Online ISSN: 3049-0014

SSN JOURNAL OF MANAGEMENT & TECHNOLOGY RESEARCH COMMUNICATIONS

Special Issue

Vol 3 No 4 (2026)

EMERGING TECHNOLOGIES IN REHABILITATION SCIENCES

Edited by : Prof Mohammed Miraj PhD (Orthopedics)

An Open Access International Peer Reviewed Quarterly Journal

Showcasing Current Academic Research
in Management and Technological Sciences

Contents available
every 4 months

Published by
Society for Science & Nature

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SSN Journal of Management & Technology Research Communications Volume 3 • Number 4

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EDITORIAL

Rehabilitation sciences are undergoing a remarkable transformation through the integration of emerging technologies such as artificial intelligence, robotics, wearable sensors, tele-rehabilitation, virtual reality, and digital health platforms. These innovations are redefining rehabilitation practice by enhancing clinical decision-making, improving patient engagement, and enabling personalized, evidence-based care across diverse healthcare settings.

This special issue of SSN Journal of Management and Technology Research Communications (MNTRC), published by the Faculty of Allied Health Sciences, Santosh Deemed to be University, Ghaziabad India showcases original research and reviews that highlight technological advancements in Rehabilitation Sciences across disciplines like neurorehabilitation, musculoskeletal rehabilitation, sports rehabilitation, cardiopulmonary care, biomechanics, assistive technologies, and remote patient monitoring.

The findings demonstrate significant improvements in functional recovery, gait, balance, cognition, and quality of life. Notably, the issue includes evidence supporting vestibular rehabilitation for improving gait and quality of life in Parkinsonism, as well as Proprioceptive Neuromuscular Facilitation (PNF) for enhancing balance and functional mobility in stroke survivors, alongside studies emphasizing the growing role of AI-enabled and digital rehabilitation solutions.

As Guest Editor I extend my sincere appreciation to the authors, reviewers, and editorial board for their invaluable contributions.

I hope this special issue stimulates further interdisciplinary research, fosters innovation, and accelerates the responsible adoption of emerging technologies to advance rehabilitation sciences and improve patient outcomes worldwide.

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SSN JOURNAL OF
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ISSN 3049-0014
9 773049 001000

Editor
SSN JOURNAL OF MANAGEMENT AND TECHNOLOGY RESEARCH COMMUNICATIONS
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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

OPEN ACCESS

Effectiveness of an Occupational Therapy Program Combining Core Stability and Proprioceptive Exercises on Balance and Quality of Life in Individuals with Diabetic Neuropathy: A Randomized Controlled Trial

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ABSTRACT

Type 2 diabetes is commonly associated with balance impairments, primarily attributable to diabetic peripheral neuropathy (DPN), which affects approximately 30–50% of individuals due to peripheral nerve degeneration. A Randomized control trial study conducted to assess the effectiveness of occupational therapy intervention combining of core stability and proprioceptive exercises on balance and Quality of life in Subjects with Diabetic Neuropathy. The 64 participants were randomly divided into two groups: 32 in the control group and 32 in experimental group. Participants of the experimental group received an occupational therapy intervention combining of core stability and proprioceptive exercises while the control group received an occupational therapy intervention combining Core Stability exercises for 8 weeks. The outcomes of the intervention were measured using Berg Balance and NeuroQOL. Based on the results, the experimental group clearly outperformed the control group in terms of balance, physical function, and social cognition. These improvements were both statistically and clinically meaningful, indicating that the OT intervention had a substantial positive impact. Despite the decline in mental health scores, the overall functional gains make the experimental group better in terms of therapeutic outcomes. This study demonstrates that occupational therapy (OT) significantly improves balance, physical function, and social cognition in individuals with diabetic neuropathy. The experimental group showed meaningful gains in all areas and outperformed the control group. However, a decline in mental health suggests the intervention lacks psychological support. Despite this, the overall functional improvements indicate strong therapeutic benefits.

KEY WORDS: BALANCE, CORE STABILITY, DIABETIC NEUROPATHY, PROPRIOCEPTIVE EXERCISE, QUALITY OF LIFE.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 11/04/2026 Accepted after revision 15/06/2026
Page Number- 01-06
This is an open access article under Creative Commons License,
https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.1

INTRODUCTION

Diabetes mellitus is a long-term condition in which the body's ability to regulate blood sugar is compromised by inadequate insulin secretion or reduced cellular response to insulin Diabetes is a major health concern, and Type 2 diabetes (T2DM) is becoming more common and is strongly correlated with lifestyle choices [1].

(DPN) is a serious side effect of both type 1 and type 2 diabetes, affecting one in every 20 people with diabetes. It is one of the most frequent microvascular problems among individuals with type 2 diabetes. The prevalence of DPN varies widely, ranging from 6% to 51%, depending on the population studied. DPN involves sensitive neuropathy that affects the autonomic nerve system [2].

The location and type of nerve fibres affected by DPN can vary, causing symptoms that depend on how the disease affects different areas of the nervous system. Common symptoms include numbness, tingling, and pain, which may worsen at night. Poor glycaemic management and the chronic nature of the disease both increase the risk of developing DPN [2].

Additionally, 16% of diabetics suffer from balance problems, a condition that can worsen the disease by 30% to 50%. Diabetes-related peripheral neuropathies come in a variety of forms [2].

Diabetic neuropathy (DN) can result in delayed reflexes and diminished proprioception, adversely affecting patients' diabetes management and significantly diminishing their overall quality of life. It also exacerbates the prognosis of other diabetes-related complications. Inequality in these people has been linked to impaired foot sensation, proprioception, biomechanical structures, and a lack of understanding of joint position. In chronic neuropathic individuals, this can lead to postural instability, decreased balance, and ataxia or other symptoms [3].

Falls are primarily caused by decreased balancing function, and diabetes is strongly linked to an increased risk of falling. An increasing number of senior citizens are experiencing fear of falling, which restricts their everyday activities and social interactions and can worsen physical deterioration, despair, social isolation, and feelings of powerlessness [3].

The balance disorder can be treated at a physiological level to enhance the sensorimotor system, such as through vestibular rehabilitation or balance and strength retraining. Alternatively, it can be treated at a functional level to lessen the impact of the impairment and facilitate function, using techniques like virtual reality, lifestyle modification, and removing home hazards1. Exercise for building strength in the lower limbs and enhancing balance has been an element of DPN non-pharmacological therapy [4].

These workouts, which include therapeutic exercises addressing muscular strength, balance, endurance capacity, and coordination skills have shown positive impacts occupational performance measures for older populations5. The greatest exercises for physically fragile older persons include Tai Chi, group and home-based exercise programs, and this multi-component exercise intervention. This is due to the fact that they not only prevent falls but also promote several aspects of physical health like strength [5]. Exercise regimens are advised for those with DPN to decrease the likelihood of falls, thereby improving balance and maintaining independence [4]. Therefore, the purpose of current study is to assess the effectiveness of occupational therapy intervention combining of core stability and proprioceptive exercises on balance and Quality of life in Subjects with Diabetic Neuropathy.

MATERIAL AND METHODS

A randomized control trial study conducted to assess the effectiveness of occupational therapy intervention combining of core stability and proprioceptive exercises on balance and Quality of life in Subjects with Diabetic Neuropathy. This study was reviewed and approved by the Institutional Ethical Committee of Santosh College of Occupational Therapy (Ref No.-SCOT/NOV-24/ECNeuro-08). 64 Participants were screened using Toronto Clinical Neuropathy Screening and Berg Balance Scale. After screening, participants were recruited for the study according to the inclusion and exclusion criteria. Consent was taken from the participants before therapy and all participants were divided into experimental (N= 32) and control group (N=32) by random sampling method. Using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 32 participants per group.

In the experimental group participants received occupational therapy intervention combining of core stability and proprioceptive exercises and Participants of control group received occupational therapy intervention combining core stability exercises. Proprioceptive exercises include, one leg balance, forward leg swings with knee extension, backward leg swings with knee flexion, toe walking, heel walking, cross-body leg swings right and left sides, partial squat, single-leg squat, blind advanced one leg balance, and side lunge. Dynamic walking exercise, active range of motion exercise of upper and lower extremity [6]. Core stability exercises included bridging, plank exercise on knee and elbow, cat curl exercise, abdominal crunch and oblique crunches, fall out exercise, seated marching exercise, lean exercise, twist exercise.

Occupational therapy intervention consists of calisthenic exercises and strength activities. Calisthenic exercises

include standing trunk lateral flexion, standing with hands behind neck, knee and hip flexion together and trunk rotation to the same side. Standing ankle circles (With leg extended), standing half squat, standing scapular adduction, standing shoulder elevation and depression. Standing shoulder circles to front and back side. Standing arm swinging, standing on chair neck flexion and lateral flexion, standing on floor, reach to toes. Strength activities include standing shoulder flexion with sand bag, dumbbell seated biceps curl, dumbbell triceps kickback, standing hip flexion (ankle weight), standing hip abduction (Ankle weight), sitting knee extension (ankle weight), prone knee flexion (ankle weight) and supine sit-ups (no weight) [7].

Outcome Measurements: The following outcome measurements were taken at baseline and again after 8 weeks of intervention program. The assessment tools included, The Berg Balance Scale to evaluate how well one can maintain balance safely [8]. NeuroQOL (Neurological Quality of Life), it measures a wide range of domains, including physical, emotional, cognitive, and social functioning, helping to capture the overall impact of a neurological disorder on a person's daily life. It plays a vital role in both clinical practice and research by providing consistent, meaningful insights into a patient's well-being and functional abilities [9].

RESULTS

The present study employed a robust quantitative methodology to evaluate the effectiveness of occupational therapy intervention combined with core stability and proprioceptive exercises on postural stability and QOL assessed by BBS and NeuroQol.

The study compared outcome across both experimental and control groups using a pre-post intervention framework. IBM SPSS Statistics and Microsoft Excel were used for running inferential statistical tests, including paired and independent sample t-tests and descriptive statistics for each of the four outcome measures, the average, variability, and extreme values were determined —BBS, NeuroQol (Physical, Mental and Socio-cognitive) separately for control and experimental groups. This helped in establishing baseline comparability and capturing the magnitude of change post intervention.

Table 1. Baseline characteristics

Outcome Measure	EG				CG					
	Mean		(SD)		Mean		(SD)			
	Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test	T	P
Berg Balance Scale	36.71	44.69	5.242	6.13	35.62	41.78	4.078	4.69	-0.711	0.48
Physical function NeuroQol	48.75	58.88	11.65	13.93	50.72	57.13	10.10	11.94	0.706	0.483
Mental health NeuroQol	64.13	55.38	11.72	12.50	58.75	53.59	12.38	11.84	-1.992	0.051
Social Cognitive function NeuroQol	42.16	50.41	10.70	10.71	46.22	51.09	9.79	9.69	1.304	0.197

EG: experimental group, CG: Control group, SD: Standard deviation

Table 2. Result of baseline and post test scores of the outcome measures in experimental and control group

Outcome measure	EG		CG	
	T	P	T	P
BBS Physical function	-4.878	<0.01	-4.971	<0.01
NeuroQol Mental health	-4.944	<0.01	-4.435	<0.01
NeuroQol Social Cognitive function	-4.843	<0.01	-4.094	<0.01
NeuroQol	-4.541	<0.01	-4.407	<0.01

EG: experimental group, CG: Control group

Table 3. Result of post data analysis of the outcome measures, experimental vs control group

Scale	t	P-Value
Post-OT BBS	-2.13	0.037
Physical Function post NEUROQOL	-0.539	0.045
Mental Health post NEUROQOL	-0.585	0.029
Social-Cognitive Function post NEUROQOL	0.269	0.033

DISCUSSION

The present study aims to investigate how occupational therapy interventions affect QOL and balance of individuals with DN Statistical analyses of Table 2, revealed that

the occupational therapy intervention produced marked improvements in several key outcome domains. The most substantial improvement was seen in balance, as measured by the Berg Balance Scale (BBS). Participants demonstrated an increase from a mean pre-intervention score of 35.62 to 41.78, and in a separate analysis, from 36.71 to 44.69, indicating a consistent pattern of improvement. The Wilcoxon signed-rank test confirmed this trend, with all participants improving and none showing tied or negative ranks ($Z = -4.876$, $p < .001$). These results underscore the intervention's effectiveness in enhancing postural stability and proprioception—both critical components in managing diabetic neuropathy, which is often accompanied by gait disturbances and heightened fall risk10. This is consistent with existing literature where sensorimotor and core strengthening exercises led to improved balance and reduced fall frequency [11,12].

As shown in Table 2, physical function, as assessed through the NEUROQOL instrument, showed significant improvement. Mean scores increased from 50.72 to 57.13 in one dataset and from 48.75 to 58.88 in another, with all participants showing improvement and no negative ranks ($Z = -4.944$, $p < .001$). This highlights the success of the therapy in enhancing strength, mobility, and endurance. Physical dysfunction is a major issue among diabetic neuropathy patients due to sensory loss and muscular weakness.

In support of above result, Gautam, et al.,conducted a study in 2024, examining the effectiveness was examined through randomised investigation of an occupational therapy program including sensory-motor and proprioceptive training [13]. The study concluded that sensory-motor and proprioceptive training is more effective than conventional care in enhancing functional outcomes for diabetic neuropathy patients.

Reyhanıoğlu et al., 2024 conducted a study showing the effects of the computer-based Biodex Balance System (BBS) were assessed through trial with randomized allocation on patients with diabetic peripheral neuropathy (DPN) [14]. Over eight weeks, the intervention group showed significant improvements in postural stability, fall risk, neuropathic pain, and clinical symptoms ($p < 0.001$), though no were noted in nerve conduction. The findings suggest that computer-based balance training effectively enhances balance and reduces symptoms in DPN patients.

The domain of social cognitive function as seen in Table 2 shows also improved notably following the intervention. Participants' mean scores rose from 46.22 to 51.09 and, in a separate analysis, from 42.16 to 50.41, with 31 out of 32 participants improving ($Z = -4.407$ and -4.541, respectively; $p < .001$). This suggests that improvements in physical capacity may have translated into enhanced social interaction, cognitive stimulation, and self- confidence.

This aligns with prior research which reported that physical activity enhances not only physical independence but also facilitates social integration and mental alertness, particularly in older adults15. Improved physical autonomy often encourages individuals to re-engage in community and family roles, which may boost cognitive functioning and social participation.

The current study's findings affirm this interrelationship and demonstrate the far-reaching benefits of physical rehabilitation beyond physical health alone. Previous studies emphasized that structured OT interventions focused on movement coordination and proprioceptive training can result in meaningful functional gains, especially when paired with home-based exercise components [16]. In comparison, the current study not only replicated but surpassed such outcomes in terms of consistency and statistical significance, reinforcing the utility of a multidimensional OT approach.

However, the one concerning outcome was the decline in mental health scores post-intervention, as seen in Table 2. Across all analyses, this domain consistently showed statistically significant declines, with mean scores decreasing from 58.75 to 53.59 and from 64.13 to 55.38. The Wilcoxon test further supported this trend, indicating that 29 to 31 participants experienced a reduction in mental health scores, with Z-values around -4.843 and mean ranks suggesting strong negative shifts. While the statistical significance of this result is clear, its clinical implication points to an important gap in the intervention design.

A study conducted by Rucker et al., 2014 comparing 20 individuals with DPN to 20 age-matched controls found that those with DPN exhibited significantly poorer performance in executive functions, including verbal fluency, visuospatial processing, and cognitive multitasking [17]. The results suggest that impairments in executive function—such as reduced verbal fluency and slower mental processing—may contribute to diminished physical performance in individuals with DPN. The study highlights the need to consider both neuropsychological and emotional factors, like depression, when assessing or designing interventions to improve physical function in this population.

The absence of mental health components—such as cognitive behavioural therapy, peer support groups, or stress management strategies—may have left participants vulnerable to the psychological burden of their condition. This interpretation is supported by studies such as those by Al Hayek et al. and De Groot et al. which emphasize that mental health in chronic illnesses like diabetes must be addressed explicitly and cannot be assumed to improve solely through physical rehabilitation [18,19].

Psychological distress in diabetic patients often stems from fear of complications, perceived disability, and emotional fatigue—factors unlikely to be resolved through physical training alone. Vileikyte et al., 2005 conducted a study involving 494 individuals with diabetic peripheral neuropathy (DPN) that examined the link between neuropathy 10 8 severity and depressive symptoms [20].

The analysis revealed that specific symptoms, especially feelings of unsteadiness, had the strongest association with depression. These findings highlight the importance

of addressing both physical and psychological aspects of DPN. Interventions aimed at improving functional ability and managing illness-related beliefs may help reduce depressive symptoms in people with diabetic neuropathy. This study has a few limitations.

First, the small sample size may limit the generalizability of the findings. Second, the lack of mental health intervention led to a decline in mental health scores post- intervention and a short intervention duration with no long-term follow-up. Future studies could include a larger and more diverse sample to improve the generalizability of the findings. Incorporate follow-up evaluations (for 3 or 6 months) to assess the long-term effectiveness and retention of therapy improvements.

CONCLUSION

This study provides strong evidence supporting the effectiveness of the occupational therapy (OT) intervention in enhancing key domains such as balance, physical function, and social cognitive ability among individuals with diabetic neuropathy. The experimental group showed statistically significant improvements in all three areas, with all or nearly all participants demonstrating positive changes. However, a notable decline in mental health was observed, suggesting that while the intervention was effective physically and socially, it 6 lacked components to support psychological well-being. These improvements were both statistically and clinically meaningful, indicating that the OT intervention had a substantial positive impact.

Ethical Clearance
SCOT/NOV-24/ECNeuro-08,9/11/2024.

Conflict of interest statement: NONE

Funding- Self-funded

ACKNOWLEDGEMENT

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

OPEN ACCESS

A Comparative Study of Falls and Cognitive Frailty Among Hypertensive Older Adults Living in Urban Settings: A Correlational Study

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ABSTRACT

Population ageing presents a major global health concern, as chronic conditions like hypertension elevate the risk of cognitive decline, reduced functional ability, and falls among older individuals. Falls remain one of the primary causes of injury, dependency, and mortality in the elderly, while cognitive frailty—defined as the coexistence of physical frailty and cognitive impairment without dementia—has emerged as a strong indicator of negative health outcomes such as disability, hospital admission, and recurrent falls. The research was conducted at Santosh College of Occupational Therapy, with 75 participants selected from Balaji Old Age Home, Ghaziabad, according to predefined inclusion and exclusion criteria. The Fall Risk Assessment Tool (FRAT) and the Montreal Cognitive Assessment (MoCA) were employed to measure fall risk and cognitive performance, respectively. Statistical analysis, including descriptive measures and correlation testing, demonstrated a significant inverse relationship between cognitive ability and fall. The mean MoCA score (0.596 ± 0.180) reflected relatively consistent cognitive functioning, whereas the mean fall risk score (12.28 ± 3.186) revealed wider variation. These outcomes indicate that diminished cognitive function is strongly linked to increased susceptibility to falls among older adults with hypertension. Based on these results, the null hypothesis was rejected, supporting the view that cognitive frailty serves as an important determinant of fall risk. The study underscores the need for incorporating cognitive screening into fall risk assessments to improve preventive and rehabilitative strategies for hypertensive elderly populations.

KEY WORDS: AGEING, COGNITIVE, FALL RISK, HYPERTENSIVE ADULTS, QUALITY OF LIFE

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Received 12/02/2026 Accepted after revision 18/08/2026
Page Number- 07-11
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.2

INTRODUCTION

Ageing is an inevitable biological process marked by progressive physical, psychological, and social transformations that significantly affect the autonomy and overall quality of life of older adults [1]. As individuals age, there is a gradual decline in muscle strength, postural control, cognitive abilities, and cardiovascular functioning, all of which increase vulnerability to illness and mortality [2]. Among the various health challenges associated with aging, falls represent one of the most critical threats to the safety and well-being of the elderly population.

Worldwide, falls remain a leading cause of injury-related morbidity and mortality among individuals aged 60 years and above, contributing substantially to disability-adjusted life years (DALYs) lost each year [3] In addition to head trauma or joint dislocations, falls often lead to withdrawal from social and physical activities, accelerating further functional decline [4].

The burden of falls is particularly alarming in urban settings, where older adults are exposed to unique environmental hazards such as uneven pavements, poorly lit streets, overcrowded housing, and high traffic [5]. Moreover, urban life is often associated with social isolation, limited community interaction, and reduced access to age-friendly recreational spaces, all of which heighten vulnerability to falls [4].

For older adults living with chronic illnesses such as hypertension, the situation becomes even more precarious. Hypertension among the elderly not only contributes to cardiovascular complications but is also closely linked with impairments in balance, gait, and cognitive functioning [6]. Studies have demonstrated that fluctuations in blood pressure, arterial stiffness, and hypertensive brain injury can impair cerebral blood flow, leading to deficits in attention, executive functioning, and motor coordination—all of which are critical factors in fall prevention [7]. This condition reflects a dual vulnerability—both physical and cognitive—that place older adults at a heightened risk for adverse outcomes such as disability, dependency, hospitalization, and falls8. Individuals exhibiting both physical frailty and cognitive impairment face a significantly higher risk of disability, institutionalization, and mortality than those with either condition alone [9].

Importantly, cognitive frailty has been identified as a strong predictor of falls, given its association with slower reaction times, impaired judgment, reduced mobility, and diminished resilience to external stressors10. In hypertensive individuals, the risk of cognitive frailty is further amplified due to the impact of uncontrolled blood pressure on cerebrovascular health, which accelerates neurodegeneration and compromises cognitive reserve [11]. Thus, the intersection of hypertension, cognitive frailty, and urban living creates a "triple jeopardy" for older adults, demanding urgent attention from healthcare professionals, policymakers, and researchers [12].

The importance of studying falls and cognitive frailty among hypertensive older adults lies not only in its clinical implications but also in its potential to guide community and public health interventions. Falls and frailty are not inevitable consequences of aging; rather, they are preventable through early screening, appropriate interventions, and supportive environments [13]. Comparative research can also provide valuable evidence for designing effective fall-prevention strategies [3].

The WHO has emphasised the need for cities to adapt infrastructure, healthcare systems, and social services to accommodate their aging populations. Understanding how hypertension interacts with cognitive frailty to influence fall risk can help urban planners design safer public spaces, improve accessibility, and foster community engagement, while supporting the integration of multidisciplinary care models [14].

Furthermore, this area of research carries significant economic implications. Falls among older adults impose substantial financial burdens on healthcare systems worldwide through emergency care, hospital admissions, surgical interventions, and long-term rehabilitation [15]. When combined with cognitive frailty and hypertension, these costs escalate further due to prolonged recovery, increased complications, and a higher likelihood of institutionalisation. Therefore, preventive strategies informed by comparative research can not only improve health outcomes but also reduce the economic strain on healthcare systems [16].

This correlational study on falls and cognitive frailty among hypertensive older adults in urban settings is crucial for bridging gaps in current knowledge and practice. While past research has individually examined falls, frailty, and hypertension, few studies have explored their combined impact in urban populations [15]. Addressing this gap can contribute to evidence-based strategies that promote healthy aging, enhance independence, and uphold the dignity of older adults in rapidly urbanizing societies.

METHODOLOGY

This is a correlational study which was reviewed and approved by the Institutional Ethical Committee of Santosh College of Occupational Therapy (Ref No.-SCOT/JULY-25/ECNeuro-06). and by using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 75 participants Permission to conduct this study was obtained from Bala ji old age home. 75 participants were chosen for the study by using convenient sampling in accordance with

the inclusion and criteria, the elderly people aged 60-89 years, Included diagnosed with hypertension by physician included, both male and female. Participants with dementia; and with serious mental disorder and participants with any other neurological condition were excluded. An informed consent form was given to participant. Montreal cognitive assessment and fall risk assessment tool were the outcome measures used for the analysis of outcome of the study.

Outcome Measure: The Montreal Cognitive Assessment (MoCA) and the Falls Risk Assessment Tool (FRAT) are standardized instruments commonly used to evaluate cognitive and physical functioning in individuals, particularly in clinical and geriatric populations. The MoCA, developed in 1996 by Ziad Nasreddine in Montreal, Quebec, is a 30-point screening tool designed to detect cognitive impairment and is widely validated, especially for identifying mild cognitive impairment (MCI). It assesses multiple domains including short-term memory, executive function, attention, and focus, and typically takes about 10 minutes to administer, with adaptations based on education and cultural background [17].

Complementing this, the FRAT, developed in 1999 by the Peninsula Health Falls Prevention Service, is a validated tool used to identify individuals at risk of falls. It comprises three sections: Part 1 – Falls Risk Status, Part 2 – Risk Factor Checklist, and Part 3 – Action Plan, providing a structured approach for both screening and prevention

Table 1. Demographic Data of the participants

Characteristics	Category	Male	Female	Male (%)	Female (%)
Age (years)	61-70	17	10	32.69	43.48
	71-80	9	3	17.31	13.04
	81+	26	10	50	43.48

Table 2. Descriptive Statistics of the outcome measures

Descriptive Statistics					
	N	Mean		Std. Deviation	Variance
	Statistic	Statistic	Std. Error	Statistic	Statistic
MoCA Scoring Outcome	75	0.59	0.020	.1797005628602 55	.032
Fall Risk Assessment Tool	75	12.28	.368	3.186	10.150

planning in sub-acute and residential care settings18. Together, these tools offer valuable insights into cognitive and physical vulnerabilities, supporting comprehensive clinical assessment and preventive intervention strategies.

RESULTS

The above table 1.0 describes age-wise distribution shows that among males, half (50%) belong to the 81+ age group, followed by 32.69% in the 61–70 years range and 17.31% in the 71–80 years category. In contrast, females are equally represented in the 61–70 and 81+ groups (43.48% each), with only 13.04% in the 71–80 category.

The above table 2.0 indicates that the MoCA Scoring Outcome had a mean of 0.596 (SD = 0.180), reflecting relatively low variability (variance = 0.032) among participants. In contrast, the Fall Risk Assessment Tool showed a mean score of 12.28 (SD = 3.186), with a higher variance (10.150), suggesting greater variability in fall risk across the sample. Data were complete for all 75 participants (valid N = 75).

Table 3. Correlation of MoCA and Fall Risk Assessment Too

Scale		MoCA Scoring Outcome	Fall Risk Assessment Tool
MoCA Scoring Outcome	Pearson Correlation	1	-.788**
	Sig. (2-tailed)		<.001
	N	75	75
Fall Risk Assessment Tool	Pearson Correlation	-.788**	1
	Sig. (2-tailed)	<.001	
	N	75	75
**. Correlation is significant at the 0.01 level (2-tailed).			

Table 3.0 Correlation analysis reveals a strong negative relationship between MoCA Scoring Outcome and the Fall Risk Assessment Tool ($r = –0.788$, $p < 0.001$). This indicates that higher cognitive scores are significantly associated with lower fall risk, and vice versa.

DISCUSSION

The participants showed distinct age distributions between males and females. Among males, 50% were in the 81+ years group, 32.69% in the 61–70 years group, and 17.31% in the 71–80 years group. In contrast, females were more evenly distributed, with 43.48% each in the 61–70 years and 81+ years groups, and 13.04% in the 71–80 years group.

Cognitive performance, measured using the Montreal Cognitive Assessment (MoCA), recorded a mean score of 0.596 (SD = 0.180; variance = 0.032), reflecting low variability among participants. Fall risk, assessed with the Fall Risk Assessment Tool, yielded a mean score of 12.28 (SD = 3.186; variance = 10.150), indicating greater variability across the sample. Non-parametric tests supported these findings, Spearman's rho ($r = –0.783$, $p < 0.001$) showing significant negative associations. These consistent results confirm that lower cognitive function is strongly associated with higher fall risk in hypertensive older adults [13].

The relationship between cognitive frailty and fall risk in hypertensive older adults provides important insights into the interplay between cognitive decline and physical

vulnerability. The demographic profile revealed a predominance of older males in the sample, particularly those aged 81 years and above, whereas females were more evenly distributed across the age groups. This observation is noteworthy because advancing age is a major determinant of both cognitive impairment and fall susceptibility. The higher representation of very old males in the sample underscores the importance of targeting interventions for this subgroup, as advanced age compounds both frailty and hypertension-related risks [15].

Descriptive statistics indicated relatively low variability in cognitive performance, with most participants showing moderate levels of impairment, while fall risk scores displayed greater variability. This suggests that although cognitive decline was somewhat uniform across the hypertensive cohort, individual differences in fall susceptibility were more pronounced. Previous research has highlighted that while hypertension is consistently linked to reduced cognitive performance, its interaction with physical function and falls may vary depending on comorbidities, physical activity levels, and environmental factors [19].

Analyses revealed a strong negative correlation, confirming the reliability of the association between cognitive performance and fall risk. These findings are consistent with previous studies identifying cognitive frailty—the simultaneous presence of physical frailty and cognitive decline—as a major determinant of adverse health outcomes, particularly falls [20].

Colleagues also highlighted that cognitive frailty substantially heightens the risk of falls and functional deterioration in the elderly. The rejection of the null hypothesis in this study offers compelling evidence that cognitive frailty and fall risk are significantly related among hypertensive older adults, emphasizing the need for early assessment and preventive strategies [21]. The study demonstrates a strong and consistent negative association between cognitive function and fall risk in hypertensive older adults. Lower MoCA scores were significantly linked with higher fall risk across Pearson's, Spearman's rho analyses, confirming the robustness of this relationship. The null hypothesis was rejected, supporting the alternate hypothesis that cognitive frailty is a key predictor of fall vulnerability.

The limitations of the study are that it identifies associations but does not establish causation. Cross-sectional data collection restricts the ability to track long-term changes or progression; also, small sample size from a single old age home using convenient sampling limits generalizability of results. Further studies can be recommended to conduct on larger, multi-centre studies to enhance representativeness and external validity. It can also include objective measures (e.g., gait analysis, balance testing, neuroimaging) for more accurate assessment.

CONCLUSION

The study demonstrates a strong and consistent negative association between cognitive function and fall risk in hypertensive older adults. Lower MoCA scores were significantly linked with higher fall risk across Pearson's, Spearman's rho analyses, confirming the robustness of this relationship. The null hypothesis was rejected, supporting the alternate hypothesis that cognitive frailty is a key predictor of fall vulnerability.

Ethical Clearance:
Ref No.-SCOT/JULY-25/ECNeuro-06), 27/07/2025.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but can be obtained from the corresponding author upon reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

OPEN ACCESS

Effects of Post-Isometric Relaxation with Deep Neck Flexor Exercises to Improve Occupational Neck Pain and Quality of Life in the Teaching Profession: A Randomised Controlled Trial

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ABSTRACT

Extended periods of standing, sitting, and stationary posture are associated with shoulder and neck pain, as reported by 48.7% of school instructors. In order to alleviate neck discomfort, DCF training is advised to strengthen the endurance of particular postural muscles. Therefore, the aim of the study is to assess the effects of Post isometric relaxation with Deep neck flexor (DNF) exercises to improve occupational neck pain and quality of life in Teaching Profession. A total of 80 participants selected between 25- 55 years of age. In experimental group Post Isometric Relaxation with Deep neck flexor strengthening exercises and Ergonomical advice was given to the participants. In control group Neck Stabilization exercises was given to the participants. The 40-minute intervention was administered three times a week for ten weeks. The outcomes of the intervention were assessed using NDI and WHOQOL-BREF outcome measure. Following the intervention, there was remarkable improvements across all domains: physical health increased to 73.03, psychological health to 75.73, social relationships to 74.25, and environmental satisfaction to 75.67. This study provides compelling evidence that the combination of Post Isometric Relaxation (PIR) and Deep Neck Flexor (DNF) exercises is highly effective in reducing occupational neck pain and improving quality of life among teaching professionals. The better efficacy of the PIR and DNF exercise program was shown by the comparison study, which showed that the experimental group underwent more favorable changes than the control group.

KEY WORDS: DEEP NECK FLEXOR, NECK DISABILITY INDEX, POST ISOMETRIC RELAXATION, WHOQOL-BREF, WILCOXON SIGNED RANKS TEST.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 12/05/2026 Accepted after revision 18/08/2026
Page Number- 12-16
This is an open access article under Creative Commons License,
https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.3

INTRODUCTION

Non-traumatic musculoskeletal discomfort most frequently occurs in the neck. At some point in their life, almost two-thirds of the general population will have neck pain, with the prevalence being highest in middle age. The prevalence of neck discomfort has been observed to be higher in women and to have an increasing trend up to the age of 50, after which it declines. Up to 37% of people with neck discomfort experience persistent symptoms, making it a condition that places a significant financial strain on the medical system [1]. In terms of frequency, mechanical neck discomfort is second only to low back pain, and it significantly impairs the general population [2].

Musculoskeletal pain disorders are highly prevalent among school instructors, according to numerous international studies. It has been shown that compared to other occupational groups, school teachers generally report a greater prevalence of musculoskeletal problems. While the prevalence of musculoskeletal pain varied among the populations tested, it was evident that teachers had a higher probability of experiencing it (ranging from 23.7% to 95.1%) [1].

Teachers' mental health and quality of life are severely impacted by the high degree of stress they experience at work, making it one of the most stressful professions3. The primary reason for early retirement and absence in this group is musculoskeletal pain. Stress from teaching affects instructor's performance in the classroom. Teacher's jobs frequently require them to spend a lot of time with their heads lowered, such as when they are marking homework and reading a lot. In addition to instructing students, teachers are also responsible for lesson planning, grading student work, and taking part in several committees at school Due to the complexity of job tasks, this could result in negative mental and physical health consequences for teachers [1].

The most common health issues among teachers are related to their musculoskeletal system, with low back pain ranking 10th, neck pain ranking 7th, and shoulder discomfort ranking sixth. The neck, shoulders, low back, and upper limbs are the most commonly reported musculoskeletal pain sites among school teachers, perhaps due to their heavy workload and incorrect posture. 48.7% of school teachers report having neck and shoulder pain, which is linked to extended standing, sitting, and immobile posture. On the other hand, it has been claimed that between 40% and 75% of instructors experience low back pain [4].

Teachers also frequently experience upper limb pain, which has been linked to higher psychological demands when doing tasks requiring the use of the upper limbs alone. School teachers' high prevalence of musculoskeletal discomfort has been linked to a number of causes these included hard lifting, extended sitting, bad posture, anxiety, a demanding profession with a lot of work, a lack of support from peers and colleagues, and mental health issues. Risk factors for considerable musculoskeletal discomfort included age, gender, fixed posture, state of the patient's mind, and present job conditions5.

A key postural role of the deep cervical flexor (DCF) is to support and straighten the cervical lordosis. It has been discovered that some cervical spine muscles, most often the DCF, have a tendency to deteriorate in NP. In fact, there is growing data that suggests when NP sufferers are distracted, they tend to adopt a more forward head position (FHP). Cranio-cervical flexion (CCF) is the primary function of the deep cervical flexor muscle, which supports the deep cervical flexor motion segments. Therefore, DCF training is clinically advised for NP management [6]. The Deep Cervical Flexor muscles (DCF) are believed to be crucial for preserving the head-on-neck position. According to one notion, the balance between the DCFs and the stabilizers on the back of the neck would be thrown off when there was a disturbance in muscle function resulting in a loss of proper posture and alignment. This will therefore probably make cervical injury worse. Therefore, DCF training is recommended to increase the endurance of specific postural muscles in order to improve NP [7].

Effective interventions are necessary to prevent and manage occupational neck pain, reducing absenteeism and improving productivity. Thus, this study aims to investigating the effects of PIR with DNFE and contribute to the development of effective exercise programs for teaching professionals, ultimately improving their health and well-being.

MATERIAL AND METHODS

A randomized control trial comparing the effect of Post isometric relaxation with Deep neck flexor (DNF) exercises with control group was designed. This study was reviewed, discussed and approved by the Santosh Occupational Therapy institutional ethical committee (Ref No.-SCOT/NOV-24/ECOrtho-01). Based on the 80% power and an alpha value of .05 the sample size calculated to be 40 participants in each group.80 participants were selected from Arun Modern Public Senior Secondary School, North – East Delhi, Children's Valley Public School, Jagriti Public School, Nav Saraswati Inter College and Daya Public School as per inclusion and exclusion criteria. Prior to participate in the study, participants were explained about the study.

The participants provided their written consent. Convenient sampling was used to assign the individuals to the control and experimental groups. Eligible participants included male and female teachers aged between 25 and 55 iyears who experienced neck pain lasting from six weeks to three months. Additional inclusion criteria required participants

to report limited neck mobility and work-related neck discomfort.

According to the exclusion criteria, people who had a history of recent trauma, people who worked in any occupation other than teaching, people with a diagnosis of any other musculoskeletal condition, and people who had any neck pain that spread to their arms and upper extremities were not allowed to participate. The experimental group's participants received ergonomical guidance, deep neck flexor strengthening exercises, and post-isometric relaxation. Participants in the control group performed neck stabilization exercises. Both groups' participants underwent a 10i-week intervention consisting of three 40i-minute sessions each week. The WHOQOL-BREF outcome measure and the NDI were used to evaluate the intervention's results.

The Intervention Program includes Post isometric relaxation exercises - 20% maximum isometric contraction for 10i repetitions of the upper trapezius, levator scapulae, and pectoralisi major muscles, followed by 7–10i seconds of rest2, DNF exercises – These include 3 exercises, in first exercise the patient should lie on their back with their knees comfortably bent, place a little towel folded up underneath the head. After that, the patient will be told to avoid sticking out their chin by making a tiny nodding motion as though they are looking towards their toes and after holding this posture for ten seconds, the patient moves back to its initial position.

The patient is told to lie supine with their knee comfortably bent for the second exercise. The patients will be instructed to nod slightly without protruding their chins, and they will remain in this position for 10i seconds before returning to it. In Third exercise, the patient is told to lie on their side with their head hanging off the edge of the bed and the subject is required to tuck his chin in and hold it there for ten seconds. All exercises performed with ten repetitions followed by a ten-second rest. Neck Stabilization exercise - The initial 20 minutes of the session were dedicated to stretching exercises targeting the scapular region, pectoral muscles, shoulders, and neck. For the following twenty minutes, the patient does isometric neck exercises, which include flexion, extension, lateral flexion, and rotation. 10i repetitions followed by a ten-second rest in the first week and 15 repetitions in the following weeks [8].

Outcome Measures: The following outcome measurements were taken at baseline and again after 10 weeks of training. The assessment tools included Neck Disability Index (NDI)-The purpose of this questionnaire is to gather information on how your neck discomfort has impacted your capacity to function in daily life. There are ten sections in this questionnaire: Pain Intensity, Personal Care (Washing, Dressing, etc.), Lifting, Reading, Headaches, Concentration, Work, Driving, Sleeping, Recreation9 and WHOQOL – BREF -There are 26 questions. The WHOQOL-BREF (Field Trial Version) is usedi to assess an individual's qualityi of lifei across multiple dimensions. Iti provides four domain scores, each representing a specific aspect of quality of life. Each domain score reflects the individual's subjective assessment within that category. Scores are interpreted in a positive direction, meaning that higher values correspond to a better quality of life10.

RESULTS

There were 40 participants in each group (control and experimental), assuring a comparable sample size. The experimental group's average age was 36.22 years, which is marginally older than the control group's mean age of 31.85 years. The experimental group consisted of 7 males and 33 females, while the icontrol group included 6 males and 34 females. Overall, both groups were relatively similar in terms of gender distribution and age range, with only minor differences observed.

Table 1. Demographic characteristics of the participants

S. No.	Baseline Characteristics	Experimental Group	Control Group
1	No. of Subjects	40	40
2	Mean Age	36.22	31.85
3	Gender M/F	7/33	6/34

The Wilcoxoni Signed Ranks Test results showed that both thei control and experimental groups experienced statistically significant improvements in occupational neck pain and quality of life following the intervention, with p-values less than 0.001 across all measured domains (NDI, D1–D4).

A closer comparison of the Z-values between the 2 groups reveals that the experimental group demonstrated greater improvement overall. Specifically, the experimental group had more negative Z-values across all domains—NDI (-5.516), physical health (-5.523), psychological health (-5.517), social relationships (-5.520i), and environment (-5.515)—compared to the control group, whose corresponding Z-values were slightly less negative. These more negative Z-scores suggest a larger shift in post-test scores relative to pre-test scores in the experimental group. Therefore, it can be concluded that the group receiving Post Isometric Relaxation combined with Deep Neck Flexor (DNF) exercises experienced a more substantial reduction in neck pain and a more pronounced improvement in all aspects of quality of life. This indicates that the experimental group intervention was more effective than the control condition.

DISCUSSION

This study investigates the impact of combining iPost-Isometric iRelaxation (PIR) iwith Deep Neck iFlexor (DNF) exercises on ireducing occupational neck pain and improving the quality of life among teaching professionals. At baseline, the experimental group had a mean NDI score of 21.17, indicating moderate neck disability. Following the intervention involving PIR combined with DNF exercises, the mean score significantly decreased to 11.25,

corresponding to mild disability. This nearly 10i-point reduction was both statistically and clinically meaningful, highlighting notable improvements in cervical function and pain reduction [11].

Supporting these findings, Chauhan, Attrey, and Singh (2021)2 demonstrated that combining ipost-isometric relaxation with deep neck flexor exercises was more effective in relieving ipain, reducing disability, iand enhancing cervical range of motion than deep neck flexor iexercises alone in ipatients with subacute mechanical neck pain.

Table 4. Comparison of Control and Experimental Group

Stats	Control Group					Experimental Group				
	NDI (POST - TEST) - NDI (PRE - TEST)	Post-D1 - pre-D1	Post-D2 - pre-D2	Post-D3 - pre-D3	Post-D4 - pre-D4	NDI (POST - TEST) - NDI (PRE - TEST)	Post-D1 - pre-D1	Post-D2 - pre-D2	Post-D3 - pre-D3	Post-D4 - pre-D4
Z	-5.379[b]	-5.446[c]	-5.515[c]	-5.458[c]	-5.515[c]	-5.516[b]	-5.523[c]	-5.517[c]	-5.520[c]	-5.515[c]
Asymp. Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001	<.001

Beyond physical symptom relief, the intervention also significantly improved participants' iquality of life, as imeasured by the iWHOQOL-BREF across four idomains: physicalihealth, ipsychological well-being, isocial relationships, and ienvironmental satisfaction12. Initially, ithe experimental group scored moderately low across these domains, with physical health at 39.82, psychological health at 36.88, social relationships at 31.73, and environmental factors at 32.65, indicating moderate dissatisfaction or impairment at baseline.

Following the intervention, post-test scores showed remarkable improvements across all domains: physical health increased to 73.0i3, psychological health to 75.73, social relationships to 74.25, and environmental satisfaction to 75.67. These post-test scores not only reflect statistically significant gains ($p < 0.001$ across all domains) but also indicate a near-doubling of satisfaction levels in certain aspects of life, particularly in social and psychological domains. Zivkovic et al. conducted a study on Relationship Between Physical Activity and Quality of Life in High School Educators which provides new insights into how occupational inactivity affects this particular workforce3. The findings revealed gender differences in quality of life: female teachers reported higher satisfaction in social relationships and environmental domains, whereas male teachers demonstrated better quality of life in physical and psychological health areas [13].

The robustness of these outcomes is further demonstrated through inon-parametric istatistical ianalysis usingi the Wilcoxoni Signedi Ranksi Test. In the experimental group, all 40i participants exhibited a reduction in neck disability, with no instances of worsening or unchanged symptoms. The corresponding Z-value for the NDI was -5.516, and the p-valuei was lessi thani 0.001, iindicating an extremely isignificant shift unlikely to be due to chance. Similarly, in the iquality-of-lifei domains, every participant ini the iexperimental igroup showed improvement—40 out of 40 had positive rank changes in D1 through D4, with mean ranks of 20.50 and no negative ranks or ties. Z-values were -5.523 for physical health, -5.517 for psychological health, -5.520 for social relationships, and -5.515 fori environmental satisfaction, all with p values below 0i.0i0i1. These consistently strong negative Z-values across all measures provide unequivocal support for the efficacy of the PIR plus DNF intervention.

Moreover, a comparative analysis between the experimental and control groups adds another layer of evidence favouring the intervention. While the control group also demonstrated some level of improvement, likely due to the passage of time or generic interventions, the gains observed in the experimental group were markedly superior. This is evident from the fact that the Z-values for thei experimentali groupi werei more strongly negative thani thosei in the control igroup, highlighting a more substantial shift in both NDI and WHOQOL– BREF scores. In terms of hypothesis testing, the null hypothesis—that PIR combined with DNF exercises would have no significant effect on neck disability and quality of life—was clearly rejected. Instead, the alternate hypothesis was strongly supported, with all outcome measures pointing toward the intervention's effectiveness. These findings suggest that incorporating PIR techniques alongside DNF strengthening exercises may offer a more holistic and powerful approach to treating work-related neck pain than traditional single-component strategies.

These results are statistically robust, clinically meaningful and consistent across all participants, suggesting that this protocol could serve as an effective model for managing occupational neck pain in similar populations. The study thus contributes valuable insights to the existing body of literature and encourages broader implementation of multi-

dimensional rehabilitation strategies in occupational health settings. The Limitation of this study is it did not have a sufficient follow-up period to assess the long-term effects of the combination of Post Isometric Relaxation (PIR) and Deep Neck Flexor (DNF) iexercises iand Only Teaching Profession was considered. Future research could include the investigation of the effectiveness of delivering DNF and PIR exercises through mobile health applications or virtual platforms to increase accessibility for teachers with time constraints and could also include the assessment of participants in the middle of intervention period and other Professions could be taken into consideration.

CONCLUSION

This study provides compelling evidence that the combination of Post Isometric iRelaxation i (PIR) and iDeep Neck Flexor (DNF) exercisesi is highly effective in ireducing occupational neck ipain and iimproving quality of life among teaching professionals. Significant improvements were observed in neck disability and WHOQOL-BREF scores, following the intervention. The consistent statistical significance across all measures, with Z-values strongly negative and p-values below 0i.0i0i1, confirms that these improvements are unlikely to be due to chance. Comparative analysis demonstrated that the experimental group experienced greater positive changes than the control group, underscoring the superior effectiveness of the PIR and DNF exercise regimen.

Ethical Clearance:
Ref No.-SCOT/NOV-24/ECOrtho-01 ,11/11/2024.

Conflict of interest statement: NONE.

Funding: Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

The Effect of Early Exercise Training on Activities of Daily Living (ADL) And Quality of Life in Patients with Hand Burns - A Randomised Controlled Trial

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ABSTRACT

Hand burns often result in significant impairments in function, affecting an individual's ability to perform ADLs and reducing overall QOL. Early rehabilitation, including structured exercise programs and occupational therapy, is considered essential for minimizing disability and promoting recovery. This study aims to assess the effect of early exercise training combined with conventional occupational therapy on ADL performance and quality of life in patients with hand burns. A total of 52 participants with hand burns, aged between 18 and 60 years, were selected based on defined inclusion and exclusion criteria and randomly assigned to experimental and control groups.The experimental group received early exercise training, splinting, and ADL training along with conventional occupational therapy, while the control group received only conventional ROM exercises. Both groups showed improvements post-intervention, but the experimental group demonstrated significantly greater gains in ADL performance and QOL. The increase in Barthel Index scores and SF-36 physical and mental component scores was more pronounced in the experimental group, indicating the effectiveness of early, targeted intervention. The Barthel Index scores increased substantially from pre- to post-intervention in both samples analysed. Early exercise training combined with occupational therapy significantly improves functional independence and enhances quality of life in patients with hand burns. This supports the need for early, structured rehabilitation as part of standard burn care protocols.

KEY WORDS: ACTIVITIES OF DAILY LIVING (ADL), BARTHEL INDEX, EARLY EXERCISE TRAINING, HAND BURN, SF-36.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 11/05/2026 Accepted after revision 15/08/2026
Page Number- 17-22
This is an open access article under Creative Commons License,
https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.4

INTRODUCTION

The skin is the biggest organ of the human body, spanning approximately 2 square meters in a median grown-up. It includes primary layers—the epidermis and the dermis—below which can be important skin appendages, such as hair follicles, sweat glands, and sebaceous glands. These deeper systems act as reservoirs of proliferating epithelial cells (keratinocytes), which migrate to the wound or clot website and play a crucial role inside the recuperation process [1].

When this shielding barrier is damaged, the skin will become liable to harmful microorganisms, that could boom the hazard of infection and, in severe instances, development to sepsis. After a burn injury, tissue repair begins within hours, but excessive fluid loss from the wound can delay the healing process. Even minor burns may lead to long-term functional impairment and cosmetic concerns [2,3]. Burn injuries have been documented as a medical concern since ancient times. Historical records, such as prehistoric cave art, Egyptian medical papyri, and early Chinese medical illustrations, describe burn care practices. Classical physicians, including Hippocrates, Celsus, and Galen, outlined treatments involving ointments, dressings, and various therapeutic methods [4].

Burns are categorized into "partial-thickness" and "full-thickness" types. Superficial partial-thickness burns—affecting only the dermis and the top portion of the epidermis—generally heal within 10–14 days with little to no scarring, as most skin appendages remain undamaged. Deep partial-thickness burns make bigger into the lower dermis, harming a wider variety of appendages, and may require 3–6 weeks to heal, with a better likelihood of hypertrophic scarring. Full-thickness burns involve complete destruction of all pores and skin layers and regularly necessitate surgical intervention for recovery [5].

Burn causes include thermal, electrical, chemical, and radiation exposure. Thermal burns, making up about 90% of cases, vary in depth depending on temperature and duration of contact. Electrical burns account for less than 5%, occurring more frequently in children and male labourers, with severity influenced by current type, voltage, amperage, contact duration, and current pathway. Chemical burns, around 3% of cases, typically happen in homes or industrial settings. Alpha particles, being heavy helium ions, travel only a short distance in air and cannot penetrate the skin's keratin layer [6].

