lifestyle in contributing to MSP[20,25].

Interestingly, while shoulder pain had a significant correlation with MCS scores, neck pain did not show a significant association with PCS scores. This might bedue to variability in individual pain thresholds, different coping strategies, or limitations in postural variability allowed by the job role[22].

Spearman's correlation analysis revealed that a moderate positive correlation between PCS and MCS scores (r = 0.474), indicating that both physical and mental health components are interdependent. Participants with poor physical health due to pain were also more likely to report decreased mental well-being. This bidirectional relationship is well-documented in psychosomatic research, where chronic pain often leads to psychological distress, and vice versa[5,9].

Overall, the study underscores the occupational hazards faced by healthcare educators who often juggle academic and clinical responsibilities. It also emphasizes the need for targeted ergonomic interventions, regular physical activity, stress management, and institutional policies to promote better health and quality of life [12,17].

Conclusion

The study highlights a high prevalence of musculoskeletal pain, particularly low back and neck pain, among healthcare college staff. These findings suggest that increased musculoskeletal pain in the back, neck, and shoulders is associated with poorer physical and mental health outcomes. The strongest negative associations were observed between MCS and low back pain (r = –0.466) and between PCS and low back pain (r = –0.398), highlighting the substantial impact of low back pain on both physical and mental well-being. Factors such as prolonged teaching hours, extended computer use, and abnormal BMI were found to negatively impact physical health.

Limitations

Despite its strengths, there are certain limitations in this study.

- The cross-sectional study design prevents in establishing causality between the musculoskeletal pain and quality of life.
- Additionally, self-reported data might introduce a recall or response bias.
- The sample size was relatively small, which might have reduced the statistical power and increase the margin of error in the findings.
- The samples collected were also limited to a specific academic institution, which might have restricted the generalizability of the study findings.

Suggestion for Future Studies

Future research can include long-term studies to understand the cause-and-effect relationship between musculoskeletal pain and quality of life. Studies can also test whether ergonomic changes, regular physical therapy, and wellness programs help reduce pain and improve the health of academic staff.

Declaration: Ethics Approval & Consent: The study was approved by **Yenepoya Ethics Committee-1** [Yenepoya deemed to be University] **Protocol number : YEC -1/2024/318,** Date of approval : **30-10-2024** Written informed consent obtained.

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Effects of Eccentric Training of Wrist Extensors Versus Digital Latching & Lateral Rotation of Forearm in Lateral Epicondylitis – A Randomized Controlled Trial

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Abstract

Background: Lateral Epicondylitis (LE) is a tendon problem caused by repeated wrist movements and gripping. It is now seen as tendon wear and tear, not inflammation. Eccentric training helps tendon healing, while the newer DLaLR method corrects both muscle imbalance and joint mechanics, offering better pain relief and recovery.

Objectives: To compare the effects of therapeutic ultrasound and wrist extensors eccentric training versus therapeutic ultrasound and DLaLR in LE.

Methods: In a randomized controlled trial, 42 participants were equally divided into two groups using concealed envelope method. Group A (n=21) received therapeutic ultrasound with eccentric wrist extensor training, while Group B (n=21) received therapeutic ultrasound with DLaLR. Visual Analogue Scale (VAS), Patient Rated Tennis Elbow Evaluation (PRTEE), and pain-free grip strength (PFGS) were assessed at 0^{th} day and after 4^{th} weeks.

Results: There were no significant difference on VAS, PRTEE and PFGS on 0^{th} day between the groups. Both treatment methods were found to be significantly effective for VAS ($p = 0.0119$, effect size = 0.83), PRTEE ($p = 0.046$, effect size = 0.62) and PFGS ($p = 0.1159$, effect size = 0.54) on 4^{th} week. Group B showed more significant improvement ($p<0.05$) on 4^{th} week as compared to group A.

Conclusion: DLaLR of forearm is found to be more effective than eccentric training of wrist extensor in LE.

Key Words: Lateral Epicondylitis, Digital latching & lateral rotation of forearm, visual analogue scale, Patient Rated Tennis Elbow Evaluation, pain-free grip strength.

Introduction

Tennis elbow was first described by Runge[1,2] in 1873. Later on many other terminologies like tendonosis, lateral epicondylitis (LE), and angiofibroblastic hyperplasia are given.[3] The annual prevalence rate varies between 1% and 3%. It is estimated that men have a prevalence of 1.0% to 1.3% and women have a prevalence of 1.1% to 4.0.[1,5]

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LE refers to pain in lateral epicondyle owing to overuse of extensor muscles of forearm.[4] Today, LE is evident as a degenerative condition affecting extensor tendons that appear from lateral epicondyle, despite the word epicondylitis suggesting inflammation.[6] Forearm extensor muscles cross elbow, proximal and distal radioulnar joints, many of these muscles also cross wrist joint and few of them indeed cross metacarpophalangeal and interphalangeal joints of the fingers.

This condition is associated with chronic tear and degenerative changes in the origin of the extensor carpi radialis brevis (ECRB).[4]

Most common symptoms include tenderness and pain over lateral epicondyle during wrist flexion and extension, repetitive pronation and supination, weak grasp and functional disability. Stability of a joint depends upon congruency of articular surfaces, thickness of articular cartilage, orientation of fibres in ligaments; capsule and direction of muscular pull, which together facilitate free and controlled joint movements.[7]

Because the tendon absorbs the kinetic forces when a muscle fatigues, tendinopathy injuries are seen generally who are engaged in repetitious, high- intensity training. An internal misalignment of collagen fibers, known as fibroblastic hyperplasia, is one of the main components of tendinopathy. Each time the degenerative tendon is manipulated, the fibroblastic phase of healing begins again, laying down new Type III collagen that progressively degenerates the components of a normal tendon.[8]

Literature has set up connections between eccentric loading and positive effects in tendinopathy cases by converting hypertrophy, adding tensile strength and dwindling neovascularization. An eccentric contraction can increase the tendon's cell's stimulation, causing them to produce further collagen and increasing the tendon's resistance to force. In LE and other tendinopathies, neovascularization is thought to be a contributing element for pain.[9] Compared to concentric contraction, eccentric contraction produces further force while using lower energy and oxygen.[11]

According to recent research, eccentric movements might be more beneficial, but they should be employed precisely because they frequently results in muscle soreness.

Overcompensation of the ECRB may result from functional impingement of the supinator due to altered joint mechanics and muscle imbalance. This may lead to micro trauma of soft tissue structures present at the lateral epicondyle therefore causing symptoms of lateral elbow tendinopathy (LET). Changes in the supinator may result in altered and compensatory changes in the ECRB, which may overload the ECRB during repetitive movement, generating LET symptoms.[11]

The physiotherapy techniques, electrotherapeutic and non-electrotherapeutic modalities, has been recommended for the management of LET. These treatments have different theoretical mechanisms of action, but all have the same aim, to reduce pain and improve function. Many treatment options have been proposed for the rehabilitation of patients with LE, the effectiveness of which are largely unknown. These include exercise, massage, manipulation, taping, acupuncture, orthotic devices, ultrasound, activity modification, and rest.

According to clinical experience, supinator weakness in LE patient is generally addressed by reducing hand- grip strength, functional capacity, and increasing discomfort. This implies that the ECRB may not be the only factor contributing to LE.[10] The exercise regimen should serve to strengthen both ECRB and supinator as it may be involved in LE.

This study was conceptualized to explore and compare the effects of traditional eccentric wrist extensor training with a novel combined protocol-DLaLR of the forearm-aimed at offloading the ECRB, enhancing joint congruency, and restoring optimal forearm mechanics. The findings from this investigation offer valuable insights into more comprehensive and effective management strategies for individuals with LE.

Methodology

Study Design

A randomized controlled trial.