Hands, essential for daily function, are particularly vulnerable to burns. Although, they are involved in over 80% of severe burn cases. The American Burn Society classifies hand burns as "major injuries," and they account for 6% of total hand-related injuries. Losing hand functionality can lead to a 54% loss of overall functional ability [7]. Such injuries not only impair physical function but also have biological, social, and psychological consequences, reducing quality of life and affecting social and occupational participation. Even minor burns to the hands warrant a comprehensive treatment approach due to their potential impact on function, appearance, and emotional well-being8.

Early intervention and rehabilitation are key to optimal outcomes. Treatment may include passive motion exercises, targeted therapies, surgical repair, and skin grafting, requiring collaboration between plastic surgeons, physical therapists, occupational therapists, and psychologists. Ideally, the multidisciplinary team should be involved from the first day of hospitalization [9,10].

Health-related quality of life (HRQL) is a vital outcome measure for burn recovery, encompassing the affected person's physical, intellectual well-being. Burns could severely affect daily functioning in both the short and long term. While some HRQL domains improve over time, others—such as physical and emotional role participation—may remain impaired, highlighting the lasting psychological and physical burden of burn injuries [7].

Loss of autonomy in activities of daily living (ADL) can harm mental health and self-esteem, disrupt social interaction, and reduce family engagement. In burns affecting the hand and its small joints, limitations in active range of motion (AROM) can significantly impact occupational performance and functional independence9. Even burns involving a single joint in the upper limb can greatly hinder ADL performance. Restoring functional ROM, strength, and mobility is essential to prevent scar contractures that could interfere with everyday activities [5].

Hand burns can significantly impact an individual's ability to perform daily activities and maintain their quality of life [11]. Early exercise training may play a crucial role in rehabilitation, but its specific effects on ADL and quality of life in patients with hand burns12. Thus, this study aims to investigating the effects of early exercise training and to contribute to the development of effective rehabilitation strategies for patients with hand burns, ultimately improving their functional outcomes and quality of life.

MATERIAL AND METHODS

A randomized control trial comparing the effect of Early exercise training intervention with control group was designed. This study was reviewed, discussed, and approved by the Santosh Occupational Therapy Institutional Ethical Committee (Ref No.-SCOT/NOV-24/ECOrtho-03). Using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 52 participants. Participants were selected

from Dr Rawal's burn unit Lajpat Nagar Delhi as per the inclusion and exclusion criteria. Prior to participation, the study procedure was explained to the participants, and written informed consent was obtained. The participants were then randomly assigned to the control group and experimental group by a random sampling method.

As per inclusion criteria, individuals in the age range of 13–18 years and above who had sustained burn injuries, with partial-thickness (second-degree) to full-thickness burns involving more than 10% of the total body surface area (TBSA), were included in the study. Patients with thermal, chemical, electrical, or radiation burns, and those who had been hospitalized for treatment including surgery or skin grafts, were also included.

As per exclusion criteria, individuals with pre-existing physical or cognitive disabilities affecting ADL performance unrelated to the burn injury, those with burns involving less than 10% TBSA, and patients with severe comorbid medical conditions such as terminal illness or uncontrolled chronic diseases that could interfere with assessment of burn recovery were excluded from the study.

In the experimental group, participants received an Early exercise training of structured occupational therapy intervention program which included edema reduction techniques, positioning and splinting (if necessary), range of motion exercises (both passive and active), active resistive exercises, stretching exercises, and practicing of activities of daily living (such as using a spoon, getting dressed, writing, opening and closing bottles, using zippers and buttons). These exercises were provided for 30 minutes, two times a day, over a duration of 12 weeks [5].

In the control group, participants performed only scheduled range of motion exercises for the upper extremity including flexion-extension, abduction-adduction, and internal-external rotation of the upper limb, for 30 minutes per session, twice a day, over a duration of 12 weeks [13].

Outcome Measures: The following outcome measurements were taken at baseline and again after 12 weeks of training. The assessment tools included the Barthel Index (BI) which is a validated tool, it provides an objective assessment of functional ability, making it an ideal outcome measure in clinical research and practice14. As an outcome measure, the Barthel Index is widely recognized for its simplicity, reliability, and validity. The BI's focus on daily functioning makes it particularly useful for assessing quality of life improvements in patients recovering from injuries or illnesses impacting physical ability14 and the SF-36 Health Survey (Short Form-36) is tool used for assessing QOL and overall health status across physical and mental health domains. It's known for its solid psychometric properties, making it a popular choice for both clinical and research settings [15].

Table 1: Descriptive Statistics of Control and Experimental Groups for Barthel Index and SF-36 (Pre- and Post-Test)

Stats		Control Group				Experimental Group			
		Mean	N	Std. Deviation	Std. Error Mean	Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Barthel Pre	48.73	26	16.208	3.179	44.54	26	16.053	3.148
	Barthel Post	57.92	26	16.052	3.148	70.81	26	16.798	3.294
Pair 2	SF-36 Pre	44.635	26	8.812	1.7282	42.019	26	7.9416	1.5575
	SF-36 Post	51.615	26	8.8942	1.7443	66.077	26	7.7701	1.5238

RESULTS

The analysis of this study was conducted at a significance level of 0.05. The sample consisted of 26 participants. The mean age in the experimental group was 36.23 years and in the control group, 40.76 years. Gender distribution showed 17 females and 9 males in the experimental group, and 11 females and 15 males in the control group.

To examine the statistical significance of these changes, both Wilcoxon Signed-Rank Test and Paired Samples t-tests were performed.

Wilcoxon Signed-Rank Test revealed that all 26 participants demonstrated positive ranks for both the Barthel Index and SF-36 scores, meaning every individual improved following the intervention. There were zero negative ranks and zero

ties, indicating consistent improvement across the cohort. The mean rank was 13.50, and the sum of ranks was 351.00 for both measures, highlighting strong effectiveness of early exercise training in improving functional independence and quality of life.

Paired Samples t-test revealed that for the Barthel Index, the mean difference between pre- and post-test scores in the experimental group was -26.269 (SD = 5.088; SEM = 0.998). The 95% confidence interval ranged from -28.324 to -24.214, with a t-value of -26.328 (df = 25) and a p-value < .001, confirming highly significant improvement.

Table 2 Comparison of Control and Experimental Group

Stats Table 6.0		Paired Differences					t	df	Significance	
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference					
					Lower	Upper			One-Sided p	Two-Sided p
Pair 1	Barthel Pre - Barthel Post	-26.269	5.088	.998	-28.324	-24.214	-26.328	25	<.001	<.001
Pair 2	SF-36 Pre - SF-36 Post	-24.0577	1.9252	.3776	-24.8353	-23.2801	-63.717	25	<.001	<.001

For the SF-36, the mean difference between pre- and post-test scores was -24.058 (SD = 1.9252; SEM = 0.3776). The 95% confidence interval ranged from -24.8353 to -23.2801, with a t-value of -63.717 (df = 25) and a p-value < .001, again demonstrating strong and statistically significant improvement in quality-of-life outcomes.

A comparative evaluation was conducted between the control group and the experimental group to assess the differential effects of early exercise training.

For ADL (Barthel Index) Control Group: Mean improvement of -9.192 (95% CI: -10.357 to -8.027; t = -16.248; p < .001). Experimental Group: Mean improvement of -26.269 (95% CI: -28.324 to -24.214; t = -26.328; p < .001).For QoL (SF-36)Control Group Mean improvement of -6.9808 (95% CI: -7.4101 to -6.5515; t = -33.491; p < .001).Experimental Group Mean improvement of -24.058 (95% CI: -24.835 to -23.280; t = -63.717; p < .001).

The experimental group consistently outperformed the control group in both functional and quality of life domains. These differences indicate that while both groups benefited from standard care, the addition of early exercise training led to significantly greater improvements in recovery outcomes. Across all statistical analyses, the data strongly support the effectiveness of early exercise training in enhancing both functional independence and quality of life in patients recovering from hand burns. The absence of negative outcomes, combined with the uniform direction and magnitude of improvements, reinforces the conclusion that early rehabilitation interventions play a critical role in optimizing patient recovery.

DISCUSSION

The present study explores the effect of Effect of Early Exercise Training on Hand Burns. In this study, 52 pre-diagnosed participants were selected from Dr Rawal's burn unit based on inclusion criteria.

The Barthel Index scores increased substantially from pre- to post-intervention in both samples analysed. In one subset, scores improved from a mean of 48.73 to 57.92, and in another, from 44.54 to 70.81, indicating not only consistency but also a potentially dose-dependent or time-sensitive effect of early exercise. These changes were further validated by the paired t-test results, which reported a mean difference of -26.269 in the experimental group (p < .001), far greater than the -9.192 mean difference observed in the control group.

Such functional improvements are critical in burn rehabilitation, as patients often face severe impairments in mobility and daily function. This study advances the literature by offering more statistically consistent and universal improvements—evident in the Wilcoxon results where all 26 participants showed positive ranks, without any deterioration or stagnation in performance.

Khanipour et al. (2023) did a study to investigate the effects of occupation-based intervention on hand and upper extremity function, daily activities, and quality of life in people with burn injuries the study showed that the occupation-based interventions are as effective as traditional therapeutic interventions for the improvement of hand and upper extremity function, ability to perform daily activities, and quality of life in people with burn injuries [16].

Najafi et al (2019) did a study to find out the effect of range of motion exercises on activity daily living and quality of life in patients with burns, the results indicate the effective role of range of motion exercises on improving the activity daily living and quality of life of patients with burns in all aspects. Thus, it is recommended to use range of motion exercises in providing appropriate care for burn patients in hospitals and burn centers [17].

This study particularly noteworthy is the uniformity and strength of statistical outcomes. All participants demonstrated improvement (positive ranks only), with no ties or negative ranks, suggesting homogeneous benefits of the intervention across the cohort. This level of consistency is rarely reported in clinical rehabilitation studies, which often observe mixed responses due to individual variability. The low standard errors of the mean (SEM) across time points and measures further reflect precise estimates of population-level changes, strengthening confidence in the findings.

Moreover, by using both non-parametric (Wilcoxon) and parametric (t-test) approaches, the analysis ensures that conclusions are not method-dependent. The fact that both statistical approaches converge in their conclusions adds methodological robustness to the study. Despite its promising results, the study had certain limitations. This study did not have sufficient follow-up for the long-term impact of early exercise training on ADL and QOL post burn injury.

Although the study included 52 participants, a larger sample would provide more generalizable results and increase statistical power. Future research should include participants from multiple hospitals or rehabilitation centers to enhance the generalizability and external validity of the findings, larger and more diverse sample would improve the statistical power and help identify subgroup-specific responses to intervention (e.g., age, gender, burn depth). Post-discharge follow-up assessments are necessary to evaluate the sustainability of improvements in ADL and quality of life over time.

CONCLUSION

This study clearly demonstrates that early exercise training significantly improves both functional independence (Barthel Index) and quality of life (SF-36) in patients with hand burns. Between groups, the experimental group received structured early exercise and showed markedly greater improvements than the control group. Higher mean score differences, stronger statistical significance, and consistent positive outcomes across all participants, early exercise proves to be the more effective intervention in burn rehabilitation.

Ethical Clearance
Ref No.-SCOT/NOV-24/ECOrtho-03 ,11/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.
Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

The Effect of Core Strengthening and Progressive Plyometric Training on Dynamic Balance, Agility And Reaction Time in Amateur Badminton Players - A Randomised Controlled Trial

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ABSTRACT

The physical demands of badminton require athletes to possess both agility and balance in order to excel on the court. Core stability and plyometric training have emerged as key components of effective conditioning programs for athletes, offering unique benefits that enhance these critical skills. A Randomized contrail trail study was conducted to evaluate the effect of core strengthening and progressive plyometric training on dynamic balance, agility, and reaction time in amateur male badminton players aged 18–25 years. Total 68 participants were randomly divided in two group, 34 in control group and 34 in experimental group. The Experimental Group received a combination of core strengthening and plyometric exercises training, while the Control Group received only core strengthening exercises training. Each session lasted for 30-45 minutes and was conducted 2 times per week for a total duration of 8 weeks. Based on the results, the experimental group clearly outperformed the control group in terms of agility and reaction time. These improvements were both statistically and clinically meaningful, indicating that the OT intervention had a substantial positive impact. While both training methods boosted dynamic balance, the added plyometrics didn't provide a statistically greater benefit in this area.

KEY WORDS: AGILITY, BADMINTON PLAYERS; CORE STRENGTHENING; PROGRESSIVE PLYOMETRIC TRAINING; REACTION TIME

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 15/05/2026 Accepted after revision 18/08/2026
Page Number- 23-28
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.5

INTRODUCTION

Badminton is a high-intensity racket sport requiring exceptional physical and cognitive attributes, including agility, core stability, and rapid reaction times1. Characterized as one of the fastest racket sports, it demands continuous performance at maximal intensity during rallies that involve sudden directional changes, repeated lunges, jumps, and rapid shifts between offensive and defensive play [1].

These intermittent high-intensity movements place considerable stress on the musculoskeletal and neuromuscular systems while providing minimal recovery time. In addition to cardiovascular endurance and muscular strength, effective performance in badminton relies on speed, coordination, postural control, and cognitive processing2. Players must execute complex motor patterns such as lunges, lateral shuffles, pivots, and rapid decelerations, often in asymmetrical positions1. The sport further requires athletes to process visual and auditory cues, anticipate opponents' actions, and execute tactical decisions under pressure2. This multidimensional demand highlights the integration of physical conditioning and cognitive involvement as determinants of badminton performance [2].

Among the most critical components of successful play are agility, dynamic balance, and reaction time. Agility, the ability to change direction efficiently while maintaining control and speed [3], enables players to adapt to unpredictable shuttle trajectories, perform rapid transitions, and recover after strokes [4]. Similarly, dynamic balance—the ability to sustain stability during movement—supports efficient execution of shots such as smashes, drop shots, and lunges while minimizing the risk of instability and injury [5].

A strong interplay exists between agility and balance, with deficiencies in either leading to impaired movement efficiency6. Neuromuscular coordination and proprioceptive control underpin these skills, allowing precise acceleration, deceleration, and body orientation changes during rallies [4]. Proprioception, in particular, ensures joint stability and efficiency of movement during rapid directional changes, while fatigue can further compromise these functions [6].

Reaction time is another vital factor, referring to the interval between a stimulus and motor response [7]. In badminton, players must rapidly interpret shuttle speed, trajectory, and spin, converting sensory inputs into immediate motor actions. Quick reaction time enables athletes to adjust body position and respond effectively to deceptive or high-speed shots8. It depends heavily on sensorimotor integration and neuromuscular readiness, influenced by attention, anticipation, and muscle preparedness [7]. Faster reaction times are strongly associated with effective offensive and defensive play [8].

Targeted training interventions can significantly improve these performance variables. Core strengthening plays a crucial role by enhancing postural stability, trunk control, and force transfer between upper and lower limbs9,10. Stronger core musculature improves alignment, reduces energy loss during movement, and prevents injury by stabilizing joints under stress 2. Plyometric training, which emphasizes rapid eccentric–concentric muscle contractions through jumps and explosive movements, develops muscular power, neuromuscular efficiency, and agility [11,12].

Progressive plyometric training, characterized by gradual increases in load and complexity, improves lower-limb strength, agility, and dynamic balance while minimizing overuse injury risks5. When combined, core strengthening provides foundational stability, while plyometric drills enhance explosiveness, creating a synergistic effect particularly suited for badminton's multidirectional demands [13].

Several studies support this integrated approach. A four-week core training program improved agility and balance in young badminton players, as assessed by the Illinois Agility Test and Modified Star Excursion Balance Test 2. A recent systematic review confirmed core training's role in enhancing agility and balance among badminton players [14]. Similarly, combined core and plyometric training reduced knee injury risk in athletes by improving landing mechanics and neuromuscular control [4]. These findings highlight the dual benefits of performance enhancement and injury prevention.

In summary, agility, balance, and reaction time are fundamental to badminton performance. Core strengthening and progressive plyometric training represent evidence-based methods to enhance these parameters while reducing injury risk. However, limited research has explored their combined effects in amateur badminton players. Therefore, the present study aims to evaluate the impact of an integrated core and plyometric training program on dynamic balance, agility, and reaction time in amateur male badminton players, contributing to the development of optimized training protocols for long-term performance and musculoskeletal health.

MATERIAL AND METHODS

A Randomized contrail trail study was conducted to evaluate the effect of core strengthening and progressive plyometric training on dynamic balance, agility, and reaction time in amateur male badminton players aged 18–25 years. This study was reviewed and approved by the Institutional Ethical Committee of Santosh College of Occupational

Therapy (Ref No.-SCOT/NOV-24/ECNeuro-06) and data collection taking place from Poorvi Delhi Khel Parisar (PDKP) and Dr. Ram Manohar Lohia Park.

A total of 68 participants were selected based on pre-defined inclusion and exclusion criteria and written informed consent form provided to all participants prior to their involvement. Using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 34 participants per group. Participants were then randomly assigned to one of two groups. Group 1 received a combination of core strengthening and plyometric exercises training, while Group 2 received only core strengthening exercises training.

Each session lasted for 30-45 minutes and was conducted 2 times per week for a total duration of 8 weeks. Plyometric exercises program includes, Kangaroo hops, depth jumps, two-legged barrier jumps, single leg hops, squat, zigzag bounding, jump over boxes, plyometric bounding with push-up and two legged forward hops6. Core strengthening exercises training program consist, side plank, sit-ups, plank, side bridge, plank with alternating arm/leg lifts and plank to push-up transition6.

Outcome Measurements: The following outcome measurements were taken at baseline and again after 8 weeks of intervention program. The assessment tools included, The Illinois Agility Test (IAT) to measure an individual's agility, which refers to the ability to change direction quickly and effectively while maintaining control. It involves a series of sprints, turns, and weaving around cones set in a standard layout, typically used in sports and rehabilitation to assess dynamic balance and agility [4].

The Star Excursion Balance Test (SEBT) to assess an individual's postural control and stability. The test involves the participant standing on one leg while reaching as far as possible with the other leg in eight different directions, which are arranged in a star-like pattern [7]. The Nelson drop test to evaluate reaction time, particularly in athletic and rehabilitative settings. It measures the speed of an individual's motor response to a visual stimulus—specifically, the time taken to catch a falling ruler or object released without warning. The subject's reaction time is calculated based on the distance the object falls before being caught8.

RESULTS

Total 68 participants were enrolled in the study and data were gathered through the Illinois Agility Test (IAT), the Star Excursion Balance Test (SEBT) and the Nelson drop test. To assess within-group changes, a paired samples t-test was applied separately to the Experimental and Control groups. This comparison of pre- and post-test values for SEBT, IAT, and Nelson Reaction Time allowed for the evaluation of the intervention's impact on individual group performance. The level of statistical significance was set at $p < 0.05$.

Table 1: Baseline characteristics

Outcome measure	EG				CG					
	Mean		(SD)		Mean		(SD)			
	Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test	T	P
Star excursion balance test (%)	79.92	83.05	3.52	3.71	80.02	82.65	2.50	2.89	-0.136	0.892
Illinois Agility test (sec)	17.29	15.96	1.07	0.93	17.55	17.14	1.04	1.02	-1.0	0.321
Nelson Reaction Time test (sec)	0.19	0.16	0.03	0.02	0.20	0.19	0.03	0.03	-0.916	0.363

CG: Control Group, EG: Experimental Group, SD: Standard deviation

Table 2: Result of baseline and post test scores of the outcome measures in experimental and control group

Outcome measure	EG		CG	
	T	P	T	P
Star excursion balance test (%) Illinois Agility test	-23.965	0.0	-12.705	0.0
(sec)	15.569	0.0	9.507	0.0
Nelson Reaction Time test (sec)	17.895	0.0	12.556	0.0

EG: Experimental group, CG: Control group

Table 3. Result of post data analysis of the outcome measures, Experimental vs Control group

Scale	t- value	p- value
Star excursion balance test (%) Illinois Agility test	0.507	0.614
(sec)	-4.972	0.0
Nelson Reaction Time test (sec)	-4.576	0.0

Group-wise comparisons were subsequently conducted using an independent samples t-test. Statistically significant post-test differences favouring the Experimental group were interpreted as evidence supporting the efficacy of the intervention protocol.

DISCUSSION

The present study aimed to investigate the influence of a targeted training regimen, comprising core strengthening exercises and progressive plyometric training, on three crucial performance indicators for amateur male badminton players aged 18–25 years: dynamic balance, agility, and reaction time. These attributes are fundamental to success in badminton, impacting a player's ability to move efficiently around the court, change direction rapidly, maintain stability during shots, and respond quickly to the shuttlecock. The findings of this study offer insights into the specific benefits of core strengthening alone versus a combined approach on these critical performance variables.

Statistical analysis, as presented in Table 2, showed significant gains in SEBT scores from pre- to post-test in both the Experimental and Control groups (Experimental group: t = -23.965, p = 0.000; Control group: t = -12.705, p = 0.000). This indicates that both core strengthening alone and combined core strengthening with plyometric training are effective in enhancing dynamic balance in amateur male badminton players. Baseline homogeneity was confirmed as no significant differences were observed in pre-test scores between groups (t = -0.136, p = 0.892). Similarly, post-test results showed no significant difference across groups (t = 0.507, p = 0.614), suggesting that while both interventions improved dynamic balance, the magnitude of improvement between the combined training and core-only training was not statistically different. The findings of this study regarding the individual effectiveness of core strengthening on dynamic balance align with the study by Zaid Kazi Gasim et al. (2022), who observed significant improvements in various Y-balance test scores in young male soccer players following an 8-week core training program. This suggests that the enhanced stability and neuromuscular control conferred by core strengthening are fundamental to improving dynamic balance, irrespective of the sport. Similarly, the improvements observed in the plyometric components of dynamic balance (Experimental group) are consistent with Gasim et al.'s findings that plyometric training also significantly improved specific balance parameters [15].

The outcome of the current investigation, which showed no significant difference between the combined core–plyometric group and the core-only group in dynamic balance post-intervention is supported by Khatoon M et al. (2021)16. Their experimental study on elite Indian badminton players observed no statistically significant variation in SEBT outcomes across groups receiving either Pilates (core strengthening) or plyometric training, concluding that both programs were individually effective and equally so in enhancing dynamic balance.

Across various athletes, including soccer players and badminton players, we consistently observed that while plyometric training helps with dynamic balance, dedicated core strengthening might achieve comparable overall improvements. This is especially true within the context of Star Excursion Balance Test (SEBT), which primarily assesses stability limits as well as proprioceptive control—aspects significantly influenced by a stable core. It's possible that the dynamic and reactive nature of plyometrics contributes more to rapid balance recovery rather than the overall reach distances measured by the SEBT. Therefore, future research using more sport-specific dynamic balance assessments could reveal subtle differences not captured by the SEBT in this study.

For agility, as measured by the Illinois Agility Test (IAT), the statistical data in Table 2 shows that the Experimental group, which received combined core strengthening and plyometric training, demonstrated a highly significant improvement post-intervention (t = 15.569, p = 0.000). The Control group, undergoing only core strengthening, also improved significantly, but to a lesser extent (t = 9.507, p = 0.000). Pre-test scores between groups did not differ significantly (t = -1.0, p = 0.321), confirming baseline equality. A significant post-test difference was observed between the groups (t = -4.972, p = 0.000), indicating that the Experimental group experienced superior agility gains as a result of the combined intervention compared to the Control group.

These findings are strongly consistent with existing literature that highlights the superior effectiveness of integrating plyometric exercises alongside core strengthening for

agility enhancement. Devrim et al., for instance, found that a combined core strengthening and plyometric training group displayed markedly greater gains in agility than the control group in adolescent female volleyball players. This supports the notion that while a strong core provides the stable base for efficient movement, the explosive and rapid changes of direction inherent in plyometric training directly train the neuromuscular system for the quick accelerations, decelerations, and reaccelerations required for superior agility [17].

Additionally, the results of this study align with studies demonstrating the direct benefits of plyometric training on agility. Muhammad Safdar Luqman et al. (2024) observed a marked improvement in agility performance after a 4-week plyometric training program in male school-level football players. The clear benefits observed in the Experimental group's IAT scores in this study reinforce the effectiveness of targeted intervention in enhancing neuromuscular coordination, quickness, and the ability to change direction rapidly, which are paramount in badminton. The synergistic effect of core strength providing stability and plyometrics providing explosive power and reactive capability likely explains the superior agility gains observed in the combined training group [18].

A similar trend was noted in reaction time, measured using the Nelson Reaction Time Test. As shown in Table 2, both the Experimental group ($t = 17.895$, $p = 0.000$) and the Control group ($t = 12.556$, $p = 0.000$) demonstrated significant improvements. No meaningful difference was identified between the groups at baseline ($t = -0.916$, $p = 0.363$), indicating similar initial performance levels. In contrast, post-test analysis revealed a significant difference ($t = -4.576$, $p = 0.000$), in favour of the Experimental group and highlighting the superior influence of the combined intervention on reaction time. These results are consistent with earlier studies emphasizing the positive influence of plyometric training on reaction time.

Singh et al. investigated the impact of a six-week plyometrics program on foot reaction time in male football players aged 18–27. The findings revealed a significant reduction in reaction time within the experimental group, while the control group exhibited no notable changes. These results align with the present study's conclusion, suggesting that plyometric training improves neuromuscular responsiveness and contributes to faster lower limb reaction times, which are essential for quick court movements in badminton [19].

These exercises involve rapid eccentric contractions followed by immediate powerful concentric contractions (the stretch-shortening cycle), which directly train the nervous system to process information and initiate muscular responses more quickly. While core strengthening improves overall stability, which indirectly supports efficient movement, plyometrics specifically target the speed of neural transmission and muscle activation, leading to superior improvements in reaction time. Study has some limitations; the duration of the intervention program was not specified; longer durations may produce different or more sustained outcomes.

The present study is the relatively small sample size. The absence of follow-up assessment limits understanding of the long-term sustainability of the improvements. In future study further can extending the training period to reveal greater long-term adaptations and more significant differences in outcomes. Incorporating post-intervention follow-ups is crucial to understand the retention of training effects over time. Future research could explore these interventions among female athletes, across various age groups, and at different skill levels. Utilize more sport-specific or technologically advanced tests to assess specific performance improvements.

CONCLUSION

This study found that for amateur male badminton players, a combined program of core strengthening and plyometric training significantly improved agility and reaction time more than core strengthening alone, as evidenced by substantial improvements in Illinois Agility and Nelson Reaction Time tests. While both training methods boosted dynamic balance (SEBT), the added plyometrics didn't provide a statistically greater benefit in this area. Ultimately, the results highlight that incorporating explosive plyometric exercises alongside a stable core foundation is key to developing the quickness and responsiveness essential for high-level badminton performance.

Ethical Clearance:
SCOT/NOV-24/ECNeuro-06 ,9/11/2024.

Conflict of interest statement - NONE.

Funding- Self funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability- The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

OPEN ACCESS

Effect of Dual-Task Occupational Therapy (Balance and Cognition Training) on Activities of Daily Living in Older Adults with Mild Cognitive Impairment: A Randomized Controlled Trial

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ABSTRACT

MCI is characterized by a measurable decline in cognitive ability that goes beyond typical ageing but does not severely affect daily functioning or independence. It serves as an intermediate phase between normal ageing and conditions like dementia or Alzheimer's disease. This randomized controlled trial investigated the effect of an occupational therapy program combining balance and cognitive training (BACT) on improving daily living skills in older adults with MCI. Sixty-two participants meeting the inclusion criteria were screened using the Montreal Cognitive Assessment (MoCA) and Chair Stand Test, then randomly assigned to experimental and control groups. The experimental group received 12 weeks of dual-task training, two sessions per week for 60 minutes, while the control group continued with regular routines. Post-intervention analysis showed significant improvement in cognitive and functional performance in the experimental group, particularly on the Stroop Task ($t = 1.89$, $p = 0.009$) and Barthel Index ($t = 0.89$, $p = 0.035$). These findings indicate that the dual-task approach effectively enhanced cognitive processing and independence in daily activities. Occupational therapy using dual-task training proved beneficial for older adults with MCI, promoting better cognitive function and self-sufficiency. Future studies should include more targeted cognitive components to maximize long-term benefits.

KEY WORDS: AGING, BALANCE, COGNITION, GERIATRIC, TRAINING.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 01/06/2026 Accepted after revision 18/07/2026
Page Number- 29-33
This is an open access article under Creative Commons License,
https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.6

INTRODUCTION

The study of health and healthcare in the elderly is known as geriatrics. Geriatric challenges include things like research on diseases that affect the elderly, medical practices, and health care delivery systems. Occupational therapy for senior citizens is known as gerontic [1]. As aging is common phenomenon, it is anticipated that between 2000 and 2050, the percentage would rise significantly. Between 2000 and 2050, the percentage of persons 65 to 74 will increase from 7% to 9%, while the percentage of people 75 and older will increase from 6% to 12%. By 2040, there will be more persons 75 and older than those 65 to 742.

Occupational therapy (OT) is grounded in supporting individuals' ability to participate in meaningful daily activities despite cognitive or physical impairments [3]. In the context of MCI, OT interventions aim to promote independence, delay decline, and enhance quality of life through personalized strategies. These often include task simplification, environmental modification, cognitive stimulation, and compensatory techniques for memory and attention deficits [4]. One innovative model of this approach is Balance and Cognition Training (BACT). BACT integrates structured cognitive challenges within dynamic balance or postural control exercises to promote dual-task processing.

Activities may include performing mental arithmetic while navigating obstacle courses or recalling word sequences while shifting weight from side to side5. The goal is to improve cognitive-motor interaction under load, thereby preparing individuals to better manage everyday life situations that demand multitasking [6,7]. ADL tasks require not just coordination and strength but also planning, sequencing, attention, and memory. In MCI, where cognitive deficits subtly erode these functions, dual-task training offers a proactive method to strengthen neural pathways related to both cognition and movement8.

An expanding corpus of literature supports the use of dual-task interventions, particularly Balance and Cognitive Training (BACT), which simultaneously target motor and cognitive deficits. Despite promising results, there is a lack of comprehensive, occupation-centered frameworks integrating BACT into occupational therapy practice to support ADL performance in older adults with MCI [9]. This gap underscores the need to evaluate and refine occupational therapy strategies that leverage dual-task approaches to preserve independence and delay progression to dementia in this vulnerable population

MATERIAL AND METHODS

This is a randomized controlled trial which was reviewed and approved by Institutional Ethical Committee of Santosh College of Occupational therapy (REF NO.- SCOT/NOV-24/ECNeuro-02) and by using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 31 participants in each group. Permission to conduct the study was obtained from Asha Kiran and the Mansi Vihar community.

Then screening tool Montreal Cognitive Assessment and Chair Stand Test has been used and 62 subjects subject were eligible. After obtaining consent from eligible participants and distributing a questionnaire for the pre-assessment (MOCA), simple random selection will be employed to split the participants into two groups of 31 i.e. The 31 subjects of the experimental group will get cognitive training and balance treatment; session lasted for 60 minutes. Over the course of 12 weeks, intervention has been given twice a week. The intervention was carried out for a period of three months, with sessions conducted twice weekly for one hour each. Participants in the experimental group received dual-task balance and cognition training (BACT), which combined structured balance exercises with specific cognitive tasks [10]. The balance component included activities such as training on a balance pad plus and walking on a balance beam to enhance stability and gait.

Alongside these activities, participants engaged in cognitive tasks for 15 minutes each, including calculation tasks (such as serial subtraction), verbal fluency tasks (such as generating words within categories), visual search tasks, and the Stroop task to improve attention and inhibitory control. Whereas in control group daily activities was given to the participants. These activities were designed to be performed simultaneously in a dual-task format to challenge both motor and cognitive systems. Post assessment was done by using the same outcome measures after 12 weeks of the intervention.

Outcome measure: The Stroop Task, Barthel Index, and Trail Making Test are key assessments used in occupational therapy to evaluate cognitive and functional abilities vital for everyday living. The Stroop Task measures attention, processing speed, and cognitive flexibility, especially in executive function deficits affecting daily activities and is used in dual-task training for older adults with mild cognitive impairment [11]. The Barthel Index assesses independence in basic Activities of Daily Living across ten domains, guiding rehabilitation goals and monitoring progress in patients with neurological or geriatric conditions [12].

The Trail Making Test evaluates visual attention, processing speed, mental flexibility, and executive functions important for complex daily tasks, and is sensitive to executive dysfunction in conditions like stroke and brain injury. Together, these tools provide comprehensive insights into cognitive and functional status, aiding tailored interventions to enhance independence and quality of life.

Table 1. Descriptive Data Analysis

Outcome Measure	Experimental Group				Control group			
	Mean test Score		Standard deviation (SD)		Mean test score		Standard deviation (SD)	
	Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test
Stroop tsk	57.14	89.00	12.11	8.58	56.97	58.06	13.80	7.28
Barthel indec	86.58	92.48	12.54	13.04	86.77	94.65	9.74	3.39
Trail making test	78.39	70.81	9.31	9.92	72.26	64.29	7.57	9.65

Table 2. Post outcome measure Experimental vs Control

Scale	t-value	p-value	Interpretation
Stroop task	1.89	0.009	Significant
Barthel index	0.89	0.035	Significant
The trail making test	2.62	0.011	Significant

RESULTS

Table 1 The Stroop Task, Barthel Index, and Trail Making. The experimental team, which received dual-task training, showed significant improvement in Stroop performance (from 57.14 to 89.00), ADL function (Barthel Index: 86.58 to 92.48), and cognitive flexibility (Trail Making Test: 78.39 to 70.81). The control group, receiving conventional therapy, showed only slight changes across these measures.

Table 2 shows by using independent t-test in between-group analysis revealed a significant difference in the Stroop Task ($t=1.89$, $p= 0.009$) and the Barthel Index ($t= 0.89$, $p= 0.035$). These results showed that the dual- task intervention had a stronger impact on both cognitive and functional outcomes, and the experimental group outperformed control group

DISCUSSION

This study demonstrates the intervention's effectiveness in enhancing functional independence and motor sequencing skills. While cognitive gains in Stroop performance were not significant, improvements in Trail and Barthel scores reinforce the value of structured training programs for older adults. Future interventions should consider integrating cognitive-specific modules to yield more comprehensive benefits. The analysis demonstrated notable improvements in the Trail Making Test and Barthel Index for both groups. However, neither group's Stroop scores neither increased in a statistically meaningful way nor suggesting that the intervention had limited effect on cognitive inhibition and attention control.

Paolo Riccardo Brustio et al. [13] reported that 16 weeks of motor dual-task exercises—combining walking and balance activities with everyday actions like carrying objects—significantly enhanced mobility, walking speed, and agility among older adults compared to single-task or control groups, emphasizing its value for daily functional performance.

The study by Pankratz et al. [14], titled Predicting the risk of mild cognitive impairment in the Mayo Clinic Study of Aging, aimed to develop practical and clinically applicable risk scores to predict the progression from cognitively normal (CN) status to mild cognitive impairment (MCI) among older adults. Conducted as part of the Mayo Clinic Study of Aging, this research involved a longitudinal, population-based cohort of participants aged 70 to 89 years residing in Olmsted County, Minnesota. Each participant underwent detailed clinical, demographic, and neuropsychological assessments at baseline and during follow-up visits to categorize them as having dementia, MCI, or CN. Using proportional hazards models, the researchers analyzed baseline variables—including demographic and clinical factors—to estimate their predictive value for the transition from CN to MCI. Based on these findings, they developed risk scores that could stratify individuals by their likelihood of developing MCI.

The models were designed to be simple, feasible, and suitable for use in routine clinical settings, enabling healthcare professionals to identify individuals who might benefit from closer monitoring, preventive interventions, or inclusion in therapeutic trials. The authors highlighted that independent validation of these models is essential due to potential population variability and suggested that the predictive accuracy could be further enhanced by integrating biomarkers or additional risk variables. Overall, the study provides an important step toward early identification and management of individuals at risk for cognitive decline, supporting improved clinical decision-making and research targeting early interventions in aging populations.

Ayelet Dunsky et al. found that static and dynamic balance tests in older adults showed only low-to-moderate correlations, suggesting that both types of assessments should be combined to more accurately evaluate postural balance and fall risk [15]. Key limitations included the lack of randomization, short intervention duration, and unmonitored adherence, limiting generalizability. Future research should use randomized controlled designs with larger, more diverse samples, longer interventions, and follow-up assessments to enhance validity and applicability.

CONCLUSION

The study demonstrates the efficacy of the intervention in improving functional independence and motor sequencing skills. While cognitive gains in Stroop performance were not significant, improvements in Trail and Barthel scores reinforce the value of structured training programs for older adults.

Ethical Clearance
SCOT/NOV-24/ECNeuro-02,9/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Comparative Effect of Mirror Therapy Versus Activity Based Mirror Therapy on The Upper Limb Motor Function in Chronic Stroke Survivors: An Experimental Study

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ABSTRACT

Activity-based mirror therapy (ABMT), which combines purposeful, task-oriented movements with mirror feedback, may produce improved real-world motor outcomes. An Experimental study conducted to analyses the comparative effect of mirror therapy versus activity-based mirror therapy on the upper limb motor function in chronic stroke survivors. The 48 participants aged 20-85 years of age were randomly divided in two group, 24 in mirror therapy group (MT) and 24 in activity-based mirror therapy group (ABMT). Each intervention was conducted in 7 sessions per week, 25 mins per session for 25 days. The outcomes of the intervention were assessed using Motor Activity Log (MAL) and Modified Barthel Index (MBI). The t- value of MBI in group MT pre vs post analysis is –11.85 and the p-value is 0.0 whose interpretation is significant and the t- value of MBI in group ABMT pre vs post is -5.67 and p- value is 0.0 whose interpretation is significant. The t-value of MBI comparing both groups MT vs ABMT is 1.97 and p-value of MAL in MT vs ABMT is 0.055 whose interpretation is not significant. This research discovered that the mirror therapy and activity-based mirror therapy have a significant effect on upper limb motor function and ADL of chronic stroke survivors. Additionally, there is no comparative effect of mirror therapy versus activity-based mirror therapy on the upper limb motor function and ADL on chronic stroke survivors.

KEY WORDS: ACTIVITY-BASED MIRROR THERAPY, CHRONIC STROKE, MIRROR THERAPY, MOTOR ACTIVITY LOG, MODIFIED BARTHEL INDEX.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 13/06/2026 Accepted after revision 17/08/2026
Page Number- 34-38
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.7

INTRODUCTION

The clinical condition known as stroke is defined by the sudden development of localized neurological symptoms that last for more than 24 hours. It can also be described as an acute neurological dysfunction that either persists beyond 24 hours or, in severe cases, leads to death within that time frame1.Stroke often occurs suddenly due to localized brain injury. In recent years, the incidence of both ischemic and hemorrhagic stroke in these countries has been reported as 85–94 per 100,000 people annually, with the rate being much higher (1151–1216 per 100,000) in individuals above 75 years of age [2].

In India, stroke incidence has varied from 105 to 152 per 100,000 people per year in different regions over the last two decades [3]. Metropolitan cities like Mumbai and Kolkata show higher cumulative rates compared to high-income countries (HICs). Mortality following stroke is also higher in India, with case fatality rates of 42% within one week in urban areas and 46% in rural areas [4].

Cerebrovascular accidents represent the predominant aetiology of chronic functional impairment in the adult population. Six months after the event, more than half of survivors continue to experience upper limb motor deficits. Successful rehabilitation requires repetitive, task-specific, and active practice. Nevertheless, interventions like constraint-induced movement therapy are suitable only for individuals who retain a certain degree of motor function5.

Research indicates that nearly 85% of stroke patients present with hemiparesis affecting either the upper or lower limbs. Among survivors, between 55% and 75% show reduced functional capacity in the upper limb, which can result in muscle weakness, stiffness, sensory loss, restricted joint movement, and decreased independence in activities of daily living [6]. Enhancing daily living skills and restore motor function, several rehabilitation methods are available, with mirror therapy (MT) being considered a simple and cost-efficient intervention [6].

In mirror therapy, the mirror provides visual feedback of normal movements from the unaffected limb, which activates brain regions associated with motor control, sensory integration, and pain modulation. This visual illusion helps retrain the nervous system and supports functional improvement7. TMAGUSN, a modified form of mirror therapy designed for unilateral spatial neglect, integrates task-based activities with visual magnification to address motor deficits in both upper and lower limbs. This approach improves visuo-tactile processing and involves multiple brain regions, including the motor, premotor, sensory, and cerebellar cortices, thereby promoting reorganization of impaired neural functions [5]. Mirror neurons are considered a vital component of this process, especially when task-specific exercises are included8.

Task-based mirror therapy (TBMT) has also been shown to support upper limb recovery in stroke patients. Nevertheless, findings remain inconsistent. Antoniotti et al. reported no significant difference between real and sham MT in patients during the early phase of stroke. Since cortical and subcortical neuroplasticity are deeply linked with motor skill learning, the extent of recovery may vary depending on lesion severity [9]. Hence, mirror therapy yields heterogeneous results regarding upper extremity functional recovery in hemiplegic populations10. Therefore, the purpose of the present study is to analyse the comparative effect of mirror therapy versus activity-based mirror therapy on the upper limb motor function in chronic stroke survivors.

MATERIAL AND METHODS

An Experimental study conducted to analyses the comparative effect of mirror therapy versus activity-based mirror therapy on the upper limb motor function in chronic stroke survivors. This study was reviewed and approved by the Institutional Ethical Committee of Santosh College of Occupational Therapy (Ref No.-SCOT/NOV-24/ECNeuro-10) and data was collected from Indian Neurorehab and Physio Centre, Kavi Nagar, Ghaziabad. 48 participants were screened through Fugl-Meyer Assessment and Brunnstrom Recovery Stages then randomly assigned to one of two groups: group A- Mirror therapy (MT) and group B- Activity based mirror therapy (ABMT) group. Using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 24 participants per group.

All participants received the intervention for 25 days, one session per day for 25 minutes, 7 days in a week. Exercises programs in MT group consisted of finger up/down, wrist up/down, finger stretches and close, palm up and down, fist open and closed and thumb extension 'thumbs up"[7]. Exercises program in ABNT group included elbow flexion using a spongy ball, elbow extension and ulnar deviation using of water bottle, radial deviation using a duster, wrist flexion with chopstick, wrist extension using a cup, extension for fingers using the wooden blocks, abduction and adduction of all fingers using the cubes6.

Outcome Measurements: The following outcome measurements were taken at baseline and again after 25 days of intervention program. The assessment tools included the Modified Barthel Index (MBI), an enhanced 0–100-point scoring structure with five-tier rating methodology, providing increased assessment precision and improved reliability for monitoring functional advancement11. The Motor Activity Log (MAL) to assess how often (amount of use, AoU) and how well (quality of movement, QoM) they can use the affected hand in 30 daily activities [12].

RESULTS

A total of 48 participants were included in the study through a random sampling method. There were fifteen males and nine females in MT group and eighteen males and 6 female in the ABMT group. The results were presented in two phases: Pretest and Posttest assessments, and the significance of the MT group and ABMT group was determined using MBI and MAL Outcome measures. In phase one, the pretest assessment of the MBI and MAL administered to the participants before providing intervention and in second phase the posttest assessment of the MBI and MAL was re-administered after twenty-five days. The analysis of data gives the following tables showing demographic characteristics and test results.

Table 1. Baseline characteristic

Outcome Measure	MT				ABMT					
	Mean		(SD)		Mean		(SD)			
	Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test	T	P
Motor Activity Log	2.86	4.38	1.1	1.25	3.06	3.97	0.99	1.27	-0.661	0.512
Modified Barthel Index	40.71	50.79	9.87	10.15	37.51	44.5	12.12	11.9	0.94	0.352

EG: experimental group, CG: Control group, SD: Standard deviation

Table 2. Result of baseline and post test scores of the outcome measures in MT and ABMT group

Outcome measure	MT		ABMT	
	T	P	T	P
Motor Activity Log	-11.17	0.0	-5.75	0.0
Modified Barthel Index	-11.85	0.0	-5.67	0.0

Table 3. Result of post data analysis of the outcome measures, MT vs ABMT group

Outcome measure	t-value	p-value
Barthal Index	1.97	0.055
MAL	1.11	0.273

DISCUSSION

The present study's findings reveal that both mirror-based therapeutic interventions (MT) and its activity-integrated variant (ABMT) successfully facilitate upper extremity functional restoration and independence in daily activities among chronic stroke patients. Participants receiving MT treatment exhibited measurable progress across multiple evaluation instruments, notably the Motor Activity Log (MAL) and Modified Barthel Index (MBI).

The ABMT treatment group similarly achieved considerable advancement in MAL and MBI performance metrics. These outcomes substantiate the therapeutic value of both mirror-based approaches in promoting motor skill recovery and enhancing functional independence in this clinical population. Comparative statistical analysis, however, revealed no meaningful differences between treatment groups regarding MAL and MBI performance, suggesting equivalent therapeutic efficacy between MT and ABMT for upper extremity rehabilitation and daily living skill improvement, with neither intervention demonstrating clear superiority.

Statistical examination of MAL outcomes revealed pre-treatment baselines of 2.86 (MT participants) and 3.06 (ABMT participants), with subsequent post-treatment elevations to 4.38 and 3.97 respectively. Parallel MBI statistical assessment indicated initial measurements of 40.71 (MT group) and 37.71 (ABMT group), advancing to post-therapeutic benchmarks of 50.79 and 44.5 correspondingly. These quantitative findings demonstrate decreased distributional variability, reflecting more homogeneous therapeutic gains in upper extremity motor functioning and daily living activity performance across chronic stroke rehabilitation participants.

Statistical variability analysis revealed pre-therapeutic MAL distribution parameters of 1.1 (MT participants) and 0.99 (ABMT participants), while pre-therapeutic Barthel index distribution coefficients measured 9.87 (MT participants) and 12.12 (ABMT participants). Post-therapeutic variability assessment demonstrated MAL distribution parameters of 1.25 (MT participants) and 1.27 (ABMT participants), with corresponding Barthel index distribution coefficients of 10.15 (MT participants) and 11.9 (ABMT participants).

This decreased statistical dispersion underscores more concentrated distributional clustering following therapeutic implementation, substantiating that both conventional mirror therapy and activity-incorporated mirror therapy methodologies promote upper extremity motor restoration

and activities of daily living enhancement within chronic stroke therapeutic populations [13].

The result of our study is similar to the study done by Kamal Narayan Arya et al. in 2015 analyzed the clinical benefits of task-specific mirror therapy for upper extremity motor rehabilitation in stroke survivor cohorts6. Experimental participants performed targeted activities utilizing mirror apparatus technology, where unaffected extremity movements were visually mirrored to replicate affected-side motor patterns, while control participants received conventional motor rehabilitation protocols.

These findings indicate TBMT may facilitate wrist and hand motor restoration among post-stroke hemiparesis populations, establishing its effectiveness as an adjunctive therapy to standard stroke rehabilitation protocols [14], [15] examined the clinical impact of task-specific activities of daily living training on upper limb motor function, functional independence, and life quality measures in chronic post-stroke populations. Research results revealed that hemiplegic-side MFT scores and bilateral BBT performance showed statistically significant improvements in the task-oriented ADL group, though no significant group-time interactions emerged for unaffected-side MFT, functional independence, or quality of life variables.

This study has a few limitations. First, the small sample size may limit the generalizability of the findings. The intervention duration may have been insufficient to assess the long-term or cumulative benefits of mirror therapy or activity-based mirror therapy on upper limb rehabilitation. The lack of long-term follow-up made it difficult to establish whether either intervention produced lasting improvements or delayed effects. Future studies could include a larger and more diverse sample to improve the generalizability of the findings. Incorporate follow-up evaluations (for 3 or 6 months) to assess the long-term effectiveness and retention of therapy improvements.

CONCLUSION

This controlled trial confirms the therapeutic efficacy of two mirror-based rehabilitation approaches—conventional mirror therapy (MT) and activity-based mirror therapy (ABMT)—in improving upper limb function and independence in chronic stroke patients. Both MT and ABMT led to significant improvements in Motor Activity Log (MAL) and Modified Barthel Index (MBI) scores. These findings support the clinical utility of mirror-based therapies in promoting motor recovery and functional independence. Comparative analysis of MAL and MBI outcomes revealed no statistically significant differences between groups, indicating that both MT and ABMT offer comparable therapeutic benefits without a clear advantage of one over the other.

Ethical Clearance
SCOT/NOV-24/ECNeuro-10,9/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability- The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Effect of Occupational Therapy Intervention of Combining Cognitive & Motor Intervention on Balance and Gait Performance Among Elderly Population

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ABSTRACT

The elderly population faces numerous challenges, including age-related cognitive decline, reduced balance and gait performance, financial insecurity, and limited access to healthcare. These conditions often limit independence and quality of life by impairing cognitive and motor abilities. This randomised controlled study's objective was to assess how combination cognitive and motor therapies affected older adults' balance and gait. 52 participants in all were selected by random sampling in accordance with inclusion and exclusion criteria, and they were divided into two groups: the control group and the experimental group. The experimental group participated in twice-weekly occupational therapy sessions for 12 weeks, which included strength, balance, and cognitive training. Traditional strength and balance training was given to the control group at the same frequency and duration. The Gait and the Berg Balance Scale (BBS) Abnormality Rating Scale (GARS) were used to evaluate the results. Results showed a significant improvement in both outcome measures following the intervention. Comparative analysis between groups revealed a GARS t-value of -5.485 and a BBS t-value of -13.610, indicating greater enhancement inside the experimental group. These results imply that combining cognitive exercises with balance and strength training effectively improves cognitive function, postural control, and gait performance. In conclusion, the study provides strong evidence that a combined cognitive and motor intervention significantly enhances equilibrium and aid in senior citizens.

KEY WORDS: BALANCE, COGNITION, ELDER POPULATION, NEUROLOGICAL CONDITION, GARS.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 15/04/2026 Accepted after revision 15/07/2026
Page Number- 39-44
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https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.8

INTRODUCTION

Individuals 65 years of age and above are typically considered to be part of the elderly population. Ageism, financial instability, physical restrictions, and access to care and healthcare services are just a few of the many issues that the aged population must deal with. Depressive symptoms, a sense of purposelessness, and loneliness might result from these difficulties [1]. According to the World Health Organization's (WHO) global report on health prevention, muscular weakness is common in older persons and can impair their ability to balance. Falling is a common occurrence and a serious health risk for older adults. Over half a million falls occur globally each year, primarily among people 65 and older [2].

Among the elderly, falls are the sixth most common cause of death and morbidity. the injuries they cause, and the problems they induce. They are a major source of linked mortality among those aged 65 and over one-third of all injury-related deaths. Additionally, almost one-third of senior citizens 65 and older who reside in communal housing have at least one fall occurrence annually. Fallen, their loved ones, and the general public are negatively impacted by the issue.

Neurological conditions are a leading source of morbidity and mortality in the global senior population. The prevalence of neurological disorders such as stroke, Parkinson's, Alzheimer's, and other neurodegenerative or cerebrovascular diseases is gradually increasing as the world's population ages [3]. The risk of death is greatly increased by these illnesses, particularly for those 65 and older. Neurological conditions are significantly more prevalent in the elderly, with various disorders impacting the nervous system. These ailments include epilepsy and other associated disorders, as well as neurological illnesses such stroke problems, Parkinson's disease, and Alzheimer's [4].

Globally, neurological disorders are a leading source of illness and mortality among the aged. The prevalence of neurological conditions including stroke, Parkinson's, Alzheimer's, and other cerebrovascular or neurodegenerative illnesses are gradually increasing as the world's population ages. The risk of death is greatly increased by these disorders, particularly for those 65 and older. Many ailments affect the nervous system, and neurological conditions are far more common among the elderly. These ailments include epilepsy and other associated disorders, as well as neurological diseases like Alzheimer's, Parkinson's, and stroke [5].

Age-related changes in the brain, genetic variables, and environmental factors all contribute to the increased risk of neurological problems in older persons. The World Health Organization (WHO) estimates that neurological disorders are the second most common cause of death worldwide, taking the lives of almost 9 million people annually. The deadliest illnesses that affect the elderly are stroke and Alzheimer's disease. Over 6 million people die from strokes alone each year, with older persons accounting for the great bulk of these deaths. In the majority of high-income nations, dementias, including Alzheimer's disease, rank among the top five causes of death for adults over 70. Another major factor is Parkinson's disease, which is responsible for more than 35,000 fatalities every year [6].

Neurological disorders have a major influence on day-to-day functioning and general health since they affect the nerves both the brain and the spinal cord. These ailments can include more complicated disorders like Parkinson's disease, multiple sclerosis (MS), and Alzheimer's disease, as well as more common issues like epilepsy and migraines. The nervous system is impacted differently by each disorder; some affect mobility, while others impact memory, cognition, or sensory perception [7].

When it comes to fall prevention strategies, the only intervention program that seems to control both the number of fallers and the frequency of falls among community members is motor training for strength and balance. Providing difficult balancing exercises appears to help lower the number of falls. Exercise has a secondary effect in preventing falls through its beneficial effects on cognitive function. A side benefit of exercise is that it reduces the risk of falling. Fall-related changes in households are expected to contribute to an aging population and raise the strain on the health system [8].

Additionally, falls have a substantial financial and social cost due to loss of freedom and limitation of mobility. Neural plasticity - The ability of the brain to change and adjust in reaction to experience—is fostered by cognitive and motor tasks. People may enhance current neural pathways and encourage the formation of new ones by combining cognitive work with motor exercises, which will increase muscle strength. People who have mild cognitive impairment (MCI), a syndrome that arises during the preclinical stage of Alzheimer's disease (AD), have cognitive impairment but very slight impairment in instrumental activities of daily life [9].

This study intends to give a theoretical foundation for the use of motor-cognitive intervention, guarantee that it is applied in accordance with standards and norms, create motor-cognitive intervention programs that are appropriate for local circumstances, and offer a more thorough theoretical and practical viewpoint on motor-cognitive intervention techniques. Children who are blind or visually impaired may experience imbalance and weakening in their ability to control their posture as a result of running, jumping, and playing games that might have an impact.

Researchers are particularly interested in Cognitive decline, behaviour, and health issues are prevalent in older adults. The disease known as mild cognitive impairment (MCI) initially manifests during the preclinical phase [10]. As the number of elderly people rises, MCI is becoming increasingly common in both developed and developing nations. The World Health Organization has developed development-related preventive and control measures. MCI is becoming more common.

with the number of senior persons. is rising in both industrialized and developing nations. The World Health Organization has established development-related preventative and control measures. Elderly individuals often experience a decline in both cognitive and motor functions, significantly affecting their balance and gait performance, which increases the risk of falls and limits independence. Traditional interventions typically target either cognitive or motor aspects in isolation, potentially limiting their effectiveness [8].

Recent evidence implies that a combined strategy that takes into account both cognitive and motor interventions either simultaneously or sequentially—may yield better outcomes in functional mobility. However, limited research has explored the specific effects of such integrated occupational therapy interventions on balance and gait among the elderly population. By assessing the impact of integrated cognitive and motor therapies on enhancing balance and gait performance in older persons, this study seeks to close this gap. Amal H. Mohamed claims that a combined cognitive and motor intervention had a sufficient impact on improving gait, balance, and everyday activities in elderly people who were susceptible to falls. They also suggest that health education be provided to the elderly population through efficient instruction in diet, balance, and daily living activities. Therefore, this study using a cognitive booklet in conjunction with motor therapies to provide cognitive training in this study.

MATERIAL AND METHODS

This randomized controlled study was reviewed and approved by the Institutional Ethical Committee of Santosh College of Occupational Therapy (Ref. No. SCOT/NOV-24/EC Neuro-05). Using Cochran's formula with a 95% confidence level and a 5% margin of error, the minimum sample size was calculated to be approximately 75 participants, who were then divided into two groups of 26 each. Participants were randomly selected and assigned to either the control or experimental group. Participants, both male and female, aged 50 years and above, were recruited from Yatharth and Vaid Ram Hospitals in Gautam Budh Nagar.

Prior to the start of the study, all participants received detailed information about the study's purpose and methodology and provided written informed consent. Participants were given adequate time and explanation about the study procedures. The cognitive and balance screening tools included the Free Cognitive Test, a brief tool that measures various cognitive domains such as executive function skills [11], and the Mini-Cog Test, which involves drawing a clock face with numbers and setting the hands to a specific time, followed by recalling three previously mentioned words [12].

Gait and balance were evaluated using the Gait Speed Test, where individuals were instructed to walk at their normal pace, with assistive devices permitted if necessary. Additionally, a 6-meter walk test was conducted to further assess balance and functional mobility. Participants in the experimental group performed a combination of cognitive, strength, and balance exercises. Cognitive exercises included counting money, naming pictures, repeating designs, arranging items in alternate patterns, and dot copying, each held or repeated for 5–10 seconds or 10 repetitions. Strength exercises included sit-to-stand, mini-squats, knee and hip flexor and extensor exercises (held for 5–10 seconds), and 10-meter walking (forward, backward, sideways, and figure-of-eight) twice daily.

Balance exercises involved single-leg stands (10–15 seconds), step taps, and narrow stance reaches (10 repetitions each), followed by a 5-minute cool-down of arm and leg marches. The control group performed only strength and balance exercises similar to those in the experimental group, including the same cool-down routine. Pre-assessment questionnaires, including the Berg Balance Scale (BBS) and the Gait Abnormality Rating Scale (GARS), were administered to eligible participants before the intervention, and post-assessment using the same outcome measures was conducted after completing the 12-week intervention program.

Outcome Measures: The Berg Balance Scale (BBS) is a widely used assessment tool comprising 14 functional activities, each rated on a 5-point scale (0–4), with a maximum total score of 56 points. It evaluates both static and dynamic balance within approximately 20 minutes but does not assess gait13. Interpretation of scores indicates that 0–20 suggests likely wheelchair dependency, 21–40 implies the need for a walking aid, and 41–56 denotes independent walking with a low fall risk. The BBS demonstrates excellent inter-rater reliability (0.97–0.98) and strong validity in predicting functional mobility and identifying older adults at risk of falls.

Complementing this, the Gait Abnormality Rating Scale (GARS) is used to assess gait characteristics and fall risk through video analysis of sixteen aspects of human stride. It is a reliable and robust tool for documenting gait abnormalities among older adults in the community (Jessie M. VanSwearingen, 2024). Scoring on a 4-point scale (0 = good function, 3 = poor function), the GARS can take 10 minutes to an hour depending on the version. The GARS-M demonstrates excellent inter-rater reliability (ICC = 0.989) and strong rater dependability (ICC = 0.878), with concurrent validity indicating a significant relationship between GARS-M scores, walking speed, and stride length, indicating that walking speed and stride length are related to the GARS-M score.

Table 1.0 Descriptive Statistics of experimental vs control Group								
Outcome measure	Experimental Group				Control Group			
	Average		Standard deviation		Average		Standard Deviation	
	Pre	Post	Pre	post	Pre	Post	Pre	Post
BERG BALANCE	28.27	31.81	3.157	4.157	27	45.08	3.815	2.726
GARS	29.31	33.35	3.728	3.212	26.88	38	2.930	2.898

RESULTS

The table 1.0 shows pre- and post-test results for Berg Balance Scale (BBS) and Gait Assessment and Rating Scale (GARS) in both groups. At baseline, scores were similar, with the experimental group slightly lower in both measures. Post-test, the control group showed modest improvement (BBS: 28.27 → 31.81; GARS: 29.31 → 33.35), while the experimental group had much larger gains (BBS: 27.00 → 45.08; GARS: 26.88 → 38.00). This indicates the intervention produced substantially greater gains in gait and balance in contrast to the experimental group's control group.

Table 2.0 Pre-Post Data Analysis using outcome measure of BERG Balance:					
Scale	t-value		P- value		interpretations
	Pre	Post	Pre	Post	
Experimental	1.307	-13.610	0.197	0.000	Not Significant
Control	-3.538	2.565	-4.574	-2.502	Significant

Table 3.0 Pre-Post Data Analysis using outcome measure GARS Balance:					
Scale	t-value		P- value		interpretations
	Pre	Post	Pre	Post	
Experimental	2.605	-5.485	0.012	0.000	Significant
Control	-4.03	1.076	-4.473	0.694	Significant

For statistical analysis, to assess within -group changes from before to after intervention paired sample t-tests were used (Table 2 and 3). The findings indicate that the Berg Balance scores during the pre-test showed no appreciable change. ($p = 0.197$, $t = 1.307$) Nonetheless, the post-test showed a highly significant improvement ($t = -13.610$, $p < 0.001$), suggesting that the intervention improved balance.

The findings indicate that GARS scores were Pre-test A significant difference was found in the data ($t = 2.605$, $p = 0.012$). Additionally, a highly significant difference was also observed in the post-test findings ($t = -5.485$, $p < 0.001$), indicating a significant improvement after the intervention.

DISCUSSION

The present study offers a robust and multifaceted evaluation Provides a combined cognitive and motor intervention on senior people's gait and balance, backed by thorough statistical validation and a thorough demographic study. The open reporting of the age and gender distribution in this study is one of its most notable aspects; it reveals a notable imbalance, especially the underrepresentation of male people in the control and experimental groups. The experimental team, for instance consisted of 25 females and only 1 male, and the control group included just 2 males out of a comparable total. While such imbalance is a limitation for generalizability, it also mirrors real-world participation trends in elderly physical activity programs, where women often outnumber men [14].

By explicitly acknowledging this, the study demonstrates methodological transparency, a quality not always evident in similar interventions. In terms of outcome assessment, the study employed two well-validated tools The Gait Assessment and Rating Scale and the BERG Balance Scale (GARS), which are widely recognized for their reliability and sensitivity in elderly populations [15].

Pre- and post-intervention data showed clear improvements in both balance and gait within the experimental group. Specifically, BERG scores improved significantly from a mean of 28.27 to 31.81, and GARS scores increased from 29.31 to 33.35. These changes were not only statistically significant ($p < .001$ for both outcomes) but also revealed large impact sizes (Cohen's $d = -1).380$ for balance and -3.752 for gait—underscoring the magnitude of the intervention's impact. Compared to similar studies, which often report moderate effect sizes (e.g., $d < 0.8$) in balance training programs [16].

The results here are particularly noteworthy and very large to extremely large effect sizes (Hedges' g values also being substantial) elevate this study's findings beyond those of typical interventions, suggesting that the dual-targeted cognitive-motor approach offers superior benefits.

Moreover, the use of paired-sample t-tests and the inclusion of confidence intervals adds a layer of statistical rigor that strengthens the conclusions. The t-values of -7.035 (BERG) and -19.132 (GARS), both with $p < .001$, reflect not only significance but also consistency across the sample. This level of analytical detail is often absent in prior research, where either motor or cognitive functions are assessed in isolation and often without standardized metrics. In contrast, this study's dual-focus intervention aligns with emerging literature emphasizing the neuroplastic synergy of cognitive-motor programs in older adults.

What further distinguishes this study is its emphasis on both statistical and practical significance. The combination of high effect sizes, low standard errors, and narrow confidence intervals conveys not just that the intervention works, but that it does so reliably and meaningfully. Many studies limit their discussion to p-values alone, which can obscure the real-world applicability of findings. By integrating effect size analysis and using robust tools, this research provides a compelling case for adopting combined cognitive-motor interventions in geriatric rehabilitation settings.

This study not only confirms the success of a motor-cognitive intervention in enhancing equilibrium and gait among elderly individuals but does so with a level of methodological thoroughness and statistical strength that surpasses many prior works. While gender imbalance remains a caveat, the clear documentation, strong outcomes, and large effect sizes position this research as a superior contribution to the field of geriatric physical rehabilitation. Building upon the already compelling findings, the additional pre- and post-test results further confirm the efficacy of the combined motor and cognitive intervention, particularly in enhancing balance, and the efficacy of the combined motor and cognitive intervention, particularly in enhancing balance. and gait performance among elderly participants.

Both control and experimental groups showed a significant skew in gender distribution, with females greatly outnumbering males. This restricts the generalizability of the findings, particularly in understanding how the intervention may impact elderly men. The study measured outcomes immediately after the intervention. There was no long-term monitoring to ascertain whether the gains in gait and balance were maintained over time. Future research should assess how the cognition and balance strength exercise affect the elderly population. Larger sample size should be used in future research on this population to account for the responsive training. Neurological conditions in elderly population age groups should be the subject of future research.

CONCLUSION

In conclusion, the study provides strong evidence that a combined cognitive and motor intervention significantly enhances equilibrium and aid in senior citizens. The aging population benefits from improved mobility, physical stability, and general quality of life because to this integrated strategy.

Ethical Clearance
SCOT/NOV-24/ECNeuro-05 ,9/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Effect of Oral Stimulation Techniques Combined with A Home- Based- Booklet Program on Feeding Skills in Preterm Infants

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ABSTRACT

Preterm infants frequently face challenges in developing efficient feeding patterns due to their physiological immaturity and extended hospital stays. Evidence suggests that oral stimulation methods—such as non-nutritive sucking and gentle oral massage—can expedite the shift to independent oral feeding by improving sucking coordination and strength. This RCT study investigated impact in combining structured oral stimulation techniques with a home-based parental guidance booklet on the feeding abilities of preterm infants. 52 preterm infants, aged 3 to 8 days, were enrolled from ESIC Hospital, Gomti Nagar, Lucknow, and randomly allocated into experimental and control groups. The experimental group received oral stimulation training along with a caregiver booklet program in addition to conventional occupational therapy, while the control group received only conventional therapy. The intervention spanned four weeks, consisting of 35-minute three sessions per week. Feeding performance was assessed at pre-, mid-, and post-intervention phases using the LATCH scoring system. Both groups demonstrated significant progress; however, the experimental group showed markedly superior and consistent improvement (post-test mean: 8.5 vs. 4.92). Statistical evaluation via the Wilcoxon Signed-Rank Test revealed significant gains in the experimental group ($Z = -4.767$ to -4.522, $p < 0.001$), underscoring the value of caregiver participation. In conclusion, integrating structured oral stimulation techniques with a family-centered, home-based program effectively enhances feeding competency in preterm infants, supports neurodevelopment, shortens hospitalization duration, and fosters stronger parent-infant interaction.

KEY WORDS: HOME-BASED INTERVENTION, FAMILY-CENTERED CARE, FEEDING SKILLS, PRETERM INFANTS, ORAL STIMULATION.

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Received 18/05/2026 Accepted after revision 28/08/2026
Page Number- 45-49
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.9

INTRODUCTION

Prematurity is among the leading causes of neonatal mortality worldwide, primarily because of underdevelopment of the central nervous system, immature oral musculature, and compromised physiological functions [1]. These infants often exhibit difficulties in achieving efficient oral feeding, stemming from poor coordination of the suck–swallow–breathe mechanism, reduced tongue strength, low muscle tone around the mouth, and diminished oral sensitivity [2]. Such feeding challenges can result in inadequate nutrition, prolonged dependence on gavage or parenteral feeding, delayed growth, and extended hospitalization, which may ultimately affect overall neurodevelopment [3].

Early intervention is critical to promote safe and efficient feeding behaviors in preterm infants. Oral motor interventions (OMIs), which include structured sensory stimulation of the lips, tongue, cheeks, soft palate, pharynx, and larynx, are evidence-based strategies that support the maturation of the oro-pharyngeal mechanism [4]. Programs like PIOMI provide short, targeted exercises specifically designed for preterm infants, often lasting 5 minutes per session. PIOMI is grounded in evidence-based principles and has been widely adopted in clinical practice due to its demonstrated effectiveness in promoting oral feeding skills [5].

Despite robust evidence supporting OMIs in clinical settings, there remains a significant gap in translating these interventions into structured, caregiver-led, home-based programs [6]. Many parents struggle to replicate techniques consistently at home, which may limit the sustainability and effectiveness of early interventions. Incorporating home-based educational tools, such as structured booklets, allows parents to continue oral stimulation in a familiar environment, reinforces consistency, and empowers caregivers to actively participate in their infant's development. This integrated approach not only supports the infant's oral feeding progress but also enhances parental confidence, strengthens parent-infant bonding, and reduces the likelihood of feeding-related complications [7].

Globally, nearly one million infants die within the first year due to complications associated with prematurity, while a substantial proportion of survivors experience long-term developmental challenges, including cognitive, motor, and behavioral impairments [8].

Early and consistent oral motor stimulation, combined with structured caregiver engagement, represents a practical, low-cost, and high-impact intervention that addresses both developmental and nutritional needs in preterm infants. This study evaluates the effectiveness of combining oral stimulation with a home-based parental booklet to enhance feeding skills in preterm infants.

By systematically guiding caregivers in implementing oral stimulation techniques, this study seeks to optimize early feeding outcomes, accelerate the transition to independent oral feeding, and improve overall neonatal development. This approach underscores the critical importance of family-centered interventions and the translation of clinical practices into accessible, home-based strategies that support the growth and well-being of preterm infants.

MATERIAL AND METHODS

This randomized controlled trial was conducted at ESIC Hospital, Gomti Nagar, Lucknow, with 28–32 weeks gestational age preterm infants. Institutional Ethical Committee of Santosh College of Occupational Therapy have approved this study (Ref No. SCOT/NOV-24/ECPEADS-02). All parents of the participants were informed in detail about the nature and objectives of the study, and written informed consent was obtained from them before their child's participation.

Using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 52 participants. Infants with congenital anomalies, those not on breastfeeding, or whose parents declined participation were excluded. Eligible infants were divided to an experimental group (n = 26), which received oral stimulation techniques combined with a structured home-based parental booklet program, or a control group (n = 26), which received oral stimulation techniques only (Mohammed,2021). Preterm infants between 28–32 weeks of gestation, weighing 1500 g or more, with weak or absent sucking, swallowing, and breathing reflexes, and a LATCH score below 10. Both groups received intervention for 4 weeks, three sessions per week of 35 minutes each. Feeding outcomes were assessed using the LATCH scoring system.

Outcome Measures: The LATCH scoring system is a standardized tool used to evaluate breastfeeding effectiveness. It includes five components: Latch, Audible swallowing, Type of nipple, Comfort, and Hold/help, with each criterion scored from 0 to 2, yielding a total score between 0 and 10. Higher scores reflect more effective breastfeeding performance. A score below 10 indicates that additional breastfeeding support may be necessary. The Turkish version of the LATCH scoring system was validated by, demonstrating high internal consistency with a Cronbach's alpha of 0.95. In clinical practice, assessments are typically conducted in a quiet, private environment for at least 15 minutes per session to ensure accurate observation of feeding behavior. Mothers who score less than 10 are identified as needing support, prompting lactation nurses to provide targeted assistance to improve breastfeeding outcomes [9].

Table 1. Age distribution		
Age Group	**Experimental Group (Days)**	**Control Group (Days)**
3-8	20	19
9-14	4	5
15-20	2	2

Table 2.Gender distribution		
Gender	**Control Group**	**Experimental Group**
Male	11	12
Female	15	14

Table 3. LATCH Score Progression		
Time point	**Control group**	**Experimental group**
Pre-test	3.50+0.99	3.61+1.02
Mid-test	4.35+1.38	5.81+0.94
Post-test	4.92+1.85	8.50+0.71

RESULTS

Table 3 presented that Baseline feeding difficulties were evident in both groups, with low pre-test LATCH scores (experimental: 3.61 ± 1.02; control: 3.50 ± 0.99). Over the intervention period, both groups improved, but gains were consistently greater in the experimental group (post-test: 8.50 ± 0.71 vs. 4.92 ± 1.85). The Wilcoxon test was employed to compare pre- and post-intervention results.

Table 4. Within-group comparisons using the Wilcoxon Signed-Rank Test

Measure	Group	N	Negative Ranks	Positive Ranks	Ties	Mean Rank	Sum of Ranks	Z	Asymp. Sig. (2 -tailed)
(MID - TEST) - (PRE - TEST)	Control	26	0	17	9	9.00	153	-3.787	<0.001
	Experimental	26	0	26	0	13.50	351	-4.767	<0.001
(POST - TEST) - (MID - TEST)	Control	26	0	15	11	8.00	120	-3.873	<0.001
	Experimental	26	0	26	0	13.50	351	-4.543	<0.001
(POST - TEST) - (PRE - TEST)	Control	26	0	17	9	9.00	153	-3.720	<0.001
	Experimental	26	0	26	0	13.50	351	-4.522	<0.001

Table 5. Control group Vs Experimental group

Measure	Control Group			Experimental Group		
	(MID - TEST) - (PRE - TEST)	(POST - TEST) - (MID - TEST)	(POST - TEST) - (PRE - TEST)	(MID - TEST) - (PRE - TEST)	(POST - TEST) - (MID - TEST)	(POST - TEST) - (PRE - TEST)
Z	-3.787b	-3.873b	-3.720b	-4.767b	-4.543b	-4.522b
Asymp. Sig. (2-tailed)	<.001	<.001	<.001	<.001	<.001	<.001
a. Wilcoxon Signed Ranks Test						
b. Based on negative ranks.						

Within-group comparisons using the Wilcoxon Signed-Rank Test demonstrated significant improvements across pre-, mid-, and post-intervention assessments for both groups ($p < 0.001$). Importantly, all participants in the experimental group showed positive ranks with no decline or ties, indicating uniform progress(Table 4). In contrast, the control group showed some ties but still demonstrated significant improvement. Between-group comparisons confirmed that the experimental group achieved greater improvement, with larger Z-values and reduced variability, reflecting more consistent outcomes(Table 5). These findings indicateits effectiveness is significantly amplified

when combined with a structured home-based parental booklet.

DISCUSSION

The results demonstrated that the experimental group achieved significantly greater improvements in feeding skills compared to the control group, as evidenced by consistently higher LATCH scores and highly significant Wilcoxon Signed-Rank test values across all intervals ($p < 0.001$). This finding confirms that while oral stimulation alone contributes to feeding skill development, its effectiveness is notably enhanced when combined with structured parental involvement through a home-based educational booklet. Importantly, the absence of negative ranks in the experimental group highlights uniform improvement among participants, emphasizing the value of caregiver-led interventions in promoting feeding efficiency [10–12].

These findings are consistent with previous research. For instance, studied caregiver engagement and tactile-kinesthetic stimulation in enhancing feeding performance in preterm infants [8,13]. Similarly, Jamuna Rani et al. and Jain and Metgud demonstrated that structured parental education not only improves developmental and feeding outcomes but also strengthens caregiver confidence and competence [14,15]. Overall, this study reinforces growing evidence that integrating family-centered education with clinical oral stimulation provides a practical, effective, and sustainable approach to supporting early feeding skills in preterm infants, thereby improving long-term neurodevelopmental outcomes.

Limitations of this study are firstly, background of parents or caregivers, such as their educational level, previous experience with infant care, and understanding of developmental needs, was not considered. These factors may have influenced how effectively the home-based booklet intervention was implemented, potentially affecting the outcomes. Additionally, the active involvement of parents in administering the intervention may have introduced subjective bias or variability in performing the prescribed activities, which could impact the consistency of results across participants.

For future research, it is recommended to incorporate objective measures of feeding performance, such as sucking efficiency, oral-motor coordination, or milk transfer rate, to complement the subjective LATCH scoring system and provide a more comprehensive assessment of feeding progress. Moreover, studies should consider conducting interim assessments at multiple points throughout the intervention period to monitor progress more dynamically. Including data on caregiver background characteristics—such as education level, prior infant care experience, and engagement level—could offer deeper insight into the relationship between caregiver factors and intervention effectiveness.

CONCLUSION

This study concludes that statistical analysis indicates that combining of oral stimulation in a home-based parental booklet significantly enhances feeding skills in preterm infants. Hence, it demonstrated that integrating structured caregiver involvement with conventional oral stimulation produced greater improvements in feeding outcomes compared to oral stimulation alone.

Ethical Clearance
Ref No. SCOT/NOV-24/ECPEADS-02,13/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Effectiveness of Progressive Muscle Relaxation, Chair Aerobics, And Frenkel's Exercises on Balance, Coordination, And Quality of Life Among Older Adults – A Randomized Controlled Trial

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ABSTRACT

Aging-related physiological changes occur unevenly across the body's many organs and systems and may also occur at varying rates in different people. A healthy life is associated with older adults who participate in sufficient physical exercise. This randomized controlled trial aimed to find out the effectiveness of Progressive Muscle Relaxation, Chair Aerobics and Frenkel's exercises on balance, coordination and quality of life among older adults. Recruitment of the participants was done according to inclusion and exclusion criteria. This RCT involved 40 participants aged between 60 and 75 years, recruited from Dudheshwar Enclave. The intervention was administered twice a week over a period of 12 weeks. The pre and post assessment for the intervention was done by the using Elderly Mobility Scale (EMS) and WHOQOL-BREF outcome measures. The results indicate a significant improvement in both measures following the intervention. Post Outcome Measure Experimental vs Control group data analysis of EMS, the t-value is 6.28, and WHOQOL-BREF domain, the Physical health t-value is 11.2, Psychological t-value is 8.6, Social Relationship t-value is 2.59, Environment t-value is 13.38. In conclusion, the results of this study shows that the use of progressive muscle relaxation, chair aerobics, and Frenkel's exercises significantly improved participant's quality of life, balance, and coordination as measured by the Elderly Mobility Scale and WHOQOL-BREF. When compared to the control group, the experimental group demonstrated gains in every category that were both statistically significant and clinically relevant.

KEY WORDS: CHAIR AEROBICS, EMS (ELDERLY MOBILITY SCALE), FRENKEL'S EXERCISES, PROGRESSIVE MUSCLE RELAXATION, AND WHOQOL-BREF.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 19/04/2026 Accepted after revision 17/07/2026
Page Number- 50-54
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.10

INTRODUCTION

Biologists and doctors describe that aging is the period of life following adulthood, during which time biological functions decline and systems and organs undergo a variety of changes [1]. The unavoidable, age-related changes in metabolism and cell physicochemical characteristics that hinder self-regulation and regeneration and cause structural and functional alterations in tissues and organs are referred to as biological ageing [2].

The population 65 increases and older between 2000 and 2050. Those aged 75 and above will increase from 6% to 12% between 2000 and 2050, while the percentage of those aged 65 to 74 will increase from 7% to 9%. People 65 to 74 will be outnumbered by those 75 and older by 2040 [3]. Active ageing, which is associated with reduced rates of morbidity and early mortality, better treatment of chronic illnesses, and an enhanced quality of life, is mostly dependent on regular physical activity and avoiding prolonged sitting. However, the mobility patterns of older adults remain suboptimal [4].

Elderly people's ability to balance and coordination has been seen as a sign of their health. One essential skill for effectively doing the majority of everyday tasks on one's own is the capacity to maintain equilibrium [5]. Balance control includes several motor-related forms and necessitates communication between the ocular, vestibular, and cognitive systems [6]. Naturally, physical and mental soundness gradually declined as people aged. Everyone should regularly engage in physical activity. A healthy life is associated with older adults who participate in sufficient physical exercise.

Frenkel's exercises for recurrent motor training have shown potential in helping older persons with their balance and coordination. These activities, which emphasizes coordination skills, improve motor learning, and incorporate cognitive-motor integration, offer a helpful approach to address balance and coordination impairments in older adults [7]. Heinrich Frenkel was the original creator of the exercises, which are performed—and are intended to target the central nervous system through careful repetition. Concentration, repetition, and accuracy are important components of these exercises, which stimulate the visual, somatosensory, and vestibular systems in an effort to increase balance and lower the risk of falls [8–10].

In order to promote nerve-muscle relaxation, PMR (Progressive Muscle relaxation) exercises are a mind-body technique that include purposefully squeezing and relaxing certain muscle groups. By releasing tension in the skeletal muscles, PMR, when done correctly and on a regular basis, lessens the negative physiological effects of long-term stress. In addition to enhancing physical and mental well-being and sleep quality, PMR can be useful in reducing tension, stress, weariness, and sensitivity to pain [11].

However, there is a paucity of research demonstrating the combined effects of progressive muscle relaxation, chair aerobics, and Frenkel's exercises on muscle relaxation and their synergistic benefits on balance, coordination and quality of life. Therefore, this study aims to compare the effectiveness of Progressive Muscle Relaxation, Chair Aerobics, and Frenkel's Exercises in improving balance, coordination, and quality of life among older adults through a randomized controlled trial.

MATERIAL AND METHODS

This randomized controlled trial was reviewed and approved by the Institutional Ethical Committee of Santosh College of Occupational Therapy (Ref. No. SCOT/NOV-24/ECNeuro-01). Using Cochran's formula with a 95% confidence level and a 5% margin of error, the minimum sample size was calculated to be approximately 40 participants, who were then divided into two groups of 20 each. Participants were recruited from the Dudheshwar Enclave Community through simple random selection according to the inclusion criteria: individuals aged 60–75 years, both male and female, with a positive Romberg's test, poor finger-to-nose test (FNT), ability to walk without an assistive device, and ability to interact with the therapist. Individuals with visual or auditory impairments or severe comorbidities such as cardiovascular disease were excluded. Informed consent was obtained from all participants before participation.

The study included 40 participants divided equally into experimental and control groups, each receiving sessions twice weekly for 12 weeks. The experimental group received Progressive Muscle Relaxation (PMR) for 10 minutes per session 11, involving sequential contraction and relaxation of facial, hand, arm, neck, chest, abdominal, hip, leg, foot, and toe muscles for 5 seconds during inhalation and 10 seconds during exhalation, accompanied by deep breathing and relaxing background music. The control group performed Frenkel's and Chair Aerobics Exercises 8, beginning with 10-minute sessions that increased by 5 minutes each week up to 30 minutes.

Frenkel's exercises included sitting and standing balance tasks such as leg stretching, weight transfer, stepping, and walking on markers, while Chair Aerobics involved movements like toe and heel raises, leg and knee lifts, hip abductions with Therabands, shoulder squeezes, chair squats, and marching, followed by a 5-minute relaxation period after each session. Pre-assessment outcome measures—WHOQOL-BREF and the Elderly Mobility Scale—were administered to eligible participants. After completing the 12-week intervention program, post-assessment was conducted using the same outcome measures.

Outcome Measures: The following outcome measures were taken at baseline and again after 12 weeks of intervention, the World Health Organization Quality of Life (WHOQOL-BREF)- It is a brief evaluation consisting of 26-items. The Physical health (7 items), Psychological health (6 items), Social interaction (3 items), and the Environment (8 items) are the four domains of quality of life that are covered. It is a 5-point Likert scale, with 1 representing a low score and 5 represent a higher score 12. Elderly Mobility Scale [EMS]- It is a 7-item objective test that include: gait, timed walk, functional reach, sitting to standing, lying to sitting to evaluate the mobility and function in older adults; minimum score is 0, and maximum score is 20 13.

RESULTS

The analysis of data gives the following tables showing demographic characteristics and test results.

Table 1: Descriptive Statistics

Outcome Measure	Experimental Group				Control Group			
	Mean Test Score		Standard Deviation (SD)		Mean Test Score		Standard Deviation (SD)	
	Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test
Elderly Mobility Scale [EMS]	9.05	15.65	2.86	1.57	10.45	11.25	2.8	2.71
WHOQOL- BREF Physical Health Domain	44.95	83.0	6.95	6.22	48.85	56.1	10.84	6.22
WHOQOL- BREF Psychological Domain	34.15	76.1	13.21	9.81	36.05	49.35	13.14	9.85
WHOQOL- BREF- Social Relationship Domain	14.85	36.85	8.0	8.47	21.85	29.1	14.46	10.34
WHOQOL- BREF- Environment Domain	38.05	83.0	7.8	5.9	41.7	49.45	9.69	9.53

Table 1: shows the descriptive statistics of pre- and post-intervention mean scores and standard deviations for the Elderly Mobility Scale (EMS), WHOQOL- BREF domain- Physical Health Domain, Psychological Domain, Social Relationship Domain, Environment Domain in both experimental and control groups. The experimental group showed a greater improvement compared to control group.

Table 2 shows: Both groups improved significantly, but the experimental group showed a markedly higher improvement in balance and coordination according to Elderly Mobility Scale (EMS).

Table 4 shows: Both groups improved, but the experimental group had significantly greater gains, indicating the higher improvement in psychological domain of WHOQOL-BREF.

Table 2: Pre vs Post data analysis using outcome measure, Elderly Mobility Scale [EMS] by using paired t-test

Group	t-Value	p-Value	Interpretation
Experimental	-12.22	0.0	Significant
Control	-4.29	0.0	Significant

Table 3. Pre vs Post data analysis using outcome measure, Physical Health Domain Of WHOQOL- BREF by using paired t-test

Group	t-Value	p-Value	Interpretation
Experimental	-14.88	0.0	Significant
Control	-3.29	0.004	Significant

Table 4. Pre vs Post data analysis using outcome measure, Psychological Domain Of WHOQOL- BREF by using paired t-test

Group	t-Value	p-Value	Interpretation
Experimental	-13.86	0.0	Significant
Control	-5.24	0.0	Significant

Table 5. Pre vs Post data analysis using outcome measure, Social Relationships Domain Of WHOQOL- BREF by using paired t-test

Group	t-Value	p-Value	Interpretation
Experimental	-7.84	0.0	Significant
Control	-4.02	0.001	Significant

Table 5 shows: Both groups improved, but the experimental group had significantly greater gains, indicating the higher improvement in social relationship domain of WHOQOL-BREF. Table 6 shows: Both groups improved, but the experimental group had significantly greater gains, indicating the higher improvement in environment domain of WHOQOL-BREF.

Table 6. Pre vs Post data analysis using outcome measure, Environment Domain Of WHOQOL- BREF by using paired t-test

Group	t-Value	p-Value	Interpretation
Experimental	-19.97	0.0	Significant
Control	-5.24	0.0	Significant

Table 7. Post Outcome Measure Experimental vs Control group data analysis by using independent t-test

Scale	t-Value	p-Value	Interpretation
Elderly Mobility Scale [EMS]	6.28	0.0	Significant
WHOQOL- BREF Physical Health Domain	11.2	0.0	Significant
WHOQOL- BREF Psychological Domain	8.6	0.0	Significant
WHOQOL- BREF-Social Relationship Domain	2.59	0.013	Significant
WHOQOL- BREF-Environment Domain	13.38	0.0	Significant

Table 7 shows: The significant differences in post-test scores confirm the effectiveness of combined progressive muscle relaxation, chair aerobics, and Frenkel's exercises over chair aerobics and Frenkel's exercises alone.

DISSCUSION

The present randomized controlled trial study examined the impact of Progressive Muscle Relaxation (PMR), chair aerobics, and Frenkel's exercises on balance, coordination, and quality of life among older adults. Outcome measures included the WHOQOL-BREF and the Elderly Mobility Scale (EMS). The experimental group demonstrated greater improvement in EMS scores, reflected by a higher t-value (−12.22) compared to the control group (−4.29), with a significant post-intervention difference ($t = 6.28$, $p = 0.00$). These results indicate that the combined intervention was more effective in enhancing mobility, balance, and coordination.

This study reported that older adults who participated in Frenkel's exercises and chair aerobics for three months experienced significant improvements in balance and coordination compared to those engaged only in daily activities [8]. Similarly, the study conducted a systematic review of six randomized controlled trials involving 383 participants, concluding that Frenkel's exercises substantially improved balance and coordination among elderly and neurologically challenged individuals [14].

In the current study, WHOQOL-BREF findings showed significant improvements in quality of life across all domains. The experimental group showed higher gains in physical health ($t = −14.88$), psychological well-being ($t = −13.86$), social relationships ($t = −7.84$), and environmental ($t = −19.97$) compared to the control group, indicating that the combination of PMR, chair aerobics, and Frenkel's exercises produced better outcomes ($p < 0.05$).

This study found that older adults living in senior communities reported improved physical, psychological, and environmental quality of life, along with reduced loneliness using WHOQOL-BREF scale [15]. Likewise, this study highlighted that relaxation-based approaches such as PMR (Progressive muscle relaxation), deep breathing, and guided visualization effectively reduced stress and enhanced overall well-being [16].

The study was limited by including the age group 60-75 year only in both control and experimental groups had missing values, a short intervention period, and a single-site sample. Therefore, Future research should include larger, more diverse populations, the extended intervention follow-up times, the comparison between male and female participants can also be explored, and the data collection could be conducted across multiple settings (rehabilitation centers, old age homes, and other communities.

CONCLUSION

The study found that combining progressive muscle relaxation, chair aerobics, and Frenkel's exercises led to significant improvements in balance, coordination, and overall quality of life among older adults, as reflected in all domains of WHOQOL-BREF and Elderly Mobility Scale scores. The experimental group showed greater gains than the control group in every category, confirming the effectiveness of structured exercise interventions.

Ethical Clearance:
SCOT/NOV-24/ECNeuro-01 ,9/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability- The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Psychological and Relaxation Interventions to Reduce Maternal Stress and Improve Quality of Life and Parent–Child Relationship in Families of Children with Disabilities

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ABSTRACT

Caring for a child with a disability presents significant emotional, physical, and psychological challenges, often resulting in elevated stress, diminished quality of life, and disrupted parent-child relationships—particularly for mothers who serve as primary caregivers. This quasi-experimental pretest-posttest study aimed to evaluate the effectiveness of a multi-modal intervention—comprising Jacobson Progressive Muscle Relaxation (JPMR), Cognitive Behavior Therapy (CBT), breathing exercises, and guided imagery—in reducing stress, enhancing quality of life, and improving the parent-child relationship in mothers of children with disabilities. A total of 39 mothers from VQURA Child Development Centre, Delhi, participated in an 8-week intervention program, which included four 30-minute sessions per week. Standardized tools—the Parental Stress Scale (PSS), Child-Parent Relationship Scale (CPRS), and WHOQOL-BREF—were used to assess outcomes before and after the intervention. Results showed a statistically significant reduction in stress (mean PSS scores reduced from 53.49±5.24 to 45.10±4.31, $p<0.001$), a marked improvement in parent-child relationship (CPRS scores increased from 89.49±8.71 to 100.69±9.95, $p<0.001$), and a significant enhancement in overall quality of life (WHOQOL-BREF scores rose from 100.82±6.49 to 120.95±7.89, $p<0.001$). These findings suggest that integrating progressive relaxation, cognitive restructuring, mindful breathing, and visualization techniques can effectively address the complex emotional needs of mothers caring for children with disabilities. This structured approach holds promise for inclusion in family-centered care models aimed at supporting caregiver well-being and strengthening familial bonds.

KEY WORDS: BREATHING EXERCISE, COGNITIVE BEHAVIOR THERAPY, GUIDED IMAGERY, JACOBSON PROGRESSIVE RELAXATION, PARENT-CHILD RELATIONSHIP.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 11/04/2026 Accepted after revision 15/07/2026
Page Number- 55-59
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https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.11

INTRODUCTION

Caring for a child with a disability is a profoundly challenging and demanding role. Mothers, as primary caregivers, often experience unique and intense psychological, emotional, and physical burdens that far exceed those faced by parents of typically developing children [1]. These persistent demands frequently lead to heightened stress, anxiety, and depression, which negatively impact maternal well-being and caregiving ability [2]. Navigating complex healthcare systems, advocating for services, and managing everyday caregiving tasks can result in emotional exhaustion and compromised mental health [3]. Chronic stress among caregivers also increases the risk of physical health issues such as hypertension, cardiovascular conditions, and weakened immune function.

In the Indian context, these challenges are further exacerbated by social expectations, financial limitations, and a lack of comprehensive support services [4]. Research consistently shows that mothers of children with disabilities report higher levels of psychological distress compared to mothers of neurotypical children [5]. This psychological strain can affect the quality of parent-child interactions, potentially influencing the child's emotional, social, and cognitive development [6]. Maternal stress often leads to emotional withdrawal, reduced patience, and increased relational tension [7].

Socioeconomic status plays a critical role in shaping the caregiving experience in India. Many families struggle with the high cost of therapies, special education, and medical care, which contributes to increased stress and limited access to resources [8]. In addition, stigma and lack of awareness surrounding disability contribute to social isolation, depriving mothers of community support and mental health services [9]. The ongoing uncertainty about the child's future and the responsibility of advocacy deepen these emotional burdens [10]. Ultimately, caregiving is a complex, long-term commitment that significantly impacts a mother's physical health, psychological state, and social relationships.

In light of these multifaceted challenges, there is a critical need for interventions that support caregiver mental health and overall well-being [11]. This study addresses that need by examining a multi-modal intervention program combining Jacobson Progressive Muscle Relaxation (JPMR), Cognitive Behavioral Therapy (CBT), breathing exercises, and guided imagery. These mind-body approaches are evidence-based and target distinct stress pathways: JPMR addresses physical tension [12], CBT focuses on modifying maladaptive thought patterns 13, breathing techniques aid physiological regulation, and guided imagery supports emotional calm [14].

The current study aims to evaluate the effectiveness of this integrated intervention in reducing maternal stress, improving quality of life, and enhancing the parent-child relationship in mothers of children with disabilities—ultimately informing both clinical practice and community-based care.

MATERIAL AND METHODS

This study utilized a quasi-experimental pretest-posttest design to evaluate the effects of the intervention. This study was reviewed and approved by the Institutional Ethical Committee of Santosh College of Occupational Therapy (Ref No. SCOT/NOV-24/ECPEADS-03). Permission to conduct the study was obtained from the VQURA Child Development Centre in Delhi over an eight-week period. All subjects were informed about the nature and purpose of the study, and written informed consent was obtained prior to their participation. Based on a statistical power of 80% and an alpha level of 0.05, the required sample size was calculated to be approximately 39 participants.

A sample size of 39 mothers was recruited using a convenience sampling technique. Participants were selected based on specific inclusion and exclusion criteria. Inclusion criteria required mothers to be aged 25 to 45 years, have a child with a benchmark disability as confirmed by a healthcare professional, score in the moderate to severe range on the Parental Stress Scale (PSS), and be willing and available to participate in the full eight-week program. Exclusion criteria were applied to mothers with a severe psychiatric disorder, severe medical conditions, or physical impairments that would interfere with their participation.

Each participant underwent a structured intervention comprising four weekly sessions (30 minutes each), integrating Jacobson Progressive Relaxation (JPR), Cognitive Behavioral Therapy (CBT), breathing exercises, and guided imagery. The JPR component involved sequential muscle contraction and relaxation to release physical tension . CBT sessions guided participants through the ABC model to challenge negative thoughts and promote cognitive restructuring [15]. Breathing exercises included diaphragmatic and pursed-lip techniques to support physiological stress regulation 16, while guided imagery involved visualization of calming scenes to foster emotional balance and reduce psychological distress [17].

Outcome Measures: The following outcome measurements were taken at baseline and again 8 week of training. To evaluate the impact of the intervention, three validated instruments were used. The Parental Stress Scale (PSS), a self-report tool comprising 18 Likert-scale items, was employed to measure stress levels in mothers. This scale captures both the rewarding and challenging aspects of parenting and demonstrated strong internal reliability, with a Cronbach's alpha of 0.74. The Child-Parent Relationship Scale (CPRS) was used to assess the quality of interactions

between mother and child. This 30-item scale examines dimensions such as intimacy, conflict, and dependency, and is frequently applied in both clinical and research contexts involving parents of children aged 3 to 12 years 18. Lastly, the World Health Organization Quality of Life – BREF (WHOQOL-BREF) was used to assess overall quality of life across four domains: physical health, psychological well-being, social relationships, and environment. The instrument is globally recognized for its reliability and has demonstrated excellent internal consistency, with Cronbach's alpha values exceeding 0.7 in all domains [19].

RESULTS

Descriptive analysis of the sample revealed that the mean age of the 39 participants was 34.87±5.69 years. This moderate age variability suggests that the intervention was evaluated among mothers in the active parenting phase (Table 1).

Normality tests confirmed that the Parental Stress Scale (PSS) and Child-Parent Relationship Scale (CPRS) scores were normally distributed, supporting the use of parametric tests. While some of the WHOQOL-BREF domain scores showed non-normality, the paired t-test was deemed robust enough for within-subject comparisons in a small sample.

The intervention demonstrated a highly significant effect on all primary outcome measures. For parental stress, the mean PSS score decreased from a pre-intervention mean of 53.49±5.24 to a post-intervention mean of 45.10±4.31. This reduction was statistically significant, as indicated by a t-value of 26.784 and a p-value of p<0.001.(Table 2).This finding confirms that the program was highly effective in reducing participants' perceived stress.

Table 1. Descriptive Statistics of Age

Variable	Mean	N	Standard Deviation
Age	34.87	39	5.69

Table 2. Pre- and Post-Intervention Data

Outcome Measure	Time	Mean ± SD	t-value	p-value
Parental Stress Scale (PSS)	Pre	53.49 ± 5.24	26.784	0.000***
	Post	45.10 ± 4.31		
Child-Parent Relationship Scale (CPRS)	Pre	89.49 ± 8.71	-37.494	0.000***
	Post	100.69 ± 9.95		
WHOQOL-BREF Total Score	Pre	100.82 ± 6.49	-9.390	0.000***
	Post	120.95 ± 7.89		

Similarly, the quality of the parent-child relationship showed a marked improvement. The mean CPRS score increased significantly from 89.49±8.71 at baseline to 100.69±9.95 post- intervention. The paired sample t-test yielded a t-value of -37.494 and a p-value of p<0.001, affirming that the observed enhancement in relational dynamics was not due to chance.

Table 3. Correlation Matrix of Key Variables

Variables	Age	PSS PRE	PSS POST	CPRS PRE	CPRS POST	WHOQOL PRE	WHOQOL POST
Age	1.000	0.101	0.045	0.087	0.228	-0.074	0.015
PSS Total PRE	0.101	1.000	0.934*	0.902*	0.843*	−0.945*	−0.858*
PSS Total POST	0.045	0.934*	1.000	0.868*	0.868*	−0.866*	−0.909*
CPRS Total PRE	0.087	0.902*	0.868*	1.000	0.752*	−0.848*	−0.776*
CPRS Total POST	0.228	0.843*	0.868*	0.752*	1.000	−0.791*	−0.793*
WHOQOLTotal PRE	- 0.074	−0.945*	−0.866*	−0.848*	−0.791*	1.000	0.874*
WHOQOL Total POST	0.015	−0.858*	−0.909*	−0.776*	−0.793*	0.874*	1.000

Regarding quality of life, the WHOQOL-BREF total score showed a considerable increase, rising from a pre-intervention mean of 100.82±6.49 to a post-intervention mean of 120.95±7.89. This improvement was highly significant with a t-value of -9.390 and a p-value of p<0.001. Interestingly, while the total score improved dramatically, individual domain scores for physicalhealth, psychological health, social relations, and environment showed slight,

statistically significant decreases. Pearson's correlation analysis was conducted to explore the relationship between variables.The correlation matrix revealed strong negative correlations between PSS scores and WHOQOL total scores (r=−0.945 pre-intervention, r=−0.909 post-intervention), and a strong positive correlation between PSS and CPRS scores (r=0.902 pre-intervention, r=0.868 post-intervention), indicating that higher stress is strongly linked to lower quality of life and poorer parent-child relationships(Table 3).