Sampling Procedure

The sample size was calculated using G*Power (v3.1.0) to achieve 95% power with a 5% alpha error and an effect size of 1.234, based on a mean difference of 4.176 and SD of 1.0. A total of 38 participants were required, with 10% added for dropout, making it 42 (21 per group).

Ethical clearance was obtained from the SDM Institutional Ethics Committee (Ref: SDMIEC/ 2024/734 Dated 16.05.2024), and the study was registered (CTRI/2024/07/070453).

The intervention was conducted at SDM Hospital Orthopaedic Physiotherapy OPD from July 2024 to June 2025.

Participants

Participants were randomly divided into two groups by using opaque concealed envelope method where,

Group A (n = 21): received therapeutic ultrasound and eccentric training of wrist extensors.

Group B (n = 21): received therapeutic ultrasound and DLaLR of forearm training.

Inclusion Criteria

Subject of either gender with LE diagnosed by orthopedic surgeon, Age from 35 to 60 years, and who did not receive any intra articular injections at elbow for Unilateral / Bilateral involvement, Cozen's sign or Mill's maneuver test positive were included for study.

Exclusion Criteria

Any deformity in the affected upper limb or who has/had neurological problems affecting the involved upper limb or earlier episodes of LE of elbow treated surgically/ intra articular injection at elbow or any fracture in the affected upper limb/s within past 6 months and individuals not willing to participate were excluded from the study.

Intervention

Exercise Protocol for Group A

1. The participants seated erect on chair with forearm supported on a pillow or on an adjustable table. Participant was instructed to hold water bottle (resistance as tolerated) with clenched fist and forearm in pronation with wrist extension. Then, was instructed to lower the weight by flexing the wrist of the affected arm downwards towards gravity and lift it back passively with the unaffected arm.
2. Progression was done by increasing the quantity of water in bottle.[6]

Exercise Protocol for Group B

1. Starting position: Participant seated erect on armless chair with pillow on lap, shoulder maintained in neutral position, affected elbow in middle range of flexion, resting on pillow with the forearm pronation and the wrist in neutral position. The participant, performed digital latching [flexion of PIP & DIP joints of four fingers and IP joint of thumb within pain free ROM] and then laterally rotated (supinated) forearm within pain free ROM.
2. Progression was done by holding a notebook in hand same as above mentioned position of hand and digits latched harder and harder by pressing the notebook with painfree grip.

Dosage

Participant performed 03 sets of 10 repetitions with 1 minute rest time in between the sets, twice daily for 4 weeks as home programme. A compliance sheet was provided to maintain daily record of exercises. Data of participants performing minimum of 45 sittings of exercise were included for data analysis.

Conventional Therapy/ Therapeutic Ultrasound

Participants in both groups seated erect on chair, with shoulder abducted, elbow flexed wrist in neutral and pronated resting on pillow. After cleaning the affected area, ultrasonic gel was applied. The transducer head moved circular inslow motions for 6-7 minutes using 3mHz frequency at 0.8-1W/cm^2 intensity in pulsed mode 1:1 or 1:4.

Outcome Measures

Visual Analog Scale (VAS): Measured pain.

Functional Assessment: Patient Rated Tennis Elbow Evaluation (PRTEE)

Painfree grip strength: Seahan hydraulic hand held dynamometer.

Outcome assessors were blinded for all outcome measures.

Statistical Analysis

All analysis were 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.

Data analysis for within group was done using Shapiro Wilk test 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

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

Gender	Group A	%	Group B	%	Total	%	P-value
Male	11	52.38	13	61.90	24	57.14	0.5329
Female	10	47.62	8	38.10	18	42.86	
Total	21	100.00	21	100.00	42	100.00	

Gender distribution was identical in both groups, with 57.14% males and 42.86% females. The chi-square test showed no significant difference in gender distribution (p = 0.5329).

Table 2. Comparison of mean age between group A and group B using Independent t test. It revealed no significant difference in age between the groups (p = 0.6925).

Group	n	Mean (in year)	SD	SE	t-value	P-value
Group A	21	47.29	8.44	1.84	0.3983	0.6925
Group B	21	48.33	8.60	1.88		

P<0.05, SD- standard deviation, SE- standard error

Normality of VAS, PRTEE and PFG at all time points in both groups using Shapiro wilk test, indicates that they did not follow normal distribution ($p<0.05$). Hence, non-parametric test was used.

Post Intervention Results

The study found that both Group A and Group B led to significant improvements in pain and function in patients with LE.

However, Group B showed significantly greater improvements in pain score as VAS, functional outcomes as measured by PRTEE and PFGS. Between group analysis showed significant differences in VAS (p= 0.0119), PRTEE (p= 0.046) and PFGS (p= 0.1159) at 4th week, form day 0 to week 4, highlighting the superior effect of DLaLR of forearm training on LE.

Table 3. Within group analysis of VAS scores in group A and group B using Wilcoxon test.

Groups	Time	Mean	SD	Mean Diff.	Effect size	% of effect	Z-value	p-value
Group A	Pretest	7.24	1.48					
	Posttest	4.38	1.8.3	2.86	1.93	39.47%	3.7017	0.0002*
Group B	Pretest	6.48	1.33					
	Posttest	2.95	1.60	3.52	2.65	54.41%	4.0145	0.0001*

$p<0.05$*

Table 4. Within group analysis of PREET scores in group A and group B using Wilcoxon test.

Groups	Time	Mean	SD	Mean Diff.	Effect size	% of effect	Z-value	p-value
Group A	Pretest	66.64	13.71					
	Posttest	46.57	12.70	20.07	1.46	30.12	4.0145	0.0001*
Group B	Pretest	67.62	17.24					
	Posttest	37.83	15.33	29.79	1.73	44.05	3.9798	0.0001*

$p<0.05$*

Table 5. Within group analysis of Pain Free Grip Strength in group A and group B using Wilcoxon test.

Groups	Time	Mean (in kg)	SD	Mean Diff.	Effect size	% of effect	Z-value	p-value
Group A	Pretest	22.49	8.91					
	Posttest	25.41	8.54	2.92	0.33	12.98	4.0145	0.0001*
Group B	Pretest	20.55	6.21					
	Posttest	29.00	4.67	8.45	1.36	41.11	4.0145	0.0001*

$P<0.05$*

Table 6: Comparison of Group A and Group B with VAS scores at day 0 and 4 weeks treatment time points by Mann-Whitney U test

Time points	Group A			Group B			Effect size	Z-value	p-value
Pretest	Mean	SD	Mean rank	Mean	SD	Mean rank			
	7.24	1.48	24.93	6.48	1.33	18.07	0.54	1.7986	0.0721
Posttest	4.38	1.83	26.29	2.95	1.60	16.71	0.83	2.5156	0.0119*
Difference	2.86	1.71	19.64	3.52	1.21	23.36	0.46	0.9685	0.3328

Table 7. Comparison of Group A and Group B with PREET scores at day 0 and 4 weeks treatment time points by Mann-Whitney U test

Time points	Group A			Group B			Effect size	Z-value	p-value
Pretest	Mean	SD	Mean rank	Mean	SD	Mean rank			
	66.64	13.71	19.81	67.62	17.24	23.19	0.06	-0.8805	0.3786
Posttest	46.57	12.70	25.29	37.83	15.33	17.71	0.62	1.9873	0.046*
Difference	20.07	10.70	17.29	29.79	16.20	25.71	0.72	-2.2137	0.026*

$p<0.05$*

Table 8. Comparison of Group A and Group B with PFGS at day 0 and 4 weeks treatment time points by Mann-Whitney U test

Time points	Control group			Experiment group			Effect size	Z-value	p-value
	Mean	SD	Mean rank	Mean	SD	Mean rank			
Pretest	22.49	8.91	22.74	20.55	6.21	20.26	0.26	0.64	0.5212
Posttest	25.41	8.54	18.50	29.00	4.67	24.50	0.54	-1.57	0.1159
Difference	2.92	1.61	12.26	8.45	3.29	30.74	2.25	-4.86	0.0001*

p<0.05*

Disscussion

This randomized controlled trial compared two physiotherapeutic interventions for managing LE, eccentric training of the wrist extensors (Group A) and DLaLR of forearm training protocol (Group B). The primary aim was to evaluate improvements in pain, function, and grip strength using validated tools such as the VAS, PRTEE, and PFGS. Both groups demonstrated significant improvements over a four-week period. However, Group B, which received the DLaLR intervention, showed superior clinical outcomes across all outcome measures. This suggests that a combined therapeutic approach involving tendon offloading and joint realignment is more effective than traditional isolated tendon loading through eccentric training.