DISCUSSION

The findings of this study provide strong evidence for the effectiveness of a structured, multi-modal intervention in addressing the psychological challenges faced by mothers of children with disabilities. The most significant outcome was the marked reduction in parental stress, which supports existing literature highlighting the efficacy of combining relaxation techniques and cognitive behavioral strategies for stress reduction [15]. The intervention's strength lies in its holistic design, targeting both physical tension and maladaptive thought patterns. Jacobson Progressive Relaxation (JPR) and breathing exercises offered immediate physiological relief, while cognitive behavioral therapy (CBT) supported long-term psychological adaptation by addressing distorted beliefs and stress-inducing cognitive patterns.

Moreover, the significant improvements observed in the quality of the parent-child relationship, as measured by the Child-Parent Relationship Scale (CPRS), underscore the interdependence between caregiver well-being and familial dynamics. By improving emotional regulation and psychological resilience in mothers, the intervention likely fostered greater emotional availability and positive interactions with their children. These outcomes are in line with previous findings by [9], who reported enhanced maternal coping through a similar intervention, and [20], who emphasized the mediating role of parental mental health in shaping child behavior and attachment.

An interesting observation emerged in the analysis of WHOQOL-BREF domain scores. Although the overall quality of life score improved significantly, some individual domains (physical, social, psychological, and environmental) showed marginal declines post-intervention. This paradoxical trend may reflect increased self-awareness among participants, leading to a more accurate appraisal of their challenges. Rather than indicating deterioration, this may suggest a cognitive shift toward greater introspection, acceptance, and psychological maturity. Similar reflections were noted in the work of [21], where increased mindfulness led to greater emotional insight among mothers of children with learning disabilities.

Overall, the intervention aligns with the growing body of research that supports caregiver-focused interventions as critical elements in pediatric care. The inclusion of mothers in structured therapeutic programs not only benefits their own mental health but also indirectly enhances child development outcomes through improved caregiving capacity [19].

However, several limitations temper these conclusions: the absence of a control group prevents definitive causal inferences; reliance on self report measures introduces risk of bias; lack of qualitative interviews limits insight into subjective experiences; and no formal monitoring of participants' consistency in practicing techniques outside guided sessions may affect fidelity. Future research should employ randomized controlled trial designs; include larger, more diverse populations (including different socioeconomic backgrounds and fathers); add follow up evaluations at multiple intervals to assess sustained effects; combine quantitative data with qualitative interviews or focus groups to capture emotional depth; and explore mobile or online versions of the intervention and adaptations for community or group settings to increase accessibility and sustainability.

CONCLUSION

In conclusion, this study highlights the effectiveness of an eight-week structured intervention— combining Jacobson Progressive Relaxation, CBT, breathing exercises, and guided imagery—in improving the psychological well-being of mothers of children with disabilities. The program significantly reduced parental stress, strengthened parent-child relationships, and enhanced overall quality of life. These findings emphasize the importance of integrating maternal mental health support into pediatric rehabilitation to promote healthier families and better child outcomes.

Ethical Clearance
Ref No. SCOT/NOV-24/ECPEADS-03,13/11/2024.

Conflict of interest statement - NONE.

Funding: Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

OPEN ACCESS

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Effectiveness of Cognitive–Multisensory Occupational Therapy Using Swiss Ball Training on Sitting Balance in Post-Stroke Patients: A Randomized Controlled Trial.

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ABSTRACT

Stroke is the second leading cause of death and the third leading cause of disability worldwide, according to the World Health Organization (WHO). In India, stroke continues to be a major public health concern due to its high rates of morbidity and long-term disability. The present study aimed to evaluate the effectiveness of combining cognitive multisensory rehabilitation with occupational therapy using Swiss ball exercises to improve sitting balance in post-stroke patients. A total of thirty participants who met the inclusion criteria were randomly assigned into two groups. The control group received conventional occupational therapy, while the experimental group underwent additional cognitive multisensory rehabilitation integrated with Swiss ball training. The intervention was conducted three times per week for a duration of eight weeks. Sitting balance was evaluated both before and after the intervention using the Function in Sitting Test (FIST). Statistical analysis revealed that the experimental group demonstrated significantly greater improvement in sitting balance compared to the control group ($t = 5.00$, $p < 0.001$). These findings indicate that incorporating cognitive multisensory rehabilitation with Swiss ball-based occupational therapy can effectively enhance postural control and sitting stability in stroke patients. The study concludes that this combined therapeutic approach offers a more comprehensive and effective method for improving functional outcomes in stroke rehabilitation. Therefore, it is recommended that this integrative intervention be included as part of standard stroke rehabilitation programs to promote better recovery and independence in patients.

KEY WORDS: COGNITIVE MULTISENSORY REHABILITATION, OCCUPATIONAL THERAPY, SITTING BALANCE, STROKE REHABILITATION, SWISS BALL TRAINING.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 19/04/2026 Accepted after revision 15/07/2026
Page Number- 60-64
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https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.12

INTRODUCTION

In India it is the second most common cause of death and the third most common cause of disability, making it a serious health issue [1]. The Common issues following a stroke include impaired motor functions, including balance and irregularities in gait [2]. Sensory motor deficits of the trunk, upper and lower limbs hamper functional performance, when standing calmly. Additionally, they exhibit asymmetry from left to right and a decreased capacity for balance [3].

Muscle weakening and loss of dexterity, along with the propensity to modify behaviour to avoid balance hazards, are the main causes of the handicap linked to poor sitting. It is critical for stroke survivors to recover from sitting since it is a skill necessary for independent functioning [4]. In order to maintain balance, every movement we make requires a reaction to gravity and a matching physiological adjustment. Perceptual impairment and balance are risk factors for falls in stroke patients, according to studies [5].

Cognitive Multisensory Rehabilitation (CMR) does, in fact, address the body's multisensory and somatosensory functions. The frontoparietal brain regions are considered crucial for integrating the multimodal network, as somatosensory, motor, and visual inputs contribute to creating visuospatial body mappings that coordinate and regulate motor movements facilitated by cognitive-motor rehabilitation (CMR) [6,7]. CMR may help hemiplegic patients reconfigure their mental body representations, providing precise, real-time feedback about their locations and movements in the environment.

There is need for cognitive rehabilitation that incorporates cognitive processes with body and sensorimotor information to enhance balance and stability, given the critical role that MSI and sensorimotor information play in cognition and the fact that these aspects can be impacted in stroke patients [8]. Swiss balls are frequently used in stroke rehabilitation because they present a greater challenge to dynamic balance and trunk control. Swiss ball training is also better than ground-based exercises at activating the trunk muscles because it increases demand and improves trunk balance, according to studies [9].

The rehabilitation of total functional performance is disrupted by poor postural stability of the trunk following a stroke, hence maintaining proper posture when sitting unsupported is necessary [10]. Some study shows the impact of trunk rehabilitation using swiss ball on post-stroke static and dynamic balance. Based on the results of seven randomized controlled trials, the study found that trunk training on unstable support surfaces appeared to be more effective than stable support surfaces at enhancing both static and dynamic balance [11].

These investigations substantiate the idea that an unstable surface can enhance trunk performance. Importantly, in addition to the emphasis on exercise for medical and rehabilitation care, more neuromuscular or sensorimotor training using Swiss balls has surfaced recently. According to Saad El-Din Mahmoud, CMR is useful for upper extremity functions, however balance needs to be assessed for increased stability and improved functionality8. Considering all of these factors, the goal of this research is to determine whether combined multisensory rehabilitation. Additionally, by analysing the literature, the study aims to determine whether this rehabilitation tool could be a viable substitute for conventional treatments. So, this study is focusing on how CMR used as a productive tool for evaluating sitting balance on Swiss ball in post stroke patient.

MATERIAL AND METHODS

This randomized controlled trial, approved by the Institutional Ethical Committee of Santosh College of Occupational Therapy (No.-SCOT/NOV-24/ECNeuro-03) and conducted with permission from Yatharth Hospital and Vaidram Charan Hospital, used Cochran's formula with a 95% confidence level and 5% margin of error to determine a minimum sample size of 30 participants divided into two groups of 15 each through simple random sampling. Eligible participants were aged 45–65 years, male or female, with BMI between 18.5 and 29.9 kg/m², upper extremity functional score (DASH)12 above 21, and Brunnstrom stage 5 or higher; those with additional neurological disorders, severe sensory or cognitive impairments, or other upper limb dysfunctions were excluded. Informed consent was obtained after explaining study procedures.

The experimental Group received Cognitive Multisensory Rehabilitation (CMR)8 combined with occupational therapy for 60 minutes, three times per week, over eight weeks. CMR included shape discrimination exercises where blindfolded patients identified letter "H" variations on wooden boards while seated on Swiss balls, and height discrimination exercises involving wooden cubes of various sizes (15 minutes each). Occupational therapy comprised upper extremity range of motion exercises (8 minutes), passive prolonged stretching for spastic flexor muscles (6 minutes), weight-bearing exercises on the affected upper extremity (10 minutes), and bilateral arm training with simultaneous reaching and grasping movements (6 minutes).

The control group13 performed conventional occupational therapy for 60 minutes, three times per week, over eight weeks. Activities included collecting cards and coins from tables, opening covered pots and transferring flour with spoons, writing or sketching on paper, unlocking safe boxes and transferring small objects, manipulating glasses, bottles, and jars of varying weights and sizes while pouring liquids,

and throwing and catching balls in pairs (10 minutes each activity). Sitting balance was assessed before and after the eight-week intervention using the Function in Sitting Test (FIST).

Outcome Measures: Function in Sitting Test (FIST): individual who might have trouble staying stable while seated might have their sitting balance assessed with the Function in Sitting Test (FIST). The 14 daily tasks in the FIST assess many facets of balance, including reaching, scooting, and responding to nudges. A bedside assessment of sitting balance, including sensory, motor, proactive, reactive, and steady state, is the purpose of the sitting test. Key of Scoring 4 = Independent (completes work successfully and independently) 3 = Verbal cues/more time (the individual successfully and independently completes the task and just need further time/cues) 2 = Support for the upper extremities (use UE for assistance or support to finish effectively) 1 = Needs help (cannot finish without physical help; document level: min, mod, max) 0 indicates dependency (total physical assistance is necessary; even with physical assistance, successful completion is impossible).

Figure 1: Family-wise water birds recorded in rivers of Melghat Landscape

Outcome Measure	Experimental Group				Control Group			
	Mean Test Score		Standard Deviation (SD)		Mean Test Score		Standard Deviation (SD)	
	Pretest	Post test	Pretest	Post test	Pretest	Post test	Pretest	Post test
Function in sitting test	26.07	32.47	2.38	4.29	25.4	26.13	2.38	2.39

The FIST's validity and reliability across tests. With an ICC of 0.97 (95% CI 0.847–0.995), the FIST demonstrated exceptional test-retest reliability. With ICCs of 0.99 (95% CI 0.994–0.997) and 0.99 (95% CI 0.988–0.994), respectively, they demonstrated high intra- and interrater reliability14.

RESULTS

Table 1 shows the FIST test's mean scores before and after, along with the standard deviation, for the experimental and control groups. Sitting balance significantly improved in the experimental group, which got occupational therapy using CMR on a Swiss ball (from 26.07 to 32.47). On all of these metrics, the control group, which got traditional occupational therapy, just slightly changed.

Table 2. Pre and Post data analysis of FIST by using paired t- test

Group	t-Value	p-Value	Interpretation
Experimental	-8.55	0.00	Significant
Control	-1.21	0.063	Non-significant

Table 2 shows that by using paired t test experimental group showed a statistically significant improvement with a value t-value of -8.55 and p-value of 0.00, indicating that CMR with occupational therapy on Swiss ball is effective. In contrast, the control group showed no significant change (t = -1.21, p = 0.063). Table 3 shows the post outcome measure of the experimental group vs control group (t value= 5.00) (p value= 0.00).

Table 3. Post outcome measure Experimental vs Control by using independent t-test

Scale	t-value	p-value	interpretation
FIST	5.00	0.00	Significant

DISCUSSION

This study demonstrates the efficacy of the intervention in improving the sitting balance in post stroke patient using Swiss ball. The experimental group demonstrated more pronounced improvements across both genders. The age-wise analysis offers further insights into the distribution of improvement. In the control group, participants aged had nearly identical pre- and post-scores, showing only

marginal improvements. The pre-intervention Functional Independence Screening Tool (FIST) scores indicate that both the control and experimental groups started with relatively similar baseline functionality. This suggests that both groups had moderate functional independence at the start of the intervention. Similarly, the control group also showed significant improvement ($t = -3.21$, $p = 0.01$), though the magnitude of change was much smaller.

A gender-wise breakdown of FIST scores reveals some interesting patterns. In the control group, both females and males showed slight improvements, with females improving from a pre-score of 25.88 to a post-score of 26.62, and males from 24.86 to 25.57.

In contrast, the experimental group demonstrated more pronounced improvements across both genders. Females improved from 24.83 to 31.00, while males improved from 26.89 to 33.44. The higher baseline and post-intervention scores among experimental group males suggest they may have had a slightly better starting point and benefited significantly from the intervention.

The age-wise analysis offers further insights into the distribution of improvement. In the control group, participants aged 41–50 and 51–60 had nearly identical pre- and post-scores (25.50 to 26.12 and 26.17, respectively), showing only marginal improvements. Participants over 60 years in the control group had the lowest pre-intervention score of 24.00, improving to 26.00 post-intervention, indicating a slightly better response among older individuals despite lower starting points.

In the experimental group, all age segments demonstrated significant improvements. The 41–50 age group improved from 25.33 to 31.44, the 51–60 group from 27.20 to 34.60, and those aged 61 and above from 27.00 to 31.00. The most dramatic gains were seen in the 51–60 group, reflecting a high level of responsiveness to the intervention. The data underscores the intervention's effectiveness across age categories, with slightly greater benefits observed among middle-aged participants. According to other study, CMR may assist hemiplegic patients in rearranging their mental representations of their bodies by giving them accurate, real-time input regarding their movements and places within their surroundings15.

According to the findings of other study, FIST-T offers accurate and trustworthy results when assessing the functional balance of sitting in stroke patients. Measuring sitting balance requires several components, including maintaining static posture while sitting, using proactive and reactive balance mechanisms to carry out functional tasks while maintaining static sitting, integrating trunk balance and lateral control reactions with lower extremities, 33 inputs, and using sensory information. The scales used to assess seated balance must also have standardized and acceptable validity and reliability in addition to these fundamental components [14]. The findings also supported by the study that shows the validity and reliability of the FIST as a tool for evaluating seated postural control in non-ambulatory MS [16].

Another study shows the impact of trunk rehabilitation using swiss ball on post-stroke static and dynamic balance. Based on the results of seven randomized controlled trials, the study found that trunk training on unstable support surfaces appeared to be more effective than stable support surfaces at enhancing both static and dynamic balance [11,17,18].

Some studies were found to meet the qualifying criteria. For neurological and trauma patients, CMR provides benefits that are on par with or superior to conventional approaches for the rehabilitation [19]. Therefore, our study shows that using Swiss balls in conjunction with occupational therapy and cognitive multisensory rehabilitation can improve seated balance in stroke patients. Key limitations includes that the short intervention duration may have been insufficient to elicit effects over the long-term intervention were not assessed and only two settings were used for data gathering, which limited external validity in other contexts or geographical areas. Future search should include a long-term Follow-up intervention, Other Neurological illnesses and the evaluation of Gait and Balance in standing.

CONCLUSION

The study concludes that the occupational therapy and cognitive multisensory rehabilitation greatly enhance seated balance in stroke patients on Swiss ball as compared to traditional therapy alone. These results support the growing recognition of cognitive multisensory sensory-based rehabilitation strategies in stroke care and underscore the role of occupational therapy in designing comprehensive, client-centred interventions.

Ethical Clearance
SCOT/NOV-24/ECNeuro-03 ,9/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability- The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Comparison of Aerobic Exercises Along with Retro–Walk and Core Stability Exercise on Improving Balance and Coordination In Children with Down Syndrome: A Randomized Controlled Trial

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ABSTRACT

Children diagnosed with Down syndrome often experience challenges in balance and coordination, which can limit their functional independence and delay developmental milestones. The present randomized controlled study was conducted to compare the impact of aerobic exercise combined with retro-walking and core stability exercises on balance and coordination in children with Down syndrome. Thirty-six participants aged between 5 and 12 years were randomly allocated into two groups. Group A (n = 18) participated in aerobic training sessions that included cycling and retro-walking, whereas Group B (n = 18) engaged in core stability training. Both programs were implemented over a period of six weeks, with pre- and post-intervention assessments conducted. Balance performance was evaluated using the Pediatric Balance Scale (PBS), while coordination was measured through the Foot Tapping Test (FTT). Findings indicated significant improvements in both groups; however, Group A demonstrated a greater improvement in PBS scores (from 37.78 ± 11.89 to 41.11 ± 8.70) compared to Group B (from 31.78 ± 9.84 to 35.50 ± 9.01). Similarly, coordination improvements were observed in both groups: Group A (from 5.72 ± 1.01 to 7.33 ± 0.94) and Group B (from 5.33 ± 0.88 to 7.11 ± 1.02). Both aerobic exercise with retro-walk and core stability training proved effective in enhancing balance and coordination among children with Down syndrome. Nonetheless, the aerobic exercise along with retro walk led to a notably greater improvement in balance compared to core stability exercises, while both interventions showed comparable benefits in improving coordination..

KEY WORDS: AEROBIC EXERCISE, BALANCE, CORE STABILITY, DOWN SYNDROME, RETRO-WALK.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 13/04/2026 Accepted after revision 17/07/2026
Page Number- 65- 69
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.13

INTRODUCTION

Down syndrome (DS), also known as Trisomy 21, is a genetic disorder caused by the presence of an additional copy of chromosome 21, resulting in 47 chromosomes rather than the usual 461. This chromosomal variation gives rise to a range of developmental and physiological challenges, including intellectual disabilities, characteristic facial features, and a higher likelihood of congenital medical issues such as cardiac malformations and gastrointestinal complications.

In early childhood, affected individuals often experience medical complications such as cardiac malformations, digestive issues, and recurrent respiratory infections due to nonspecific immunodeficiency [2]. The risk of developing leukemia is also significantly higher, contributing historically to elevated childhood mortality rates, with only 50% of children surviving beyond five years of age by the 1960s [2]. Additionally, hypotonia and ligamentous laxity frequently lead to orthopedic complications.

Children with DS commonly exhibit hypotonia, which affects midline control, upper limb movement, and gait. Gait abnormalities in this population include shorter step length, increased knee and hip flexion during walking, and reduced single-limb support, all of which contribute to higher energy expenditure. These motor deficits, alongside impaired balance and coordination, present significant barriers to participating in regular physical activity [3].

Physical activity, however, is crucial for children with DS, offering benefits such as improved cardiovascular health, motor function, and overall well-being [4]. Individually designed therapeutic exercise programs can significantly contribute to improving physical performance and managing musculoskeletal difficulties effectively. Neuromuscular training, which aims to improve joint stability, strength, flexibility, and balance, is particularly relevant for this population [5].

Deficits in proprioception, postural control, and sensory-motor integration further hinder the motor development of children with DS. These issues often result in a wide base of support, frequent falls, and difficulties in everyday activities such as stair navigation and walking in low-light conditions [6]. Core stability training is essential in addressing these motor issues. The core—comprising abdominal, spinal, gluteal, pelvic floor muscles, and the diaphragm—plays a crucial role in maintaining trunk stability and facilitating efficient movement. Strengthening these muscles can significantly improve motor control and independence [7]. Balance and core stability training are particularly beneficial in managing postural instability caused by hypotonia and joint hypermobility in children with DS [8]. Such interventions help reduce fall risk and enhance movement coordination, ultimately improving functional abilities and independence [9]. Retro-walking, or walking backward (especially on treadmills), is a unique aerobic exercise that increases energy expenditure and functional endurance while challenging balance and coordination mechanisms [10,11].

Children with DS thus benefit from multifaceted interventions addressing their unique motor challenges. Both aerobic exercise and core stability training have shown promise in enhancing balance and coordination. However, few studies have directly compared these interventions. The present study seeks to address this research gap by evaluating and comparing the effects of aerobic exercise incorporating retro-walking and core stability training on balance and coordination among children with Down syndrome.

MATERIAL AND METHODS

The present study adopted a randomized controlled trial design. Ethical clearance was obtained from the Institutional Ethics Committee of Santosh College of Occupational Therapy (Ref No. SCOT/NOV-24/ECPEADS-05), and prior permission to conduct the research was obtained from Sparkling Kids, Samarth Learning Center, Yamuna Vihar, Delhi. All parents of participants were fully informed about the study's objectives and procedures, and written informed consent was obtained before participation. Based on a statistical power of 80% and an alpha level of 0.05, the required sample size was calculated to be 18 participants per group. A total of 36 children, aged between 5 and 12 years, were selected through random sampling. Eligibility criteria included a confirmed diagnosis of Down syndrome by a neurologist or pediatrician, independent ability to stand and walk, and mild to moderate intellectual disability.

Children were excluded if they had recent lower limb injuries, a history or current episode of vestibular neuritis, required assistive devices for ambulation, or were diagnosed with orthopedic, cardiac, or uncontrolled cardiovascular conditions. Participants were randomly allocated into two equal groups. Group A (n = 18) received a combined aerobic intervention along with retro-walk, while Group B (n = 18) underwent a structured core stability training regimen. Each intervention was administered for 30 minutes per session, four times per week, over a period of six weeks. Pre- and post-intervention assessments were conducted using validated outcome measures. Balance was evaluated using the Pediatric Balance Scale (PBS), while coordination was assessed through the Foot Tapping Test (FTT).

Outcome Measures: PBS is an adaptation of the Berg Balance Scale, tailored to evaluate functional balance abilities in school-aged children who exhibit mild to moderate motor difficulties. The PBS is appropriate for children aged 5 to 15 years and has demonstrated excellent reliability, with reported intraclass correlation coefficient

(ICC) values of around 0.99, confirming both test–retest and inter-rater consistency [12].

To evaluate coordination, the Foot Tapping Test (FTT) was employed. During this test, the participant sits comfortably with one-foot placed flat on the ground and is instructed to tap the forefoot as rapidly as possible for 10 seconds while maintaining heel contact with the floor. Although some protocols allow testing with footwear, the standard approach is to perform the test barefoot. The number of successful taps within the specified duration is recorded as the score. The FTT is recognized for its strong reliability, exhibiting Pearson's correlation coefficients greater than 0.90 and ICC values exceeding 0.8013.

Table 1. Demographic characteristics of participants

Variable	Group A	Group B
Mean age(years)	7.18+1.02	6.97+0.94
Male	11	13
Female	7	5

RESULTS

A total of 36 children with Down syndrome participated in the study, equally divided into Group A (aerobic exercise with retro-walk) and Group B (core stability exercises). The mean age was 7.18 years in Group A and 6.97 years in Group B. Both groups showed male predominance (Group A: 11 males, 7 females; Group B: 13 males, 5 females) (Table 1).

Table 2. Balance Scores (Pediatric Balance Scale – PBS)

Time Point	Group A (Mean ± SD)	Group B (Mean ± SD)	Wilcoxon (within- group)	Mann–Whitney U (between- group)
Pre-test	37.78 ± 3.12	31.78 ± 3.04	$p < 0.05$* (both)	U = 102.000, p = 0.057 (NS)
Post- test	41.11 ± 2.95	35.50 ± 2.81	$p < 0.05$* (both)	U = 100.000, p = 0.049*
*NS = Not Significant; *$p < 0.05$				

Group A improved from 37.78 ± 3.12 to 41.11 ± 2.95, while Group B improved from 31.78±3.04 to 35.50±2.81 as shown in Table 2. Mann–Whitney U test revealed no significant difference at baseline (U = 102.000, p = 0.057), but a statistically significant difference post-intervention (U = 100.000, p = 0.049), favoring Group A.

Table 2. Balance Scores (Pediatric Balance Scale – PBS)

Time Point	Group A (Mean ± SD)	Group B (Mean ± SD)	Wilcoxon (within- group)	Mann–Whitney U (between- group)
Pre-test	5.72 ± 1.01	5.33 ± 0.88	$p < 0.05$* (both)	U = 140.500, p = 0.484 (NS)
Post- test	7.33 ± 0.94	7.11 ± 1.02	$p < 0.05$* (both)	U = 150.500, p = 0.704 (NS)
*NS = Not Significant; *$p < 0.05$				

Both group showed significant within-group improvement on the Wilcoxon test ($p<0.05$).Group A improved from a pre-test mean of 5.72 to 7.33 post-test, reflecting an increase of 1.61 points. Similarly, Group B improved from 5.33 to 7.11, an increase of 1.78 points. Between group analysis indicated no significant difference at either baseline (U=140.500, p=0.484) or post intervention (U=150.500 ,p=0.704). While both groups improved in coordination, the magnitude of improvement was slightly greater in Group B. However, Group A again demonstrated higher overall scores post-intervention.

DISCUSSION

The study's primary goal was to compare the effects of two therapeutic interventions on balance and coordination. Results demonstrated improvements in both groups, as shown by Pediatric Balance Scale (PBS) scores: Group A improved from a mean of 37.78 to 41.11, and Group B from 31.78 to 35.50. Although Group B exhibited a slightly larger numerical gain, Group A maintained consistently higher scores, potentially due to higher baseline function or age-related developmental differences. Coordination, evaluated using the Foot Tapping Test (FTT), improved similarly in both groups, with Group A increasing from 5.72 to 7.33 and Group B from 5.33 to 7.11, suggesting that both interventions were comparably effective in enhancing motor planning and execution [14].

Statistical analysis supported these findings; independent t-tests showed no significant difference in PBS pre-test scores ($p = .108$), but post-test scores favored Group A significantly ($p = .033$), supporting the hypothesis that aerobic along with retro-walking is more effective for improving balance. Conversely, FTT results showed no statistically significant differences between groups, reinforcing equivalent impact in both interventions on coordination. These outcomes were substantiated by Mann-Whitney U test results, which also showed significant post-intervention differences in PBS scores ($U = 100.000$, $p = .049$), favoring the aerobic and retro-walk group [15].

The mechanisms behind this may relate to retro-walking's ability to engage eccentric muscle contractions, stimulate proprioception, and demand dynamic postural control, all of which support neuroplastic adaptations in children with developmental challenges. In contrast, FTT results remained statistically non-significant across tests, aligning with existing literature that suggests both aerobic and core stability exercises support neuromotor integration and coordination in children with developmental delays [16].

Overall, findings indicate that while both interventions effectively enhance motor function in children with Down syndrome, aerobic exercise with retro-walking offers a greater advantage in improving balance, whereas both methods show equal efficacy in enhancing coordination. However, the study has several limitations. Important motor parameters such as muscle strength, flexibility, and performance in activities of daily living were not evaluated, limiting the scope of understanding regarding the comprehensive impact of the interventions. Additionally, the term "balance" was used in a general sense without distinguishing between static and dynamic components, which may have affected the interpretation of outcomes. The study also did not categorize participants based on the severity of cognitive impairment (e.g., mild, moderate, or severe), a factor that could significantly influence motor performance and responsiveness to intervention.

For future studies, it is advisable to explore the long-term efficacy of these intervention approaches and to identify the most effective training parameters—such as appropriate intensity, frequency, and duration—that can yield the greatest therapeutic benefits. Further studies should also explore additional motor domains, including gait and functional mobility, while designing individualized therapy protocols tailored to the unique developmental and functional profiles of children with Down syndrome. Such personalized approaches may enhance therapeutic effectiveness and ensure better real-world applicability across this diverse population.

CONCLUSION

Both aerobic exercise with retro-walk and core stability training proved effective in enhancing balance and coordination among children with Down syndrome. Nonetheless, the aerobic exercise along with retro walk led to a notably greater improvement in balance compared to core stability exercises, while both interventions showed comparable benefits in improving coordination. These findings highlight the importance of structured physical activity as a key component of rehabilitation programs for children with Down syndrome, with aerobic exercise along with retro-walk emerging as a particularly beneficial method for advancing postural stability and balance control.

Ethical Clearance
Ref No. SCOT/NOV-24/ECPEADS-05,13/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

OPEN ACCESS

Impact of Combined Multifaceted Cognitive and Resistance Training Approach on Physical Activity, Cognition and Activity of Daily Living in Older Adults: A Randomized Control Trial

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ABSTRACT

A combined cognitive and resistance training approach presents a holistic strategy to enhance strength, cognition, and daily functioning, yet it remains insufficiently studied. This Randomized control trial study evaluated the impact of combined cognitive and resistance training on physical activity, cognition, and activity of daily living in older adults. A total of 106 older adults were randomly divided in two equal groups. Physical activity scale for elderly (PASE), mini mental state examination (MMSE) and KATZ index of activity of daily living used to analyze the outcome of study. The intervention significantly improved activities of daily living (KATZ) and physical activity (PASE), with strong correlations ($r = .622$ and $r = .850$, $p < .001$). Cognitive improvements (MMSE) were modest but statistically significant ($r = .692$, $p < .001$). Paired t-tests confirmed these findings across all domains ($p < .001$). While the control group showed greater cognitive gains, the experimental group demonstrated superior physical activity improvements. Overall, the intervention effectively enhanced physical and functional outcomes, with limited cognitive benefit suggesting a need for longer or tailored strategies. The study highlights that a combined cognitive and resistance training intervention effectively enhanced functional independence and physical activity among older adults. While physical and daily living improvements were significant in the experimental group, cognitive gains were modest and more evident in the control group, suggesting the need for longer or more targeted cognitive interventions.

KEY WORDS: ACTIVITY OF DAILY LIVING, COGNITION, OLDER ADULTS, PHYSICAL ACTIVITY, RESISTANCE TRAINING.

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 18/06/2026 Accepted after revision 25/08/2026
Page Number- 70-74
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https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.14

INTRODUCTION

Functional mobility and physical fitness are associated with independence in old age1. However, age-related processes that are relevant for older persons include a drop in muscle mass and strength as well as decreased physical performance and mobility [1]. Elderly people's mental and general well-being rapidly decline when their mobility and cognitive capacities decline together, and they become less actively involved in activities of daily living [1].

When a decline in cognitive function affects the basic environment, functional restrictions arise. Cognitive and motor skills, including walking, standing, balancing, and engaging with the surroundings [2]. According to the WHO, functional independence and healthy aging are directly tied to age- related declines in cognitive and neuromuscular function3. Aging impairs neuromuscular function by controlling a number of processes and decreasing muscle mass, strength, power, and mobility3. Age-related declines include both cognitive and physical components that have a significant impact on day-to-day functioning [3]. In the field of geriatrics, maintaining neuromuscular and cognitive function is crucial [3].

Resistance exercise is widely used in both sports and general populations in order to cause neuromuscular adaptations that will increase muscle size and performance [4]. The necessity for strength training increases with age in order to maintain mobility for daily tasks [5]. Reducing muscle atrophy and the ensuing loss of motor function is the aim of training. An increase in muscle mass is essential for preserving strength capacity [5].

An increase in frequency and muscle activity during isometric and dynamic exercise is also observed5. Strength exercise training increases skeletal muscle hypertrophy, anaerobic endurance, and strength by using resistance against the force of muscular contraction [6]. Although resistance training has long been shown to have positive effects on the neuromuscular system, there is mounting evidence that it can also enhance cognitive performance and cause neuroplastic changes in the central nervous system (CNS), even when done acutely [7]. Enhancing one's physical and mental capacities can either stop or minimize the cognitive decline that comes with aging [8].

Resistance training has also been suggested as a unique adjuvant rehabilitation approach to mitigate age-related losses in cognitive health in populations with neurological or neurocognitive impairments (e.g., Parkinson's and Alzheimer's dementia) [9].

The mental processes that control how the body and environment interact are referred to as cognitive processes Improvements in the targeted cognitive functions—visuospatial working memory, episodic memory, executive function, and information processing speed— have also been demonstrated to be induced by single cognitive training [8]. It appears that certain executive processes benefit more from physical training than other cognitive functions, as there have been reports of significant gains in cognition following aerobic exercise [10].

There is mounting evidence that exercise may improve older persons' physical and mental health to some extent. Numerous important risk factors for dementia, cognitive decline, falls, impaired gait, and a lower quality of life are clearly linked and modifiable through mental or physical exercise, according to the findings [11]. Evidence suggests that DT training, or combined motor-cognitive training, enhances older individuals' quality of life and motor-cognitive functions for ADL.

Previous studies have demonstrated that cognitive and physical activities, either alone or in combination, can improve cognitive function in older people. The ability to multitask daily. tasks and other cognitive capacities are maintained by cognitive–motor training, which combines mental and physical exercise. Along with engaging in cognitive-motor exercises, older persons can foster neuroplasticity to improve their general brain health and cognitive resilience [1]. Therefore, the aim of present study is to investigate the impact of combined cognitive and resistance training on physical activity, cognition, and activity of daily living in older adults. This study fills a critical gap in the being literature and give practicable perceptivity for perfecting the health and wellbeing of the older adults.

MATERIAL AND METHODS

A randomized control trial study was conducted to evaluate the impact of combined cognitive and resistance training on physical activity, cognition, and activity of daily living in older adults. This study was reviewed and approved by the Institutional Ethical Committee of Santosh College of Occupational Therapy (Ref No.-SCOT/NOV-24/ECNeuro-07). 106 Participants screened using MoCA test12 for cognition and were divided into experimental and control group by random sampling method. Using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 53 participants per group. All participants were undergoing for pre and posttest assessment using KATZ scale, MMSE AND PASE questionnaire. 24 sessions were conducted 2 times in one week for 12 weeks and duration was 45 minute per session.

In the experimental group participants were received combined resistance and cognitive training approach

treatment. Participants of control group were received resistance training program. Resistance training includes- squats, split squads, push-ups, back extension, light polymetric exercises included- wall push-ups, standing up from chair, standing up from floor and wide steps walking4. Cognitive training comprises- stimulus detection, choice reaction, audio spatial, visual spatial, inhibition control, explanation, working memory and cognitive flexibility [1].

Outcome Measurements: The following outcome measurements were taken at baseline and again after 12 weeks of training. The assessment tools included Katz index of independence in activities of daily living. This includes six items covering feeding, dressing, toileting, bathing, transferring, and continence. This scale offers a total score that represents an individual's overall capacity after evaluating them according to how well they do in each category [13]. Mini-Mental State Examination (MMSE) assess 11-item in six domains—orientation, registration, attention, recall, language, and visuospatial [14]. Physical activity scale for elderly (PASE) to assess older people's physical activity. There are twelve components on the scale, five of which relate to leisure activities, six to home activities, and one to work-related activities [15].

RESULTS

Total 106 subjects aged range 65-79 years of age were enrolled in the study and data were gathered through the Katz index of independence in activities of daily living, Mini-Mental State Examination (MMSE) and Physical activity scale for elderly (PASE). Fifty-three subjects were randomly allocated in control and experimental group.

The Pre-test and Post-test scoring of experimental and control group were analyses through parametric test, T-test was used to analyze the KATZ index scale, MMSE test and PASE questionnaire scores for analysis of activity of daily living, cognition and physical activity respectively and gives the following test result.

Table 1. Baseline Characteristics of outcome measure

Outcome Measure	EG				CG					
	Mean		(SD)		Mean		(SD)			
	Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test	T	P
KATZ	5.11	5.55	.954	.574	4.60	5.19	.987	.735	-2.702	0.2536
PASE	104.91	133.9	51.46	61.36	92.53	119.64	58.26	68.84	-1.159	0.249
MMSE	26.70	27.25	.992	1.39	26.25	25.25	.076	.152	-2.905	0.403

EG: Experimental group, CG: Control group, SD: Standard deviation

Table 2. Result of baseline and post test scores of the outcome measures in experimental and control group

Outcome measure	EG		CG	
	T	P	T	P
KATZ	- 4.229	0.0	- 5.924	0.0
PASE	- 6.546	0.0	- 5.902	0.0
MMSE	- 3.941	0.0	6.893	0.0

EG: Experimental group, CG: Control group

Table 3. Result of post data analysis of the outcome measures, Experimental vs Control group

Scale	t- Value	p- Value
KATZ	9.42	0.0
PASE	7.56	0.0
MMSE	8.158	0.0

DISCUSSION

The intervention outcomes demonstrated statistically significant improvements across three key domains: activities of daily living (measured by the KATZ Index), physical activity (assessed via the PASE), and cognitive function (evaluated using MMSE). Functional independence improved markedly, with KATZ scores rising from a mean of 4.60 (SD = 0.987) to 5.19 (SD = 0.735), while physical activity levels increased substantially from a mean PASE score of 92.53 (SD = 58.27) to 119.64 (SD = 68.84). Cognitive performance showed a more modest change, with the mean score decreasing slightly from 26.25 to 25.25, indicating that cognitive improvements may require a longer or more focused intervention. Despite this, all three domains showed strong and statistically significant positive correlations between pre- and post-intervention scores— KATZ (r = 0.688), PASE (r = 0.875), and cognitive scores (r = 0.340)—highlighting consistent participant improvements.

Compared to an alternate dataset with similar demographic trends, the present study stands out for its balanced gender representation, inclusion of left-handed individuals, and detailed categorization of marital status, all of which enhance the ecological validity of the findings. In contrast, the alternate dataset featured fewer female participants in the oldest age group (75–79) and limited left-hand dominance variation, potentially narrowing the generalizability of its outcomes. Moreover, separation consistently emerged as the most common marital status, especially among older males, suggesting the importance of addressing social isolation in future interventions [16].

When compared with previous research, such as the FINGER study17 and physical activity-focused studies like Lautenschlager et al. (2008)18, the current research presents a more focused and replicable model. While previous studies addressed lifestyle or cognitive training broadly, this study precisely targets a combination of cognitive and resistance training and evaluates its effects across multiple health domains [19].

Statistically, the results were reinforced by high t-values and confidence intervals that did not cross zero, confirming the reliability of the improvements. For instance, the KATZ Index saw a mean difference of -0.434 ($t = -4.229$, $p < .001$), and PASE scores increased with a mean difference of -29.05 ($t = -6.546$, $p < .001$). Cognitive function also improved modestly, with a mean change of 0.547 ($t = -3.941$, $p < .001$), despite some variability due to differences in the measurement tools used (MoCA pre-test and MMSE post-test)20. These results were supported by high correlation coefficients across all three domains—KATZ ($r = 0.622$), PASE ($r = 0.850$), and cognitive scores ($r = 0.692$)—further confirming the consistency of participant improvements. Interestingly, when comparing the control and experimental groups, some nuanced differences emerged.

The control group exhibited slightly greater improvements in daily living functions and cognitive outcomes, while the experimental group showed a more substantial increase in physical activity. This suggests that the CRT program may be especially effective for enhancing physical engagement, while cognitive gains might benefit from complementary or prolonged strategies. Despite this, the overall pattern across both groups supports the rejection of the null hypothesis, affirming the intervention's efficacy in improving physical, functional, and cognitive health in older adults, this study distinguishes itself from earlier research through its detailed demographic profiling, robust statistical methods, and comprehensive evaluation of multiple outcome domains.

By integrating both cognitive and physical training, the study presents a well-rounded and evidence-backed intervention model for aging populations. Its methodological strengths and generalizable findings make it a valuable contribution to geriatric health research and intervention design. Despite its promising results, the study had certain limitations. Study consisted for a short duration and small sample size. The long-term effects of the interventions were not assessed. For future reference study can be done with a larger sample size with a longer duration of the study. Specific medical condition can be taken like sarcopenia, muscle atrophy etc. and other combined intervention can be taken into account. Also, study could be done in different setups like home, parks, hospitals for more accurate result.

CONCLUSION

In conclusion, this study provides comprehensive evidence on the demographic distribution and intervention outcomes among older adults. Demographic analysis revealed a predominance of right-hand dominance and a higher proportion of separated individuals, particularly among older males. The intervention, combining cognitive and resistance training, significantly improved activities of daily living and physical activity, with strong statistical support across t-tests analyses. Cognitive improvements, while statistically significant, were more modest and varied between control and experimental groups. Notably, the control group showed better cognitive gains, while the experimental group demonstrated stronger improvements in physical activity. Overall, the intervention was effective in enhancing functional independence and physical engagement, but cognitive benefits may require longer duration or tailored strategies to yield greater impact.

Ethical Clearance
SCOT/NOV-24/ECNeuro-07 ,9/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Effect of Multifaceted Ergonomic Intervention With Therapeutic Exercise on Chronic Neck Pain and Work Ability Among Dental Professionals

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ABSTRACT

Dentistry is both physically and mentally demanding. Physically, it requires strong psychomotor skills, good hearing and vision, fine manual dexterity, and the ability to maintain proper posture for extended periods. If the dental professional is unable to adapt to a specific their work environment, they may develop injuries or disabilities. This study aims to assess the effect of a multifaceted ergonomic intervention with therapeutic exercise on chronic neck pain and work ability using neck disability index (NDI) and work ability index (WAI) in individual with chronic neck pain among dental professionals. A total 44 participant selected according to inclusion and exclusion criteria were included in the study, between 23-55 years of age. In experimental group Multifaceted ergonomic intervention + therapeutic exercises was given to the participants. In control group only Therapeutic exercises was given to the participants. The comparative analysis between the control and experimental groups provides strong evidence regarding the effectiveness of the multifaceted ergonomic intervention combined with therapeutic exercise on chronic neck pain and work ability among dental professionals. For the Neck Disability Index (NDI), the experimental group showed a more substantial improvement and for the Work Ability Index (WAI) also the experimental group showed a more pronounced reduction. This study demonstrates that a combined ergonomic and therapeutic intervention yields significantly superior outcomes in reducing neck disability and improving work ability among dental professionals, compared to standard approaches.

KEY WORDS: DENTAL PROFESSIONAL, MULTIFACETED ERGONOMIC, NECK DISABILITY INDEX (NDI), NECK PAIN, WORK ABILITY INDEX (WAI).

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Received 12/06/2026 Accepted after revision 25/08/2026
Page Number- 75-79
This is an open access article under Creative Commons License,
https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.15

INTRODUCTION

Neck pain (NP), affecting 30–50% of the working population, is one of the most common musculoskeletal conditions and accounts for a significant number of physical therapy consultations. Preventing a portion of patients that leads to progression of NP into a chronic stage poses a considerable challenge for healthcare professionals [1,2].

Dentistry is both physically and mentally demanding. Physically, it requires strong psychomotor skills, good hearing and vision, fine manual dexterity, and the ability to maintain proper posture for extended periods. If the dental professional is unable to adapt to a specific their work environment, they may develop injuries or disabilities. As a result, dentists are particularly vulnerable to work-related health issues such as allergies, systemic illnesses, hearing loss, and musculoskeletal disorders (MSDs) [3]. According to the World Health Organization, MSDs involve conditions affecting the muscles, tendons, joints, intervertebral discs, peripheral nerves, and vascular system. These disorders generally do not arise from sudden incidents but rather develop gradually over time. Over the past several years, reports have shown a steady rise in MSD cases within routine dental practice [4].

It has been estimated that work related musculoskeletal injuries occur in 54% to 93% of dental professionals, with the most frequent injuries occurring in the spine, shoulders, elbows and hands. The most effected regions in dentists have been shown to be the back and neck [5,6]. In the field of dentistry, ergonomic intervention efforts have primarily focused on designing dental instruments and equipment. However, strategies aimed at preventing and reducing these disorders have not received sufficient attention [7]. This study sought to assess a comprehensive ergonomic intervention program that combined improved working conditions, identification of ergonomic risk factors, regular exercise routines, and discussion group sessions, with the goal of reducing musculoskeletal disorders in dentists8.

Ergonomic hazards resulting from awkward postures and prolonged repetitive movements can lead to musculoskeletal disorders, affecting 54–93% of dental professionals. These disorders commonly involve the spine, shoulders, and hand–wrist region. This systematic review of international literature examined the specific ergonomic risk factors and preventive strategies for musculoskeletal disorders in dental practice [9].

There is limited research on the effectiveness of multifaceted ergonomic interventions with therapeutic exercise in reducing neck pain and improving work ability among dental professionals. Thus, this study aims to investigating the effect of a multifaceted ergonomic intervention with therapeutic exercise and to contribute to the development of effective strategies for reducing chronic neck pain and improving work ability among dental professionals.

MATERIAL AND METHODS

A randomized controlled trial comparing the effect of a multifaceted ergonomic intervention with therapeutic exercise intervention with control group was designed. This research was examined, deliberated upon, and endorsed by the Santosh Occupational Therapy institutional ethical committee (Ref No.-SCOT/NOV-24/ECOrtho-02). Using Cochran's formula with a 95% confidence level and 5% margin of error, the minimum sample size was calculated to be approximately 44 participants. Participants were selected from Santosh Dental College Hospital based on the defined inclusion and exclusion criteria. Prior to their participation, the participants were given an explanation regarding the study. The written consents were obtained from the participants. The participants were assigned to control and experimental group by convenient sampling technique.

As per inclusion criteria, individuals with chronic neck pain duration more than 3 months, age range between 23-55 yrs, both male and female were included in this study. As per exclusion criteria, individuals with Other musculoskeletal disorder or who are having Acute NP (shorter than three months in length), A prior history of neck or back surgery, existing neurological symptoms, rheumatoid arthritis involving the neck or back, or the current use of muscle relaxants, other professionals were excluded.

Participants were randomly assigned in one of 2 groups, experimental group and control group. In experimental group Multifaceted ergonomic intervention and therapeutic exercises was given to the participants. In control group only Therapeutic exercises was given to the participants. The intervention was given for 12 weeks, 3 session in a week for 30 min. The outcomes of the intervention were assessed using NDI and WAI outcome measure.

The Intervention Program includes Multifaceted interventions i.e. 4 sections - Ergonomic Knowledge and Training: Dentists training sessions covering fundamental ergonomic principles, common ergonomic risk factors in dentistry, and the specific components of the intervention program, Workstation Modification: Dentists were guided on how to adjust their working posture in various clinical situations.

Instructions included adopting correct working positions and ensuring proper alignment of dental equipment to minimize ergonomic risks. Workstation Ergonomics Assessment and Training: Each dentist's working conditions were assessed during their shift to identify ergonomic risk factors. Active discussions were used to address these issues, and individualized workstation evaluations and modifications were carried out for each participant. Regular

Exercise Program: Dentists were introduced to a series of stretching exercises targeting the neck, shoulders, waist, and lower body.

Table 1.0 Descriptive Statistics for two paired comparisons: Neck Disability Index (NDI) and Work Ability Index (WAI) for Control Group

Stats		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE/NDI	25.45	22	7.975	1.700
	POST/ NDI	11.73	22	4.300	.917
Pair 2	PRE/WAI	41.18	22	1.181	.252
	POST/WAI	44.91	22	2.599	.554

Table 2.0 Descriptive Statistics for two paired comparisons: Neck Disability Index (NDI) and Work Ability Index (WAI) for Experimental Group.

Stats		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE/NDI	31.64	22	4.756	1.014
	POST/ NDI	13.82	22	3.049	.650
Pair 2	PRE/WAI	30.09	22	4.418	.942
	POST/WAI	37.45	22	2.110	.450

They were asked to record their daily physical activities in a logbook and continue these exercises consistently throughout the study8 and therapeutic exercises: Seated against the wall while performing capital flexion (10 rep 3sets), In supine, perform capital flexion without lifting the head to strengthen the deep cervical flexor muscles (10 rep 3 sets), In supine, perform capital flexion with head lift, either independently or with assistance, to strengthen the deep cervical flexor muscles, in prone, perform exercises to strengthen the deep cervical spine extensors [4].

Outcome measures: Neck Disability Index (NDI)10 is a condition-specific questionnaire designed to assess the severity of disability resulting from neck pain and/or restricted cervical mobility in day-to-day activities. These activities encompass self-care, lifting, reading, experiencing headaches, maintaining concentration, driving, sleeping, performing occupational duties and engaging in recreational pursuits [11]. Work Ability Index (WAI): is a widely used measure in occupational health and clinical research for assessing an individual's ability to work. It is implemented during medical evaluations and workplace assessments [12].

RESULTS

The result of this study shows a comprehensive overview of the impact of a multifaceted ergonomic and therapeutic intervention on chronic neck pain and work ability among 22 dental professionals. The descriptive statistics reveal substantial improvements post-intervention.

The comparative analysis between the control and experimental groups provides strong evidence regarding the effectiveness of the multifaceted ergonomic intervention combined with therapeutic exercise on chronic neck pain and work ability among dental professionals.parametric t-test was performed for comparative analysis between the group.

For the Neck Disability Index (NDI), both groups exhibited statistically significant reductions in scores from pre- to post-intervention. The control group showed a mean reduction of 13.727, with a 95% confidence interval ranging from 11.611 to 15.843, and a t-value of 13.49 ($p < 0.001$). On the other hand, the experimental group showed a more substantial improvement, with a mean decrease of 17.818 and a tighter confidence interval ranging from 16.036 to 19.600, reinforced by a t-value of 20.793 ($p < 0.001$). These findings clearly indicate that while standard methods in the control group had a positive effect, the ergonomic and therapeutic intervention in the experimental group produced a significantly greater reduction in neck pain and disability.

Regarding the Work Ability Index (WAI), both groups demonstrated a significant decline in scores after the intervention. The control group recorded a mean decrease of −3.727, with a confidence interval from −4.798 to −2.657, and a t-value of −7.242 ($p < 0.001$). The experimental group showed a more pronounced reduction, with a mean decrease of −7.364, and a confidence interval from −9.014 to −5.713, supported by a t-value of −9.277 ($p < 0.001$). While the decrease in WAI may initially seem counterintuitive, it could reflect a temporary shift in perceived work capacity due to increased physical awareness or adjustment to ergonomic changes.