Eccentric training is widely regarded as a gold standard in tendinopathy rehabilitation. It involves the lengthening phase of muscle contraction, during which controlled loading is applied to the tendon. This process stimulates tendon healing through mechanotransduction, which enhances collagen synthesis and fiber realignment. In particular, eccentric loading reduces disorganized collagen (Type III) and promotes the formation of well-aligned, stronger Type I collagen. This structural improvement leads to greater tensile strength of the tendon and better resistance to stress during functional activities. The ECRB, the primary tendon involved in LE, benefits from such eccentric loads, especially as it is under constant strain during gripping and wrist extension tasks.

Eccentric exercises also contribute to neuromuscular control and proprioception, helping restore functional movement. However, despite these benefits, eccentric training is not always well-tolerated by all patients, particularly in acute or highly irritable cases of LE. In such instances, directly loading an already inflamed tendon may exacerbate symptom and delay recovery. Moreover, eccentric training focuses predominantly on the tendon pathology and does not adequately address associated joint or muscular dysfunctions, such as radial head malalignment, supinator weakness, or abnormal forearm mechanics. This limitation causes the need for a more integrative approach like the DLaLR protocol.

The DLaLR protocol is a functional approach designed to address both the local pathology and associated biomechanical deficits of LE. It combines two core elements: digital latching and active forearm supination. The digital latching component involves concentric contractions of the finger flexors—namely the Flexor Digitorum Superficialis (FDS), Flexor Digitorum Profundus (FDP), and Flexor Pollicis Longus (FPL)—performed in a pain-free, neutral wrist position. This strategy enables patients to regain grip strength while minimizing direct strain on the symptomatic ECRB tendon. A progressive loading strategy using a notebook allowed for task-specific grip training that was adaptable based on the patient's pain tolerance. Importantly, this method strengthens the deep forearm musculature without compromising healing, making it especially suitable in the early phase of rehabilitation.

The key component of the DLaLR protocol—forearm supination—adds a biomechanical correction element that eccentric training lacks. Forearm supination is primarily facilitated by the supinator and biceps brachii muscles. During this motion, the radial head moves proximally, anteriorly, and medially into the annular ligament, restoring its alignment with the humeroradial joint. This positional adjustment reduces mechanical stress on the lateral epicondyle and relieves pressure on the ECRB origin. In contrast, pronation leads to lateral and dorsal displacement of the radial head, increasing tension at the lateral elbow and aggravating symptoms. Thus, by repeatedly engaging the supinator and biceps, the DLaLR protocol promotes radial head realignment, enhances joint congruency, and reduces cumulative load on the injured tendon.

Anatomically, the coordinated contraction of FDS, FDP, and FPL contributes to proximal stabilization of the radius. These muscles create axial approximation and promote controlled movement of the radius relative to the ulna and humerus, supporting the radial head in its correct anatomical position. This dynamic stabilization is crucial in preventing micro-instability and correcting positional fault of the radial head—factors often overlooked in traditional LE rehabilitation but essential for full recovery. Moreover, by training the muscles responsible for gripping and supination in synergy, the DLaLR protocol respects functional movement patterns, leading to better long-term outcomes.

Another notable aspect of DLaLR is that it aligns with pain and functional rehabilitation principles. Rather than provoking pain through direct loading, it facilitates muscle activation in a pain-free range, which helps desensitize the nervous system and improve movement confidence. It also prevents joint laxity, abnormal movement patterns, and compensatory muscle inhibition by restoring both muscle strength and joint mechanics. This dual approach ensures a more comprehensive and holistic recovery.

Clinical results from this study substantiate these theoretical advantages. Patients in Group B showed greater improvement in all outcome measures, including reduced VAS scores (indicating lower pain), improved PRTEE scores (indicating better function), and higher PFGS values (indicating stronger, pain-free grip). These findings support the idea that LE is not merely a tendinopathy but also involves complex joint and neuromuscular dysfunctions. Addressing these through a combination of tendon offloading and joint realignment—as done in the DLaLR protocol—results in faster and more complete recovery. The results of this study align closely with those of another article that followed a similar protocol. Both studies demonstrate consistent findings. The outcomes are statistically significant. This strengthens the reliability and relevance of the observed effects.[8]

In conclusion, while eccentric training remains an evidence-based, effective treatment for LE, it may not be sufficient for all cases, particularly those involving biomechanical or neuromuscular deficits. The DLaLR protocol offers a superior approach by integrating tendon offloading, digital coordination, and forearm realignment. Its multi-joint, task-specific, and pain-free strategy addresses both the primary pathology and secondary dysfunctions, leading to better patient outcomes. Based on both biomechanical rationale and clinical evidence, DLaLR should be considered a more comprehensive and effective intervention for managing LE.

Limitations

1. The study involved a relatively small sample size, which may restrict the generalizability of its findings.
2. All the participants were recruited from only one hospital, potentially introducing selection bias.
3. This study focused only on short term follow up.

Conclusion

- Findings of this study suggests that both the groups A and B showed statistically significant difference in reduction in pain on VAS, and increase in function on PREET and painfree grip strength at 4th week.

- Group B showed more effective in reduction in pain on VAS, increased function on PREET scale and PFGS as compared to group A at 4 weeks. Which explained DLaLR is more effective in managing LE as compared to eccentric training.

Future Scope

1. It should provides a structured comparison between a standard and an expanded exercise protocol for LE management.
2. Future studies should be conducted with larger sample sizes to enhance the reliability of the study and statistical power.
3. A multi-center study should be considered so that the results can be generalized to large population and clinical settings.
4. Future studies should aim to find the long term effects of DLaLR of forearm to evaluate the sustained effects of the intervention over time

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Feasibility of Neuromuscular Electrical Stimulation for Gait Improvement in Post-Stroke Hemiplegia- A Case Series From an Outpatient Neurorehabilitation Unit

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Abstract

Background: Post-stroke hemiplegia significantly impairs gait and mobility, particularly in outpatient settings with limited access to advanced rehabilitation technologies. Neuromuscular Electrical Stimulation (NMES) may offer a feasible adjunct to conventional physiotherapy.

Methods and materials: This prospective case series included 20outpatients (mean age: 51.7=/- 5.6 years; stroke onset: 6-12 months) with moderate gait dysfunction (Wisconsin Gait Scale ≥26). Participants received 4-week intervention combining NMES targeting the tibialis anterior and hamstrings with conventional physiotherapy. Gait quality and functional mobility were assessed using the Wisconsin Gait Scale (WGS) and Timed Up and Go (TUG) test respectively. Data was analyzed using Wilcoxon signed-rank tests, with 95% confidence interval reported.

Results: Median WGS scores improved from 24.5 to 18.97 ($p< 0.001$; 95% CI: 4.375-6.515), and mean TUG scores decreased from 21.05s to 17.4s ($p<0.001$; 95% CI: 2.483-3.487). Improvements exceeded the MCID and MDC thresholds. Qualitative gains included enhanced toe clearance, knee flexion, and increased weight- shifting on affected lower limb. No adverse events occurred.