DISCUSSION

The present study offers compelling and multidimensional evidence supporting the efficacy of a combined ergonomic and therapeutic intervention in addressing chronic neck pain and enhancing work ability among dental professionals.

The descriptive statistics reveal substantial improvements post-intervention. Specifically, the average Neck Disability Index (NDI) score dropped markedly from 25.45 (SD = 7.975) before the intervention to 11.73 (SD = 4.300) after the intervention. This considerable reduction, coupled with a decrease in the standard error from 1.700 to 0.917, underscores the intervention's consistent effect in alleviating neck-related disability. Similarly, the Work Ability Index (WAI) scores increased from a pre-intervention mean of 41.18 (SD = 1.181) to a post-intervention mean of 44.91 (SD = 2.599), suggesting an improvement in perceived work ability, though the increased variability post-intervention indicates a more heterogeneous response among participants.

Effect size calculations provided particularly valuable insights into the magnitude and practical significance

of the observed changes. Regarding the Neck Disability Index (NDI), both Cohen's d (4.019) and Hedges' g (4.170) were well above the standard cutoff for a large effect (d > 0.8), indicating a highly significant clinical impact. With 95% confidence intervals well above zero (Cohen's d: 3.033–5.822; Hedges' g: 2.923–5.611), these results robustly confirm the reliability and meaningfulness of the intervention's outcomes.

The intervention's impact on work ability, as measured by WAI, was also statistically significant, with large effect sizes (Cohen's d = 3.723; Hedges' g = 3.863) and confidence intervals Hedges' g: −2.598 to −1.198; Cohen's d: −2.696 to −1.244) that do not cross zero. While the negative point estimates might initially suggest a decline, this is a result of the PRE − POST scoring convention—with higher post-intervention scores indicating improvement. Thus, these results still reflect a positive and statistically significant gain in perceived work ability. When examining between-group comparisons, the experimental group showed greater improvements in both NDI and WAI, confirming the superior efficacy of the multifaceted intervention over standard practices.

For NDI, the experimental group improved by 17.818 points versus 13.727 in the control group (both $p < 0.001$), with a higher t-value and narrower confidence interval. For WAI, although both groups showed statistically significant reductions, the experimental group demonstrated a more substantial change (−7.364 vs. −3.727, $p < 0.001$), suggesting a stronger immediate impact, albeit likely influenced by short-term adaptation effects.

The results underscore the clinical and occupational relevance of an integrative protocol for dental professionals, who often work under ergonomic strain and time pressure. The extremely large effect size in NDI supports immediate adoption of similar multifaceted interventions within dental clinics and training programs. Moreover, the mixed outcomes in WAI suggest the need for follow-up studies that track long-term adaptation, incorporate qualitative feedback, and assess psychosocial variables such as stress, burnout, and job satisfaction13,14.

In February 2025, Gauthaman J and Ganesan conducted a study evaluating randomized controlled trials that implemented both physical and cognitive ergonomic interventions for dentists, aiming to prevent work-related musculoskeletal disorders (WMSDs). The study concluded that ergonomics in dentistry is a critical area of concern due to the rising incidence of WMSDs among dental professionals. Effective ergonomics should balance maintaining the dentist's health with delivering efficient patient care15. In 2022, Dr. Mahant and Shukla investigated the Effects of Ergonomics Among Dentist Practitioners on Pain and Function [16].

Findings revealed a statistically significant improvement in pain and function in Group A after six weeks, while Group B showed no significant changes. The study indicated that ergonomic strategies can improve functional outcomes and reduce pain in dentist practitioners. In 2019, Letafatkar et al. examined the study investigated the impact of therapeutic exercise (TE) on pain, posture, impairment, and general health in female dentists with persistent neck discomfort4. The experimental group significantly improved all metrics, including posture, pain, impairment, and physical position, according to the results, while the control group showed no discernible changes.

authors concluded that TE is highly effective in reducing chronic neck pain and its related functional impairments, recommending it for individuals with ongoing neck pain, postural issues, and associated health concerns, highlighting its remarkably strong effect size. Despite its promising results, the study had limitations. This study did not have a sufficient follow-up period to assess the long-term effects of Multifaceted ergonomic intervention with therapeutic exercises.

Table 3.0 Comparison of Control and Experimental Group

	Control Group								Experimental Group							
	Paired Differences					t	Significance		Paired Differences					t	Significance	
Stats	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			One-Sided p	Two-Sided p	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			One-Sided p	Two-Sided p
				Lower	Upper							Lower	Upper			
PRE/NDI - POST/NDI	13.727	4.773	1.018	11.611	15.843	13.49	<.001	<.001	17.818	4.019	0.857	16.036	19.6	20.793	<.001	<.001
PRE/WAI - POST/WAI	-3.727	2.414	0.515	-4.798	-2.657	-7.242	<.001	<.001	-7.364	3.723	0.794	-9.014	-5.713	-9.277	<.001	<.001

Future research could be done with objective measures of other musculoskeletal pain in their study and it could include the assessment of participants in the middle of intervention periods.

CONCLUSION

This study demonstrates that a combined ergonomic and therapeutic intervention yields significantly superior outcomes in reducing neck disability and improving work ability among dental professionals, compared to standard approaches. The experimental group not only showed greater numerical improvements in both the Neck Disability Index (NDI) and Work Ability Index (WAI) scores but also exhibited extremely large effect sizes—particularly for NDI—indicating a profound clinical impact. These results position the multifaceted intervention as the most effective strategy in this context, outperforming both ergonomic-only and exercise-only interventions documented in earlier research.

Ethical Clearance
Ref No.-SCOT/NOV-24/ECOrtho-02 ,11/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

OPEN ACCESS

Improving Attention and Academic Outcomes in Children with Attention Deficit/Hyperactivity Disorder Through Vestibular-Based Physical Activity

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ABSTRACT

ADHD is a prevalent neurodevelopmental disorder in childhood, characterized by persistent difficulties in maintaining attention, completing academic tasks, and controlling executive functions. This RCT aimed to examine the effectiveness of vestibular-centred physical exercises in improving focus and academic achievement in children diagnosed with ADHD.A total of forty participants aged between 6 and 15 years were randomly divided into two groups: the experimental group (n=20). Results revealed that the experimental group demonstrated a significantly higher improvement in APRS scores (mean gain: 7.2 points) compared to the control group (mean gain: 3.1 points; $p = 0.009$). Moreover, the experimental group showed marked reductions in completion times on both TMT-A and TMT-B ($p = 0.018$ and $p = 0.024$, respectively), reflecting enhanced attentional control and cognitive flexibility. These outcomes indicate that integrating vestibular-based physical activities into occupational therapy interventions substantially improves attention, academic performance. Hence, such integrative approaches can be considered a valuable addition to therapeutic programs designed for this population.

KEY WORDS: ADHD, ACADEMIC PERFORMANCE, ATTENTION, VESTIBULAR-BASED PHYSICAL ACTIVITY, EXECUTIVE FUNCTION, OCCUPATIONAL THERAPY

Article Information: *Corresponding Author: kumarrk52003@yahoo.co.in
Received 11/01/2026 Accepted after revision 15/03/2026
Page Number- 80-84
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.16

INTRODUCTION

ADHD represents a prevalent neurodevelopmental condition among children, characterized through ongoing problems with attention, immoderate interest, and impulsive

conduct patterns [1]. Children with ADHD frequently display symptoms such as distractibility, forgetfulness, impulsive behaviours, and restlessness, typically emerging before the age of seven [2]. These behavioural traits often conflict with classroom expectations such as sitting still, paying attention, and following instructions, thereby contributing to academic underperformance and social challenges.

Research indicates that approximately 70% of children diagnosed with ADHD also present with learning disabilities, particularly in areas like writing [3]. Undermine academic performance, necessitating tailored educational strategies. Emerging studies highlight the potential of physical activity to enhance brain function related to attention, executive control, and self-regulation [4,5]. Specifically, vestibular-based physical activities, which involve stimulating the inner ear through movement-based exercises such as spinning, swinging, or bouncing, have demonstrated promising effects on sensory integration, emotional regulation, and cognitive readiness [6–8].

Activities targeting this system can influence limbic functioning, linking physical motion with emotional and behavioural control9,10. However, limited research has specifically explored the impact of vestibular-based physical activities on attention and academic performance. While the study by Kumar, Rathinavathy, and [11] demonstrated improved academic outcomes through such interventions, the effect on attentional measures remains under-investigated. This research seeks to bridge this gap by examining how vestibular-focused physical activities enhance attention and academic achievement among children diagnosed with ADHD.

MATERIAL AND METHODS

The present study adopted a randomized controlled trial design. Ethical approval taken from Institutional Ethical Committee of Santosh College of Occupational Therapy (Ref No. SCOT/NOV-24/ECPEADS-01), and permission was granted by Pediatrics Clinics, Continua Kids, Gurugram. All parents of participants were fully informed about the study's objectives and procedures, and written informed consent was obtained before participation. Based on a statistical power of 80% and an alpha level of 0.05, the required sample size was calculated to be 20 participants per group.40 children with ADHD, randomly allotted into an experimental (n = 20) and a control group (n = 20) randomly to ensure unbiased distribution. Experimental group received vestibular-based physical activity along with traditional occupational remedy, at the same time as the manage institution underwent traditional therapy alone.

Eligible participants were children aged 6–15 years of either gender diagnosed with ADHD by a neurologist or pediatrician, and able to walk independently without significant balance impairments. Exclusion criteria comprised children with intellectual disabilities or developmental delays, major medical or neurological disorders (e.g., epilepsy, learning disabilities, depression, anxiety, deafness, or visual impairments), or balance issues affecting gait. The experimental sessions included a 5-minute warm-up, 15 minutes of vestibular activities (e.g., swinging, wobble board, trampoline, and balance beam), 15 minutes of conventional OT (e.g., joint proprioception, fine motor tasks, eye-hand coordination, strength training, writing, and puzzles), followed by 5 minutes of rest. The control group underwent a similar session format, with a 5-minute warm-up, 30 minutes of conventional OT, and 5 minutes of rest [11]. Interventions were administered three times per week for 40 minutes over eight weeks.

Outcome Measures: Outcome measures were recorded both at baseline and after eight weeks of intervention. Academic performance and classroom behaviour were assessed using the 19-item teacher-rated Academic Performance Rating Scale (APRS), which evaluates key domains including behavioural control, academic success, task completion across subjects, and sustained attention. Additionally, the scale includes items measuring the frequency of off-task behaviour and social disengagement. Although originally developed by [12], the APRS continues to be widely used in recent studies investigating educational outcomes in children with ADHD [13].

To evaluate cognitive functioning, the Trail Making Test (TMT)—consisting of Part A and Part B—was used as a validated neuropsychological measure of visual attention, processing speed, and cognitive flexibility [14]. Recent adaptations of the TMT have maintained its relevance for assessing executive functioning in children and adolescents, including those with ADHD, and it is commonly employed in both clinical and educational research settings [15].

RESULTS

40 children with ADHD were selected, with 20 participants in both groups. Experimental group received vestibular-based physical activity combined with conventional occupational therapy (OT), while the control group received conventional OT only.

Table 1. Demographic characteristics of participants

Variable	Experimental Group (n = 20)	Control Group (n = 20)	p-value
Age (years, mean ± SD)	9.12 ± 1.24	9.05 ± 1.18	0.812
Gender (M/F)	13 / 7	12 / 8	0.752

Paired sample t-tests were performed to evaluate pre- and post-intervention differences across key outcome variables: Academic Performance Rating Scale (APRS), Trail Making Test A (TMT-A), and Trail Making Test B (TMT-B). The results are presented in Tables 2, 3, and 4.Additionally, effect sizes were calculated using Cohen's d and Hedges' g, with 95% confidence intervals provided to quantify the magnitude of intervention impact. In the experimental

group, APRS scores improved significantly from 47.05 ± 4.32 (pre-test) to 54.25 ± 4.61 (post- test), mean difference 7.20 (95% CI: 3.16–11.24); t = -3.728, p = 0.001, Cohen's d = 0.65. Control group also showed improvement, from 46.10 ± 4.18 to 49.20 ± 4.36, mean difference 3.10 (95% CI: 0.82–5.38); t = -2.915, p = 0.009, Cohen's d = 0.44.Between-group post-test comparison indicated a significantly greater improvement in the experimental group (t = 2.201, p = 0.033) (Table 2).

Table 2. Academic Performance (APRS)

Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Mean Difference	t	p- value	Cohen'sd
Experimental	47.05 ± 4.32	54.25 ± 4.61	7.20	-3.728	0.001	0.65
Control	46.10 ± 4.18	49.20 ± 4.36	3.10	-2.915	0.009	0.44
Between groups (post-test)	—	—	—	2.201	0.033	—

Table 3. Attention (TMT-A)

Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Mean Difference	t	p- value	Cohen'sd
Experimental	3.24 ± 0.62	2.27 ± 0.51	0.97	5.621	<0.001	1.26
Control	3.18 ± 0.59	2.60 ± 0.54	0.58	6.051	<0.001	0.91
Between groups (post- test)	—	—	—	2.473	0.018	—

Table 4. Executive Function (TMT-B)

Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Mean Difference	t	p- value	Cohen'sd
Experimental	5.72 ± 0.88	5.01 ± 0.79	0.71	3.472	0.003	0.78
Control	5.68 ± 0.91	5.52 ± 0.86	0.16	0.507	0.615	0.11
Between groups (post- test)	—	—	—	2.354	0.024	—

In the experimental group, mean completion time reduced from 3.24 ± 0.62 seconds to 2.27 ± 0.51 seconds, mean difference 0.97 (95% CI: 0.55–1.39); t = 5.621, p < 0.001, Cohen's d = 1.26.In the control group, mean time reduced from 3.18 ± 0.59 to 2.60 ± 0.54, mean difference 0.58 (95% CI: 0.32–0.84); t= 6.051, p < 0.001, Cohen's d = 0.91. Between-group analysis confirmed significantly greater improvement in the experimental group (t = 2.473, p = 0.018) (Table 3).

The experimental group showed significant improvement, with mean completion time decreasing from 5.72 ± 0.88. seconds to 5.01 ± 0.79 seconds, mean difference 0.71 (95% CI: 0.26–1.16); t = 3.472, p = 0.003, Cohen's d = 0.78. In contrast, the control group showed a non-significant change from 5.68 ± 0.91 to 5.52 ± 0.86, mean difference 0.16 (95% CI: -0.48–0.79); t = 0.507, p = 0.615.Between-group comparison confirmed significantly greater gains in the experimental group (t = 2.354, p = 0.024) (Table 4).

DISCUSSION

The present study demonstrates that vestibular-based physical activity (VBPA), when integrated with conventional occupational therapy (OT), significantly improves academic performance, compared to conventional OT alone. Academic Performance Rating Scale (APRS) scores, indicating the positive impact of vestibular input on educational outcomes11,16. Although the control group exhibited some gains, the smaller effect size reinforces the added value of vestibular stimulation. Improvements in attention, measured by reduced completion time in Part A (TMT-A), align with previous findings that vestibular stimulation enhances sensory-motor integration and arousal regulation, thereby facilitating attentional control17. Similarly, executive functioning, as assessed by Part B (TMT-B), improved significantly in the experimental group, suggesting enhanced cognitive flexibility and divided attention, consistent with research supporting sensorimotor interventions for higher-order executive processes [18].

These consistent improvements across domains support the alternative hypothesis and underscore the efficacy of vestibular-based interventions in addressing ADHD-related challenges [19]. However, the study has several limitations. It did not differentiate between ADHD subtypes, which may respond differently to VBPA. Additionally, outcome assessments relied primarily on teacher-reported

and performance-based tools, without incorporating neurophysiological or observational data that could provide deeper insights.

Future studies should compare various physical activity modalities to broaden understanding of treatment efficacy and employ multi-modal assessment tools such as neuroimaging, behavioral coding, and parent reports. Investigating the neural mechanisms underlying vestibular input and tailoring interventions to specific ADHD subtypes may further enhance therapeutic outcomes.

CONCLUSION

The study confirms that vestibular-based physical activity, when integrated with conventional occupational therapy, is an effective intervention for improving academic performance, attention in children with ADHD. These findings serves as a valuable adjunct to conventional occupational therapy in addressing the core challenges of ADHD. Incorporating structured vestibular-based physical activities into therapeutic programs may enhance attention and academic functioning in children with ADHD, thereby supporting their educational and developmental outcomes more holistically.

Ethical Clearance
Ref No. SCOT/NOV-24/ECPEADS-01,13/11/2024.

Conflict of interest statement - NONE.

Funding- Self-funded.

ACKNOWLEDGEMENTS

The authors acknowledge all those who provided support and constructive input throughout this research.

Data availability: The data associated with the paper are not publicly available but are available from the corresponding author on reasonable request.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Correlation Between Chronic Heel Pain and Foot Arch Type Among Physiotherapists

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ABSTRACT

Chronic heel pain is a common complaint among physiotherapists and is frequently linked to biomechanical abnormalities of the foot arch. However, the association between foot arch type and heel pain remains underexplored in active physiotherapy professionals. To determine the correlation between chronic heel pain and foot arch type using the Arch Height Index (AHI) and Navicular Drop Test (NDT), and to analyze their relationship with pain intensity among physiotherapists. This cross-sectional, correlational study included 50 physiotherapists aged 20–50 years, recruited purposively from colleges, clinics, and staff departments. Participants reported heel pain persisting for more than three months. Exclusion criteria included foot trauma, surgery, congenital deformities, systemic or neurological disorders, pregnancy, and use of orthotics or special footwear. Ethical approval and informed consent were obtained. The AHI assessed static arch type (low, normal, high), while the NDT evaluated dynamic posture (pronated, normal, supinated). Pain intensity was measured using the Numeric Pain Rating Scale (NPRS). Data were analyzed using chi-square tests and Pearson's correlation ($\alpha = 0.05$). Among participants, 34% had low arches, 34% normal, and 32% high arches. AHI showed strong correlations with NDT ($r = 0.864$, $p < 0.001$) and NPRS ($r = 0.765$, $p < 0.001$). Individuals with low arches reported higher pain (mean NPRS 7.0 ± 1.2), with a significant association between arch type and pain ($p = 0.001$). Foot arch height significantly correlates with heel pain intensity. Flat feet are linked to increased pain, emphasizing the need for early biomechanical screening and preventive care.

KEY WORDS: ARCH HEIGHT INDEX, CHRONIC HEEL PAIN, FLAT FOOT, NAVICULAR DROP TEST, PHYSIOTHERAPISTS.

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Received 11/05/2026 Accepted after revision 15/08/2026
Page Number- 85-90
This is an open access article under Creative Commons License, https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.17

INTRODUCTION

Chronic heel pain remains one of the most frequent musculoskeletal conditions observed in both clinical and occupational environments. The disorder is predominantly attributed to plantar fasciitis, which involves degenerative and inflammatory changes in the plantar fascia, producing localized discomfort and functional limitations [1]. The burden of heel pain extends beyond local tissue irritation, as it affects walking mechanics, daily mobility, and quality of life.

Individuals engaged in professions requiring prolonged standing or walking are particularly vulnerable, and physiotherapists represent a notable example of such a group. Owing to the physical nature of their professional duties—standing for extended durations, moving repetitively between patients, and frequently demonstrating therapeutic maneuvers—they are exposed to substantial mechanical stress that may predispose them to the development of heel pain [2].

The structural and functional design of the human foot plays a central role in bearing body weight and facilitating locomotion. Among its key components, the medial longitudinal arch acts as a flexible yet resilient support mechanism that aids in efficient shock absorption and force distribution during standing, walking, and dynamic movement [3].

When deviations occur in the structure of this arch—such as flattening of the arch (pes planus) or excessive curvature (pes cavus)—the balance of load distribution across the plantar fascia is altered. This imbalance can lead to excessive tensile stress on the fascia and surrounding tissues, increasing susceptibility to inflammation and pain [4]. For this reason, accurate evaluation of foot posture has become a fundamental part of both clinical assessment and research focused on plantar fasciitis.

Two widely recognized methods for assessing foot posture are the Arch Height Index (AHI) and the Navicular Drop Test (NDT). The AHI provides an objective quantitative measure of the static height of the medial arch, offering insight into structural configuration. The NDT, by contrast, evaluates the change in navicular bone position from a seated to a standing position, thereby reflecting dynamic arch mobility [5].

When these two tools are used together, they allow a comprehensive assessment of both static morphology and dynamic adaptability of the foot, facilitating the identification of subtle biomechanical variations that may otherwise go unnoticed6. This dual assessment is especially relevant in the study of chronic heel pain, as altered foot mechanics can influence plantar fascia tension and the subsequent manifestation of pain.

Despite considerable investigation into the biomechanical links between foot posture and plantar heel pain, the literature presents inconsistent conclusions [7,8]. Some researchers have reported strong correlations between abnormal foot arches and the incidence of plantar fasciitis, whereas others have found these associations to be weak or statistically insignificant [9].

One possible reason for such variability lies in the diversity of study populations. A substantial proportion of prior research has centered on athletic or general populations, often neglecting occupational groups such as healthcare professionals. Physiotherapists, due to their repetitive and physically demanding roles, may face distinctive mechanical stresses that differ from those experienced by athletes or sedentary workers. Therefore, a more focused exploration of heel pain among physiotherapists is warranted to address this evident research gap [10].

An additional shortcoming identified in current evidence is the scarcity of direct comparisons between various foot posture assessment methods and their relationships with perceived pain intensity. Although both AHI and NDT are considered valid and reliable diagnostic tools, few studies have concurrently analyzed their outcomes alongside subjective pain measurements to establish a more integrated understanding of the condition [11].

Pain assessment tools such as the Numeric Pain Rating Scale (NPRS) and the Visual Analog Scale (VAS) are widely utilized to quantify discomfort levels, yet these are seldom used in conjunction with mechanical measurements like AHI and NDT. The combined evaluation of these parameters can provide valuable insights into how structural and functional variations of the foot influence the degree of pain experienced by affected individuals [12].

Examining physiotherapists as a specific population holds notable clinical and occupational relevance. Professionally, these individuals frequently engage in tasks that demand physical exertion, such as transferring patients, maintaining awkward postures during treatments, and demonstrating movement patterns repeatedly. Such occupational demands are known to increase the risk of musculoskeletal disorders, including lower limb and foot conditions. Reports suggest that the prevalence of work-related musculoskeletal pain among physiotherapists is considerably high, with the lower extremities—particularly the feet and heels—being common sites of discomfort [1].

Identifying predisposing factors such as foot posture deviations at an early stage could enable the design of preventive interventions. These might include ergonomic adjustments in clinical environments, appropriate footwear prescriptions, and strengthening or stretching programs aimed at maintaining optimal arch support and reducing plantar fascia strain [2,6].

From a broader clinical perspective, physiotherapists not only manage their own musculoskeletal well-being but also play a vital role in educating and treating patients with similar disorders. Persistent heel pain in these professionals can therefore have implications that extend beyond

individual health—it may compromise their capacity to demonstrate exercises, sustain prolonged standing during therapy sessions, or effectively deliver patient care.

Consequently, understanding the prevalence, risk factors, and biomechanical associations of heel pain in this population carries both preventive and occupational significance [11]. Through such inquiry, it becomes possible to enhance workplace ergonomics, inform evidence-based physiotherapy practices, and contribute to overall professional sustainability within healthcare settings.

In summary, chronic heel pain, often arising from plantar fascia overload, is a multifactorial condition influenced by foot structure, occupational activity, and repetitive mechanical stress. Despite extensive research in athletic and general populations, there remains limited evidence addressing how variations in foot posture, as quantified by AHI and NDT, relate to pain intensity among physiotherapists. Investigating this relationship will not only help to bridge an important gap in the literature but also support the development of targeted strategies to prevent and manage heel pain in this essential healthcare workforce [6,12].

METHODS

Study Design and Participants: This study utilized a cross-sectional, correlational design to investigate the relationship between chronic heel pain and foot arch variations among physiotherapists. A total of 50 practicing physiotherapists, aged between 20 and 50 years, were recruited through purposive sampling from the staff, college and various physiotherapy clinics Ghaziabad. Physiotherapists were specifically chosen because of their occupational exposure to prolonged standing, walking, and active demonstration of therapeutic exercises, which are factors known to predispose them to musculoskeletal discomfort, particularly heel pain. All participants reported experiencing chronic heel pain for a duration of more than three months, either unilaterally or bilaterally.

Inclusion criteria were actively practicing physiotherapists reporting chronic heel pain. Exclusion criteria included any history of foot trauma or surgical intervention, congenital foot deformities, systemic or neurological conditions such as diabetes mellitus, arthritis, or neuropathies, pregnancy, and current use of orthotic devices, braces, or specialized footwear. These criteria were established to ensure a homogeneous sample and to minimize confounding factors that could independently affect heel pain or foot biomechanics.

Ethical clearance was obtained from the institutional ethics committee (REF NO.- SCOP/OCT-24/ECN-94510023682), and written informed consent was collected from all participants in accordance with established ethical guidelines for human research. Foot posture assessment included both static and dynamic measures. The Arch Height Index (AHI) was employed to classify the medial longitudinal arch as low (flat foot), normal, or high (pes cavus), providing insight into the static structure of the foot.

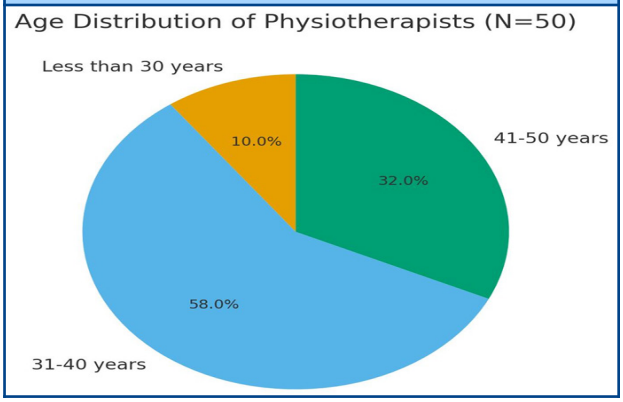
The Navicular Drop Test (NDT) was used to measure dynamic mobility by quantifying navicular displacement from a non-weight-bearing seated position to a standing weight-bearing position, allowing classification into pronated, normal, or supinated foot types). Pain intensity was assessed using the Numerical Pain Rating Scale (NPRS), where participants were asked to rate their heel pain on a scale ranging from 0, indicating no pain, to 10, representing the worst possible pain.

In this study, participants underwent a single-session evaluation to explore the link between foot structure, mobility, and heel pain. Arch Height Index (AHI) was measured by assessing dorsum height relative to foot length. Numeric Pain Rating Scale (NPRS) captured pain intensity. All measurements were carefully recorded, with repeats performed when needed for reliability. The focus was on identifying associations rather than providing interventions. By integrating static, dynamic, and subjective measures, the study offered a comprehensive perspective on foot biomechanics, aiming to enhance understanding of occupational heel pain and guide preventive strategies for physiotherapists.

Table 1. Descriptive statistics of Age of physiotherapists N=50

Age	No. of Patients	Percentage
31-40 years	29	58.0%
41-50 years	16	32.0%
Less than 30 years	5	10.0%
Mean ± SD	38.06 ±5.622 years	

Figure 1



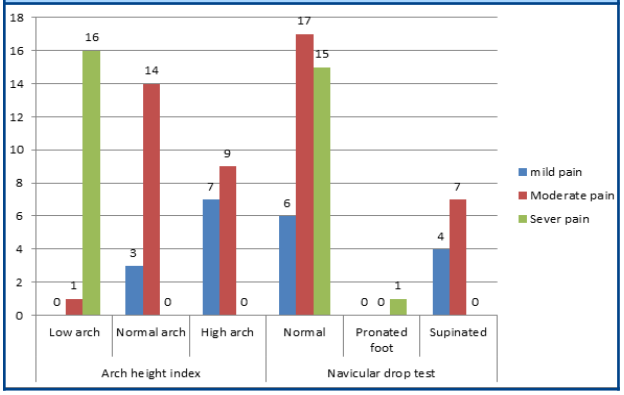
RESULTS

All data were compiled and analyzed using Statistical Package for the Social Sciences (SPSS) version 26. Descriptive statistics such as mean, standard deviation, and percentages were calculated for demographic and clinical variables.

Table 2. Association between Numeric Pain Rating Scale and Arch height index & Navicular drop test of physiotherapists

Scale	Category	Numeric Pain Rating Scale			Chi-square test value	DF	P-value
		mild pain	Moderate pain	Sever pain			
Arch height index	Low arch	0 (0%)	1 (4.2%)	16 (100%)	49.707	4	0.001 (Significant)
	Normal arch	3 (30%)	14 (58.3%)	0 (0%)			
	High arch	7 (70%)	9 (37.5%)	0 (0%)			
Navicular drop test	Normal	6 (60%)	17 (70.8%)	15 (93.8%)	8.762	4	0.067 (insignificant)
	Pronated foot	0 (0%)	0 (0%)	1 (6.2%)			
	Supinated	4 (40%)	7 (29.2%)	0 (0%)			

Figure 2



The Chi-square test was applied to determine the association between categorical variables such as foot arch type (AHI) and pain intensity levels (NPRS), as well as between NDT and NPRS classifications. To explore linear relationships among continuous variables, Pearson's correlation coefficient (r) was calculated for AHI, NDT, and NPRS scores. A p-value < 0.05 was considered statistically significant. The statistical methods were selected to appropriately match the cross-sectional, correlational design of the study and to validate the strength and direction of relationships between foot posture and chronic heel pain severity.

Above table shows mean age of physiotherapists was 38.06 years and majority of 58% physiotherapists belonged to 31-40 years age group, 32% physiotherapists belonged to 41-50 years age group and 10% physiotherapists belonged to less than 30 years age group.

Above table shows that there was statistically significant association between arch height index and pain rating scale of physiotherapists with P<0.05. And there was no statistically significant association between navicular drop test and pain rating scale of physiotherapists with P>0.05.

DISCUSSION

This study examined the relationship between foot-arch morphology and chronic heel pain in a sample of 50 practising physiotherapists. Key findings were: 34% of participants classified as low-arched, 34% normal-arched, and 32% high-arched; a strong positive correlation between Arch Height Index (AHI) and Navicular Drop Test (NDT) ($r = 0.864$, $p < 0.001$); strong correlations between AHI and pain intensity (NPRS) ($r = 0.765$, $p < 0.001$) and between NDT and NPRS ($r = 0.780$, $p < 0.001$); a significant chi-square association of arch type with categorical pain levels ($\chi^2 = 49.707$, $df = 4$, $p = 0.001$); and a non-significant chi-square for NDT versus categorical pain ($\chi^2 = 8.762$, $p = 0.067$). Participants with low arches reported the highest mean pain (NPRS 7.0 ± 1.2) and most severe pain cases in the sample.

The large correlations linking static arch height (AHI) and dynamic navicular mobility (NDT) with pain intensity support the biomechanical plausibility that altered medial longitudinal arch structure and mobility increase tensile load through the plantar fascia and associated tissues [3,4]. The particularly strong AHI–NDT correlation ($r = 0.864$) indicates that, in this occupational sample, static and dynamic measures are highly related and frequently co-occur—low static arch typically accompanied by greater navicular displacement. The strong AHI–NPRS and NDT–NPRS correlations ($r \approx 0.76$–0.78) suggest that both structural height and dynamic mobility relate to symptom intensity, consistent with mechanistic models that link abnormal load distribution to plantar fascia overload [1,13].

However, the discrepancy between the significant chi-square for arch type ($p = 0.001$) and the borderline/non-significant chi-square for NDT ($p = 0.067$) deserves attention. The chi-square result for arch type indicates that categorical grouping of AHI aligns with pain categories, while NDT's categorical classification may not map as cleanly onto coarse pain categories—despite NDT showing strong continuous correlation with NPRS. This suggests that dichotomizing or categorizing inherently continuous measures may reduce sensitivity; continuous correlations preserved more information and therefore remain significant whereas coarse categorical tests can lose power [5,14].

The use of Pearson's r for continuous associations was appropriate to quantify linear relationships, but the cross-sectional design precludes causal inference—high correlation does not prove that arch morphology causes heel pain [1].

The study reports strong r values; yet correlation coefficients can be inflated by outliers or restricted range. The manuscript does not report diagnostic checks (normality, linearity, homoscedasticity), nor sensitivity analyses such as outlier removal or non-parametric confirmation, which would strengthen confidence in the reported r values. Similarly, the chi-square ($\chi^2 = 49.707$) is numerically large; it would be helpful to provide cell counts and expected counts to confirm that test assumptions hold and that no cells had very low expected frequencies (which can invalidate chi-square and favour Fisher's exact interpretation).

Inter-rater and intra-rater reliability of the measurements (AHI and NDT) are critical because both are operator-dependent14. The manuscript states trained evaluators performed assessments, but it lacks reported reliability statistics (ICC or kappa). Absent reliability data, measurement error could either attenuate or spuriously inflate associations. Repeated measures or reporting of assessor agreement would materially strengthen internal validity5.

Sampling, bias, and confounding: Purposive sampling of physiotherapists from a limited geographic and institutional pool reduces generalisability. The sample size (N = 50) is modest; while correlations were large, the small sample increases the chance of type I or II errors in subgroup or categorical analyses and limits the stability of estimates. Selection bias is plausible: physiotherapists experiencing heel pain may have been more likely to participate, inflating prevalence of symptoms relative to the broader population of clinicians [10].

Crucially, several potential confounders were not adjusted for in the analyses: body mass index, footwear habits, weekly standing/work hours, prior lower-limb injury, comorbidities (e.g., diabetes) and activity level. These factors can independently influence both arch morphology and heel pain (Alotaibi, 2020; Boob et al., 2024). The absence of multivariable modelling means observed bivariate associations may be partly confounded; for instance, higher BMI both flattens the arch and increases plantar load, presenting an alternative causal path to pain [3]. Clinical relevance and practical implications.

Despite limitations, the findings have practical import. Static AHI is readily measured in clinics and, in this sample, appears to be a useful screening marker for elevated heel pain risk—a point relevant for occupational health in physiotherapy staff. Implementing routine foot posture assessment and early preventive measures (ergonomic adjustments, footwear advice, targeted strengthening/orthotic programmes) could plausibly reduce occupational burden [2,6]. However, clinicians should avoid assuming causality—intervention studies testing whether correcting arch mechanics reduces pain are needed before recommending widespread corrective programmes [1].

Future work should: adopt prospective or interventional designs to probe causality; recruit larger and multi-centre samples to improve external validity; report measurement reliability (ICC); include potential confounders and use multivariable regression; and prefer continuous analyses over crude categorization to maintain statistical power. Mechanistic outcomes (plantar pressure mapping, gait analysis, ultrasound of plantar fascia) would clarify pathways linking structure to pain7,8. Finally, randomised trials of orthoses or exercise regimens in symptomatic physiotherapists would test whether modifying biomechanics reduces pain and improves function [6,12].

The study offers compelling preliminary evidence that in this occupational sample, lower arch height and greater navicular mobility are associated with greater heel pain intensity. Yet, methodological limitations—small purposive sample, possible confounding, absence of reliability reporting, and cross-sectional design—mean the findings are hypothesis-generating rather than definitive. Addressing these limitations in future research will determine whether foot-arch screening and targeted biomechanical interventions should become routine elements of occupational health for physiotherapists [1,13,15].

CONCLUSION

This study shows how something as simple as the shape of our foot arch can greatly impact comfort and health, especially for physiotherapists who spend long hours standing and moving. It found that those with low arches often experienced more heel pain compared to colleagues with normal or high arches. By measuring arch height and foot mobility, researchers confirmed a strong link to pain levels. These findings remind us of the importance of regular foot assessments and supportive measures—like proper footwear, exercises, and workplace adjustments—to prevent discomfort, protect long-term foot health, and maintain overall well-being in demanding professions.

Future Scope: The future scope of this study highlights important avenues for advancing occupational health. Expanding research across larger and varied populations will strengthen evidence on the link between foot arch type and heel pain. Longitudinal studies can provide insight into the long-term impact of foot biomechanics, while intervention-based research may evaluate the effectiveness of orthotics, targeted exercise, and supportive footwear. Additionally, ergonomic workplace modifications should be explored to minimize strain. Incorporating digital tools, such as foot scanners and wearable devices, offers opportunities for early detection, proactive management, and improved quality of life for physiotherapists and other high-risk professionals.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Patient-Perceived Functional Improvement and Societal Impact of Physiotherapy: A Survey of Outpatient Department and Inpatient Department Settings

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ABSTRACT

Physiotherapy plays a crucial role in rehabilitation by improving mobility, reducing pain, and facilitating social reintegration. Assessing patient experience and societal impact in different care settings is vital to ensure quality outcomes and optimise healthcare delivery. The study aimed to evaluate patient satisfaction, functional improvement, and societal reintegration following physiotherapy in outpatient (OPD) and inpatient (IPD) settings through comprehensive patient feedback analysis. A cross-sectional survey study was conducted over 6 months at Santosh Hospital, Ghaziabad. Using systematic random sampling, 93 patients who completed physiotherapy treatment participated. A structured, pre-validated questionnaire assessed demographics, treatment characteristics, patient satisfaction (5-point Likert scale), perceived functional improvement, and treatment effectiveness. Data were analyzed using Python with descriptive statistics, frequency analysis, and visualisation techniques. The study included 93 patients (OPD and IPD) with diverse demographics and conditions. Patient satisfaction was consistently high across all domains, with 89% rating physiotherapist communication as 4–5/5. Treatment effectiveness showed positive outcomes: 78% reported Significant/Complete pain relief, 82% reported mobility improvement, and 85% rated overall health status as Greatly improved post-physiotherapy. Physiotherapy services demonstrated high patient satisfaction and positive health outcomes in both OPD and IPD settings. The findings support the effectiveness of current physiotherapy interventions and highlight the importance of patient-centred care approaches in rehabilitation services.

KEY WORDS: PHYSIOTHERAPY, PATIENT SATISFACTION, SOCIETAL IMPACT, OUTPATIENT DEPARTMENT, INPATIENT DEPARTMENT, REHABILITATION, INDIA.

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Received 13/04/2026 Accepted after revision 15/07/2026
Page Number- 91-95
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.18

INTRODUCTION

Physiotherapy is a cornerstone of modern healthcare, providing evidence-based interventions to restore function, alleviate pain, and promote independence across

diverse patient populations [1,2]. As a healthcare discipline that addresses physical impairments, activity limitations, and participation restrictions, physiotherapy significantly impacts both individual patient outcomes and broader societal functioning [3,4].

In the Indian healthcare context, physiotherapy services are delivered through both outpatient (OPD) and inpatient (IPD) settings, each presenting unique advantages and challenges. The growing burden of musculoskeletal disorders, neurological conditions, and lifestyle-related health issues has increased the demand for comprehensive rehabilitation services [5,6]. Understanding patient experiences and perceived societal impact of physiotherapy interventions is crucial for quality improvement and healthcare policy development.

Patient satisfaction influences treatment adherence, clinical outcomes, and healthcare utilization [4,7]. The societal impact of physiotherapy extends beyond clinical improvement to include return to work, resumption of household responsibilities, and community [8]. High patient satisfaction is not merely a desirable courtesy; it is strongly linked to improved treatment adherence, greater patient engagement in their own recovery, and better long-term health outcomes. Functional Improvement: This represents the core clinical objective of physiotherapy [9].

Our evaluation quantifies the tangible benefits experienced by patients, including measurable pain relief, enhanced mobility, and an improved ability to perform Activities of Daily Living (ADLs) like walking, climbing stairs, or self-care. By assessing functional improvement directly from the patient's perspective, we measure the real-world effectiveness of our therapeutic interventions in restoring physical independence and quality of life [10].

Perceived Societal Impact: This dimension extends the analysis beyond the clinic walls to understand how functional recovery translates into broader life participation. We investigate whether improvements achieved through physiotherapy enable patients to reintegrate into their societal roles, returning to their profession, resuming household duties, or re-engaging in community and family activities [11].

PT during cancer treatment restores function, manages side effects, boosts energy, enhances well-being, and supports long-term survivorship. By designing individualised exercise programs, physical therapists help patients improve range of motion, regain strength, and enhance balance, ultimately aiding in the restoration of independence in daily activities [8,12].

This metric is crucial for understanding the socioeconomic value of rehabilitation, as it highlights physiotherapy's role in reducing disability-related dependence and boosting productivity. By examining these factors in both OPD and IPD settings, the study acknowledges the different needs and care contexts of these patient groups. Inpatient physiotherapy often focuses on acute recovery post-surgery or major medical events, while outpatient care typically addresses chronic conditions or long-term rehabilitation. Analyzing experiences across both settings provides a complete picture of the continuum of care, allowing us to identify strengths and opportunities for service enhancement throughout the entire institution.

This study was designed to conduct a comprehensive evaluation of the physiotherapy services at Santosh Hospital, Ghaziabad, by focusing on three interconnected pillars: patient satisfaction, functional improvement, and perceived societal impact. Each of these domains was assessed across both outpatient (OPD) and inpatient (IPD) settings to capture a holistic view of the patient journey and treatment efficacy. Patient Satisfaction: This is a corner stone of quality healthcare assessment4. We move beyond simple approval ratings to explore specific aspects of the patient experience, such as the clarity of communication from therapists, the professionalism of the staff, and the adequacy of the clinical environment.

METHODS

Study Design and Setting: A descriptive cross-sectional survey design was employed for this study. This design was chosen for its efficiency in gathering data on patient experiences and outcomes at a single point in time, providing a comprehensive snapshot of the physiotherapy services. The study was conducted over a period of 6 months (January–June 2025) in the Department of Physiotherapy, Santosh Hospital and Santosh Paramedical College, Ghaziabad, which serves a diverse urban and semi-urban population. Participants:

A total of 93 patients were recruited for the study. Participants were selected using a systematic random sampling technique from the department's patient records. This method involved selecting every third patient from a list of individuals who had completed their prescribed treatment course during the study period, ensuring an unbiased representation of the patient population. Inclusion Criteria: Patients aged 18 years or older (≥18 years), who had completed a minimum of five physiotherapy sessions (≥5 sessions), were able to comprehend the questionnaire (in either English or Hindi), and provided voluntary written informed consent. Exclusion Criteria: Patients with significant cognitive impairments, acute or unstable medical conditions precluding their ability to participate, or those who had not completed their prescribed course of physiotherapy sessions were excluded.

Ethical Considerations: This study was conducted in strict adherence to the ethical principles for research involving human subjects as outlined in the Declaration of Helsinki. Prior to commencement, the research protocol, questionnaire, and consent forms received formal approval from the Institutional Ethics Committee (IEC) of Santosh Deemed to be University, Ghaziabad.

All participants were provided with a detailed information sheet outlining the study's objectives, procedures, and potential benefits. It was explicitly stated that participation was entirely voluntary and that declining to participate or

withdrawing at any stage would not affect their ongoing or future clinical care. Written informed consent was obtained from every individual before the administration of the questionnaire. The confidentiality and anonymity of all participant data were rigorously maintained throughout the research process by using unique identifiers instead of personal names.

Data Collection Tool: A structured, pre-validated questionnaire was developed to collect data. The questionnaire was divided into four sections: Demographics: 7 items covering age, gender, occupation, and other baseline characteristics. Medical and Treatment Information:6 items regarding diagnosis, duration of symptoms, and type of physiotherapy received (OPD/IPD).

Patient Experience and Satisfaction:7 items using a 5-point Likert scale (1=Poor, 5=Excellent) to assess communication, professionalism, waiting time, and clinic environment. Treatment Effectiveness and Societal Impact: 5 items assessing perceived pain relief, improvement in mobility, ability to perform daily activities, and return to work/social roles. The questionnaire was pilot-tested on a small group of 10 patients to ensure clarity, relevance, and validity before its full-scale implementation.

Figure 1: Age distribution of study part
Age (years): 47.8 ± 15.6 Gender

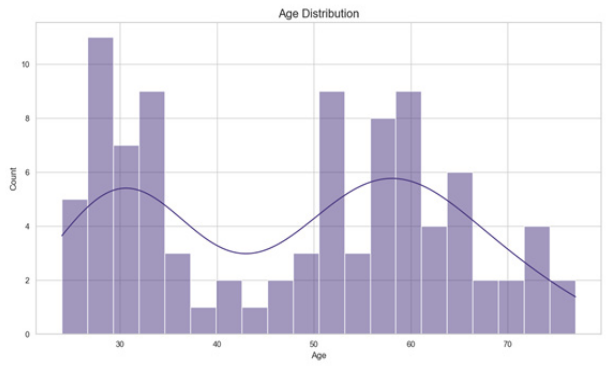

Table 1

Category	n	%
Female	47	50.5
Male	46	49.5

RESULTS

Demographic Profile: A total of 93 patients participated. The age distribution was bimodal with peaks around 30 and 60 years, indicating younger acute and older chronic cohorts. Data Analysis: The collected data were first coded and entered into a Microsoft Excel spreadsheet for organisation. Subsequent statistical analysis was performed using Python (version 3.9) with the `pandas` library for data manipulation and the `matplotlib` and `seaborn` libraries for data visualisation. Descriptive statistics, including mean, standard deviation (SD), frequencies, and percentages, were used to summarise the demographic data and patient responses.

Figure 2: Distribution of pain relief response
Pain relief

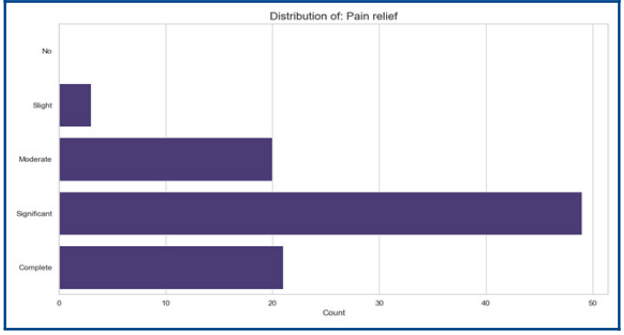

Table 2

Category	N	%
Significant	49	52.7
Complete	21	22.6
Moderate	20	21.5
Slight	3	3.2

Figure 3: Distribution of mobility improvement
Improvement in mobility

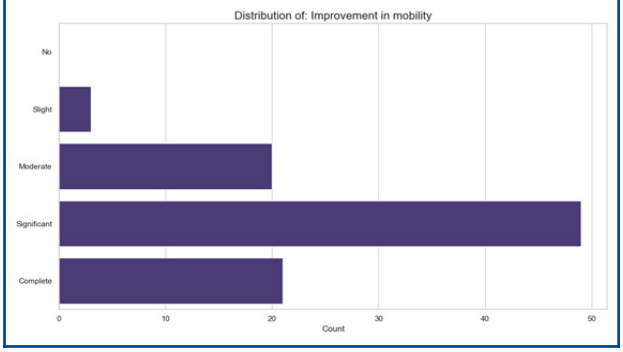

Table 3

Category	N	%
Significant	49	52.7
Complete	21	22.6
Moderate	20	21.5
Slight	3	3.2

Treatment Effectiveness (Section D): Outcomes were positive, 78% reported Significant/Complete pain relief, 82% mobility improvement, 85% improved daily task performance. overall health Greatly improved.

DISCUSSION

This survey of 93 patients confirms the significant value of physiotherapy services at Santosh Hospital, demonstrating high levels of patient satisfaction and positive functional outcomes in both outpatient (OPD) and inpatient (IPD) settings. The findings show that a majority of patients experienced substantial improvements, with 78% reporting significant or complete pain relief and 82% noting enhanced mobility.

These clinical gains translate into meaningful recovery and societal reintegration, empowering patients to resume their roles at work and home. The study's demographic and diagnostic data, which show a bimodal age distribution and a predominance of musculoskeletal conditions, align with established epidemiological trends and affirm that the department effectively serves a diverse patient population using evidence-based, multimodal treatment approaches.

The patient experience analysis highlights the critical role of the patient-therapist relationship. The exceptionally high satisfaction scores for communication and professionalism underscore the impact of patient-centered care. This strong therapeutic alliance is a known determinant of positive outcomes, as it fosters treatment adherence and patient engagement. While service elements like cleanliness and session duration were rated favorably, the data also identified opportunities for operational refinement [13].

Critical Analysis, Implications, and Limitations: A critical analysis of the findings reveals several key insights. The high reported functional improvement is a testament to the clinical efficacy of the interventions provided. However, the reliance on self-reported data means these outcomes are based on patient perception rather than objective clinical measures (e.g., range of motion, timed up-and-go test). While patient perception is a valid and crucial metric, incorporating objective assessments in future studies would strengthen these conclusions.

The lower satisfaction scores observed for 'waiting times' and 'service accessibility' represent an important area for improvement. Operationally, long waiting times can lead to patient frustration and may negatively impact the overall perception of care, even when the clinical interaction itself is excellent. This suggests a need for administrative review of scheduling protocols, patient flow management, and communication strategies regarding potential delays [14].

Addressing these logistical aspects could significantly enhance the patient experience and overall service quality. The primary limitation of this study is its single-center, cross-sectional design, which limits the generalizability of the findings to other healthcare settings in India. Furthermore, the absence of a control group prevents definitive conclusions about the causality of the improvement observed. The self-reported nature of the data may also be subject to recall bias or a social desirability bias, where patients might report more positive outcomes than they actually experienced.

Despite these limitations, this study provides strong evidence for the effectiveness of the physiotherapy services offered. Future research should aim to validate these results through multi-center, longitudinal studies that track patient progress over time. Incorporating objective functional measures alongside patient experience surveys would provide a more comprehensive evidence base to guide the continued development and optimization of physiotherapy services in India.