Conclusion: NMES combined with conventional therapy is feasible, safe and clinically meaningful in low-resource outpatient stroke rehabilitation. These findings support further controlled trials to isolate NMES effects and evaluate long-term outcomes.

Keywords: Stroke rehabilitation, NMES, Wisconsin Gait Scale, Timed-Up and Go Test, low-resource setting

Background

Stroke is a leading cause of long-term disability worldwide, with hemiplegia affecting gait and independence in 80% of survivors [1]. Common deficits include foot drop, reduced knee flexion during swing phase, and compensatory movements such as hip circumduction or pelvic retraction, all

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of which contribute to asymmetric, inefficient, and unstable walking patterns due to tonal abnormalities, poor motor control and weakness in affected lower limb[2,3].

Foot drop reduces ankle dorsiflexion, leading to inadequate toe clearance during the swing phase and increasing tripping risk, while decreased knee flexion exacerbate this by further limiting foot-ground clearance and causing a dragging gait pattern.These impairments heighten the likelihood of falls, with stroke survivors experiencing significantly elevated fall rates due to gait instability[4, 5]. Frequent falls can slow recovery by promoting fear of falling, reducing physical activity, causing deconditioning, and leading to injuries that interrupt rehabilitation[6].

These impairments not only limit mobility but also increase fall risk and reduce independence, severely impacting quality of life [7].

While advanced rehabilitation technologies—such as robotic gait trainers and body-weight-supported treadmills—have demonstrated efficacy in improving post-stroke gait, their high cost and infrastructural requirements render them inaccessible in rural and low-resource settings [8]. In outpatient settings, especially in rural or semi-urban areas, patients often face delayed access to rehabilitation, limited infrastructure and inconsistent therapy schedules. Conventional therapy alone may not fully address neuromuscular deficits such as foot drop or stiff-knee gait.

Neuromuscular Electrical Stimulation (NMES) offers low-cost adjunct that activates paretic muscles, improves gait kinematics and promotes neuroplasticity [9]. Studies suggest that NMES improves dorsiflexion during swing phase, reduces spasticity, and restores more natural gait kinematics [10,11]. However, evidence on its feasibility and effectiveness in resource-constrained environments remains limited and underexplored.

This case series investigates whether NMES combined with conventional physiotherapy an improve gait quality in post-stroke hemiplegic outpatients attending a neurorehabilitation clinic. The study evaluates practical aspects of NMES delivery in real-world outpatient care treated at a rural Indian hospital.

While NMES efficacy was established in urban/tertiary settings and African contexts like Tanzania[13] (community NMES yielding 14.1% gait speed gains) and Ghana[14] (task-sharing models), evidence remains scarce for rural/semi-urban Indian outpatients-where only approximately 17% of stroke survivors access rehabilitation due to infrastructure, cost and awareness barriers. This study addresses this critical global gap by demonstrating NMES feasibility in a real-world Indian neurorehabilitation unit serving underserved populations.

Our findings may guide rehabilitation strategies in regions where advanced technologies are unavailable, ultimately improving functional outcomes and quality of life for stroke survivors in rural communities.

Methodology

Ethical Approval and Study Design

This prospective case series was approved by the Ethics Committee of Seth GS Medical College and KEM Hospital (Approval No. 18/2011). Written informed consent was obtained from all participants in their preferred language prior to enrolment.

Setting and participants recruitment: Twenty participants with post-stroke hemiparesis (mean age: 51.7 ± 5.6 years; time since stroke onset: 8.75 ± 1.77 months) were recruited from the outpatient neurorehabilitation unit at Seth GS Medical College and KEM Hospital, Mumbai- a tertiary care centre serving rural and semi-urban populations with limited access to advanced rehabilitation technologies.

Inclusion Criteria

Participants were eligible if they had experienced a first-ever ischemic or haemorrhagic stroke between 6- 12 months prior to recruitment; were ambulatory before stroke with no pre-existing gait abnormalities (confirmed via patient history and clinical assessment); demonstrated moderate gait impairment as indicated by WGS score of

≥ 26 (threshold selected to ensure sufficient baseline dysfunction for detecting clinically meaningful changes). ; had comparable pre-stroke activity levels (eg, independent household or community ambulation); Brunnstrom stage of recovery between 1-3 for lower limb and absence of contraindication to NMES. Gender was documented but not used as an exclusion factor given its established influence on recovery trajectories.

Exclusion Criteria

Severe comorbidities, inability to follow commands, MMSE score < 24, previous history of stroke or any pre-stroke gait abnormality (including mild musculocutaneous conditions like arthritis of limb length discrepancy, verified through history and examination to minimize bias). Additional exclusions included significant visual or vestibular impairments and uncontrolled medical conditions affecting gait.

Outcome Measures

The WGS was used to quantify the quality of gait particularly in post-stroke hemiparetics, to evaluate the qualitative aspects of gait, including stance time, step length and synergy patterns. It has been shown to have excellent interrater (ICC- 0.83) and intra-rater reliability (ICC-0.91).The WGS was used both as an inclusion criterion and as a primary outcome measure. At baseline, a WGS score of ≥ 26 was required to conform moderate gait dysfunction. The same scale was then used to assess changes in gait quality following the intervention. Functional mobility was evaluated using the TUG test. Both tools are validated, sensitive to change, and appropriate for tracking post-stroke rehabilitation progress.

Interventions

All participants received a structured 4-week rehabilitation program (4 sessions/week) combining conventional physiotherapy with NMES. The conventional therapy protocol consisted of 2-hour daily sessions administered 4 days per week, totalling 16 sessions. Each session incorporated patient-specific exercises including stretching of key muscle groups (plantar flexors, hamstrings, and adductors), functional training exercises (sit-to-stand transitions, wall squats, and unilateral stance practice), and gait activities (controlled stepping exercises, stair climbing, side walking, obstacle walking).

The NMES intervention targeted two key muscle groups - the tibialis anterior and hamstrings - with each muscle receiving 10 minutes of stimulation per session. The electrical stimulation parameters included a surged faradic current at 50 Hz frequency with 0.3 ms pulse duration, delivered in 5-second on: off cycles[19,20]. Stimulation intensity was carefully adjusted to produce minimal visible muscle contraction without discomfort, with two rubber electrodes positioned near the origin and insertion points of each target muscle. This NMES protocol was administered concurrently with conventional therapy, 4 days per week for the 4-week intervention period.

Feasibility indicators

- Patient adherence and tolerance
- Ease of NMES administration

No adverse events or dropouts

Statistical Analysis

Data were analysed using SPSS v20. Non-normally distributed outcomes (Shapiro-Wilk test) were compared using the Wilcoxon signed-rank test with significance set at *p* < 0.05. Median and interquartile range (IQR) was reported for WGS and mean and standard deviation for TUG test.

Results

All twenty participants completed the 4-week intervention protocol without any adverse events or dropouts, confirming the safety and tolerability of thecombined NMES and conventional therapy approach.

Quantitative Outcomes

Significant improvements were observed in both gait quality and functional mobility.

Wisconsin Gait Scale

Median scores decreased from 24.5 (IQR: 4.1) at baseline to 18.97 (IQR: 3) post intervention, reflecting a median improvement of 5.53 points (p<0.001). The 95% confidence interval for this change was 4.374 to 6.515, exceeding both the minimally clinically important difference (MCID= 2.25) and minimal detectable change (MDC= 4.24), indicating a clinically meaningful and reliably measurable improvement.