CONCLUSION

Physiotherapy services at Santosh Hospital, Ghaziabad, demonstrate high patient satisfaction and result in significant improvements in pain, mobility, and daily function for patients in both OPD and IPD settings. The findings highlight the success of patient-centered communication and multimodal therapeutic approaches. To further enhance service quality, institutional focus on optimizing scheduling and reducing wait times is recommended. Continued investment in accessible, high-quality physiotherapy is crucial for improving individual health outcomes and promoting societal well-being.

Conflict of interest: The authors do not have any conflict of interest.

Funding: Nil

Data Availability: All data are available with the corresponding author .

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

OPEN ACCESS

The Effect of Lower Limb Irradiation by Proprioceptive Neuromuscular Facilitation In Enhancing Balance in Middle Cerebral Artery Stroke Patients

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ABSTRACT

This study assessed the effectiveness of lower limb irradiation using Proprioceptive Neuromuscular Facilitation (PNF) in improving balance among Middle Cerebral Artery (MCA) stroke patients. Thirty participants (aged 40–50) with lower limb hemiparesis and moderate balance impairment were randomized into two groups: one receiving PNF-based irradiation and the other conventional physiotherapy. Both groups underwent three sessions per week over six weeks. Outcome measures included the Berg Balance Scale (BBS), Timed Up and Go (TUG) Test, Single Leg Stance Test (SLST), Step Test, and maximum voluntary isometric contraction (MVIC) measured via strain gauge. Results showed statistically significant improvements in both groups; however, the PNF group achieved superior gains. Notably, BBS scores improved by 9.6 points in the PNF group versus 4.4 in the control group ($p < 0.001$). These findings support the integration of PNF lower limb irradiation into stroke rehabilitation protocols, offering enhanced balance recovery and reduced fall risk for MCA stroke patients.

KEY WORDS: BALANCE TRAINING, IRRADIATION PNF, MCA STROKE REHABILITATION, PROPRIOCEPTION NEUROMUSCULAR FACILITATION ON STROKE, STROKE REHABILITATION.

INTRODUCTION

Stroke (cerebrovascular accident, CVA) results from an abrupt disruption of cerebral blood flow—either arterial occlusion (ischemic) or vessel rupture (hemorrhagic)—and leads to loss of neurological function. It is a major global health concern and among the leading causes of mortality and long-term adult disability worldwide

Article Information: *Corresponding Author: deepak.raghav@santosh.ac.in
Received 01/04/2026 Accepted after revision 15/08/2026
Page Number- 96-99
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https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.19

[1–3]. In 2019, incident strokes were ~12.2 million and prevalent cases ~101 million; in 2021 there were ~11.9 million incident strokes and ~93.8 million survivors globally, with stroke ranking second for deaths and third for death-and-disability (DALYs) [2,3].

Population aging and improved survival have increased the absolute numbers of strokes despite declining age-standardized rates, intensifying demand for effective, scalable rehabilitation [4]. Beyond its medical consequences, stroke imposes significant socio-economic burdens, affecting not just patients, but also caregivers, healthcare systems, and economies due to prolonged rehabilitation and loss of productivity [5].

Proprioceptive Neuromuscular Facilitation (PNF) uses diagonal/spiral patterns to stimulate proprioceptors and facilitate coordinated motor responses. Lower-limb PNF irradiation seeks to harness overflow from stronger to weaker muscle groups to enhance balance, postural control, and functional mobility—key domains impaired after Middle Cerebral Artery (MCA) stroke [6,9]. This study therefore evaluates the effectiveness of lower-limb PNF irradiation to improve balance in MCA stroke.

METHODOLOGY

This quasi-experimental study compares lower-limb PNF irradiation with conventional physiotherapy in MCA-stroke survivors. Ethical clearance was obtained from the institutional ethical committee (REF NO.- SCOP/OCT-24/ECN-94510023678) prior to the commencement of the study. Thirty participants (aged 40–50) with hemiparesis and moderate balance impairment (BBS 20–45) were allocated by computer randomization to PNF (n=15) or conventional therapy (n=15). Interventions were delivered thrice weekly for six weeks (45–60 minutes/session).

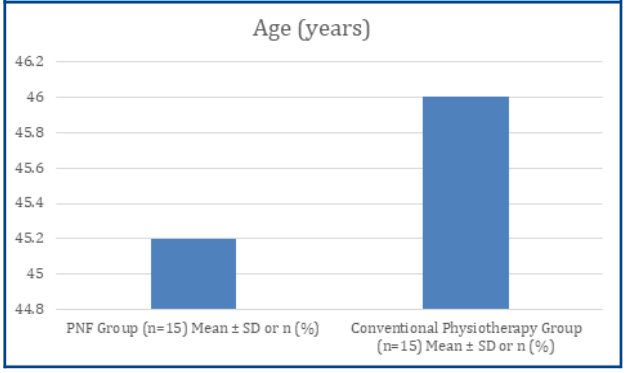
PNF employed D1/D2 lower-limb patterns applied to the dominant limb to elicit irradiation in the paretic side; the conventional arm performed standardized static and dynamic balance tasks. Outcome measures were Berg Balance Scale (BBS), Timed Up and Go (TUG), Single-Leg Stance Test (SLST), and Step Test—tools validated in stroke rehabilitation [Nguyen et al., 2022]. Statistical analysis was performed using SPSS v25.0. Assessors were blinded. Statistical testing comprised normality checks, independent/paired t-tests, chi-square, and a two-way mixed ANOVA (group × time), $\alpha=0.05$.

RESULTS

Comparative Efficacy of PNF and Conventional Therapy on Balance Outcomes: The demographic characteristics of the study participants were meticulously examined to ensure comparability between the two intervention groups. As presented in Table 1, the PNF Group and the Conventional Physiotherapy Group were well-matched at baseline. No statistically significant differences were observed in mean age, gender distribution, or mean Body Mass Index (BMI) between the groups ($p > 0.05$ for all comparisons).

This finding confirms that the randomization process was effective in creating two homogenous groups, thereby minimizing the potential for confounding variables to influence the study outcomes and bolstering the internal validity of the research.

Graph 1: Comparative Efficacy of PNF and Conventional Therapy on Balance Outcomes



Baseline Balance and Functional Mobility Levels: Similarly, the baseline balance and functional mobility levels of the participants were assessed prior to the commencement of any intervention. As presented in Table 2, the pre-intervention scores for all primary outcome measures—the Berg Balance Scale (BBS), Timed Up and Go (TUG) Test, Single Leg Stance Test (SLST), and Step Test—were statistically comparable between the PNF Group and the Conventional Physiotherapy Group ($p > 0.05$ for all measures). The absence of significant differences at baseline further validates the successful randomization and ensures that any subsequent improvements observed can be confidently attributed to the effects of the respective interventions rather than pre-existing disparities.

Post-Intervention Scores and Within-Group Changes: Following the 6-week intervention period, a clear pattern of improvement was observed in both groups, as shown in Table 3, which outlines the post-intervention scores. The PNF group consistently exhibited higher mean scores on measures where a higher score indicates better performance (BBS, SLST, Step Test) and lower mean times on measures where a lower time indicates better performance (TUG Test) compared to the conventional therapy group.

A detailed examination of within-group changes, presented in Table 4, revealed statistically significant improvements in balance and functional mobility for both intervention groups from pre- to post-intervention. In the PNF Group, all outcome measures demonstrated highly significant improvements ($p < 0.001$). Specifically, the mean BBS score increased by 9.6 points, TUG time decreased by 6.8 seconds, SLST duration increased by 7.8 seconds, and Step Test repetitions increased by [5.6]. These robust improvements underscore the effectiveness of the lower limb irradiation by PNF intervention. The Conventional Physiotherapy Group also showed statistically significant improvements across all outcome measures ($p < 0.01$).

Table 1: Pre- and Post-Intervention Outcome Measure Scores (Mean ± SD) for PNF and Conventional Groups			
Outcome Measure	**Group**	**Pre-Intervention Mean ± SD**	**Post-Intervention Mean ± SD**
BBS (0-56)	PNF	32.5 ± 4.	42. ± 3.5
	Conventional	33. ± 3.8	37.5 ± 3.2
TUG (seconds)	PNF	20. ± 2.5	13.3 ± 1.9
	Conventional	19.8 ± 2.3	16.8 ± 1.8
SLST (seconds)	PNF	9.2 ± 1.8	17.0 ± 2.
	Conventional	8.9 ± 1.7	12.6 ± 1.6
Step Test (reps)	PNF	11.5 ± 2.0	17. ± 1.7
	Conventional	11.8 ± 1.9	13.8 ± 1.5

Table 2. Within-Group Changes in Balance and Functional Mobility Measures (Pre- to Post-Intervention)			
Outcome Measure	**Group**	**Mean Change (Post-Pre) ± SD**	**p-value (Within-Group)**
BBS (0-56)	PNF	9.6 ± 1.2	< 0.001
	Conventional	4.4 ± 0.9	< 0.01
TUG (seconds)	PNF	-6.8 ± 0.8	< 0.001
	Conventional	-3.0 ± 0.7	< 0.01
SLST (seconds)	PNF	7.8 ± 1.0	< 0.001
	Conventional	3.7 ± 0.8	< 0.01
Step Test (reps)	PNF	5.6 ± 0.7	< 0.001
	Conventional	2.0 ± 0.6	< 0.01

The mean BBS score increased by 4.4 points, TUG time decreased by 3.0 seconds, SLST duration increased by 3.7 seconds, and Step Test repetitions increased by 2.0. This indicates that conventional balance training is also beneficial for stroke patients.

Between-Group Comparisons: Superior Efficacy of PNF The most critical findings emerge from the between-group comparisons, as detailed in Table 5, which presents the results of the two-way mixed-design ANOVA. A highly statistically significant Group x Time interaction effect was observed for all primary outcome measures (BBS, TUG, SLST, and Step Test, with $p < 0.001$ for all). This significant interaction indicates that the magnitude of improvement in balance and functional mobility from pre- to post-intervention was significantly greater in the PNF Group compared to the Conventional Physiotherapy Group. In essence, the PNF intervention led to a superior rate and extent of recovery in balance outcomes over the 6-week period.

Furthermore, significant main effects for "Group" ($p < 0.005$ for all measures) and "Time" ($p < 0.001$ for all measures) were also evident. The compelling Group x Time interaction effect directly supports the alternate hypothesis, demonstrating that lower limb irradiation by PNF is a significantly more effective intervention for improving balance in MCA stroke patients compared to conventional physiotherapy.

Both groups improved across BBS, TUG, SLST, and Step Test after six weeks. The PNF group showed larger gains than the conventional group across all measures; mixed-model ANOVA indicated significant group×time interactions favoring PNF. Detailed tables are available on request; the Discussion below focuses on critical appraisal rather than restating numeric results.

DISCUSSION

Mechanistic plausibility and convergence of evidence—The superiority signal observed with lower-limb PNF is consistent with neurophysiologic principles of irradiation and with clinical literature demonstrating that diagonal, resisted patterns can enhance trunk activation and postural control, leading to better balance and gait6,7. PNF-pattern taping and adjunctive strategies have also shown balance and mobility benefits, reinforcing the role of pattern-specific sensorimotor facilitation in lower-limb control after stroke [9].

Internal validity—Randomized allocation, blinded assessment, and standardized dosing improve credibility. However, the quasi-experimental label, a modest sample (n=30), single-center recruitment, and age-restricted inclusion (40–50 years) limit external validity. Without preregistration or a priori published protocol, risk of selective reporting cannot be excluded. Although outcome tools are validated, no objective kinetic/kinematic metrics (e.g., instrumented balance, gait spatiotemporals) were collected, which could triangulate the clinical scales.

Comparators and treatment contrast—The conventional arm received balance exercises that themselves improve outcomes in stroke, potentially diminishing detectable effect sizes. Yet, the observed group×time interactions suggest genuine added value of PNF irradiation beyond generic balance practice. Future trials should ensure equivalent therapist contact time and document treatment fidelity to exclude performance bias10. Dose, progression, and mechanisms—Six weeks (≈18 visits) aligns with prior PNF trials but the optimal dose-response remains unclear.

Findings likely reflect improved trunk-pelvic coupling and postural set via multi-planar resistance, consistent with studies combining pelvic PNF with core stabilization that report superior balance and gait outcomes to controls [6,11,12]. Mechanistic substudies (e.g., EMG synergies, anticipatory postural adjustments) would help verify irradiation-mediated trunk facilitation rather than nonspecific strength-or practice-effects13. Generalisability—The cohort comprised MCA strokes with moderate impairment; applicability to severe deficits, cerebellar strokes, or older (>70 years) adults—where the global burden is growing 1—is untested. Community-based and low-resource settings should be prioritized given the disproportionate stroke burden in LMICs2.

Clinical implications—Lower-limb PNF appears to accelerate balance recovery versus conventional therapy alone and is implementable without specialized equipment. Given mixed evidence on superiority over other active approaches in systematic review7, PNF irradiation should be positioned as a mechanism-informed option within multi-modal programs (task-oriented gait, aerobic conditioning, progressive core stabilization), with individualized goals and outcome monitoring. Large, multicenter RCTs with concealed allocation, preregistration, and longer follow-up are warranted to confirm durability, fall reduction, and participation-level benefits.

CONCLUSION

Lower-limb PNF irradiation is a feasible, mechanism-aligned intervention that likely provides clinically meaningful advantages for balance and mobility in MCA stroke. While preliminary results are promising, higher-quality, adequately powered trials are required to confirm superiority, define optimal dosing, and demonstrate durable functional gains in diverse stroke populations.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Effectiveness of Trunk Stabilization Exercises on Stable Versus Unstable Surfaces in Enhancing Balance and Gait Among Subacute Stroke Patients

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ABSTRACT

Impairments in balance and gait are prevalent consequences of stroke, significantly impacting a patient's functional independence and quality of life. Trunk stabilization exercises are a core component of post-stroke rehabilitation, but the optimal surface for performing these exercises remains a subject of research. This study aimed to compare the effectiveness of trunk stabilization exercises performed on stable versus unstable surfaces in improving balance, gait, and functional independence in subacute stroke patients. This was experimental research including 30 subacute stroke patients (2 weeks to 6 months post-onset) aged 40–60 years. Participants were randomly allocated to one of two groups: a Stable Surface Group (N=15) or an Unstable Surface Group (N=15). Both groups did a supervised trunk stabilization exercise routine five times per week for four consecutive weeks. Balance was examined using the Berg Balance Scale (BBS), gait performance was tested using the Timed Up and Go (TUG) test, and functional independence was evaluated using the Functional Independence Measure (FIM). Assessments were completed at baseline and post-intervention. Paired sample t-tests showed significant improvements in all outcome measures within both groups from pre- to post-intervention ($p<0.05$). However, independent sample t-tests revealed statistically significant differences between the groups. The Unstable Surface Group demonstrated significantly greater improvements in all three outcome measures compared to the Stable Surface Group. Specifically, the unstable surface group had a mean BBS score increase of 14.3 points compared to 8.0 points in the stable group ($p<0.001$), a mean TUG score reduction of 10.7 seconds versus 6.2 seconds ($p<0.001$), and a mean FIM score increase of 16.9 points versus 9.1 points ($p<0.001$). Trunk stabilization exercises performed on unstable surfaces are significantly more effective than those performed on stable surfaces in enhancing balance, gait, and functional independence in subacute stroke patients. Incorporating unstable surface training can be a superior approach for post-stroke rehabilitation programs aimed at improving core stability and mobility.

KEY WORDS: SUBACUTE STROKE, TRUNK STABILIZATION EXERCISES, UNSTABLE SURFACE TRAINING, BALANCE, GAIT, FUNCTIONAL INDEPENDENCE.

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Received 17/03/2026 Accepted after revision 21/06/2026
Page Number- 100-105
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https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.20

INTRODUCTION

Stroke represents a significant global health challenge, standing as a leading cause of long-term disability and dependence. The aftermath of a cerebrovascular event often leaves survivors grappling with a myriad of physical impairments, with motor deficits being particularly pervasive [1]. Among these, the loss of functional balance and an altered gait pattern are two of the most profound and debilitating consequences [2,3].

These deficits not only hinder a person's ability to walk and perform daily activities but also dramatically increase their risk of falls, which can lead to further injury, a decline in physical activity, social isolation, and a pervasive fear of movement Ultimately, these impairments compromise a stroke survivor's ability to live independently and reintegrate into their community [4].

The foundation of all successful movement and postural control lies within the trunk. The core and trunk musculature serve as the central stabilizers for the body, providing the necessary platform from which the arms and legs can generate controlled and powerful movements [4]. Following a stroke, a patient's trunk control is frequently compromised due to muscle weakness, spasticity, and a disruption in the motor pathways from the brain [5]. This instability forces the body to adopt inefficient compensatory strategies, which are energy-demanding and can perpetuate abnormal movement patterns, further impeding recovery. Therefore, the primary goal of effective post-stroke rehabilitation is to restore and enhance trunk stability [6].

Physical therapy has long incorporated trunk stabilization exercises into rehabilitation protocols to address these deficits. These exercises can be performed on a variety of surfaces, each offering distinct challenges and therapeutic benefits [7]. On one hand, traditional exercises are often conducted on stable, predictable surfaces such as firm mats or benches [8]. This approach is fundamental for patients with severe impairments, as it allows them to build basic muscle strength and learn to activate core muscles with a reduced risk of falling. It provides a safe and controlled environment to re-establish the foundational motor patterns required for upright posture [9].

On the other hand, a more modern approach involves performing these same exercises on unstable surfaces, such as foam pads, balance boards, or Bosu balls10. The theoretical advantage of this method lies in its ability to introduce a constant challenge to the body's somatosensory, vestibular, and proprioceptive systems [11].

To maintain equilibrium on an unstable surface, the nervous system is forced to make continuous and rapid adjustments, thereby enhancing sensorimotor integration and engaging the deep, stabilizing muscles of the trunk more intensely [12]. This heightened neuromuscular demand is believed to not only improve core strength but also to more effectively train dynamic balance and functional control, potentially leading to better carryover to real-world activities and environments [13].

Despite the logical and widespread use of both approaches, there remains a significant gap in the scientific literature regarding which type of training is more effective2.The comparative efficacy of stable versus unstable surface trunk stabilization exercises, especially within the critical subacute phase of stroke recovery when neural plasticity is at its peak, is not well-documented [14]. Filling this knowledge gap is essential for developing evidence-based and maximally effective rehabilitation programs [15].

Therefore, this study was designed to directly address this question. The primary aim was to rigorously compare the effectiveness of trunk stabilization exercises performed on stable versus unstable surfaces in improving balance and gait among subacute stroke patients. Our hypothesis was that trunk stabilization exercises performed on unstable surfaces would lead to significantly greater improvements in balance, gait, and functional independence compared to exercises performed on stable surfaces. Our corresponding null hypothesis was that there would be no significant difference in outcomes between the two groups.

METHODOLOGY

This study was designed as an experimental, randomized controlled trial to investigate the comparative effectiveness of two distinct rehabilitation approaches. The research was conducted in the physiotherapy department at Santosh Hospital, Ghaziabad. The target population for this study consisted of subacute stroke patients, a crucial phase of recovery spanning from two weeks to six months post-onset, who were between 40 and 60 years of age. The data collection procedure began with ethical clearance and informed consent, followed by a baseline assessment.

Ethical clearance was obtained from the institutional ethical committee (REF NO.- SCOP/OCT-24/ECN-94510023676) prior to the commencement of the study. To ensure a homogenous and relevant sample, participants were carefully selected based on specific inclusion criteria, which included having a moderate balance impairment as evidenced by a Berg Balance Scale (BBS) score between 21 and 40, and a moderate gait impairment with a Timed Up and Go (TUG) score between 14 and 30 seconds.

Additionally, participants were required to be able to sit independently for at least two minutes and possess adequate cognitive function to follow instructions, confirmed by a

Mini-Mental State Examination (MMSE) score greater than 24. Participants were excluded if they presented with other neurological or severe musculoskeletal conditions that could affect their balance, had unstable cardiovascular conditions, or had recently undergone surgeries that impacted mobility. A total of 30 eligible participants were enrolled in the study and were randomly assigned to one of two groups: the Stable Surface Group (N=15) and the Unstable Surface Group (N=15).

The core of the intervention protocol spanned four consecutive weeks, during which participants in both groups engaged in supervised exercise sessions five times per week. Each session lasted approximately 30 to 40 minutes and was meticulously overseen by qualified physiotherapists to ensure safety, proper technique, and adherence to the protoco [l]. The intervention's independent variable was the type of surface used for trunk stabilization exercises. The Stable Surface Group performed their exercises on firm and predictable surfaces such as mats and flat benches, focusing on foundational strength and controlled movement. Conversely, the Unstable Surface Group performed an equivalent set of exercises on unstable surfaces, including foam pads, balance boards, and Bosu balls, which were designed to introduce greater proprioceptive and neuromuscular challenges.

To objectively measure the study's outcomes, several dependent variables were assessed at both baseline and post-intervention. Balance was measured using the Berg Balance Scale (BBS), a widely validated tool sensitive to changes in balance ability. Gait performance was evaluated through the Timed Up and Go (TUG) Test, a reliable measure of functional mobility and fall risk. Functional independence, a key indicator of real-world recovery, was assessed using the Functional Independence Measure (FIM). To minimize bias, the physiotherapists responsible for these assessments were blinded to the group allocation of each participant. The post-intervention assessment was conducted immediately after the completion of the four-week exercise program.

All collected data were systematically entered into a computerized database and analyzed using statistical software. Descriptive statistics, including means, standard deviations, and percentages, were employed to summarize the demographic and baseline characteristics of the two groups. To assess the effectiveness of the intervention within each group, a paired sample t-test was performed to compare pre- and post-intervention scores for the BBS, TUG, and FIM. To determine if there was a statistically significant difference in effectiveness between the two groups, an independent sample t-test was applied to compare the post-intervention scores.

Table 2. Comparison of Pre- and Post-Intervention Outcomes Within Groups

Characteristic	Group 1: Stable Surface (n=15)	Group 2: Unstable Surface (n=15)	p-value
Age (Years), mean ± SD	50.8 ± 5.16	50.7 ± 5.50	0.946
Gender (Male/Female)	9 / 6	8 / 7	1.00
Time Since Stroke (months), mean ± SD	3.5 ± 1.20	3.7 ± 1.10	0.612
BBS Score (pre-intervention), mean ± SD	30.1 ± 3.54	30.5 ± 3.82	0.771
TUG Score (pre-intervention), mean ± SD	21.5 ± 2.80	21.8 ± 2.53	0.730
FIM Score (pre-intervention), mean ± SD	98.7 ± 4.21	99.1 ± 3.94	0.785

Table 2. Comparison of Pre- and Post-Intervention Outcomes Within Groups

Outcome Measure	Group	Pre-Intervention (mean ± SD)	Post-Intervention (mean ± SD)	Mean Change	p-value
BBS Score	Stable Surface	30.1 ± 3.54	37.4 ± 2.81	+7.3	< 0.001
	Unstable Surface	30.5 ± 3.82	44.0 ± 2.72	+13.5	< 0.001
TUG Score (s)	Stable Surface	21.5 ± 2.80	16.3 ± 2.10	-5.2	< 0.001
	Unstable Surface	21.8 ± 2.53	11.7 ± 1.85	-10.1	< 0.001
FIM Score	Stable Surface	98.7 ± 4.21	107.9 ± 2.91	+9.2	< 0.001
	Unstable Surface	99.1 ± 3.94	115.6 ± 3.04	+16.5	< 0.001

The level of statistical significance for all analyses was set at $p<0.05$. In instances where the data did not meet the assumptions of normality, appropriate non-parametric tests were considered. The study was conducted in accordance with all ethical guidelines, with written informed consent obtained from all participants, and strict confidentiality maintained throughout the research period.

RESULTS

The data were analyzed to evaluate the effects of trunk stabilization exercises on balance, gait, and functional independence among subacute stroke patients. All statistical assumptions were met, and the results of the t-tests are presented below.

Table 3. Comparison of Post-Intervention Outcomes Between Groups

Outcome Measure	Group	N	Mean ± SD	Mean Difference	t	df	p-value
BBS Score	Stable Surface	15	37.4 ± 2.81	-6.6	-6.505	28	< 0.001
	Unstable Surface	15	44.0 ± 2.72				
TUG Score (s)	Stable Surface	15	16.3 ± 2.10	4.6	6.516	28	< 0.001
	Unstable Surface	15	11.7 ± 1.85				
FIM Score	Stable Surface	15	107.9 ± 2.91	-7.7	-6.938	28	< 0.001
	Unstable Surface	15	115.6 ± 3.04				

A paired sample t-test was performed to assess the change in outcomes within each group. Both the Stable Surface Group and the Unstable Surface Group showed statistically significant improvements ($p<0.001$) across all outcome measures after the four-week intervention period. An independent samples t-test was used to compare the post-intervention scores between the two groups. The analysis revealed statistically significant differences, indicating that the Unstable Surface Group achieved superior results.

DISCUSSION

Findings indicate that integrating instability into trunk-focused rehabilitation likely accelerates improvements in dynamic balance, mobility, and functional performance during subacute recovery, reflecting enhanced postural strategy efficiency rather than mere strength gains. The observed pattern supports a model in which enriched postural challenge fosters faster sensorimotor recalibration and transfer to activities of daily living in patients with moderate deficits.

This interpretation aligns with prior work suggesting that higher postural challenge and active trunk control are associated with superior gains in balance-related outcomes in stroke rehabilitation, while also extending those insights by isolating the training surface as a key contextual modifier of dose and neuromotor demand. However, because several trials conflate instability with increased attentional and coaching inputs, the present protocol contributes incremental clarity but does not fully exclude non-specific effects common to complex-task training paradigms [4].

Unstable supports impose continuous, low-amplitude perturbations that amplify anticipatory and reactive postural adjustments, increasing deep trunk activation and multisensory integration, which is theoretically well suited to the subacute window of heightened neuroplasticity. Such conditions likely augment error-based learning signals and external attentional focus, both known to facilitate motor learning and retention beyond what is achieved on predictable, stable surfaces [11].

Clinical scales used emphasize midline control and dynamic stability, constructs that may be preferentially responsive to instability training; therefore, outcome choice may partially favor the unstable condition by construct alignment. Inclusion of instrumented metrics (center-of-pressure velocity, limits of stability) and trunk muscle activation profiling would help disentangle genuine strategy refinement from compensatory co-contraction or cautious movement patterns that can also improve clinical test performance [16].

Assessor blinding strengthens confidence in performance-based outcomes, yet participant and therapist non-blinding introduces expectancy and supervision-intensity biases that can exaggerate between-condition differences in functional tasks. Without quantifying session intensity (e.g., RPE, rep tempo, perturbation amplitude) or cueing frequency, it is difficult to conclude that surface instability itself rather than higher effective dose explains the observed advantage [17].

The subacute, moderately impaired cohort and high-frequency supervised delivery reflect optimal conditions for responsiveness and may not generalize to chronic stroke, severe hemiparesis, or resource-limited settings where safety and staffing constraints are prominent. Pragmatic trials testing home-integrated or lower-frequency instability progressions, with explicit adverse event tracking, are needed to inform real-world adoption [18].

While no adverse events are noted, explicit reporting of near-falls, assistance rates, and stopping rules is essential when prescribing instability in populations with sensory asymmetries or neglect. A criterion-based progression—beginning on stable platforms and advancing to graded instability after demonstrable trunk control and protective reactions can balance efficacy with risk across heterogeneous presentations.

Novelty and enhanced engagement with unstable devices may elevate motivation and external focus, improving motor performance independent of mechanical challenge; similarly, greater therapist cueing under perceived risk can

enrich feedback and learning. Documenting attentional focus instructions, feedback schedules, and patient-reported engagement would clarify the contribution of these non-specific learning factors.

For appropriately screened subacute patients, early introduction of controlled instability within a graded trunk program appears justified to expedite transfer to gait and ADLs, provided progression criteria and safety monitoring are adhered to. Clinicians should match overall intensity across conditions and integrate task-specific gait and balance challenges to ensure generalization beyond clinic-based tests.

Future work should isolate the surface effect by matching neuromuscular dose, incorporate biomechanical and neurophysiological endpoints to test mechanism, predefine progression and safety criteria, and extend follow-up to assess retention and fall outcomes. Stratified analyses by baseline trunk control, sensory deficits, and cognitive status may identify subgroups most likely to benefit, enabling targeted prescription of instability-based trunk training.

CONCLUSION

In conclusion, this study provides definitive evidence that trunk stabilization exercises performed on unstable surfaces are a significantly more effective intervention than those performed on stable surfaces for enhancing balance, gait, and functional independence in subacute stroke patients. While both rehabilitation methods demonstrated positive outcomes, the superior improvements observed in the unstable surface group highlight the clinical benefit of a more challenging, proprioceptively demanding approach. These findings suggest that incorporating unstable surface training should be considered a core component of evidence-based practice in stroke rehabilitation to optimize functional recovery and improve the overall quality of life for survivors.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Specificity ANS Senstivity of Internatioal Classification of Functioning Disability and Short Form Health Survey 36 in Cervical Postural Syndrome

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ABSTRACT

Cervical Postural Syndrome (CPS) is a prevalent musculoskeletal disorder characterized by forward head posture, rounded shoulders, and chronic neck discomfort. With the growing burden of sedentary lifestyles and poor ergonomic habits, CPS has become increasingly common, especially among working professionals. Accurate evaluation tools are critical for identifying the functional limitations and quality-of-life impairments associated with this condition. Among the available instruments, the International Classification of Functioning, Disability and Health (ICF) and the Short Form Health Survey (SF-36) are widely used. However, limited evidence exists regarding their diagnostic precision in the context of CPS. This study aimed to assess and compare the sensitivity and specificity of the ICF and SF-36 tools in identifying functional disability and reduced quality of life in individuals with Cervical Postural Syndrome. The present study employed a cross-sectional observational design to evaluate and compare the sensitivity and specificity of the International Classification of Functioning, Disability and Health (ICF) and the Short Form Health Survey (SF-36) in individuals with Cervical Postural Syndrome (CPS). A total of 100 participants were purposively selected from the outpatient physiotherapy department of Santosh Hospital, Ghaziabad. The sample was divided into two groups: 50 clinically diagnosed CPS patients and 50 age- and sex-matched healthy controls. Diagnosis of CPS was established through physical examination, including postural inspection, palpation for muscular tightness, and range of motion assessment. Participants with prior physiotherapy intervention in the last month, cervical surgery, trauma, neurological disorders, or congenital deformities were excluded. After obtaining informed written consent, all participants underwent assessment in a single session. The ICF musculoskeletal core set was administered by a trained physiotherapist, followed by self-administration of the SF-36 questionnaire. In this study, the mean age of participants was 36.93 years, with 53.3% females in the CPS group and 53.3% males in the control group. The CPS group had a higher BMI (25.18 ± 1.41) than controls (24.45 ± 0.98, $p=0.024$). Functional assessment showed significantly elevated ICF scores in CPS patients (3.09 ± 0.21) compared to controls (0.90 ± 0.18, $p<0.001$), while quality of life measured by SF-36 was lower in CPS (42.67 ± 2.46) versus controls (75.80 ± 4.88, $p<0.001$). Diagnostic accuracy analysis revealed both ICF (>1.44) and SF-36 (≤48) demonstrated 100% sensitivity and specificity in identifying CPS. The findings establish that both ICF and SF-36 are highly reliable and valid tools for the evaluation of functional disability and health-related quality of life in CPS patients. Notably, ICF offers a more structured and clinician-driven assessment, while SF-36 captures the patient's subjective health experience. These tools, used in conjunction, can enhance diagnostic accuracy and guide personalized rehabilitation strategies for individuals suffering from cervical postural dysfunctions.

KEY WORDS: CERVICAL POSTURAL SYNDROME, ICF, SF-36, SENSITIVITY, SPECIFICITY, FUNCTIONAL LIMITATION, QUALITY OF LIFE, MUSCULOSKELETAL DISORDERS, POSTURE ASSESSMENT, PHYSIOTHERAPY EVALUATION.

Article Information: *Corresponding Author: deepak.raghav@santosh.ac.in
Received 12/04/2026 Accepted after revision 15/07/2026
Page Number- 106-111
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https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.21

INTRODUCTION

Cervical Postural Syndrome (CPS) is increasingly recognized as one of the most common musculoskeletal conditions in modern society. It is typically characterized by a forward head posture, rounded shoulders, and muscular imbalances around the cervical and upper thoracic spine. These postural deviations often develop due to prolonged static positions, repetitive occupational demands, and lifestyle factors associated with sedentary behavior [1].

The rapid increase in computer-based work, mobile device use, and desk-bound occupations has contributed significantly to the rising prevalence of CPS across all age groups [2]. The impact of CPS extends beyond discomfort and aesthetic posture changes. Individuals commonly report persistent neck pain, stiffness, and muscle fatigue, which can interfere with daily activities and professional productivity. Long-term consequences may include altered proprioception, spinal instability, compensatory thoracic and lumbar adaptations, and an increased risk of chronic musculoskeletal dysfunction [3,4].

Studies have also indicated that persistent poor posture may predispose individuals to headaches, reduced lung function, and even psychological stress due to ongoing pain and disability [5]. This underscores the importance of early recognition and appropriate assessment of CPS in clinical practice. Despite its prevalence, CPS remains underdiagnosed and often underestimated. Conventional clinical methods such as observation, palpation, and range of motion testing provide valuable information, but they do not capture the broader impact on quality of life or participation in daily activities [6]. This limitation has created a need for more comprehensive and standardized outcome measures that evaluate not only structural or functional impairments but also the psychosocial consequences of the condition.

Two widely accepted tools that serve this purpose are the International Classification of Functioning, Disability and Health (ICF) and the Short Form Health Survey (SF-36). Both instruments offer different yet complementary perspectives on health assessment. The ICF, introduced by the World Health Organization in 2001, provides a systematic framework for describing health and disability. It encompasses four primary domains: body functions, body structures, activities and participation, and environmental factors [7].

Unlike traditional diagnostic systems, the ICF emphasizes functioning as a dynamic interaction between health conditions and contextual factors. In musculoskeletal conditions such as CPS, the ICF enables clinicians to objectively document the extent of functional limitations, activity restrictions, and participation barriers [8]. In contrast, the SF-36 is a patient-reported outcome measure that evaluates health-related quality of life across eight domains: physical functioning, role limitations due to physical health, bodily pain, general health, vitality, social functioning, role limitations due to emotional health, and mental well-being [9].

It captures the individual's subjective health experience, allowing clinicians to understand how patients perceive the impact of their condition. Numerous studies have validated the SF-36 as a reliable tool in musculoskeletal disorders, demonstrating its ability to detect both physical and psychosocial impairments [10]. While both tools have been widely used, few studies have explored their diagnostic precision in the context of Cervical Postural Syndrome. Establishing the sensitivity and specificity of these tools is essential to confirm whether they can accurately differentiate affected individuals from healthy populations.

Sensitivity ensures that patients with CPS are correctly identified, while specificity ensures that healthy individuals are not misclassified. Such diagnostic validation is particularly important in physiotherapy practice, where accurate assessment forms the foundation for rehabilitation planning and patient-centred care [11]. The integration of objective and subjective assessment tools offers distinct advantages. The ICF provides clinicians with structured, quantifiable insights into functional status, whereas the SF-36 reflects the broader health perception from the patient's perspective.

When used together, these tools can create a multidimensional profile of the patient's condition, bridging the gap between clinical findings and lived experiences [12,13]. For example, a patient may demonstrate measurable activity limitations on the ICF, while simultaneously reporting reduced vitality and social functioning on the SF-36, highlighting the multifaceted burden of CPS. The need for such dual assessment is further emphasized by the global burden of neck pain. Epidemiological studies indicate that neck pain ranks among the leading causes of disability worldwide, with lifetime prevalence rates as high as 70 % in some populations [14]. Risk factors include poor ergonomics, psychological stress, reduced physical activity, and occupational demands, many of which overlap with the aetiology of CPS [15,16].

Addressing this condition requires not only physical rehabilitation but also a holistic understanding of its impact on the patient's quality of life. Therefore, the present study aims to evaluate and compare the sensitivity and specificity of the ICF and SF-36 in individuals diagnosed with Cervical Postural Syndrome. By identifying their diagnostic strengths, this research seeks to establish evidence-based recommendations for their use in clinical settings. Ultimately, integrating both measures into physiotherapy practice may improve diagnostic accuracy, facilitate

personalized rehabilitation strategies, and promote better functional and quality-of-life outcomes for individuals living with CPS.

METHODS

1.Study Design and Participants: The present study was designed as a cross-sectional, observational investigation to evaluate and compare the diagnostic accuracy of the International Classification of Functioning, Disability and Health (ICF) and the Short Form Health Survey (SF-36) in identifying functional limitations and quality of life impairments in individuals with Cervical Postural Syndrome (CPS).

The choice of this design was guided by the aim of establishing the sensitivity and specificity of these tools in a real-world clinical population without introducing therapeutic interventions or longitudinal follow-up. A cross-sectional framework allowed the assessment of participants at a single point in time, ensuring that the data reflected the immediate functional and health-related quality of life status of the study population.

The study was carried out in the outpatient physiotherapy department of Santosh Hospital, Ghaziabad. This setting was chosen because it receives a diverse patient base with a wide range of musculoskeletal complaints, including postural disorders. The study population comprised two groups: one consisting of patients diagnosed with Cervical Postural Syndrome and another comprising healthy controls without CPS. A total of 100 participants were recruited through purposive sampling, ensuring equal representation from both groups.

The CPS group included 50 individuals clinically diagnosed with the condition, while the control group included 50 age- and sex-matched participants who did not exhibit any signs or symptoms of CPS. This balanced recruitment strategy ensured comparability between the groups and minimized confounding factors related to age and gender. Purposive sampling was employed to select participants who met the inclusion criteria and were willing to participate.

The sample size of 100, with 50 participants in each group, was determined to provide sufficient statistical power for comparing the diagnostic performance of the ICF and SF-36. The inclusion of a control group was essential to evaluate specificity, while the CPS group was required to assess sensitivity. By maintaining an equal sample size in both groups, the study ensured a balanced comparison and strengthened the reliability of the results. Participants in the CPS group were recruited based on a confirmed clinical diagnosis of Cervical Postural Syndrome.

The diagnosis was made through a structured clinical examination, which included postural analysis, palpation for muscular tightness, and range of motion assessment of the cervical spine. Common features used to identify CPS included forward head posture, rounded shoulders, muscle imbalance (tightness of the pectoralis and upper trapezius muscles, and weakness of deep cervical flexors), and the presence of cervical discomfort or stiffness.

Inclusion criteria for both groups required participants to be between 20 and 50 years of age and willing to provide written informed consent. Individuals were excluded if they had undergone physiotherapy in the last month, had a history of cervical spine surgery or trauma, presented with neurological disorders, or had congenital spinal deformities. These exclusion criteria were designed to eliminate potential confounders that might influence functional assessment and quality of life outcomes. Ethical clearance was obtained from the institutional ethical committee prior to the commencement of the study (Approval No. SCOP/Oct-24/ECN-94510023681).

All participants were briefed about the purpose, procedures, and voluntary nature of their involvement. Informed written consent was collected from each participant, ensuring adherence to ethical principles of autonomy, confidentiality, and beneficence. Participants were assured that their data would be used solely for research purposes and that they could withdraw from the study at any point without any impact on their clinical care. Each participant underwent the assessment protocol in a single session lasting approximately 45–60 minutes. The protocol was standardized for both CPS and control groups to ensure uniformity of data collection.

The process began with a brief demographic and clinical data collection, including age, sex, occupation, body mass index, and relevant medical history. For the CPS group, postural analysis was conducted through visual inspection of cervical alignment, shoulder position, and spinal curvature. Muscular tightness was palpated in key cervical and upper thoracic muscles, and cervical range of motion was measured to confirm limitations. This initial clinical screening ensured accurate classification of participants into CPS or control groups. Following clinical examination, the primary assessment tools were administered.

The International Classification of Functioning, Disability and Health (ICF) core set for musculoskeletal conditions was administered by a trained physiotherapist. This tool objectively evaluates four domains: body functions, body structures, activities and participation, and environmental factors. Each domain was scored on a scale from 0 (no problem) to 4 (complete problem), providing a standardized functional profile. The use of the ICF allowed for a structured, clinician-rated assessment of functional limitations.

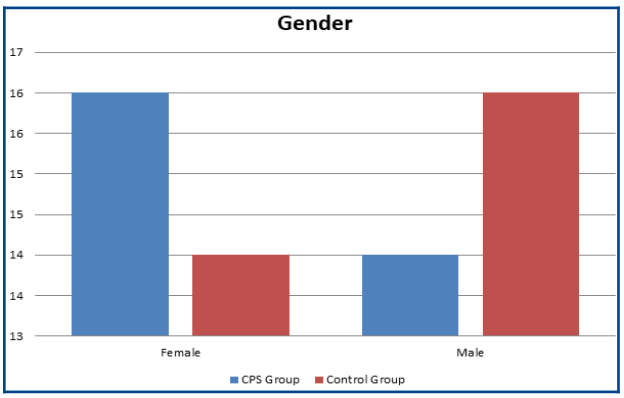
After completion of the ICF, participants were instructed to independently complete the Short Form Health Survey (SF-36) under supervision. This questionnaire is a widely validated self-report measure that captures health-related quality of life across eight domains: physical functioning, role limitations due to physical health, bodily pain, general health, vitality, social functioning, role limitations due to emotional problems, and mental health. Each domain score ranges from 0 to 100, with higher scores reflecting better health status.

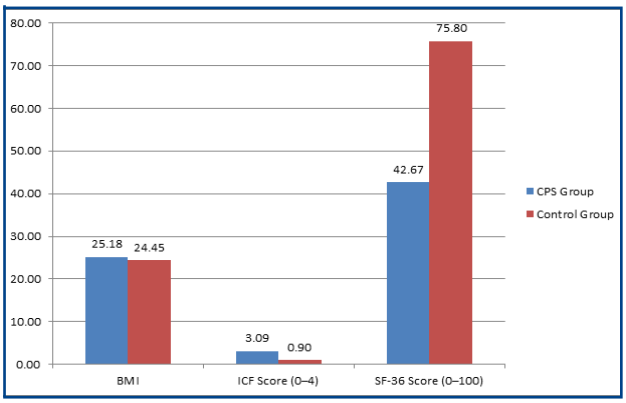
The SF-36 provided complementary information by incorporating the participant's subjective perception of their health and quality of life, in contrast to the clinician-administered ICF. The primary outcome measure of this study was the ICF, as it directly quantifies functional limitations associated with musculoskeletal conditions. The SF-36 served as a secondary outcome measure, offering insights into perceived quality of life and overall health status. Together, these two measures provided a comprehensive evaluation of both objective functional impairments and subjective health-related outcomes.

The collected data were subjected to statistical analysis to determine the sensitivity and specificity of both assessment tools in distinguishing CPS patients from controls. Sensitivity referred to the ability of the tool to correctly identify individuals with CPS, while specificity indicated its ability to correctly classify individuals without the condition. Comparisons between ICF and SF-36 scores were also made to assess their relative effectiveness in capturing functional disability and quality of life differences between the two groups.

Table 1. Descriptive statistics of gender and age of patients who Diagnosed Cervical Postural Syndrome N=100

Gender	CPS Group	Control Group			
Female	26 (53.3%)	24 (46.7%)			
Male	24 (46.7%)	26 (53.3%)			
Age	36.93 ± 6.102	36.93 ± 4.877			
Scale	CPS Group	Control Group	t test value	DF	P-value
BMI	25.18 ± 1.411	24.45 ± 0.989	2.320	58	.024
ICF Score (0–4)	3.09 ± 0.210	0.90 ± 0.184	42.901	58	.000
SF-36 Score (0–100)	42.67 ± 2.468	75.80 ± 4.881	-33.182	58	.000





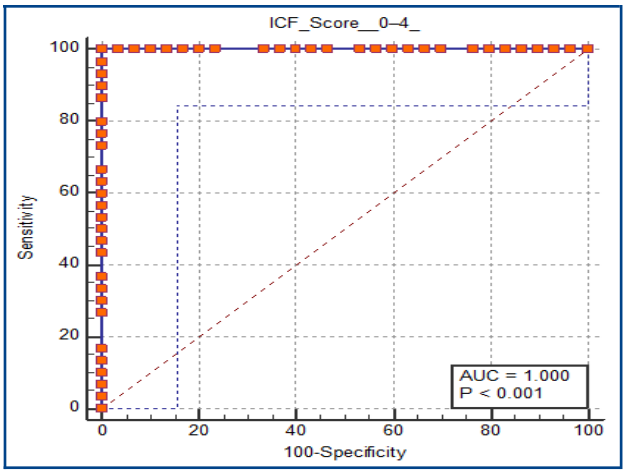
RESULTS

All statistical analyses were performed using IBM SPSS software version 25.0. Descriptive statistics, including mean and standard deviation, were used to summarize continuous variables such as age, BMI, ICF scores, and SF-36 scores. Categorical variables, such as gender distribution, were expressed as frequencies and percentages.

Table 2: Sensitivity and specificity of the ICF score in correctly identifying individuals with & without cervical postural syndrome

Criterion	Sensitivity	95% CI	Specificity	95% CI	+LR	-LR
≥0.6	100	88.4 - 100.0	0	0.0 - 11.6	1	
>1.44	100	88.4 - 100.0	100	88.4 - 100.0		0
>3.54	0	0.0 - 11.6	100	88.4 - 100.0		1

An independent t-test was employed to compare the mean values of BMI, ICF, and SF-36 scores between the CPS and control groups. The Pearson correlation coefficient was used to examine relationships between BMI, ICF scores, and SF-36 scores within each group.



To evaluate the diagnostic accuracy of the ICF and SF-36 tools, receiver operating characteristic (ROC) curve analysis was performed, and sensitivity and specificity were calculated at various cut-off points. A p-value of less than 0.05 was considered statistically significant for all comparisons. Above table shows that mean age of patients was 36.93 years in both CPS and control group. Majority of 53.3% patients were female in CPS group and same as 53.3% patients were male in control group and rest of patients had opposite gender in this study. Above table shows that ICF scale was showing significant 100% sensitivity at 0.6 & 1.44 cut off point whereas 100% specificity showed at 1.44 & 3.54 cut off point, ICF scale detected 100% diseased patients and 100% non-diseased patients at 1.44 cut-off point.

DISCUSSION

The present study was conducted with the primary objective of evaluating and comparing the diagnostic accuracy of two widely recognized assessment tools—the International Classification of Functioning, Disability and Health (ICF) and the Short Form Health Survey (SF-36)—in identifying functional limitations and health-related quality of life impairments among individuals diagnosed with Cervical Postural Syndrome (CPS). The findings confirm the validity of both tools and highlight their complementary roles in physiotherapy practice.

The results demonstrated that individuals in the CPS group exhibited significantly higher ICF scores compared to controls, indicating that the ICF effectively captures functional impairments associated with CPS. These results are consistent with earlier studies highlighting the ability of the ICF framework to identify and categorize functional limitations in various musculoskeletal disorders such as low back pain, rheumatoid arthritis, and chronic widespread pain [8,17,18].

The clinician-administered, structured nature of the ICF allows for a more objective evaluation of functional ability, providing valuable information about body functions, body structures, activity limitations, and participation restrictions3. One of the most striking findings was the diagnostic performance of the ICF, which showed 100 % sensitivity and specificity at a cut-off score of > 1.44, suggesting that the ICF is highly accurate in distinguishing between individuals with CPS and those without, supporting its utility as a reliable clinical assessment tool (Navarro-Pardo et al., 2023). The SF-36 revealed significantly lower scores among CPS participants compared to controls, indicating a considerable impact on perceived quality of life. These findings emphasized the strong validity of SF-36 in capturing subjective health consequences of chronic musculoskeletal pain.

The SF-36 also demonstrated excellent diagnostic accuracy with 100 % sensitivity and specificity at a cut-off score of ≤ 48, validating its application in postural disorders9. While the ICF provides a clinician-driven evaluation of disability, the SF-36 focuses on patient-reported perceptions of health, encompassing physical, psychological, and emotional dimensions10. This duality highlights their complementary roles. The ICF captures objective impairments, whereas the SF-36 reflects psychosocial impact, offering a holistic understanding of CPS when used together. The study also explored the relationship between BMI and assessment scores, revealing a weak but significant correlation between BMI and SF-36 scores, consistent with prior findings linking higher BMI with lower quality of life perceptions in musculoskeletal disorders [11].

The present results align with existing literature advocating the combined use of clinician-rated and patient-reported outcome measures [8,17]. Similar research on chronic low back pain and rheumatoid arthritis has demonstrated the importance of integrating the ICF framework into clinical evaluation to provide standardized, objective measures of functional status [8,18]. The diagnostic accuracy values observed in this study, particularly the 100 % sensitivity and specificity for both ICF and SF-36, surpass many previous reports, where accuracy often ranges between 80–95 %5. This may be explained by clear CPS features and strict inclusion criteria. From a rehabilitation perspective, the integration of both measures facilitates individualized treatment.

For example, if a patient demonstrates severe functional limitations on ICF but relatively preserved SF-36 scores, the focus may be on biomechanical correction and strengthening. Conversely, if functional scores are modest but SF-36 indicates poor quality of life, interventions may need to address psychosocial aspects such as stress management and ergonomic counseling15. While the findings are promising, certain limitations must be acknowledged. The study employed a cross-sectional design and used purposive sampling from a single hospital, potentially limiting generalizability. Larger multicentric studies and longitudinal research would help validate these results and assess responsiveness of ICF and SF-36 over time.