Timed Up and Go Test

Mean of time taken to complete the TUG test reduced from 21.05 ± 4.68 seconds to 17.4 ±4.7 seconds, with a mean improvement of 3.65 seconds (p<0.001). The 95% confidence interval for this change was 2.483 to 3.487, surpassing the MCID threshold of 10% for stroke populations.

Large effect size (dz=1.73, 95%CI [4.37-6.51]) for WGS confirms robust clinically meaningful gait improvements

Table 1. Changes in gait and mobility outcomes pre- and post- intervention

Outcome Measure	Pre- test scores	Post- test scores	Mean Diff	**Pooled SD**	**Effect size**	**95% confidence interval**	***p*-value**
Wisconsin Gait Scale	24.5 (IQR: 4.1)	18.97 (IQR: 3)	5.53 points	2.61	1.73 [large]	4.375-6.515	<0.001
Timed Up and Go	21.05 (SD: 4.68)	17.4 (SD:4.7)	3.65 seconds	4.69	0.64 [medium-large]	2.483-3.487	<0.001

IQR- interquartile range; SD- standard deviation

Qualitative Gait Improvements

Observational analysis revealed notable enhancements in gait mechanics:

During swing phase of gait cycle:

- Toe Clearance improved in 80% of participants (vs. 35% pre-intervention).
- Knee Flexion during mid-swing increased in 70%.
- Pelvic retraction during terminal swing was reduced.

During stance phase of gait cycle**:**

- 90% of participants achieved full weight transfer to the affected limb.
- Step length symmetry improved between affected and unaffected sides.
- Abnormal stance width reduced in 44% participants.

Additionally, pre-intervention guardedness (hesitation before stepping) resolved in 85% of participants, contributing to smoother gait transitions and reduced fall risk.

Discussion

This case series demonstrates that a 4-week combined intervention of NMES targeting tibialis anterior and hamstrings with conventional physiotherapy produced statistically significant and clinically meaningful improvements. The median WGS score reduction of change of 5.53 points [IQR4.1 to 3, p<0.001; 95%CI 4.375-6.515] exceeded both MCID (2.25 points) and MDC (4.25 points) thresholds, confirming reliable detection of true change. TUG improvements averaged 3.65 seconds (p<0.001, 95% CI 2.483-3.487), representing 17.3% gain and surpassing stroke-specific MCID benchmarks. Effect sizes were large for WGS (dz=1.73) and medium-large for TUG (dz=0.64), underscoring substantial practical impact.

Qualitative gains- toe clearance (80%).knee flexion (70%), weight shifting (90%)- suggest NMES facilitated neuroplasticity and normalized swing/ stance kinematics[15,16,17,18], addressing foot drop and stiff-knee gait patters characteristics of hemiplegia[15,16].

Findings align with NMES trials demonstrating gait improvements[9,10,12] while extending evidence to low-resource settings. Unlike urban-focused studies or African community models [13,14], this work validates NMES feasibility in semi-urban Indian outpatients serving rural populations-where stroke rehab access remains <20% due to cost and infrastructure gaps.

Clinical Implications

The protocols brevity (16 sessions), 100% adherence, zero adverse events and minimal equipment needs position MES as a scalable adjunct for low-resource neurorehabilitation units across LMICs. Targeting muscle groups with 5s on-off cycles effectively managed fatigue while enhancing real-world mobility, offering a practical bridge for the urban-rural rehabilitation divide

Limitations

The absence of a control group limits causal inference and small sample size restricts generalizability; data collected 2011-2012 lacks recent validation; no long-term follow-up or blinding.

Future Directions

Randomized controlled trials should isolate NMES effects, optimize parameters (frequency, pulse width), assess cost-effectiveness, and evaluate sustained outcomes. Integration with telerehabilitation could enhance scalability for geographically isolated stroke survivors.

Conclusion

NMES combined with conventional therapy is feasible, effective, and scalable intervention for improving gait and functionalmobility in post-stroke hemiplegia, especially in rural and resource-limited settings. The use of affordable, portable NMES devices alongside simple physiotherapy exercises addresses both muscle impairments and functional limitations, leading to clinically meaningful improvements in gait parameters and daily activities. These findings support NMES as a practical tool to bridge the urban-rural rehabilitation gap and promote neuroplasticity and functional recovery in stroke survivors across diverse contexts.

List of Abbreviations

- NMES- Neuromuscular electrical stimulation
- WGS- Wisconsin Gait Scale
- TUG- Timed Up and Go Test
- MCID- Minimally Clinically Important Difference
- MDC- Minimal Detectable Change
- IQR- Interquartile Range
- SD- Standard Deviation

Declarations

Ethics Approval and Consent to Participate: This study was approved by the Ethics Committee of Seth GS Medical College and KEM Hospital (Approval No.18/2011). Written informed consent was obtained from all participants prior to enrolment

Availability of data and Material: The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request

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Conflict of Interest: The authors declare that they have no competing financial interests or personal relationshipsthat could have appeared to influence the work reported in this paper.

Authors' Contributions

Shruti Patil designed the intervention protocol, recruited participants, administered physiotherapy sessions, contributed to data acquisition and clinical observations, performed statistical analysis, formatted tables and supported manuscript editing.

Archana Gore conceptualized the study, contributed to clinical observations and supported manuscript editing

All authors read and approved the final manuscript.

All authors meet ICMJE authorship criteria: (1) substantial contributions, (2) rafting/revising, (3) final approval, and (4) agreement to be accountable.

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Age-Stratified Effects of Exercise on Foot Posture, Balance and Functional Performance in Type 2 Diabetes Mellitus : Randomized Controlled Trial

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Abstract

Background: Type 2 diabetes mellitus (T2DM) is associated with impairments in foot posture, balance, and functional performance, which may be further influenced by aging. However, age-related differences in response to exercise interventions remain insufficiently explored.

Objective: To evaluate age-stratified effects of a structured exercise program on foot posture, balance, and functional performance in individuals with T2DM.

Methods: In this controlled, age-stratified study, 54 participants with T2DM were allocated to an exercise (n=27) or control group (n=27) and further stratified into middle-aged (40–59 years) and older (60–80 years) subgroups. The intervention consisted of an 8-week structured physiotherapy program. Outcomes included Foot Posture Index (FPI), static balance (center of gravity sway on firm surface), dynamic balance (Limits of Stability), and functional performance (6-minute walk test), assessed at baseline, 4 weeks, and 8 weeks.

Results: The exercise group demonstrated significant improvements in foot posture, balance, and functional performance compared to controls ($p < 0.05$). FPI scores improved toward neutral alignment, while static and dynamic balance showed reduced sway and enhanced stability. Functional performance improved significantly, exceeding clinically meaningful thresholds. Age-stratified analysis revealed greater improvements in foot posture among middle-aged participants, whereas balance and functional gains were observed across both age groups, with comparable improvements in older adults.

Conclusion: Structured exercise significantly improves foot posture, balance, and functional performance in individuals with T2DM. While age influences the magnitude of structural adaptation, functional and balance improvements are preserved in older adults, supporting the use of exercise interventions across age groups.

Keywords: Type 2 diabetes mellitus, exercise therapy, foot posture, balance, functional performance, aging

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Introduction

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and progressive pancreatic β-cell dysfunction, resulting in sustained hyperglycemia and multisystem complications. The global prevalence of T2DM has increased substantially over recent decades, with particular impact on aging populations. In India, the burden is particularly acute: approximately 89.8 million individuals aged 20–79 years were living with diabetes in 2024, representing approximately 10.5% of that population and making India the second highest diabetes burden globally [1]

T2DM is associated with musculoskeletal impairments affecting the foot–ankle complex, leading to reduced joint mobility, muscle weakness, and impaired postural control, which collectively compromise functional mobility [2,3]. Individuals with T2DM commonly present with altered foot posture, reduced ankle mobility, decreased muscle strength, impaired balance, and diminished functional performance[4,5].

Aging significantly amplifies these musculoskeletal impairments in individuals with T2DM. Middle-aged adults (40–59 years) typically retain preserved neuromuscular plasticity and anabolic responsiveness to exercise, whereas older adults (60–80 years) experience the compounded effects of age-related sarcopenia combined with diabetes-induced muscle dysfunction [6]. These age-related differences in baseline impairment severity raise the possibility that middle-aged and older adults may demonstrate differential adaptive responses to exercise interventions. However, few studies have directly compared exercise outcomes across age-stratified groups with T2DM, limiting evidence-based development of age-appropriate rehabilitation protocols.

Exercise therapy is widely recognized as a cornerstone in T2DM management. Structured physical activity provides well-documented benefits for glycemic control, cardiovascular risk reduction, and metabolic health through improvements in insulin action and body composition [7]. Recent evidence demonstrates that multimodal exercise programs simultaneously addressing strength and balance deficits produce superior outcomes compared with single-modality interventions [8,9].

Despite these promising findings, critical evidence gaps persist. Most exercise studies in T2DM focus primarily on glycemic and metabolic outcomes, with limited investigation of integrated foot-ankle-balance-functional measures. The majority of existing research either combines data across age groups without stratification or includes primarily younger or mixed-age cohorts, failing to differentiate exercise responses between middle-aged and older adults. In view of the rising prevalence of T2DM among aging populations, the progressive nature of foot-ankle-balance dysfunction, and the absence of age-comparative research on integrated musculoskeletal outcomes, structured exercise interventions targeting these specific domains warrant rigorous investigation. Therefore, this study aimed to evaluate age-related differences in response to a structured exercise program on foot posture, balance, and functional performance in individuals with T2DM.

Materials & Methods

Study Design

This study employed a controlled, age-stratified exercise intervention design with repeated measures. Participants were randomly allocatedusing chit system, with a seal concealment to either an experimental-exercise group (Group A) or a control group (Group B) and were further stratified into middle-aged (40–59 years) and older (60–80 years) subgroups. Outcome measures were assessed by two different blind assessors at baseline, 4 weeks, and 8 weeks to evaluate changes over time and differences between groups.

Study Setting

Participants were recruited from the outpatient departments ofHakeem Abdul Hameed Centenary (HAHC) Hospital and surrounding areas of Jamia

Hamdard, New Delhi. The study was carried out at the Rehabilitation centre, Jamia Hamdard, New Delhi – 110062, India.

Sample Size

A total of 54 patients of type 2 diabetes were randomly allocated into experimental (exercise) and control groups and stratified into middle-aged (40–59 years) and older (60–80 years) subgroups. Sample size was estimated based on a moderate effect size (d = 0.6), α = 0.05, and 80% power, with adjustment for 20% attrition, resulting in 54 participants.

Inclusion criteria were diagnosed cases of T2DM, of age between 40 and 80 years, suffering from T2DM For more than 2 years duration, with HbA1c levels between 6.5% and 10%. and presence of low medial longitudinal arch, identified through clinical assessment using the Foot Posture Index. Subjects were exclusively by oral hypoglycemic medications.

T2DM patients with lower-extremity amputation beyond the toes., plantar foot ulcers, BMI ≥ 30 kg/m^2, peripheral neuropathy,Lower-limb orthopedic or neurological disorders or structural foot deformities such as joint pathology, congenital vertical talus or cerebral palsy.

Also Type 1 Diabetes Mellitus were excluded.

Materials, Equipment, and Outcome Assessment Tools

The following instruments and equipment were used in the study:

- 10 g Semmes–Weinstein monofilament (validity:0.49, reliability: 0.74)[10]
- Foot Posture Index (FPI)(validity: 0.62, reliability: 0.95)[11]
- Humac Balance System (validity: 0.93, reliability: 0.80)[12]

Variables

Independent Variables

1. Exercise intervention (exercise vs no exercise)
2. Time (baseline, 4 weeks, 8 weeks)
3. Age group (40–59 years, 60–80 years)

Dependent Variables

1. Foot posture assessed using the Foot Posture Index (FPI)
2. Static balance assessed as center of gravity (COG) sway velocity
3. Dynamic balance assessed using the Limits of Stability (LOS) composite score
4. Functional performance measured using the Six-Minute Walk Test (6MWT)

Procedure

Ethical approval was obtained from the Institutional Ethics Committee and Research Project Approval Committee (RPAC), Jamia Hamdard, prior to commencement of the study. Written informed consent was obtained from all participants in English or the local vernacular language after explaining the study procedures.After receiving ethical clearance, potential participants were invited to participate in the study. Screening was performed based on the inclusion and exclusion criteria. Anthropometric measurements including height and weight were recorded, and BMI was calculated. Participants meeting the eligibility criteria were recruited, baseline assessments were performed, and participants were randomly allocated into experimental and control groups.

Assessment Protocol

- **Foot Posture Assessment:** Foot posture for both feet was assessed using the Foot Posture Index (FPI) with participants standing in a relaxed, double-limb stance. Assessments were conducted at baseline, 4 weeks and 8 weeks in both groups [10,11].

- **Static and Dynamic Balance Assessment:** Static and dynamic balance were assessed using the HUMAC Balance System was evaluated using the Humac Balance System [4,12,13].Static balance assessed on firm surface (eyes open), using COG sway velocity. Dynamic balance was assessed using the Limits of Stability (LOS) test on the HUMAC Balance System. The LOS composite score was recorded for analysis.
- **Functional Performance Assessment:** Functional performance was evaluated using the Six-Minute Walk Test (6MWT) conducted along a 30-meter corridor. Participants were instructed to walk as far as possible for six minutes at their own pace while standardized encouragement was provided. The total walking distance was recorded in meters.

All outcome measures were reassessed at the 4th and 8th week of the intervention period.

Intervention Protocol

Participants in the experimental group received a structured physiotherapy program for five sessions per weekfor 8 weeks. The intervention consisted of warm-up exercises, strengthening exercises for foot and ankle muscles, balance training using the Humac Balance System, and cool-down exercises. The session duration was 40-45 minutes. Gradually resistance was increased per week to maintain the progression, to avoid adherence, all session were under supervision of qualified physiotherapist. Participants in the control group received standard medical care but did not participate in supervised physiotherapy exercises during the study period.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics (Version 23). Normality was assessed using the Shapiro–Wilk test. Between-group comparisons were conducted using independent samples t-test or Mann–Whitney U test. Within-group comparisons were analyzed using paired t-test or Wilcoxon signed-rank test. Repeated measures across baseline, 4 weeks, and 8 weeks were analyzed using repeated measures ANOVA or Friedman test. Statistical significance was set at $p < 0.05$.

Results

The mean age of participants was comparable between the two groups, with values of 60.30 ± 11.53 years in the experimental group (Group A) and 60.61 ± 11.97 years in the control group (Group B). The distribution of participants across age categories was also similar. Gender distribution was also relatively balanced. All the demographic variable are summarized in **table 1**.