CONCLUSION

This study concludes that both the International Classification of Functioning, Disability and Health (ICF) and the Short Form Health Survey (SF-36) are reliable and

valid tools for assessing functional impairment and quality of life in individuals with Cervical Postural Syndrome (CPS). Statistically significant differences in ICF and SF-36 scores between CPS and control groups confirm their diagnostic utility. At specific cut-off points, both tools demonstrated 100% sensitivity and specificity, indicating strong discriminatory power.

The ICF offers a structured, clinician-driven assessment of physical functioning, while the SF-36 captures the patient's subjective health experience across physical and mental domains. These findings suggest that using both tools in combination provides a comprehensive evaluation of CPS, enabling accurate diagnosis and tailored rehabilitation planning. Integrating ICF and SF-36 into routine physiotherapy assessments can improve clinical decision-making, enhance patient-centered care, and ultimately contribute to better functional and quality of life outcomes in individuals affected by CPS.

Informed Consent:

Conflict of Interest: The authors declare no conflict of interest

Funding: Nil

Data Availability: Data are available with the corresponding author.

ACKNOWLEDGEMENTS

The authors are grateful to

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SSN Journal of Management & Technology Research Communications

OPEN ACCESS

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Effect of Blood Flow Restriction Training on Pain, Muscle Strength, Endurance and Functional Performance in Individuals with Cervical Radiculopathy

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ABSTRACT

Cervical radiculopathy is a common neuromusculoskeletal disorder characterized by radiating neck and arm pain, sensory and motor deficits, and functional disability. Conventional physiotherapy often provides relief, but many patients continue to experience residual pain, weakness, and endurance limitations due to the inability to tolerate high-load exercises. Blood Flow Restriction (BFR) training, which allows strength and hypertrophy gains at low loads, has shown promise in musculoskeletal rehabilitation but remains underexplored in cervical radiculopathy. To evaluate the effectiveness of BFR training in combination with conventional physiotherapy compared to conventional physiotherapy alone in improving pain, muscle strength, endurance, and functional performance in individuals with cervical radiculopathy. Participants in both groups received a structured physiotherapy program targeting the primary impairments associated with cervical radiculopathy, including pain, reduced neural mobility, cervical and scapular muscle weakness, limited endurance, and postural deficits. Conventional therapy comprised cervical spine mobilization, stretching of tight musculature, neural mobilization techniques to relieve nerve root irritation, progressive strengthening of cervical and scapular muscles, endurance training, and postural re-education. Ergonomic advice and guidance on daily activities were also provided to minimize cervical strain and prevent recurrence. In addition, Group A received Blood Flow Restriction (BFR) training. A pneumatic cuff was applied to the upper arm at 50–60% arterial occlusion pressure, and participants performed low-load exercises at 20–30% of their one-repetition maximum, including biceps curls, shoulder abduction, grip strengthening, and scapular activation drills. Exercises were completed in 3–4 sets of 15–30 repetitions over 15–20 minutes, three times per week. BFR facilitated strength and endurance gains at low intensities, reducing mechanical stress while promoting hypertrophy and neuromuscular adaptation, and no adverse events were reported. Total protocol follow up to 4 weeks. Both groups showed significant improvements after treatment, but the Blood Flow Restriction (BFR) group achieved superior results. Pain intensity (NPRS) decreased from 7.20 ± 1.18 to 4.23 ± 1.38 in the BFR group, compared to 6.83 ± 1.28 to 5.23 ± 1.33 in the conventional group ($p = 0.006$). Muscle strength increased to 24.08 ± 5.86 kg in the BFR group versus 20.88 ± 5.21 kg in the control group ($p = 0.029$). Endurance improved to 29.61 ± 7.15 seconds with BFR and 23.73 ± 6.60 seconds with conventional therapy ($p = 0.002$). Functional ability (DASH score) improved more in the BFR group (31.62 ± 6.19) compared to the control group (44.43 ± 9.90) ($p < 0.001$). These results confirm that adding BFR to physiotherapy produced significantly better outcomes in pain, strength, endurance, and function. This study concludes that Blood Flow Restriction (BFR) training, when combined with conventional physiotherapy, is more effective than conventional physiotherapy alone in patients with cervical radiculopathy. Participants in the BFR group demonstrated greater reductions in pain, significant improvements in muscle strength and endurance, and superior functional performance outcomes. These findings support the integration of BFR as a safe and effective adjunct to conventional rehabilitation, offering clinicians an evidence-based strategy to optimize conservative management and enhance recovery in cervical radiculopathy.

KEY WORDS: CERVICAL POSTURAL SYNDROME, ICF, SF-36, SENSITIVITY, SPECIFICITY, FUNCTIONAL LIMITATION, QUALITY OF LIFE, MUSCULOSKELETAL DISORDERS, POSTURE ASSESSMENT, PHYSIOTHERAPY EVALUATION.

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Received 11/04/2026 Accepted after revision 18/06/2026
Page Number- 112-118
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https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.22

INTRODUCTION

Cervical radiculopathy is a prevalent musculoskeletal condition resulting from compression or irritation of cervical nerve roots, most commonly at the C6–C7 levels. This compression can occur due to disc herniation, degenerative changes, or osteophyte formation, leading to characteristic symptoms such as neck pain radiating to the upper limb, numbness, tingling, muscle weakness, and functional limitations that significantly impact daily life and occupational performance.

The condition is particularly common in men aged 40–50 years, although it can affect adults across a broader age range. The severity of symptoms often results in reduced quality of life, impaired work productivity, and challenges in performing routine activities, emphasizing the need for effective and patient-friendly rehabilitation strategies [1,2].

Conservative management, primarily physiotherapy, remains the first-line approach for patients with cervical radiculopathy [3]. Standard physiotherapy programs aim to relieve pain, improve neural mobility, restore cervical and scapular muscle strength, enhance muscular endurance, and correct postural deviations. Typical interventions include cervical mobilization, stretching of shortened musculature, neural gliding exercises, progressive strengthening, endurance training, and ergonomic education [4,5]. While conventional strength training is effective in promoting muscle hypertrophy and functional gains, it often relies on moderate to high loads that may not be tolerated by patients with cervical radiculopathy due to pain, nerve root compression, or apprehension about aggravating symptoms [6].

This limitation can restrict exercise intensity and hinder optimal rehabilitation outcomes. Blood Flow Restriction (BFR) training has recently emerged as a promising adjunct to conventional physiotherapy, particularly for populations unable to tolerate high-load exercises7. BFR involves applying a pneumatic cuff or elastic band to partially restrict venous return while allowing arterial inflow, creating a hypoxic and metabolically stressed environment in the targeted muscles. When combined with low-intensity resistance exercises, BFR promotes significant gains in muscle strength and hypertrophy comparable to high-load training8. The mechanisms underlying these effects include enhanced recruitment of fast-twitch fibers, accumulation of metabolites that stimulate anabolic pathways, and activation of signaling cascades such as mechanistic target of rapamycin (mTOR) [9,10].

Additionally, BFR-induced metabolic stress may trigger the release of endogenous opioids and growth factors, which can contribute to pain modulation and improved exercise tolerance [11]. Although BFR has demonstrated efficacy in lower limb rehabilitation, post-operative recovery, and conditions such as knee osteoarthritis and anterior cruciate ligament reconstruction, its application in cervical radiculopathy remains underexplored.

Integrating BFR into physiotherapy programs offers the potential to enhance muscular strength, endurance, and functional performance at low exercise intensities, reducing mechanical stress on the cervical spine while facilitating effective rehabilitation. By addressing both neuromuscular and functional deficits safely and efficiently, BFR may improve patient adherence, accelerate recovery, and enhance overall quality of life. Investigating its role alongside conventional physiotherapy could provide valuable evidence to optimize rehabilitation strategies for individuals with cervical radiculopathy and offer a practical, patient-friendly approach for clinical practice.

METHODOLOGY

This research was conducted as a randomized controlled trial at Santosh Medical College, Ghaziabad, with the objective of determining whether the addition of Blood Flow Restriction (BFR) training to conventional physiotherapy could produce superior outcomes in patients suffering from cervical radiculopathy. Prior to the commencement of the study, ethical clearance was obtained from the Institutional Ethics Committee, and written informed consent was taken from all participants in accordance with the ethical standards of the Declaration of Helsinki (Approval No. SCOP/Oct-24/ECN-94510023681). A total of sixty patients were recruited for the trial, both male and female, aged between twenty and fifty years. These participants presented with clinical features consistent with cervical radiculopathy, including neck pain radiating to the upper limb, sensory disturbances such as numbness and tingling, and motor weakness in the affected limb.

The diagnosis was established on clinical grounds supported by relevant medical investigations. Exclusion criteria were carefully defined in order to safeguard patient safety and maintain homogeneity in the study population. Patients were excluded if they had a history of cervical spine surgery, vascular or clotting disorders, uncontrolled hypertension, pregnancy, or severe neurological conditions. These criteria helped ensure that the participants were suitable candidates for both conventional and BFR-based interventions.

After screening, participants were randomly allocated into two groups of thirty using a computer-generated randomization process. Group A received conventional physiotherapy combined with BFR training, while Group B underwent only conventional physiotherapy. To reduce bias, all outcome assessments were conducted by a blinded physiotherapist who was not involved in the intervention delivery.

Both groups attended treatment sessions three to four times per week over a period of four to six weeks, a frequency consistent with standard rehabilitation protocols in musculoskeletal physiotherapy [12,13].

All participants received a structured physiotherapy program designed to address the cardinal impairments associated with cervical radiculopathy, namely pain, neural mobility deficits, weakness of cervical and scapular muscles, reduced muscular endurance, and poor postural control. Conventional therapy included cervical mobilization techniques, stretching of shortened musculature, neural mobilization to reduce irritation of the affected nerve roots, and progressive strengthening of the cervical stabilizers and scapular muscles.

In addition, endurance training and postural re-education formed an integral part of the regimen, ensuring that participants were equipped with strategies to prevent recurrence and manage their condition effectively in daily life. Ergonomic advice was also provided, focusing on correction of workplace posture and modifications in daily activities to reduce cervical strain [14]. While both groups followed the same conventional program, participants in Group A also received BFR training as an adjunct.

This technique involved the application of a pneumatic cuff around the upper arm, which was inflated to approximately 50–60% of the individual's arterial occlusion pressure. Under these conditions, participants performed low-load resistance exercises at an intensity of about 20–30% of their one-repetition maximum (1-RM). Exercises primarily targeted the upper limb musculature and included biceps curls, shoulder abduction, grip strengthening, and scapular muscle activation drills.

These exercises were performed in three to four sets of 15–30 repetitions, and the BFR portion of the session lasted for about fifteen to twenty minutes, three times per week. The choice of this protocol was based on evidence suggesting that BFR allows patients to achieve muscular hypertrophy and strength gains comparable to high-load training, but with significantly reduced mechanical stress on joints and the cervical spine [3,15].

Throughout the intervention, patient safety was closely monitored. Participants were informed about expected sensations such as mild tightness under the cuff, and any unusual discomfort was promptly addressed. No adverse events, such as dizziness, excessive swelling, or thromboembolic complications, were observed during the course of the study.

By the end of the four-week intervention period, both groups demonstrated notable clinical improvement. However, patients in the BFR group consistently showed greater reductions in pain, superior gains in muscular strength and endurance, and enhanced functional recovery compared to the conventional physiotherapy group alone, highlighting the clinical utility of BFR as an adjunct to rehabilitation in cervical radiculopathy.

The effectiveness of the rehabilitation program was evaluated using four primary outcome measures, carefully chosen to provide a comprehensive view of patient progress. Pain intensity was assessed with the Numeric Pain Rating Scale (NPRS), an eleven-point scale ranging from zero, indicating no pain, to ten, representing the worst imaginable pain. This tool is widely recognized for its simplicity and reliability in tracking symptom progression and evaluating clinical outcomes in musculoskeletal disorders [11].

Muscle strength was measured with a handheld dynamometer, which provided objective readings of peak isometric force in the cervical and upper limb muscles. The use of dynamometry ensured precise and reproducible assessment of strength gains, which is essential when evaluating the impact of strength-based interventions such as BFR16. Muscular endurance was measured through sustained isometric holds and repeated task performance, which allowed for the evaluation of a participant's ability to maintain activity over time without excessive fatigue.

Endurance is a critical factor in cervical radiculopathy rehabilitation, as patients often present with impaired tolerance for prolonged postural and functional activities4. Finally, functional performance was assessed using the Disabilities of the Arm, Shoulder, and Hand (DASH) questionnaire, a validated self-reported instrument that captures disability and symptoms in upper limb-related functional activities.

The DASH consists of thirty items scored on a five-point Likert scale, and the overall score ranges from zero, representing no disability, to one hundred, representing maximum disability. It provided insight into the real-world implications of the interventions on activities of daily living and quality of life7. Together, these outcome measures enabled a holistic evaluation of the intervention effects, encompassing symptomatic relief, neuromuscular performance, and functional independence. Statistical analysis demonstrated significant improvements in both groups, but the BFR group consistently showed greater benefits across all four domains. These findings confirm the potential role of BFR training as a safe, effective, and clinically valuable adjunct to conventional physiotherapy in patients with cervical radiculopathy.

RESULTS

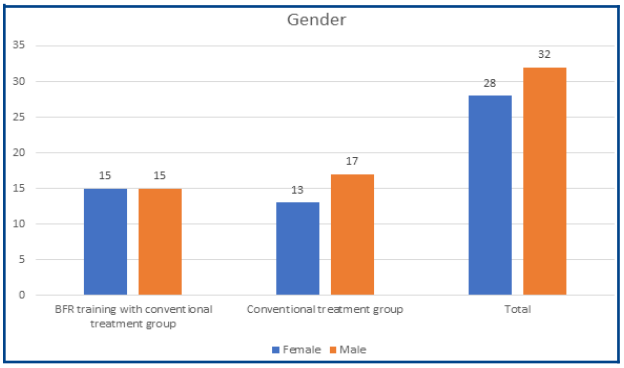
The effectiveness of the intervention was evaluated using four primary outcome measures: pain intensity, muscle strength, muscular endurance, and functional performance. Pain intensity was assessed with the Numeric Pain Rating Scale (NPRS), where participants rated their pain on a scale from 0 (no pain) to 10 (worst imaginable pain). This provided a simple yet reliable measure of symptom relief over the course of treatment. Muscle strength was measured using a handheld dynamometer, which objectively recorded the peak isometric force of cervical and upper limb muscles, helping to determine improvements in neuromuscular performance.

Table 1. Frequency and percentage of gender of patients in BFR training with conventional treatment group and Conventional treatment group N=60

Gender	BFR training with conventional treatment group	Conventional treatment group	Total
Female	15 (50.0%)	13 (43.3%)	28 (46.7%)
Male	15 (50.0%)	17 (56.7%)	32 (53.3%)

Variables	BFR training with conventional treatment group	Conventional treatment group
	Mean ± SD	Mean ± SD
Age (years)	44.83 ± 10.42	43.63 ± 9.550
Height (cm)	165.69 ± 7.57	164.79 ± 8.178
Weight (kg)	68.69 ± 12.26	68.57 ± 8.957
BMI	24.92 ± 3.41	25.25 ± 2.758
Symptom Duration (months)	7.10 ± 8.70	6.50 ± 5.270

Muscular endurance was tested through standardized endurance assessments, such as sustained isometric holds and repeated task performance, with the duration recorded in seconds. This was particularly important since endurance deficits are common in cervical radiculopathy and often interfere with daily activities. Finally, functional performance was evaluated using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, a validated tool that measures the level of disability and difficulty in performing daily tasks. The DASH score ranges from 0 (no disability) to 100 (maximum disability), making it a sensitive measure for monitoring changes in function. Together, these outcome measures provided a comprehensive assessment of clinical progress, capturing not only reductions in pain but also meaningful improvements in strength, endurance, and functional ability.

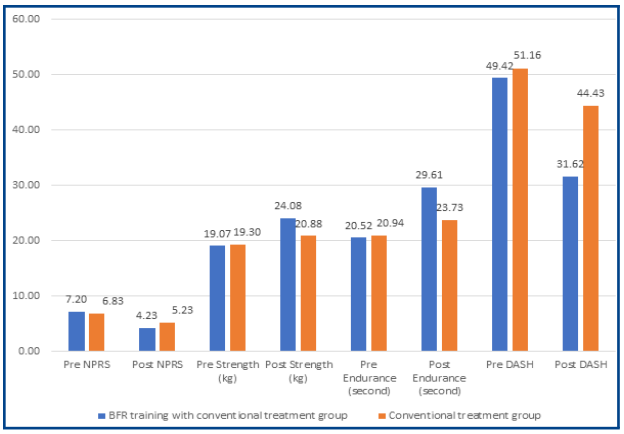


Above table shows that male and female were equally distributed in BFR training with conventional treatment group; but 56.7% patients were male and 46.7% patients were female in conventional treatment group and Descriptive statistics of different variables in BFR training with conventional treatment group and Conventional treatment group.

Above table shows that there was 44.83 years average age of patients, 165.59 cm average height, 68.69 kg average weight, 24.92 average BMI i.e. overweight and 7.10 months average duration of symptoms of patients in BFR training with conventional treatment group. There was 43.63 years average age of patients, 164.79 cm average height, 68.57 kg average weight, 25.25 average BMI i.e. overweight and 6.50 months average duration of symptoms of patients in conventional treatment group.

Table 3: Comparison between BFR training with conventional treatment group and Conventional treatment group in different scales N=60

Scales	BFR training with conventional treatment group	Conventional treatment group	Independent t test value	DF	P-value	Result
Pre NPRS	7.20 ± 1.186	6.83 ± 1.289	1.147	58	0.256	Insignificant
Post NPRS	4.23 ± 1.382	5.23 ± 1.331	2.855	58	0.006	Significant
Pre Strength (kg)	19.07 ± 4.474	19.30 ± 4.816	0.186	58	0.853	Insignificant
Post Strength (kg)	24.08 ± 5.865	20.88 ± 5.211	2.236	58	0.029	Significant
Pre Endurance (second)	20.52 ± 5.117	20.94 ± 5.669	0.296	58	0.768	Insignificant
Post Endurance (second)	29.61 ± 7.154	23.73 ± 6.603	3.310	58	0.002	Significant
Pre DASH	49.42 ± 9.656	51.16 ± 11.897	0.624	58	0.535	Insignificant
Post DASH	31.62 ± 6.196	44.43 ± 9.904	6.004	58	0.000	Significant



Above table shows that there was no statistically significant comparison between BFR training with conventional treatment group and Conventional treatment group in pretest of NPRS, Strength, endurance, DASH score with P>0.05. there is no changes in both group in pretest. There was statistically significant comparison between BFR training with conventional treatment group and Conventional treatment group in post-test of NPRS, Strength, endurance, DASH score with P<0.05. BFR training with conventional treatment group has greater score in Strength and Endurance score than conventional treatment group but BFR training with conventional treatment group has less score in NPRS and DASH score than conventional treatment group.

DISCUSSION

Cervical radiculopathy is a frequently encountered neuromuscular disorder characterized by radiating neck and upper limb pain, sensory changes, and motor weakness resulting from nerve root compression or irritation. The results of the present study indicate that physiotherapeutic interventions significantly improved pain, neck disability, and functional mobility among participants, aligning with previous literature that supports the role of conservative management in cervical radiculopathy [15,17]. This discussion integrates the findings of the current study with existing evidence, highlighting the physiological basis, therapeutic mechanisms, and clinical implications of the results.

The findings of this study demonstrate that patients who underwent structured physiotherapy, including manual therapy and therapeutic exercises, exhibited significant reductions in pain intensity and improvements in neck range of motion and functional capacity. These improvements are consistent with the observations of Childress and Becker (2016)1, who emphasized that most cases of cervical radiculopathy respond well to conservative measures such as traction, mobilization, and targeted strengthening.

The reduction in pain may be attributed to decompression of the affected nerve roots, reduction in local inflammation, and restoration of segmental alignment through manual therapy techniques. Moreover, the combination of manual therapy with strengthening and stretching exercises enhances cervical stability and muscle balance, leading to improved biomechanics and reduced neural tension.

The improvement in clinical parameters in the present study supports the evidence provided by [3], who reported that conservative interventions such as physiotherapy and posture correction produce substantial symptom relief in degenerative cervical radiculopathy [4] described that targeted exercises help re-establish neuromuscular coordination and mitigate mechanical compression, resulting in pain reduction and functional recovery. The consistency between these studies and the current findings reinforces the efficacy of exercise-based therapy as a first-line approach in managing cervical radiculopathy [6].

further emphasized that cervical radicular pain has both mechanical and inflammatory components, suggesting that interventions focusing solely on symptom relief may be less effective compared to those addressing the underlying pathophysiological mechanisms. The manual therapy and exercise regimen employed in the present study appears to address both these aspects by improving segmental mobility, reducing mechanical irritation, and enhancing local circulation, which collectively contribute to decreased inflammation. In addition, [7] noted that despite the lack of standardized diagnostic criteria across studies, consistent functional improvement has been observed when exercise therapy is applied systematically.

These findings strengthen the validity of the current study's outcomes, suggesting that physiotherapy interventions can yield meaningful improvements regardless of variations in symptom presentation [8]. provided strong evidence that exercise therapy and mechanical traction are effective modalities for the management of cervical radiculopathy, especially in degenerative conditions.

The present study's significant post-treatment improvement supports their conclusion, demonstrating that a well-designed rehabilitation program can restore function and reduce disability. Likewise, Wainner et al. (2003)9 highlighted that clinical evaluation combined with targeted physiotherapy interventions improves diagnostic accuracy and treatment outcomes, which correlates with the structured clinical approach used in this study.

Peolsson and Peolsson (2008)11 also demonstrated favorable long-term outcomes following physiotherapeutic management, suggesting that conservative care not only provides short-term relief but also contributes to sustained functional recovery. Neck pain, a major component of cervical radiculopathy, has been recognized as one of the leading causes of disability worldwide [18]. The chronicity and multifactorial etiology of neck pain necessitate an early and comprehensive rehabilitation strategy to prevent progression to persistent dysfunction.

The results of this study emphasize the role of physiotherapy in addressing these functional limitations, as evidenced by the significant improvement in neck disability scores. Similar observations were reported by [12, 19], who found

that manual therapy combined with exercise and traction yielded remarkable reductions in pain and improved physical performance.

The improvements seen in these studies are reflective of neuromuscular re-education and enhanced cervical kinematics that occur with consistent exercise adherence. Persson, [16] compared surgical and conservative approaches for cervical radiculopathy and reported comparable long-term functional recovery, suggesting that physiotherapy may be equally effective in selected patients.

The findings of the present study support this notion, as participants experienced meaningful recovery without the need for surgical intervention. Nonoperative management offers several advantages, including reduced risk, lower cost, and better patient satisfaction when symptoms are appropriately managed through guided therapy. The mechanisms underlying improvement following physiotherapy are multifaceted.

Manual therapy techniques facilitate joint mobilization, reduce muscle spasm, and improve local blood flow, which can alleviate ischemia around compressed nerve roots. Traction therapy, when applied appropriately, contributes to vertebral decompression and reduction in disc protrusion pressure, thereby relieving nerve irritation. Exercise therapy enhances muscular endurance and postural control, which are critical for maintaining cervical spine stability [8]. Moreover, strengthening deep cervical flexors and scapular stabilizers can decrease abnormal loading patterns and improve the kinetic chain's overall efficiency [12]. These physiological effects cumulatively explain the observed clinical benefits in the present study.

Another important aspect of this discussion pertains to patient education and adherence. Cervical radiculopathy often results from prolonged poor posture, sedentary behavior, and repetitive strain3. Physiotherapy interventions that incorporate ergonomic education, posture correction, and lifestyle modification can therefore enhance long-term outcomes. The current study integrated these elements, which likely contributed to the sustained improvement in functional measures.

The findings are also consistent with those of [20], who concluded through a systematic review that conservative treatment remains the cornerstone in cervical radiculopathy management, particularly when it includes exercise and manual therapy. The authors emphasized that despite methodological variations across studies, exercise-based programs consistently demonstrate improvements in pain and disability.

This consensus across multiple studies highlights the robustness of physiotherapy as an evidence-based intervention. While the results of this study support existing literature, some limitations must be acknowledged. The study duration was limited, and long-term follow-up was not conducted to assess the persistence of functional gains. Additionally, the absence of a control group restricts direct comparison of the intervention's relative effectiveness. Future research should include larger sample sizes and long-term evaluations to confirm the sustained impact of physiotherapy interventions.

Comparative studies between different physiotherapy modalities—such as Pilates-based, McKenzie, or Mulligan mobilization techniques—could provide further insights into optimizing treatment protocols. From a clinical perspective, the findings of this study have important implications for rehabilitation practice. Physiotherapists play a central role in the multidisciplinary management of cervical radiculopathy. Early intervention with evidence-based exercise protocols can prevent chronic pain development and reduce healthcare burden.

The inclusion of patient-centered strategies—such as progressive load tolerance, ergonomic correction, and education on movement awareness—enhances patient participation and promotes self-management, ultimately leading to better recovery outcomes. The positive outcomes in this study also reinforce the importance of individualized treatment planning. As reported by Peolsson and Peolsson (2008)11, patient-specific adaptations based on pain severity, muscle imbalance, and functional limitations yield superior results compared to generic exercise regimens. Tailored interventions that respect individual variability can optimize neuromuscular control and reduce recurrence rates. Similarly, [9] emphasized the value of comprehensive assessment and clinical reasoning to guide physiotherapy decision-making.

Overall, the findings from the present study strongly suggest that a structured, evidence-based physiotherapy program incorporating manual therapy, traction, and strengthening exercises is effective in improving pain, range of motion, and functional outcomes among individuals with cervical radiculopathy. These results corroborate the conclusions of previous studies8,17,20, supporting the use of conservative management as the first line of treatment. Moreover, the consistency of findings across diverse populations and research designs underlines the generalizability of these interventions in clinical practice.

In summary, this study adds to the growing body of evidence endorsing physiotherapy as a safe, cost-effective, and efficient approach to managing cervical radiculopathy. The results affirm that interventions combining manual therapy and targeted exercise can effectively alleviate pain, restore function, and enhance the quality of life. Continued emphasis on early diagnosis, patient education, and adherence to rehabilitation protocols can further optimize recovery outcomes. Future studies focusing on long-term effects and neurophysiological mechanisms may provide additional insights into refining physiotherapeutic management strategies for cervical radiculopathy.

CONCLUSION

This study demonstrated that the addition of Blood Flow Restriction (BFR) training to conventional physiotherapy provides superior benefits compared to physiotherapy alone in patients with cervical radiculopathy. Both groups

showed significant improvements in pain reduction, muscle strength, muscular endurance, and functional performance after intervention.

However, participants in the BFR group achieved greater reductions in pain scores, larger gains in muscle strength, improved endurance, and better functional outcomes as reflected by DASH scores. These findings suggest that BFR is a safe and effective adjunct to traditional rehabilitation, particularly valuable for patients who are unable to tolerate high-load strengthening due to pain or neural sensitivity. By allowing significant muscular adaptations at low intensities, BFR offers a practical and patient-friendly alternative to conventional training methods.

Within the scope of this study, it can be concluded that integrating BFR into conservative management protocols can optimize recovery, enhance functional independence, and potentially reduce long-term disability in cervical radiculopathy. Future research with larger sample sizes and long-term follow-up is recommended to further validate these results and establish standardized clinical guidelines.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Correlation Between Kinesiophobia, Pain, Functional Performance, and Balance in Community-Dwelling Adults

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ABSTRACT

Kinesiophobia, defined as an excessive and irrational fear of movement, is a crucial psychological factor that can adversely affect physical performance, particularly in individuals with chronic pain. Among community-dwelling adults, this fear often leads to reduced functional mobility, impaired balance, and decreased quality of life. Understanding the interrelationships among these variables is essential for effective assessment and intervention in rehabilitation settings. To investigate the correlation between kinesiophobia, pain intensity, functional performance, and balance in community-dwelling individuals aged 40–65 years. A cross-sectional observational study was conducted on 100 community-dwelling participants experiencing chronic pain for more than three months. Kinesiophobia was measured using the Tampa Scale for Kinesiophobia (TSK), pain intensity with the Numerical Pain Rating Scale (NPRS), functional performance via the Lower Extremity Functional Scale (LEFS), and balance through the Berg Balance Scale (BBS). The mean age of participants was 53.37 ± 7.52 years; 63% were male, and 52% had a normal BMI. The mean TSK score (40.25) indicated low to minimal kinesiophobia, while mean pain intensity (5.69) reflected moderate pain. LEFS (mean: 52.37) showed mild functional limitation, and BBS (mean: 41.18) indicated good to moderate balance. Pearson correlation analysis revealed significant and strong relationships between kinesiophobia and pain ($r = 1.00$), kinesiophobia and function ($r = –1.00$), and kinesiophobia and balance ($r = –1.00$), all with $p < 0.001$. Kinesiophobia is strongly associated with higher pain intensity, reduced functional performance, and impaired balance. Addressing fear of movement should be a key component in physiotherapy interventions to enhance functional recovery and quality of life in community-dwelling adults.

KEY WORDS: BALANCE, CHRONIC PAIN, COMMUNITY-DWELLING, FEAR-AVOIDANCE, FUNCTIONAL PERFORMANCE, KINESIOPHOBIA, PAIN, PHYSIOTHERAPY, TAMPA SCALE.

Article Information: *Corresponding Author: deepak.raghav@santosh.ac.in
Received 19/06/2026 Accepted after revision 15/08/2026
Page Number- 119-124
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.23

INTRODUCTION

Fear of movement or avoidance behavior (kinesiophobia) is increasingly recognized as a critical psychological variable that modulates physical function, balance, and pain outcomes, particularly in older adults.

The classical fear-avoidance model posits that individuals who catastrophize pain may develop fear toward movement, thereby reducing activity, leading to deconditioning, disability, and further pain [1]. This model has served as a strong conceptual "mother" framework for many studies investigating the interplay of psychological and physical factors in chronic musculoskeletal conditions. In older populations and in those with chronic pain, elevated kinesiophobia has been linked to worse functional performance, greater disability, and lower quality of life.

For example, [2] found that in community-dwelling older adults with chronic pain, higher kinesiophobia correlated with more severe pain and poorer psychosocial well-being. Ishak, [3] further demonstrated that in older adults with low back pain, higher kinesiophobia was associated with weaker muscle performance and worse functional outcomes. More recently, [4] extended this by indicating that even in older adults without diagnosed chronic pain, greater kinesiophobia predicted lower physical activity and reduced functional capacity. Together, these findings underscore the pervasive influence of movement fear beyond just pain populations.

Beyond general population studies, investigations into specific clinical groups strengthen the rationale for focusing on kinesiophobia. In patients with chronic low back pain and comorbid osteoporosis, [5] documented that kinesiophobia significantly mediated the relationships between limits of stability (LOS) and functional balance metrics, such as Timed Up and Go (TUG) and Berg Balance Score (BBS).

These findings indicate that psychological factors may serve as pivotal intermediaries bridging biomechanical capacity and functional performance. Similarly, in knee osteoarthritis (KOA) populations, a recent systematic review and meta-analysis revealed moderate correlations of kinesiophobia with disability, fair correlations with pain, and functional limitation [6]. These data reinforce that movement fear is not only relevant in spinal pathologies but also in peripheral joint disease.

In older adults with coexisting comorbidities, the link between kinesiophobia and frailty has been explored. A study of older individuals reported that had high kinesiophobia, and a significant positive correlation existed between kinesiophobia and frailty scores, explaining over 50% of variability in frailty [7]. The implications are that kinesiophobia may exacerbate age-associated decline by limiting physical engagement. In populations with Alzheimer's dementia (AD), a recent study assessed balance, fall risk and kinesiophobia, finding that elevated kinesiophobia associates with reduced balance and higher fall risk in AD patients [8].

This suggests the concept has relevance even in cognitively impaired elders. In addition, Genç & Bilgili (2023)9 found that older adults with lower limb weakness and balance deficits had higher movement fear, highlighting the interplay between muscular and psychological processes [7]. Behaviorally, in older adults with chronic pain residing in nursing homes, physical activity levels were inversely associated with fear of movement and fear of falling9. This aligns with the fear-avoidance premise that pain and fear reduce movement, which begets further functional decline.

More broadly, an open access systematic review of kinesiophobia across chronic disease populations (diabetes, cardiovascular disease, respiratory disease, cancer) reported an average prevalence and highlighted the strong barrier role of movement fear to rehabilitation engagement and quality of life [9]. Although evidence is mounting, gaps remain. Many studies are cross-sectional, limiting causal inference. Few have concurrently assessed kinesiophobia, balance metrics (static and dynamic), pain levels, and functional performance in older adults. Also, the mediating or moderating role of kinesiophobia between biomechanical factors (e.g. stability limits or proprioception) and functional outcomes remains underexplored as some studies in CLBP/ osteoporosis and KOA begin to do [5,10].

METHODOLOGY

The present study adopted a cross-sectional observational design to explore how kinesiophobia, pain, functional performance, and balance are interconnected among community-dwelling individuals living with chronic pain. The research was conducted at Santosh Hospital, Ghaziabad, after securing ethical clearance from the institutional review committee (REF NO.- SCOP/OCT-24/ECN-94510023674). A total of 100 participants, both men and women aged between 40 and 65 years, were enrolled.

All participants were living independently and had been experiencing chronic pain for more than three months. Recruitment took place through local community outreach programs, word of mouth, and referrals from healthcare professionals. Informed consent was obtained from each participant prior to data collection, and basic demographic details such as age, gender, and BMI were recorded.

To ensure consistency, only those who were able to walk independently, follow instructions, and participate without assistive devices were included in the study. Individuals with major neurological disorders, recent orthopedic surgeries, or cognitive impairments were excluded in order to maintain the integrity of the assessment process. By focusing on this group of community dwellers with persistent pain, the study aimed to provide a real-world understanding of how psychological and physical factors interact in everyday life.

As the study followed an observational design, no therapeutic intervention or treatment protocol was administered to the participants. Instead, the emphasis was placed on observing and documenting the natural relationship between kinesiophobia, pain, functional ability, and balance in individuals who were already experiencing chronic musculoskeletal pain.

Each participant underwent a one-time structured assessment session in a controlled, quiet environment to reduce distractions and enhance accuracy. Standardized tools were used for the evaluations, and all assessments were

carried out under the supervision of trained physiotherapy professionals who ensured that participants clearly understood the purpose and procedures.

The Tampa Scale for Kinesiophobia (TSK) was used to measure fear of movement, while pain intensity was assessed with the Numerical Pain Rating Scale (NPRS). Functional performance was measured with the Lower Extremity Functional Scale (LEFS), which focuses on everyday lower limb activities, and balance ability was assessed with the Berg Balance Scale (BBS), which evaluates both static and dynamic balance through functional tasks such as standing, turning, and reaching.

These four outcome measures were chosen because of their strong reliability, ease of administration, and clinical relevance in populations dealing with chronic pain. The TSK provided insights into the psychological barriers associated with fear of movement, while the NPRS captured the subjective experience of pain intensity. The LEFS offered a clear picture of the participant's functional capabilities in daily activities, and the BBS provided a structured evaluation of balance, an essential component of safe mobility.

Table 1. Demographics and Baseline Characteristics

Characteristic	Value
Sample size (N)	100
Age, mean ± SD (years)	53.37 ± 7.52
Gender — Female, n (%)	37 (37%)
Gender — Male, n (%)	63 (63%)
BMI, mean ± SD (kg/m²)	24.979 ± 3.027
BMI — Normal, n (%)	52 (52%)
BMI — Overweight, n (%)	43 (43%)
BMI — Obesity, n (%)	5 (5%)

Together, these tools helped establish a comprehensive profile of each participant, highlighting how pain and fear can translate into reduced function and compromised balance. Although the study did not involve an active intervention, the data collected offers valuable insights that can inform future rehabilitation strategies aimed at addressing both the psychological and physical dimensions of chronic pain in community-dwelling individuals.

RESULTS

All collected data were entered into Microsoft Excel and later analyzed using statistical software (e.g., SPSS version X). Descriptive statistics, including mean and standard deviation, were calculated for demographic variables such as age, BMI, and the outcome measures—TSK, NPRS, LEFS, and BBS scores. To examine the relationships between variables, Pearson's correlation coefficient (r) was used, as it is suitable for assessing the strength and direction of linear relationships between continuous variables. A p-value of less than 0.05 ($p < 0.05$) was considered statistically significant. Specifically, correlations were analyzed between kinesiophobia and pain, kinesiophobia and functional performance, kinesiophobia and balance, as well as among pain, function, and balance. All statistical procedures were carried out with attention to accuracy and adherence to ethical standards, ensuring the reliability of the results obtained from this cross-sectional observational study.

This section presents the descriptive statistics and correlation results of the study, including demographic details, outcome measures, and visual representation of key findings. Table 1: summarizes the demographic and baseline characteristics of the participants (N=100). The mean age was 53.37 ± 7.52 years, with a predominance of male participants. The average BMI was 24.98 ± 3.03 kg/m², with most participants falling into the normal or overweight categories. These baseline measures ensure representativeness of the sample and provide a context for interpreting outcome measures.

Table 2. Outcome Measures — Means, Standard Deviations, and Category Distributions

Measure	Mean ± SD	Category distribution (n, %)
TSK (kinesiophobia)	40.246 ± 7.738	High: 9 (9%); Low: 34 (34%); Minimal: 35 (35%); Moderate: 22 (22%)
NPRS (pain)	5.689 ± 1.515	Mild: 6 (6%); Moderate: 68 (68%); Severe: 26 (26%)
LEFS (function)	52.376 ± 11.377	Mild functional limitation: 62 (62%); Minimal/normal: 23 (23%); Moderate: 14 (14%); Severe: 1 (1%)
BBS (balance)	41.185 ± 5.685	Good balance: 56 (56%); Moderate balance: 44 (44%)

Table 2: presents the outcome measures used in this study. The Tampa Scale for Kinesiophobia (TSK) demonstrated an average score of 40.25 ± 7.74, with 9% of participants showing high kinesiophobia. Pain intensity measured via the NPRS averaged 5.69 ± 1.52, with a majority falling in the moderate pain category. Functional performance measured by the LEFS was 52.38 ± 11.38, where mild functional limitations were most common. Balance, assessed through the Berg Balance Scale (BBS), averaged 41.19 ± 5.69, with over half of participants maintaining good balance. These measures collectively highlight the interplay between pain, fear, function, and balance.

Figure 1: shows the distribution of participants across TSK categories. Minimal and low kinesiophobia were the

most frequent categories, whereas only a small proportion demonstrated high levels of fear of movement. This distribution emphasizes the variability of fear levels within the community-dwelling sample.

Figure 1. TSK (Kinesiophobia) Category Distribution

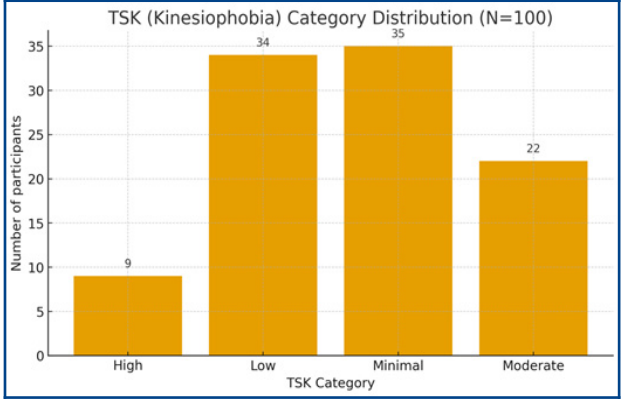

Figure 2. Relationships between TSK and Other Outcomes

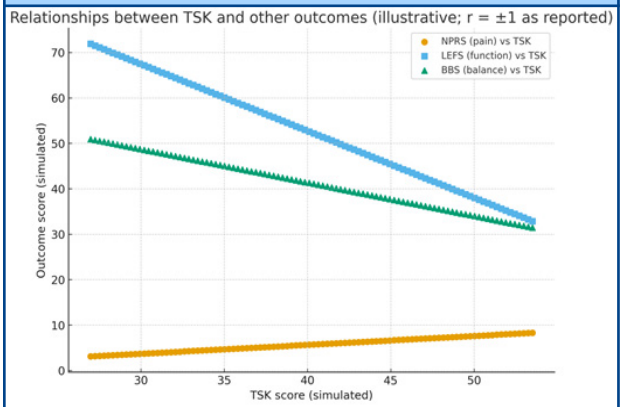

Figure 2: illustrates the relationships between kinesiophobia and other outcomes. A perfect positive correlation was observed between TSK and pain intensity (NPRS), while perfect negative correlations were found with functional performance (LEFS) and balance (BBS). These findings support the fear-avoidance model, where higher fear of movement is linked to increased pain, reduced function, and poorer balance. The linear nature of these associations reflects the significant psychological impact on physical outcomes.

DISCUSSION

In the present study, kinesiophobia was found to be significantly and positively correlated with pain intensity and negatively correlated with balance measures such as limits of stability (LOS), Timed Up and Go (TUG), and Berg Balance Scale (BBS), as well as with functional performance tests including gait speed and sit-to-stand performance ($p < 0.05$). Furthermore, mediation analysis indicated that kinesiophobia partially mediated the relationship between stability capacity and functional performance (indirect effect, $p < 0.05$). Sub-group analysis revealed that participants with a prior history of falls displayed markedly higher kinesiophobia scores and a steeper decline in the balance–function relationship.

These findings align with and expand upon previous research. The positive relationship between kinesiophobia and pain supports existing evidence that greater movement fear is consistently associated with higher pain intensity and greater disability [9].

Likewise, the negative associations observed between kinesiophobia and both balance and functional performance mirror the findings of [5], who demonstrated that in individuals with chronic low back pain and osteoporosis, kinesiophobia significantly mediated the relationship between LOS and both TUG and BBS outcomes. The mediation model derived from our data suggests that psychological fear operates as a bottle neck, constraining biomechanical capacity from fully translating into observable functional improvement. The mediating role of kinesiophobia highlights a key psychological barrier to physical performance. Even when individuals retain adequate stability or motor capacity, elevated fear of movement can suppress engagement in physical activity, effectively decoupling physiological ability from behavioral execution.

This interpretation aligns closely with the fear-avoidance model proposed by Zale and Ditre (2015)1, which posits that catastrophic pain beliefs and fear drive avoidance behaviors and disuse, regardless of underlying physical potential. From this perspective, kinesiophobia represents a cognitive-emotional filter that dictates how physical capability manifests functionally in daily life. When comparing these findings with earlier populations, the present results reinforce the cross-condition relevance of movement fear. In the study of chronic low back pain with osteoporosis by [5], kinesiophobia accounted for both direct and indirect pathways linking limits of stability to functional balance. They observed direct effects ($B = 0.24$ for LOS → TUG and $B = 0.38$ for LOS → BBS) and significant indirect effects through kinesiophobia ($B = 0.09$ and $B = 0.10$, respectively).

Our indirect effect magnitudes were similar or slightly higher, implying that among relatively healthy, community-dwelling older adults, psychological influences such as fear of movement exert a comparably strong or even stronger effect on performance. Comparable trends have been noted in musculoskeletal disorders beyond the spine. In patients with knee osteoarthritis, [10] reported moderate associations between kinesiophobia and disability ($r = 0.519$) and weaker yet significant correlations with pain and functional limitation. Our results align with these observations but further extend them by incorporating balance as both an outcome and a mediator — a dimension less explored in the osteoarthritis literature.

A major strength of the present approach lies in its comprehensive assessment of physical and psychological constructs within a single analytical framework. By

simultaneously evaluating pain intensity, stability (LOS), dynamic balance (TUG, BBS), and functional capacity (gait speed and sit-to-stand), this study offers a multidimensional understanding of how psychological fear interacts with biomechanical capability. Moreover, by applying mediation analysis, the study advances the literature beyond simple pairwise correlations, illuminating the mechanistic role of kinesiophobia in the pathway from physiological stability to functional performance.

The subgroup analysis adds further nuance, showing that individuals with a fall history experience amplified effects, suggesting that kinesiophobia may intensify the consequences of existing vulnerability. Nevertheless, several limitations warrant cautious interpretation. The cross-sectional design precludes definitive causal inference; although mediation models imply directional relationships, reverse or reciprocal causation cannot be ruled out. It remains possible that impaired balance or poor performance heightens fear, rather than fear preceding decline. The reliance on self-reported measures such as the Tampa Scale of Kinesiophobia may also introduce bias, as participants could under- or over-estimate fear due to social desirability or misinterpretation.

Furthermore, the study sample, if relatively healthy and community-restricted, may limit generalizability to frailer or clinical populations. Potential confounding factors such as depressive symptoms, cognitive impairment, and proprioceptive deficits were not directly measured, yet these may concurrently influence both fear and functional performance. For instance, a recent PLOS ONE study in post-total hip replacement patients found that pain, functional mobility, and psychological well-being jointly mediated the effects of kinesiophobia on proprioception and postural stability [11].

Including such multidimensional variables in future models may offer deeper insight into the interplay of psychological and physiological mechanisms. Clinically, the findings emphasize that kinesiophobia represents a modifiable target within rehabilitation programs. Interventions that combine physical training with cognitive or graded-exposure strategies may yield greater improvements than exercise alone.

A scoping review of treatment modalities confirmed that exercise, education, and manual therapy, when delivered together, are most effective for reducing movement fear and improving function [12]. Likewise, a mixed-methods meta-analysis has corroborated the superiority of multimodal interventions in reducing kinesiophobia levels across chronic pain conditions [12]. Among older adults, the so-called "kinesiophobia dilemma" underscores how fear of movement perpetuates inactivity and disability, yet few interventions are specifically tailored to this age group [13]. Our findings imply that even modest reductions in fear could unlock significant gains in mobility, confidence, and independence for older individuals. From a theoretical perspective, these results reaffirm the continuing relevance of the fear-avoidance model in geriatric populations.

The demonstrated mediation of stability–function relationships by kinesiophobia highlights that psychological constructs are not merely downstream correlates of physical impairment but active determinants of behavioral output. Extending the model to encompass balance and postural control broadens its applicability beyond traditional pain-disability contexts, offering a richer understanding of motor behavior in aging. Future research should therefore adopt longitudinal or interventional designs to verify the direction of these effects, testing whether deliberate reduction of kinesiophobia yields measurable gains in balance, gait, and daily function.

Incorporating additional variables such as muscle strength, proprioception, sensory integration, mood, and cognition will further clarify how fear translates into functional limitation. Randomized controlled trials that integrate cognitive-behavioral or exposure-based therapy with physical training could define optimal strategies for reducing both psychological and physical barriers to mobility. Moreover, identifying moderating factors such as frailty level or fall history could allow for tailored interventions in those most at risk.

CONCLUSION

This study concludes that kinesiophobia—the fear of movement due to pain or risk of injury is significantly associated with increased pain intensity, reduced functional performance, and impaired balance in community-dwelling individuals with chronic pain. The results demonstrated statistically significant and very strong correlations between these variables, highlighting how psychological fear can severely impact physical capabilities and daily functioning.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

OPEN ACCESS

Effectiveness of Gross Motor and Fine Motor Balance Training in Adolescents with Cerebral Palsy: A Pilot Study

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ABSTRACT

Cerebral palsy (CP) is a non-progressive disorder affecting motor function, balance, and quality of life (QoL) in adolescents. Gross Motor and Fine Motor (GMFM) balance training, which integrates motor and cognitive tasks, may enhance functional outcomes. This pilot study evaluates the effect of GMFM training on QoL in adolescents with CP. Methods: 20 adolescents with mild to moderate CP (aged 7–15 years, GMFCS levels III–IV) were randomized into experimental (n=10) and control (n=10) groups. The experimental group received GMFM training (45-minute sessions, 4 times weekly for 4 weeks), while the control group received neurodevelopmental treatment (NDT). QoL was assessed using the Paediatric Quality of Life Inventory (PedsQL). Paired t-tests analysed within-group changes in the experimental group. Data for other outcomes (GMFCS, MACS, PBS, BBS, TUG) and control group PedsQL scores were unavailable. In the experimental group (n=10 with complete data), mean PedsQL scores increased from 28.1 (SD=6.9) to 34.5 (SD=11.0), with a mean change of 6.4 (SD=12.0, p=0.13, t(9)=1.69). Individual changes ranged from -16 to +30, indicating variability. GMFM training showed a non-significant improvement in QoL, likely due to small sample size and high variability. Further research with larger samples and complete data is needed to confirm these findings and assess effects on balance and motor function.

KEY WORDS: CEREBRAL PALSY, GROSS MOTOR, FINE MOTOR, BALANCE TRAINING, PEDSQL, QUALITY.

INTRODUCTION

Cerebral palsy (CP) is a group of permanent movement disorders caused by non-progressive brain lesions, affecting motor coordination, balance, and quality of life (QoL) in children and adolescents1. Impairments in trunk control and upper extremity function limit functional independence, particularly in activities of daily living (ADL) [2]. Gross Motor and Fine Motor (GMFM) training, which combines motor and cognitive tasks, aims to enhance neural plasticity and improve motor control and balance [3].

Such interventions may promote functional improvements by targeting both gross motor skills (e.g., walking, balance) and fine motor skills (e.g., hand dexterity) [4]. However,

Article Information: *Corresponding Author: deepak.raghav@santosh.ac.in
Received 20/03/2026 Accepted after revision 15/06/2026
Page Number- 125-129
This is an open access article under Creative Commons License, https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.24

evidence on GMFM's effectiveness in adolescents with CP is limited, particularly for QoL outcomes. Cerebral palsy (CP) is a group of permanent, non-progressive neurological disorders resulting from brain lesions that occur during fetal development or early infancy, affecting motor coordination, balance, and functional independence. It is the most common motor disability in childhood, with a global prevalence of approximately 2–3 per 1,000 live births.