Table 1. Demographic Profile of Study Participants

Variable	Group A	Group B
Age (years), Mean ± SD	60.30 ± 11.53	60.61 ± 11.97
Age Group 40–59, n (%)	14 (51.9%)	13 (48.1%)
Age Group 60–80, n (%)	13 (48.1%)	14 (51.9%)
Gender – Male, n (%)	15 (55.6%)	13 (48.1%)
Gender – Female, n (%)	12 (44.4%)	14 (51.9%)
Height (cm), Mean ± SD	164.55 ± 8.09	161.51 ± 9.18
Weight (kg), Mean ± SD	63.48 ± 8.78	61.09 ± 11.62
Body Mass Index (kg/m²), Mean ± SD	26.23 ± 3.18	25.62 ± 2.38
HbA1C %, Mean ± SD	6.70 ± 0.423	6.67 ± 0.322

For Left FPI, Among participants aged 40–59 years, baseline FPI scores were comparable between the experimental group with no significant between-group difference ($p = 0.684$). At 4 weeks, the experimental group demonstrated a reduction in FPI, although this difference was not statistically significant ($p = 0.118$). By 8 weeks, the experimental group exhibited a marked improvement, whereas the control group remained relatively unchanged (p = 0.002). Within-group analysis showed a significant improvement over time in the experimental group (p = 0.001), whereas the control group did not demonstrate significant change (p = 0.213). A similar trend was observed in the 60–80 year age group. Baseline scores were comparable (6.31 ± 1.05 vs 6.18 ± 1.14; p = 0.742). The experimental group improved progressively, while the control group showed minimal change. The difference at 8 weeks was statistically significant (p = 0.004). Within-group analysis confirmed a significant improvement in the experimental group (p = 0.002) but not in the control group (p = 0.287) **(Table 2)**.

Table 2. Comparison of Left Foot Posture Index (FPI) Across Time by Age Subgroup

Time Point	Group A (Mean ± SD)	Group B (Mean ± SD)	Between-group p-value
Age group: 40–59 years			
Baseline	5.36 ± 0.94	5.21 ± 1.02	0.684
4 Weeks	4.57 ± 0.88	5.08 ± 0.96	0.118
8 Weeks	3.18 ± 0.76	4.92 ± 0.91	0.002*
Within-group p-value	**0.001***	0.213	–
Age group: 60–80 years			
Baseline	6.31 ± 1.05	6.18 ± 1.14	0.742
4 Weeks	5.42 ± 0.97	6.07 ± 1.08	0.094
8 Weeks	4.12 ± 0.89	5.96 ± 1.03	0.004*
Within-group p-value	**0.002***	**0.287**	–

Between-group comparisons at each time point were performed using the Mann–Whitney U test. Within-group comparisons across time points were performed using the Friedman test. *statistically significant at $p < 0.05$

For Right FPI **(Table 3)**, in the 40–59 year age subgroup, baseline values were similar between groups (p = 0.781). At 4 weeks, the experimental group demonstrated a reduction, while the control group showed a smaller decrease (p = 0.084). At 8 weeks, the experimental group showed substantial improvement compared to the control group, with a significant between-group difference (p = 0.001). Within-group analysis indicated significant improvement over time in the experimental group (p = 0.001) but not in the control group (p = 0.248). Among participants aged 60–80 years, baseline scores were again comparable (p = 0.864). The experimental group demonstrated progressive improvement, whereas the control group remained largely unchanged. The between-group difference at 8 weeks was statistically significant (p = 0.003). Within-group changes were significant only in the experimental group (p = 0.002).

Table 3. Comparison of Right Foot Posture Index (FPI) Across Time by Age Subgroup

Time Point	Group A (Mean ± SD)	Group B (Mean ± SD)	Between-group p-value
Age group: 40–59 years			
Baseline	5.18 ± 0.96	5.09 ± 1.01	0.781
4 Weeks	4.36 ± 0.91	4.98 ± 0.97	0.084
8 Weeks	3.02 ± 0.79	4.86 ± 0.93	**0.001***
Within-group p-value	**0.001***	0.248	—
Age group: 60–80 years			
Baseline	6.12 ± 1.08	6.05 ± 1.16	0.864
4 Weeks	5.21 ± 0.99	5.94 ± 1.10	0.072
8 Weeks	4.03 ± 0.91	5.82 ± 1.04	0.003*
Within-group p-value	**0.002***	0.301	—

Between-group comparisons at each time point were performed using the Mann–Whitney U test. Within-group comparisons across time points were performed using the Friedman test. *statistically significant at $p < 0.05$

Table 4 presents changes in static balance measured as center of gravity (COG) sway velocity on a firm surface (deg/s). In the 40–59 years age group, the experimental group demonstrated a progressive reduction in sway velocity from 2.87 ± 0.42 deg/s at baseline to 2.45 ± 0.36 deg/s at 4 weeks and further to 2.08 ± 0.31 deg/s at 8 weeks ($p < 0.001$). The control group also showed a reduction, though of smaller magnitude, decreasing from 2.91 ± 0.38 to 2.61 ± 0.33 deg/s ($p = 0.018$). Between-group comparisons revealed significant differences favoring the experimental group at both 4 weeks ($p = 0.041$) and 8 weeks ($p = 0.002$). In participants aged 60–80 years, the experimental group exhibited a decrease in sway velocity from 3.12 ± 0.48 to 2.33 ± 0.36 deg/s ($p < 0.001$). The control group showed a smaller reduction from 3.09 ± 0.45 to 2.81 ± 0.37 deg/s ($p = 0.044$). A significant between-group difference was observed at 8 weeks ($p = 0.006$), indicating superior balance performance in the experimental group.

Table 4. Static Balance (COG Sway Velocity)

Time Point	Group A (Mean ± SD)	Group B (Mean ± SD)	Between-group p-value
Age group: 40–59 years			
Baseline	2.87 ± 0.42	2.91 ± 0.38	0.756
4 Weeks	2.45 ± 0.36	2.72 ± 0.34	**0.041***
8 Weeks	2.08 ± 0.31	2.61 ± 0.33	**0.002***
Within-group p-value	**<0.001***	**0.018***	—
Age group: 60–80 years			
Baseline	3.12 ± 0.48	3.09 ± 0.45	0.842

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4 Weeks	2.71 ± 0.41	2.95 ± 0.39	0.090
8 Weeks	2.33 ± 0.36	2.81 ± 0.37	**0.006***
Within-group p-value	**<0.001***	**0.044***	–

Test Used: Between groups – Student's independent samples t-test (two-tailed); Within groups – Student's paired t-test (two-tailed); Within-group p-values represent comparison between baseline and 8 weeks; *p < 0.05 considered statistically significant.

Table 5 reports dynamic balance outcomes measured using the Limits of Stability (LOS) composite score on a firm surface. In the 40–59 years age group, the experimental group showed a substantial increase in LOS score (p < 0.001). The control group demonstrated a smaller increase (p = 0.041). Between-group differences were significant at both 4 weeks (p = 0.036) and 8 weeks (p = 0.001). In the 60–80 years subgroup, the experimental group improved (p < 0.001), while the control group improved (p = 0.022). A significant between-group difference was observed at 8 weeks (p = 0.003).

Table 5. Dynamic Balance (LOS Composite Score)

Time Point	Group A (Mean ± SD)	Group B (Mean ± SD)	Between-group p-value
Age group: 40–59 years			
Baseline	58.42 ± 6.18	57.96 ± 5.87	0.812
4 Weeks	64.71 ± 5.43	60.02 ± 5.66	**0.036***
8 Weeks	69.84 ± 4.92	61.38 ± 5.21	**0.001***
Within-group p-value	**<0.001***	**0.041***	–
Age group: 60–80 years			
Baseline	51.63 ± 6.92	52.14 ± 6.47	0.841
4 Weeks	57.08 ± 6.11	53.96 ± 6.28	0.118
8 Weeks	62.47 ± 5.38	55.21 ± 5.74	**0.003***
Within-group p-value	**<0.001***	**0.022***	–

Test Used: Between groups – Student's independent samples t-test (two-tailed); Within groups – Student's paired t-test (two-tailed); Within-group p-values represent comparison between baseline and 8 weeks; *p < 0.05 considered statistically significant.

For 6 minute walking test, in the 40–59 years age subgroup, baseline walking distances were comparable between the experimental (p = 0.882). At 4 weeks, the experimental group demonstrated a modest increase, whereas the control group showed only a slight improvement (p = 0.412). By 8 weeks, the experimental group exhibited a greater increase in walking distance compared with the control group, resulting in a statistically significant difference (p = 0.021). Within-group analysis showed significant improvement in the experimental group (p = 0.009) but not in the control group (p = 0.118). Among participants aged 60–80 years, baseline walking distances were similar between groups (p = 0.846). The experimental group increased at 8 weeks, whereas the control group demonstrated only minor changes. A statistically significant between-group difference was observed at 8 weeks (p = 0.028).

Table 6. Six-Minute Walk Test (meters)

Time Point	Group A (Mean ± SD)	Group B (Mean ± SD)	Between-group p-value
Age group: 40–59 years			
Baseline	368.42 ± 48.36	370.15 ± 46.92	0.882
4 Weeks	388.21 ± 44.37	378.84 ± 45.16	0.412
8 Weeks	414.27 ± 41.92	384.36 ± 42.78	**0.021***
Within-group p-value	**0.009***	0.118	–
Age group: 60–80 years			
Baseline	312.63 ± 52.41	315.28 ± 50.76	0.846
4 Weeks	330.74 ± 49.03	319.16 ± 48.27	0.471
8 Weeks	356.18 ± 46.11	325.42 ± 47.02	**0.028***
Within-group p-value	**0.014***	0.134	–

Test Used: Between groups – Student's independent samples t-test (two-tailed); Within groups – Student's paired t-test (two-tailed); Within-group p-values represent comparison between baseline and 8 weeks; *$p < 0.05$ considered statistically significant

Discussion

This controlled, age-stratified trial demonstrates that an 8-week structured physiotherapy-based exercise program produces clinically and statistically significant improvements across multiple dimensions of lower-extremity function in adults with Type 2 Diabetes Mellitus (T2DM)[14]. The experimental group demonstrated substantial improvements in foot posture toward neutral alignment, reduced postural sway under challenging sensory conditions, and improved six-minute walk test performance [14,15]. These improvements occurred across both age strata (40-59 and 60-80 years), though with some age-related variations in response magnitude indicating that exercise-induced functional improvements were observed acros both age strata.[16]

The experimental group demonstrated a progressive reduction in Foot Posture Index scores from baseline to 8 weeks, with the most pronounced improvement observed in the middle-aged subgroup (40-59 years). The observed improvements in FPI scores indicate reversal of pronation tendencies, a critical finding given that excessive pronation in diabetic patients is associated with abnormal plantar pressure distribution, increased metatarsal head loading, and elevated risk of neuropathic ulceration [16]. This is particularly relevant for diabetic foot complication prevention, as abnormal foot posture contributes to repetitive mechanical stress and soft tissue breakdown [17]. Bilateral symmetry in FPI gains reflects DSPN's uniform impact, consistent with symmetric muscle atrophy [18] and gait deficits, suggest that exercise interventions targeting foot and ankle musculature may produce bilateral improvements in foot posture [16,19]. Minor left pronation excess at baseline may relate to gait dominance.

Targeted exercise interventions incorporating toe flexion, spreading, gripping, and resistance exercises can induce hypertrophic adaptations in these severely atrophied muscles [20]. The more pronounced FPI improvements in the middle-aged subgroup (40-59 years) compared to older adults (60-80 years) may reflect age-related differences in tissue plasticity, motor learning capacity, and neuromuscular adaptation potential. Older adults demonstrate reduced muscle protein synthesis rates, diminished satellite cell proliferation, and attenuated anabolic responses to resistance exercise compared to younger cohorts [21]. However, the fact that older adults still demonstrated measurable improvements, albeit of smaller magnitude, indicates that neuroplastic and musculoskeletal adaptation capacity is not entirely exhausted even in advanced age with chronic metabolic disease.[7]

The experimental group demonstrated substantial and statistically significant improvements in static balance, assessed as center-of-gravity sway velocity. These improvements ranged from 25-27%, with significant between-group differences emerging by 8 weeks [14].

This pattern of improvement across graded sensory perturbations provides insight into the mechanisms underlying balance enhancement. The Sensory Organization Test paradigm, which systematically manipulates visual and somatosensory input availability, reveals the relative contribution of different sensory modalities to postural control and identifies deficits in sensory integration processes [13]. Diabetic peripheral neuropathy compromises somatosensory input from mechanoreceptors in the foot and ankle, forcing greater reliance on visual and vestibular systems for balance maintenance.[22]

Dynamic balance, assessed via the Limits of Stability test, showed comparable improvement patterns with experimental group participants increasing their composite LOS scores by 19-21% (middle-aged) and 21-27% (older adults) from baseline to 8 weeks. Improvements in LOS reflect enhanced motor planning, feedforward postural adjustments, ankle strategy utilization, and confidence in balance capabilities [12]. The progressive nature of improvements from 4 to 8 weeks suggests motor learning and skill consolidation rather than acute performance effects.[15]

Interestingly, older adults (60-80 years) demonstrated improvement magnitudes comparable to or exceeding those of middle-aged participants in several balance parameters, contrasting with the age-related attenuation observed in foot posture adaptations. This finding suggests that neural plasticity mechanisms underlying balance control may be relatively preserved in healthy aging compared to structural tissue remodeling capacity.[23]

The 6MWT revealed substantial experimental improvements in walking distance with significant between-group superiority at 8 weeks (p=0.021-0.028), confirming functional translation of prior musculoskeletal adaptations. These changes exceed established minimal clinically important differences (~30-50m) for T2DM populations, validating ankle-specific exercise efficacy [24,25]. Younger adults (40-59y) achieved 14% distance improvement versus 12% in older adults (60-80y), maintaining clinical significance despite age-attenuated baseline capacity. Consistent between-group superiority ($p<0.03$) across strata confirms intervention scalability, with proportional gains aligning to neuropathy severity gradients.[26]

Analysis of age-stratified outcomes reveals complex patterns of adaptation, with middle-aged participants (40-59 years) demonstrating superior responses in some domains (foot posture, certain ROM parameters) while older adults (60-80 years) showed comparable or superior responses in others (balance outcomes, functional capacity gains). This heterogeneity of age effects across outcome domains suggests that different physiological systems exhibit varying degrees of age-related decline in adaptive capacity.[21]

Structural adaptations requiring tissue remodeling (foot posture changes, muscle hypertrophy, connective tissue compliance enhancement) appear more constrained by aging, likely reflecting age-related reductions in protein synthesis rates, satellite cell function, growth factor responsiveness, and tissue repair mechanisms [27,28]. Older adults demonstrate blunted anabolic responses to resistance exercise and require greater training volumes or intensities to achieve hypertrophic adaptations equivalent to younger individuals.[28]

Study Limitations

The sample size (n=54) was based on feasibility and may have limited detection of smaller effect sizes. The control group was not monitored for unsupervised physical activity, which may have influenced outcomes. Additionally, the 8-week follow-up period does not provide information on the long-term sustainability of observed improvements.

Future Research Directions

Future studies should investigate the comparative effectiveness of individual exercise components and explore simplified, scalable delivery models such as home-based or tele-rehabilitation programs. Additionally, long-term follow-up studies are needed to assess sustainability of functional improvements and their impact on clinical outcomes in individuals with T2DM.

Conclusion

This study demonstrates that an 8-week structured exercise program significantly improves foot posture, balance and functional performance in individuals with Type 2 Diabetes Mellitus. Improvements were observed across both middle-aged and older adults, although age-related differences in response were evident, with relatively greater structural gains in middle age participants and preserved balance and functional improvements in older adults. These findings support the role of targeted exercise interventions in enhancing lower-extremity function and promoting functional independence in individuals with T2DM.

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Conflict of Interest: There is no conflict of interest

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