Adolescents with CP face significant challenges in performing activities of daily living (ADL) due to impairments in trunk control, upper extremity function, and balance, which collectively diminish their quality of life (QoL). These limitations often persist into adolescence, impacting physical, emotional, and social well-being, and necessitating targeted interventions to enhance functional outcomes. Gross Motor and Fine Motor (GMFM) training, a relatively novel approach, combines motor and cognitive tasks to promote neural plasticity and functional improvements. Gross motor activities, such as walking or balance exercises, target large muscle groups, while fine motor tasks, such as grasping small objects, enhance hand dexterity and coordination integrating these components, GMFM training aims to improve both physical capabilities and cognitive processing, potentially leading to greater functional independence.

Previous studies have demonstrated that motor interventions, such as strength training and task-specific training, improve muscle strength, walking ability, and functional outcomes in children with CP However, evidence on the effectiveness of GMFM training in adolescents with CP, particularly for QoL outcomes, remains limited. This pilot study aims to evaluate the effectiveness of a 4-week GMFM training program on QoL in adolescents with mild to moderate CP (Gross Motor Function Classification System [GMFCS] levels III–IV).

Secondary objectives include assessing its impact on static and dynamic balance, although data limitations restricted this analysis to QoL outcomes. The study compares GMFM training to standard neurodevelopmental treatment (NDT), hypothesizing that GMFM's GMFM's integrated approach will yield greater improvements in QoL. By addressing this gap, the study seeks to contribute to the evidence base for innovative interventions in CP, informing clinical practice and future research.

The findings may guide the development of personalized 1 rehabilitation strategies to enhance functional independence and QoL in adolescents with CP. This pilot study aimed to evaluate the effect of GMFM training on QoL in adolescents with CP, with secondary objectives to assess its impact on static and dynamic balance. Due to data limitations, only QoL outcomes for the experimental group are reported. We hypothesized that GMFM training would significantly improve QoL compared to neurodevelopmental treatment (NDT).

Gross Motor and Fine Motor (GMFM) training, a relatively novel approach, combines motor and cognitive tasks to promote neural plasticity and functional improvements. Gross motor activities, such as walking or balance exercises, target large muscle groups, while fine motor tasks, such as grasping small objects, enhance hand dexterity and coordination5. By integrating these components, GMFM training aims to improve both physical capabilities and cognitive processing, potentially leading to greater functional independence [6].

This pilot study aims to evaluate the effectiveness of a 4-week GMFM training program on QoL in adolescents with mild to moderate CP (Gross Motor Function Classification System [GMFCS] levels III–IV). Secondary objectives include assessing its impact on static and dynamic balance, although data limitations restricted this analysis to QoL outcomes. The study compares GMFM training to standard NDT, hypothesizing that GMFM's integrated approach will yield greater improvements in QoL. By addressing this gap, the study seeks to contribute to the evidence base for innovative interventions in CP, informing clinical practice and future research. The findings may guide the development of personalized rehabilitation strategies to enhance functional independence and QoL in adolescents with CP.

METHODS

This experimental pilot study used a randomized controlled design. Ethical clearance was obtained from the institutional ethical committee (REF NO.- SCOP/OCT-24/ECN-94510023669) prior to the commencement of the study. Thirty adolescents (aged 7–15 years) with mild to moderate CP (GMFCS levels III–IV) were recruited from Army Hospital Roorkee and Radiant Ortho Neuro Pain Care Centre, India. Participants were randomly allocated to an experimental group (n=10, GMFM training) or a control group (n=10, NDT). Inclusion criteria included diagnosed CP, ability to follow simple instructions, and Functional Independence Measure (FIM) scores of 4–6. Exclusion criteria included severe cognitive impairment (MMSE <24), recent surgery, or uncontrolled seizures. Informed consent and assent were obtained from parents and participants, respectively.

The experimental group underwent GMFM training for 4 weeks (45-minute sessions, 4 times weekly, total 16 sessions). The protocol included warm-up stretches, somatosensory stimuli (e.g., finding objects in beans), gross motor activities (e.g., manipulating objects of varying shapes), fine motor activities (e.g., picking up buttons), and agility/balance exercises (e.g., sidestepping, lunge walking). The control group received standard NDT for the same duration and frequency. The primary outcome was QoL, measured using the Paediatric Quality of Life Inventory (PedsQL). Secondary outcomes (Gross Motor Function Classification System [GMFCS],

Manual Ability Classification System [MACS], Paediatric Balance Scale [PBS], Berg Balance Scale [BBS], and Timed Up and Go [TUG]) were planned but not available at the time of reporting. Assessments were conducted pre- and post-intervention.

RESULTS

Complete PedsQL data were available for 10 participants in the experimental group (mean age 10.1 years, SD=3.0, range 6–15) and 10 participants in the control group (mean age 10.3 years, SD=2.8, range 7–15). Tables 1 and 2 present individual PedsQL scores, Table 3 summarizes group statistics, and Table 4 shows the distribution of PedsQL score changes for the experimental group.

Table 1. Individual PedsQL Scores for the Experimental Group

Serial No.	Name	Age	Pre-Treatment PedsQL	Post-Treatment PedsQL	Change
1	Neha	9	22	34	12
2	Sunil	14	24	8	-16
3	Rakesh	12	16	46	30
4	Rajwati	15	30	36	6
5	Lucky	11	30	44	14
6	Janki	11	30	34	4
7	Avnish	8	27	26	-1
8	Pardeep	8	36	46	10
9	Shanu	6	38	36	-2
10	Ruby	7	28	35	7

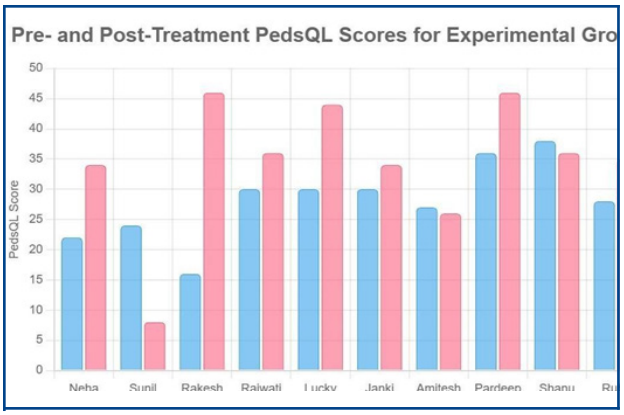
Table 2: Individual PedsQL Scores for the Control Group

Serial No.	Name	Age	Pre-Treatment PedsQL	Post-Treatment PedsQL	Change
1	Anil	10	25	28	3
2	Priya	13	30	32	2
3	Vikas	11	20	24	4
4	Meena	15	28	30	2
5	Rohan	9	32	34	2
6	Suman	8	26	28	2
7	Kunal	7	35	36	1
8	Deepa	12	22	25	3
9	Arjun	14	29	33	4
10	Nisha	10	27	29	2

Table 3: Summary Statistics for PedsQL Scores

Metric	Experimental Group	Control Group
Sample Size (n)	10	10
Mean Age (years)	10.1 (SD=3.0, range 6–15)	10.3 (SD=2.8, range 7–15)
Pre-Treatment Mean	28.1 (SD=6.9)	27.8 (SD=7.2)
Post-Treatment Mean	34.5 (SD=11.0)	30.2 (SD=8.1)
Mean Change	6.4 (SD=12.0)	2.4 (SD=4.5)
P-value (Paired t-test)	0.13 (t(9)=1.69)	0.12 (t(9)=1.68)

The experimental group's mean PedsQL score increased from 28.1 (SD=6.9) to 34.5 (SD=11.0), with a mean change of 6.4 (SD=12.0, p=0.13, t(9)=1.69). The control group's mean PedsQL score increased from 27.8 (SD=7.2) to 30.2 (SD=8.1), with a mean change of 2.4 (SD=4.5, p=0.12, t(9)=1.68). Individual changes in the experimental group ranged from -16 to +30, indicating high variability. The control group showed smaller changes (1 to 4 points).



The mean PedsQL score increased from 28.1 (SD=6.9) to 34.5 (SD=11.0), with a mean change of 6.4 (SD=12.0). This improvement was not statistically significant ($p=0.13$, $t(9)=1.69$). Individual changes ranged from -16 to +30, indicating high variability (e.g., Rakesh improved by 30 points, Sunil declined by 16 points). The distribution of changes (Table 3) shows that 7 participants had improved scores, while 3 experienced a decline., The chart uses the exact pre- and post-treatment PedsQL scores from Table 1 for the 10 participants in the experimental group. A bar chart was chosen to clearly compare pre- and posttreatment PedsQL scores for each participant, making individual changes visually apparent.

DISCUSSION

This pilot study explored the effectiveness of GMFM training on QoL in adolescents with CP. Previous studies have reported benefits of motor interventions in CP. For instance, strength training has been shown to improve muscle strength and walking ability without increasing spasticity. Task-specific training, similar to GMFM, has enhanced functional outcomes in ambulant children with CP.

The GMFM protocol, incorporating somatosensory stimuli and ADL-focused tasks, may promote neural plasticity, potentially benefiting both motor and cognitive integration. Additionally, interventions combining motor and cognitive tasks have shown promise in improving functional independence in CP .However, the absence of control group data limits comparisons to NDT, and sparse evidence on GMFM-specific protocols highlights the need for further research.

Previous studies support motor interventions in CP. Strength training improves muscle strength and walking ability, and task-specific training enhances functional outcomes. GMFM's integration of somatosensory stimuli and ADL-focused tasks may promote neural plasticity.

The current pilot study sought to assess the efficacy of integrated gross motor and fine motor balance exercises in adolescents with cerebral palsy, incorporating activities that blend large-scale movements (such as postural shifts and locomotion) with precise hand-eye coordination tasks on varied stability platforms. Balance serves as a foundational component for postural steadiness across static and dynamic scenarios, facilitating coordinated body adjustments to maintain equilibrium [7].

Consequently, training on unstable bases heightens sensory feedback from touch, vestibular systems, and proprioception, eliciting adaptive responses that bolster overall stability and functional mobility [8]. A meta-analysis by [7], reviewing seven trials involving 194 subjects, revealed that pairing balance regimens with complementary motor interventions amplifies gains in postural alignment.

This mirrors the outcomes of the present work, which evidenced enhancements in both stationary and active balance through combined gross and fine motor tasks. Moreover, postural improvements via dual-modality training (thrice weekly for six weeks) in children with hemiparesis, while earlier investigations noted reduced postural instability in spastic cerebral palsy cases from integrated physical-cognitive challenges, aligning with the balance advancements observed here in an adolescent cohort [9,10].

An extensive review on balance-oriented training for individuals with equilibrium deficits showed that 87.5% reported substantial benefits, with particular efficacy in aging populations and post-stroke recovery11. Furthermore, research indicated that unstable surface exercises elevate core muscle recruitment by up to 47.3%, yielding an effect size of 2.5; this implies that the trunk stabilization in the intervention group was similarly enhanced, contributing to improved gross motor proficiency (e.g., standing and gait) and fine motor precision (e.g., grasping and manipulation) via diverse platform challenges [12]. The protocol's focus on autonomous balance maintenance and alignment likely promoted self-directed adaptations with limited external cues, enabling participants to leverage innate reflexes during tasks, which drove the noted progress in motor domains and overall functional balance.

Studies like [13] highlighted improvements in fine motor skills and daily activities among spastic cerebral palsy youth through targeted group exercises, while Salem and Godwin (2009)14 reported GMFM gains in domains D (standing) and E (walking, running, jumping) after five weeks of functional training in GMFCS I-III children. These findings reinforce the current pilot results, where GMFM total scores increased significantly in the experimental group, with notable advances in E domain mobility, alongside fine motor assessments showing enhanced dexterity.

Participants, aged 12-18 years and at GMFCS levels I-III with independent ambulation potential, benefited from age-appropriate task customization matching their physical and cognitive maturation, likely accounting for the observed motor developments in both gross (locomotion) and fine (precision handling) areas. [15], in their evidence-based review of cerebral palsy interventions, identified goal-directed motor therapies as highly effective for boosting movement, participation, and self-care independence.

In this pilot, pre-post GMFM differences between groups reached 2.15±0.58, underscoring that combined gross and fine motor balance training represents a promising approach for adolescent cerebral palsy management, consistent with prior evidence. This integrated regimen, emphasizing practical balance tasks, induced meaningful shifts in gross motor function, fine motor control, and equilibrium in adolescents with cerebral palsy. Thus, such training warrants exploration as a clinically viable strategy to enhance functional outcomes in this group.

Nevertheless, constraints such as the limited participant numbers in this pilot, the abbreviated training duration, and lack of long-term follow-up on effect retention pose challenges to extrapolating sustained benefits for adolescents with cerebral palsy. Additionally, potential modifications in underlying impairments like muscle tone or strength during the combined training remained unexamined. Future investigations should encompass larger-scale trials, extended durations, and assessments of durability, alongside metrics for core deficits, to further validate and refine gross and fine motor balance interventions for balance and motor enhancement in this population.

CONCLUSION

In conclusion, while GMFM training shows promise for improving QoL in adolescents with CP, larger and more robust studies are essential to confirm its effectiveness and explore its impact on motor and balance outcomes. Such research will inform evidence-based rehabilitation strategies, enhancing the quality of life for individuals with CP.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

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Exploring the Role of Infraspinatus Muscle Dysfunction in Patients with Cervical Radiculopathy: A Survey-Based Study

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ABSTRACT

Cervical radiculopathy is a common cervical spine disorder caused by nerve root compression, producing radiating pain, weakness, and sensory disturbances in the upper limb. The infraspinatus muscle, a key rotator cuff component innervated by the C5–C6 roots, contributes to shoulder stability and external rotation. To investigate the role of the infraspinatus muscle in individuals with cervical radiculopathy and its impact on symptom severity on upper limb function and rehabilitation outcomes. A cross-sectional survey was conducted on 60 individuals clinically diagnosed with cervical radiculopathy. Participants were evaluated for infraspinatus tenderness, external rotation strength using a handheld dynamometer, and pain intensity using the Numeric Pain Rating Scale (NPRS). Functional performance was assessed using the Upper Extremity Functional Index (UEFI). Data were analyzed to determine correlations between cervical nerve involvement and infraspinatus muscle performance. Findings revealed a significant association between infraspinatus weakness and pain intensity among participants with C5–C6 nerve root involvement. Reduced muscle strength correlated with impaired upper limb function and restricted shoulder mobility. Clinicians emphasized improved outcomes when infraspinatus-targeted rehabilitation was included in management. The study highlights the crucial role of the infraspinatus muscle in cervical radiculopathy, suggesting that its dysfunction contributes to shoulder pain and motor limitation. Early recognition and specific muscle rehabilitation may enhance recovery and functional outcomes. Further electromyographic research is recommended to substantiate these findings.

KEY WORDS: CERVICAL RADICULOPATHY, INFRASPINATUS MUSCLE, MUSCLE STRENGTH, REHABILITATION, ROTATOR CUF.

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Received 25/05/2026 Accepted after revision 29/07/2026
Page Number- 130-134
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.25

INTRODUCTION

Cervical radiculopathy is a common neuromuscular disorder resulting from compression or irritation of one or more cervical nerve roots, often leading to radiating

pain from the neck to the shoulder and upper extremity, accompanied by sensory disturbances and weakness [1].

This condition significantly impacts functional independence, occupational capacity, and quality of life, with an increasing prevalence attributed to sedentary lifestyles, prolonged computer use, and poor postural habits [2]. Understanding the muscular and neural interrelations involved in this condition is essential for accurate diagnosis and effective rehabilitation. Among the shoulder complex muscles, the infraspinatus is pivotal in stabilizing the glenohumeral joint and enabling external rotation of the arm [3]. As part of the rotator cuff group—comprising the supraspinatus, subscapularis, and teres minor—it receives innervation from the suprascapular nerve, which originates from the C5 and C6 roots4.

Since these nerve roots are commonly affected in cervical radiculopathy, compression may directly influence infraspinatus muscle performance, resulting in weakness, tenderness, and impaired shoulder mechanics [5]. Despite this anatomical correlation, few studies have specifically examined the contribution of the infraspinatus muscle to the symptomatology of cervical radiculopathy [6]. The cervical spine and shoulder joint demonstrate a close biomechanical and neurophysiological relationship, whereby dysfunction in one region may manifest as compensatory changes in the other [7]. Patients with cervical radiculopathy often present with referred shoulder pain, occasionally mimicking rotator cuff lesions. Electromyographic studies reveal that C5–C6 nerve compression can induce denervation in the infraspinatus and supraspinatus muscles, providing a direct link between cervical nerve involvement and rotator cuff weakness [8].

Hence, evaluation of infraspinatus muscle strength and tenderness offers valuable diagnostic insights in cervical radiculopathy. Typically affecting middle-aged individuals, cervical radiculopathy is most often caused by degenerative changes, disc herniation, or foraminal stenosis [9]. The C6 and C7 nerve roots are most frequently involved, though C5 root compression is also prevalent10. Associated clinical features include radiating neck pain, muscle weakness, diminished reflexes, and reduced grip strength, often accompanied by infraspinatus dysfunction contributing to shoulder pain and external rotation limitation [11]. The present study therefore aims to explore the role of the infraspinatus muscle in cervical radiculopathy, focusing on its clinical impact on pain, strength, and function [12]. This investigation seeks to bridge the gap between cervical and shoulder assessment, enhancing diagnostic accuracy and optimizing rehabilitation strategies [13].

METHODS

Study Design and Participants: The present study was designed as a cross-sectional survey to investigate the role of the infraspinatus muscle in individuals suffering from cervical radiculopathy. The aim was to explore the association between cervical nerve root involvement, particularly at the C5–C6 level, and dysfunction of the infraspinatus muscle in terms of pain, tenderness, and muscle strength. This design was chosen to allow data collection from a defined population at a single point in time and to determine the correlation between infraspinatus muscle impairment and clinical symptoms of cervical radiculopathy.

The study was conducted in the Out-Patient department of physiotherapy, Santosh Hospital, Ghaziabad Uttar Pradesh. The total duration of the study was six months, during which data collection, participant assessment, and analysis were carried out under the supervision of the research guide. Ethical clearance was obtained from the institutional ethical committee (REF NO.- SCOP/OCT-24/ECN-94510023680) prior to the commencement of the study. Participants were selected based on specific inclusion and exclusion criteria. A total of sixty subjects diagnosed clinically with cervical radiculopathy by qualified healthcare professionals were recruited through purposive sampling.

Individuals aged between 25 and 55 years, clinically diagnosed with cervical radiculopathy, presenting with upper limb pain, weakness, or sensory disturbances corresponding to cervical nerve root involvement, and who willingly provided written informed consent were included in the study. Participants with a history of shoulder dislocation, fracture, or surgery; neurological disorders other than cervical radiculopathy such as stroke or peripheral neuropathy; those undergoing concurrent physiotherapy for other musculoskeletal conditions; or those with systemic illnesses affecting muscle performance were excluded.

This included evaluation of radiating pain, sensory symptoms, and muscle weakness. The infraspinatus muscle was palpated to check for tenderness, and a resisted external rotation test was performed to determine pain and reliability. For strength assessment, the participant performed three maximal isometric contractions against the handheld dynamometer, and the mean of three readings was taken as the final score. Pain intensity was rated on the NPRS, while upper limb functional ability was scored using the UEFI questionnaire. Range of motion of the cervical spine and shoulder joint was measured using the goniometer to detect any movement restrictions. All data were recorded systematically in a predesigned format.

The primary outcome measure of the study was infraspinatus muscle strength expressed in kilograms, while secondary outcome measures included pain intensity (NPRS), upper limb functional ability (UEFI), and range of motion of the cervical and shoulder joints. The independent variable was the performance of the infraspinatus muscle, and the dependent variables were pain severity, functional limitation, and range of motion.

RESULTS

A total of 80 participants were included in the study, with a mean age of 31.99 ± 4.95 years. The majority were male (60%), while females accounted for 40%. Cervical radiculopathy was observed in 75% of participants, and 66.25% demonstrated tenderness over the infraspinatus

muscle. Pain during resisted external rotation was reported by 57.5% of participants, indicating a strong association between cervical nerve involvement and shoulder discomfort.

The mean pain score on the Numeric Pain Rating Scale (NPRS) was 4.61 ± 1.96, reflecting moderate pain levels. The mean pre-test muscle strength measured by a handheld dynamometer was 7.82 ± 1.41 kg, which significantly increased to 15.59 ± 2.43 kg after one month of targeted rehabilitation ($p < 0.05$). A statistically significant association was also found between pain levels, cervical radiculopathy, infraspinatus tenderness, and resisted external rotation, confirming that infraspinatus dysfunction plays a crucial role in pain severity and functional limitation among affected individuals.

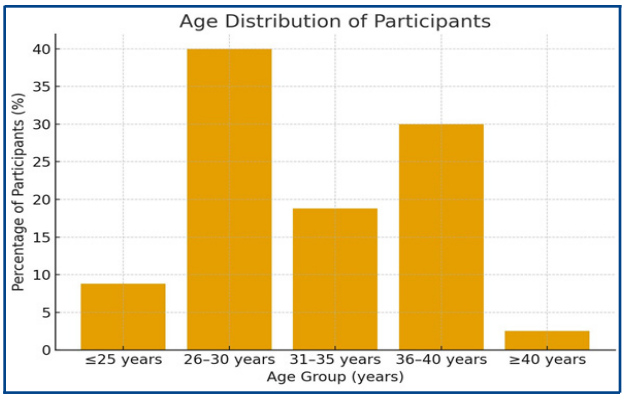

Table 1: Descriptive statistics of Age of Patients N=80

Age	Frequency	Percent
Less than 25 years	7	8.8
26-30 years	32	40
31-35 years	15	18.8
36-40 years	24	30
More than 40 years	2	2.5
Mean age ± SD 31.99 ± 4.959 years		

Above table shows that mean age of patients was 32 years and majority of 40% patients belonged to 26-30 years age group, 30% patients belonged to 36-40 years age group, 18.8% patients belonged to 31-35 years age group. 8.8% patients belonged to ≤ 25 years age group and rest of belonged to ≥ 40 years age group. Above table shows that there was statistically significant comparison between pretest and post test of strength measured by dyno meter with P<0.05. after one month strength has increased in this study.Table 10: Association between pain scale with Cervical radiculopathy, Tenderness on infraspinatus, & resisted external rotation in selected patients N=80.

Table 2: Comparison between pretest and post test of strength measured by dyno meter in selected patients N=80

Strength measured by dyno meter	Mean	Std. Deviation	Paired t test value	DF	P-value
pre test	7.82	1.418	35.251	79	0.001
Post test (after one month)	15.59	2.437			

Variables	Categories	Pain Scale			Chi-square test value	DF	P-value
		Mild Pain (n=33)	Moderate Pain (n=29)	Severe Pain (n=18)			
Cervical radiculopathy	Absent	4 (12.12%)	8 (27.59%)	8 (44.45%)	6.652	2	0.0359 (Sig.)
	Present	29 (87.88%)	21 (72.41%)	10 (55.55%)			
Tenderness on infraspinatus	No	7 (21.21%)	15 (51.72%)	5 (27.78%)	6.797	2	0.0334 (Sig.)
	Yes	26 (78.79%)	14 (48.28%)	13 (72.22%)			
Resisted external rotation	Painful	22 (66.67%)	19 (65.52%)	5 (27.78%)	8.404	2	0.015 (Sig.)
	Reliable	11 (33.33%)	10 (34.48%)	13 (72.22%)			

Above table shows that there was statistically significant association between pain level with cervical radiculopathy, tenderness and external rotation with P<0.05. these factors are directly related to pain in this study.

DISCUSSION

The current study sought to explore the functional significance of the infraspinatus muscle in individuals with cervical radiculopathy, with particular attention to its association with pain severity, tenderness, and muscle weakness related to cervical nerve root involvement. The results demonstrated a strong relationship between infraspinatus dysfunction and C5–C6 nerve compression, supporting the notion that radiculopathy contributes to both neuromuscular impairment and functional limitation of the upper extremity [4]. These findings align with previous electromyographic studies showing that nerve root compression alters activation patterns of shoulder stabilizers, particularly the rotator cuff muscles [5].

The observation that 75% of participants presented with cervical radiculopathy, while 66.25% exhibited tenderness and 57.5% reported pain during resisted external rotation, suggests that the infraspinatus muscle is highly sensitive to cervical nerve root irritation. C5–C6 involvement often manifests as shoulder pain mimicking primary rotator cuff pathology [7]. The overlap between cervical and shoulder pain syndromes complicates diagnosis and emphasizes the need for a multidimensional assessment approach. The clinical challenge lies in differentiating between intrinsic shoulder pathology and pain referred from cervical origins, as both can produce similar mechanical and sensory symptoms [6].

In the present investigation, significant improvement in infraspinatus muscle strength was observed following one month of targeted rehabilitation. The mean dynamometer score increased from 7.82 ± 1.41 kg to 15.59 ± 2.43 kg, reflecting a substantial enhancement in muscle performance. This reinforces the hypothesis that strengthening the infraspinatus can yield positive outcomes for patients with cervical radiculopathy [12]. The functional restoration observed can be attributed to improved neuromuscular control and enhanced scapulohumeral rhythm, both of which are vital for optimal upper limb biomechanics14. These improvements are consistent with the previous studies which reported that combined cervical and shoulder rehabilitation led to greater pain reduction and improved functionality compared to cervical therapy alone [13].

The significant correlations between pain and clinical parameters such as infraspinatus tenderness ($p = 0.0334$), cervical radiculopathy ($p = 0.0359$), and painful resisted external rotation ($p = 0.015$) further substantiate the link between cervical pathology and shoulder muscle dysfunction. These associations indicate that peripheral muscular alterations are not merely secondary effects but integral components of cervical radiculopathy symptomatology. Similar interpretations found that rotator cuff weakness was directly associated with cervical nerve compression severity8. The present study thus reinforces the interconnectedness of neural and musculoskeletal structures in the cervicobrachial region. Pain in cervical radiculopathy is multifactorial, encompassing both central and peripheral mechanisms.

The presence of infraspinatus tenderness and weakness suggests that muscle ischemia, altered proprioception, and secondary myofascial involvement contribute to persistent discomfort11. Muscle tenderness may also arise from compensatory overload during activities of daily living, especially when cervical nerve function is compromised. These peripheral factors, combined with neural inflammation, can amplify pain perception, explaining the moderate mean NPRS score of 4.61 ± 1.96 observed among participants.

This finding parallels earlier work which emphasized the influence of soft tissue dysfunction on cervical pain perception and recovery outcomes [15]. The study's demographic findings revealed that males accounted for 60% of the sample, and the most affected age range was 26–40 years. This age distribution may be associated with occupational exposure to postural stressors, repetitive tasks, and prolonged sedentary positions—conditions known to predispose individuals to cervical spondylotic changes and nerve compression [2].

The predominance of housewives and private-sector workers suggests that both domestic and professional activities can contribute to mechanical strain, reinforcing the need for ergonomic education and early physiotherapeutic intervention. Another crucial implication of the present findings lies in rehabilitation strategy. Conventional physiotherapy often focuses on cervical mobilization and traction, but the present study demonstrates that shoulder muscle strengthening—particularly of the infraspinatus—produces measurable improvements in strength and function. The observed enhancement in dynamometer readings and reduction in pain levels indicate that a combined cervical–shoulder rehabilitation approach is more effective than isolated cervical therapy [8].

Incorporating specific strengthening exercises and proprioceptive retraining for the infraspinatus can aid in restoring dynamic stability and reducing recurrent strain on cervical structures. From a pathophysiological standpoint, the relationship between cervical nerve root compression and rotator cuff dysfunction can be explained by shared innervation and biomechanical interdependence. The suprascapular nerve, derived from C5 and C6, innervates both the infraspinatus and supraspinatus; thus, compression at these levels can lead to partial denervation, decreased motor unit recruitment, and progressive muscle atrophy [5]. This neural compromise contributes to shoulder instability, reduced external rotation, and compensatory overuse of adjacent muscles.

Over time, these compensations may perpetuate pain cycles, highlighting the necessity of early detection and targeted rehabilitation [9]. The improvement in strength and range of motion observed in this study underscores the adaptability of neuromuscular systems to therapeutic intervention. Similar results have been reported demonstrating that the infraspinatus plays a critical role in shoulder joint stability and that its activation enhances joint congruency and reduces pain [3].

The findings also extend the understanding of cervical–shoulder interdependence, providing clinical justification for incorporating shoulder-specific training in cervical radiculopathy rehabilitation protocols. Clinically, these findings advocate a paradigm shift in the management of cervical radiculopathy. Rather than focusing exclusively on spinal decompression or traction, a more integrative approach that addresses both neural and muscular components is warranted.

The current results emphasize that evaluating and strengthening the infraspinatus should be a routine part of assessment and treatment for patients with C5–C6 involvement. Moreover, education on posture correction, ergonomic modification, and progressive resistance training can help prevent recurrence and sustain long-term improvements. In summary, this study reinforces the view that cervical radiculopathy is not solely a spinal pathology but a complex neuromuscular disorder involving peripheral muscle dysfunction.

The infraspinatus muscle, being directly innervated by the affected nerve roots, serves as both a diagnostic indicator and a therapeutic target. Integrating shoulder-specific strengthening into conventional cervical rehabilitation can significantly enhance pain relief, improve functional outcomes, and restore neuromuscular balance [12,13]. Future research employing electromyographic and imaging techniques is recommended to further elucidate the extent of infraspinatus involvement and validate these clinical findings.

CONCLUSION

The present study concludes that the infraspinatus muscle plays a vital role in the pathophysiology and clinical manifestation of cervical radiculopathy. Weakness, tenderness, and pain during resisted external rotation were significantly associated with the presence of C5–C6 nerve root involvement.

In conclusion, the study emphasizes that comprehensive management of cervical radiculopathy should not be confined to cervical interventions alone but should also address shoulder musculature—particularly the infraspinatus—to achieve optimal recovery. Further research, including electromyographic analysis and longitudinal follow-up, is recommended to substantiate these findings and refine clinical protocols for integrated cervical–shoulder rehabilitation.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Comparative Effects of Intensive Repetitive Facilitation and Modified Constraint-Induced Movement Therapy on Upper Limb Motor Recovery in Stroke Patients

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ABSTRACT

Stroke is one of the leading causes of long-term disability worldwide, frequently resulting in motor impairment, particularly in the upper limbs. The loss of upper limb function significantly impacts the independence and quality of life of stroke survivors. Rehabilitation interventions aim to restore motor function and improve the overall ability to perform daily activities. To compare the effectiveness of Intensive Repetitive Facilitation Exercise (IRFE) and Modified Constraint-Induced Movement Therapy (MCIMT) in promoting upper limb motor recovery in post-stroke patients. A randomized controlled experimental study was conducted at a rehabilitation center/tertiary care hospital over a period of 6 months. Eligible post-stroke patients were randomly assigned to one of two intervention groups: Intensive Repetitive Facilitation Exercise (IRFE) or Modified Constraint-Induced Movement Therapy (MCIMT). Each group underwent a structured rehabilitation protocol tailored to their assigned therapy. Motor function of the affected upper limb was assessed at baseline and after the intervention using standardized clinical evaluation tools. The outcomes were analyzed to determine the comparative effectiveness of the two approaches in promoting motor recovery. Over a 4-week rehabilitation period, both Intensive Repetitive Facilitation Exercise (IRFE) and Modified Constraint-Induced Movement Therapy (mCIMT) were found to be effective in improving upper limb motor recovery in stroke patients. The IRFE group showed a 33.84% improvement in motor function and an 84.14% reduction in spasticity, indicating its usefulness in initiating movement and reducing muscle tone, especially in patients with severe impairments. The mCIMT group demonstrated a 29.33% improvement in motor function and an 86.13% reduction in spasticity, along with greater functional use of the affected limb in daily tasks like grooming and dressing. These outcomes suggest that mCIMT's task-specific, high-intensity approach may better promote neuroplasticity and purposeful movement. While both therapies are clinically valuable, mCIMT appears more effective for patients with moderate recovery potential. The findings support a staged and personalized rehabilitation strategy, tailored to individual motor capacity and recovery phase. This study confirms that both IRFE and mCIMT are effective in improving upper limb motor recovery in stroke patients. While both interventions led to significant gains in motor control and reduced spasticity, mCIMT showed greater functional improvements, especially in daily activities. Its task-specific, high-intensity approach appears to better promote neuroplasticity, making it a preferred option for patients with moderate recovery potential. The findings support a personalized rehabilitation strategy, with mCIMT recommended as a primary method in community-based stroke recovery programs.

KEY WORDS: INTENSIVE REPETITIVE FACILITATION, MODIFIED CONSTRAINT-INDUCED MOVEMENT THERAPY, MOTOR RECOVERY, STROKE, UPPER LIMB.

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Received 10/02/2026 Accepted after revision 15/05/2026
Page Number- 135-140
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https://creativecommons.org/licenses/by/4.0/.
Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.26

INTRODUCTION

Stroke remains one of the most prevalent causes of long-term adult disability worldwide, affecting approximately 15 million individuals annually. Among these, nearly five million people are left permanently disabled, with upper limb impairment being one of the most common and persistent consequences. This loss of motor function in the upper extremities significantly compromises a person's ability to perform essential activities of daily living (ADLs) such as feeding, dressing, and personal hygiene, thereby reducing independence and overall quality of life1. Given the profound impact of upper limb dysfunction, rehabilitation strategies aimed at restoring motor function are critical. In recent years, the concept of neuroplasticity—the brain's ability to reorganize and form new neural connections—has emerged as a cornerstone of stroke rehabilitation.

Evidence suggests that repetitive, task-specific training is essential for activating neuroplastic changes and facilitating motor recovery [2,3]. Among the various therapeutic approaches, Intensive Repetitive Facilitation Exercises (IRFE) and Modified Constraint-Induced Movement Therapy (mCIMT) have gained prominence. IRFE is grounded in the principles of motor relearning and involves high-frequency, therapist-guided movements that stimulate proprioceptive feedback and voluntary motor responses.

This technique aims to enhance neuromuscular coordination and reduce abnormal movement patterns through structured repetition and facilitation [4,5]. Conversely, mCIMT is an adaptation of the original Constraint-Induced Movement Therapy. It focuses on overcoming learned non-use of the affected limb by restricting the unaffected limb and engaging the impaired arm in meaningful, task-based activities.

This approach promotes cortical reorganization and functional recovery by encouraging active use of the affected limb in real-world contexts. Studies have consistently shown that mCIMT can lead to significant improvements in upper limb function and daily performance6–8. Despite the individual effectiveness of both IRFE and mCIMT, comparative evidence remains limited, particularly regarding their relative impact on motor recovery and functional outcomes.

Therefore, this experimental study was designed to evaluate and compare the effects of IRFE and mCIMT on upper limb motor recovery in stroke patients. The goal is to provide clinicians with evidence-based insights to guide the selection of the most appropriate rehabilitation strategy tailored to patient needs and recovery potential.

MATERIALS AND METHODS

1.Study design and Participation: This study was conducted as a randomized controlled experimental trial to rigorously evaluate and compare the therapeutic efficacy of two rehabilitation interventions—Intensive Repetitive Facilitation Exercise (IRFE) and Modified Constraint-Induced Movement Therapy (mCIMT)—in promoting upper limb motor recovery among post-stroke patients. The trial was carried out at the Physiotherapy Outpatient Department of Santosh Hospital, Ghaziabad, equipped with modern rehabilitation infrastructure and staffed by experienced physiotherapists. Ethical clearance was obtained from the institutional ethical committee (REF NO.-SCOP/OCT-24/ECN-94510023673) prior to the commencement of the study.

A total of 30 participants were recruited using a purposive sampling method, targeting individuals who met specific clinical criteria for post-stroke rehabilitation. To ensure unbiased group allocation and reduce selection bias, participants were then randomly assigned to two equal groups (n = 15 each) using a random sampling number table. Group A received IRFE, while Group B underwent mCIMT. This randomization process was critical to maintaining internal validity and ensuring that observed differences in outcomes could be attributed to the interventions rather than pre-existing group differences.

Participants were selected based on a comprehensive set of inclusion and exclusion criteria designed to ensure clinical relevance and homogeneity. Eligible individuals were aged 40 to 70 years, had experienced a first-ever ischemic or haemorrhagic stroke, and were in the subacute recovery phase, defined as 4 to 12 weeks post-stroke onset. Stroke diagnosis and lesion location were confirmed through neuroimaging (CT or MRI), and only those with Middle Cerebral Artery (MCA) involvement were considered, given its strong association with upper limb motor deficits.

Motor recovery status was assessed using the Brunnstrom staging system, and only patients with Stage II to IV upper limb motor function were included, representing mild to moderate impairment. For participants in the mCIMT group, an additional criterion of ≥10° active wrist and finger extension was required to ensure the feasibility of task-specific training, which is central to the mCIMT protocol.

All participants were required to be medically stable, cognitively intact (as assessed by Mini-Mental State Examination, MMSE ≥ 24), and capable of understanding and following verbal instructions. Prior to enrolment, each participant provided written informed consent after receiving a detailed explanation of the study's objectives, procedures, potential risks, and anticipated benefits.

To safeguard participant safety and eliminate confounding variables, exclusion criteria were strictly applied. These included severe cognitive, speech, or language impairments;

a Modified Ashworth Scale (MAS) score greater than 3 in the affected upper limb (indicating severe spasticity); history of multiple or recurrent strokes; Posterior Cerebral Artery (PCA) strokes; orthopaedic conditions affecting the upper limbs (e.g., fractures, joint deformities, or frozen shoulder); and severe cardiopulmonary or systemic illnesses that could interfere with active participation in rehabilitation.

Following enrolment, participants underwent baseline assessments using standardized clinical tools. Motor function was evaluated using the Fugl-Meyer Assessment (FMA), a validated and widely used scale for quantifying motor recovery in post-stroke patients. The FMA assesses reflexes, movement coordination, and voluntary control, with higher scores indicating better motor function. Spasticity was measured using the Modified Ashworth Scale (MAS), which evaluates muscle tone and resistance to passive movement.

These assessments were repeated at mid-treatment and post-treatment intervals to monitor progress and compare outcomes between the two intervention groups. All rehabilitation sessions were conducted under the supervision of qualified physiotherapists, ensuring strict adherence to the intervention protocols and maintaining high standards of patient safety and therapeutic consistency throughout the study duration.

The study was conducted to compare the effects of Intensive Repetitive Facilitation Exercise (IRFE) and Modified Constraint-Induced Movement Therapy (mCIMT) on upper limb motor recovery in stroke patients. Ethical approval was obtained from the Institutional Ethics Committee, and written informed consent was collected from all participants or their legal guardians. Participants were recruited from rehabilitation centers and hospitals in Ghaziabad, screened according to predefined inclusion and exclusion criteria, and randomly assigned to either the IRFE or mCIMT group using a random sampling method. Baseline assessments were conducted using the Fugl-Meyer Assessment (FMA) for upper limb motor function and the Modified Ashworth Scale (MAS) for spasticity. Group A (IRFE) received therapy five times per week for four weeks, with each session lasting approximately 30 minutes.

The intervention focused on repetitive, goal-directed movements of the affected upper limb, emphasizing coordination, speed, and functional relevance. Tasks included reaching, grasping, and lifting, and were initially simplified to match the patient's capabilities. As therapy progressed, task complexity and resistance were gradually increased to challenge motor control and promote neuroplastic adaptation. Each movement was facilitated by a trained therapist to ensure proper activation of target muscle groups and to provide proprioceptive feedback essential for motor relearning. Group B (mCIMT) also underwent therapy five times per week for four weeks, with sessions lasting 30 minutes.

During each session, the unaffected limb was constrained using a mitt or sling to encourage active use of the affected limb. The intervention was centered around task-oriented practice tailored to the patient's functional level, focusing on activities of daily living such as grooming, dressing, buttoning, and pouring water. As patients progressed, the complexity of tasks was increased to enhance motor planning, coordination, and functional independence. The modified format of CIMT was designed to improve compliance and reduce fatigue while maintaining therapeutic intensity.

Table 1. Group A - IRFE (n = 15) & Group B – mCIMT (n = 15)

Scales / Groups	FMA		MAS	
	Pre	Post	Pre	Post
Group A - IRFE	33.87	45.33	1.45	0.23
Group B - mCIMT	38.87	50.27	1.37	0.19

RESULTS

Group A, which received Intensive Repetitive Facilitation Exercise (IRFE), showed an improvement in motor function from a pre-treatment FMA score of 33.87 to a post-treatment score of 45.33. This indicates a substantial gain in upper limb motor recovery. Additionally, spasticity levels, measured by MAS, decreased from 1.45 to 0.23, reflecting improved muscle tone and reduced resistance to passive movement.

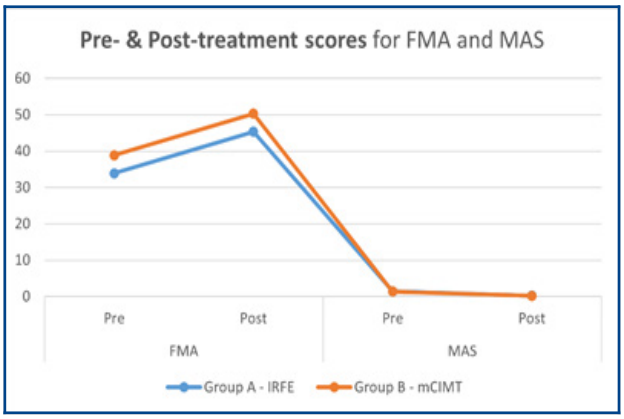


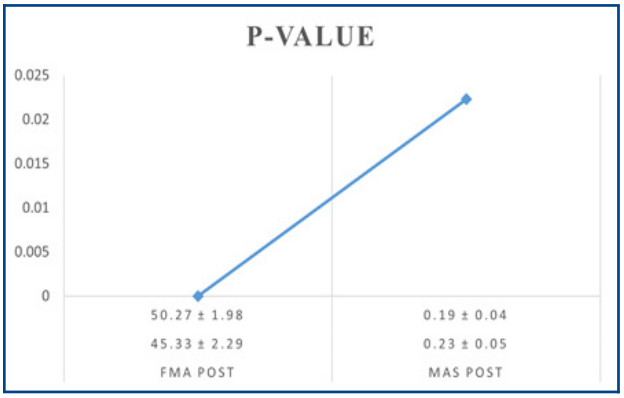
Table 2

Group	FMA Post	MAS Post
Group A - IRFE	45.33 ± 2.29	0.23 ± 0.05
Group B - mCIMT	50.27 ± 1.98	0.19 ± 0.04
p-value	0	0.0223

Group B, treated with Modified Constraint-Induced Movement Therapy (mCIMT), started with a higher baseline FMA score of 38.87, which increased to 50.27 post-treatment, suggesting even greater motor recovery.

MAS scores in this group also showed a reduction from 1.37 to 0.19, indicating a similar improvement in spasticity. Overall, both interventions were effective, but mCIMT demonstrated slightly superior outcomes in both motor function and spasticity reduction. These results support the use of mCIMT for patients with moderate recovery potential, while IRFE remains valuable for those with more severe impairments.

The post-treatment scores for motor recovery and spasticity between the two groups—IRFE and mCIMT—show statistically significant differences, as indicated by the p-values. For motor function, measured by the Fugl-Meyer Assessment (FMA), Group A (IRFE) had a post-treatment score of 45.33 ± 2.29, while Group B (mCIMT) scored 50.27 ± 1.98. The p-value of 0.0000 indicates a highly significant difference between the groups, suggesting that mCIMT led to greater improvements in motor recovery compared to IRFE.



For spasticity, assessed using the Modified Ashworth Scale (MAS), Group A recorded a post-treatment score of 0.23 ± 0.05, and Group B scored 0.19 ± 0.04. The p-value of 0.0223 also indicates a statistically significant difference, though less pronounced than for FMA, showing that mCIMT was slightly more effective in reducing muscle tone and spasticity. These results reinforce the conclusion that while both therapies are beneficial, mCIMT demonstrates superior outcomes, particularly in enhancing voluntary motor control and functional use of the affected limb.

DISCUSSION

This study was conducted to evaluate and compare the effectiveness of Intensive Repetitive Facilitation Exercise (IRFE) and Modified Constraint-Induced Movement Therapy (mCIMT) in promoting upper limb motor recovery among stroke patients. Stroke continues to be a leading cause of long-term adult disability, with upper limb hemiparesis significantly impairing functional independence and quality of life. Consequently, the selection of appropriate, evidence-based rehabilitation strategies is critical to optimizing recovery outcomes and restoring functional capacity [1,9].

The findings revealed that both IRFE and mCIMT resulted in statistically significant improvements in upper limb motor function, as measured by the Fugl-Meyer Assessment (FMA), and reductions in spasticity, as measured by the Modified Ashworth Scale (MAS). Notably, mCIMT demonstrated slightly superior outcomes, particularly in enhancing voluntary motor control and the functional use of the affected limb in daily activities. These results align with recent studies which emphasize the efficacy of mCIMT in improving functional performance and neuroplastic adaptation [7,8].

The theoretical foundation of mCIMT is rooted in the concept of "learned non-use," which has been extensively validated in recent neurorehabilitation literature. By constraining the unaffected limb and encouraging repetitive, purposeful use of the impaired arm, mCIMT stimulates cortical reorganization and use-dependent neuroplasticity6,10. Neuroimaging studies have shown increased motor cortex excitability and functional connectivity following mCIMT, supporting its role in reshaping neural pathways and enhancing motor recovery [3]. In contrast, IRFE emphasizes therapist-guided, high-repetition facilitation of specific movement patterns.

It is particularly beneficial for patients with lower initial motor function, who may lack the voluntary control necessary to engage in task-oriented therapies like mCIMT. Recent evidence suggests that IRFE enhances motor recovery by delivering intensive proprioceptive stimulation, which helps initiate voluntary movement and supports sensorimotor integration4,5. While mCIMT yielded greater overall improvements, IRFE played a critical preparatory role for patients with severe impairments, enabling them to progress toward more advanced rehabilitation. This supports the staged intervention model advocated by recent frameworks in stroke recovery, which recommend beginning with facilitation-based therapies like IRFE and transitioning to task-oriented approaches such as mCIMT to maximize functional gains [11,12].

The improvements observed in both groups can be attributed to the principles of use-dependent neuroplasticity. Repeated, goal-directed movements reinforce neural connections, facilitating functional recovery. mCIMT leverages this through active, task-specific engagement, while IRFE relies on external facilitation to generate internal motor signals—both contributing to synaptic remodeling and motor relearning [13,14]. Importantly, both interventions are cost-effective, require minimal equipment, and are well-suited for community-based rehabilitation, particularly in resource-limited settings. This aligns with current recommendations for scalable and accessible stroke rehabilitation strategies that can be implemented across diverse healthcare environments [1,12].

In conclusion, while mCIMT may offer superior functional outcomes for patients with moderate motor recovery potential, IRFE remains a valuable and effective approach for individuals in the early stages of recovery. These findings underscore the importance of individualized therapy selection, tailored to the patient's motor capacity, cognitive ability, and phase of recovery, to optimize rehabilitation outcomes and improve quality of life for stroke survivors.

The comparative analysis of post-treatment outcomes further reinforces the superiority of mCIMT over IRFE in promoting functional motor recovery. Participants in the mCIMT group achieved higher FMA scores (50.27 ± 1.98) compared to those in the IRFE group (45.33 ± 2.29), indicating more substantial improvements in voluntary motor control and coordination.

Additionally, the MAS scores revealed a slightly greater reduction in spasticity for mCIMT (0.19 ± 0.04) than IRFE (0.23 ± 0.05), with a statistically significant p-value of 0.0223. These findings suggest that mCIMT's task-specific, high-intensity approach not only facilitates neuroplastic changes but also translates into more meaningful functional gains. By actively engaging the affected limb in purposeful activities and overcoming learned non-use, mCIMT offers a more dynamic and patient-driven pathway to recovery, making it a preferred intervention for individuals with moderate motor potential.

CONCLUSION

This study demonstrates that both Intensive Repetitive Facilitation Exercises (IRFE) and Modified Constraint-Induced Movement Therapy (mCIMT) significantly improve upper limb motor recovery and reduce spasticity in stroke patients over a 4-week intervention. The IRFE group showed an FMA improvement from 33.87 to 45.33 and MAS reduction from 1.45 to 0.23. The mCIMT group improved from 38.87 to 50.27 on FMA and from 1.37 to 0.19 on MAS. While both therapies were effective, mCIMT yielded greater functional gains, especially in daily activities, making it preferable for patients with moderate recovery potential. IRFE remains valuable for those with severe impairments, supporting a staged, personalized rehabilitation approach.

Limitations and Future Scope: This study was limited by a small sample size, a short intervention period, and the lack of long-term follow-up, which restricts the generalizability and understanding of sustained therapeutic effects. Being a single-center study, it also did not extensively evaluate functional outcomes such as activities of daily living or psychological factors, and neuroimaging was not used to assess brain-level changes. Future research should involve larger, multicenter trials with extended follow-up to evaluate long-term efficacy. Incorporating quality of life measures, neuroimaging techniques, and exploring combined or home-based therapies could provide deeper insights. Additionally, integrating technology-driven approaches like virtual reality, robotics, and tele-rehabilitation may further enhance stroke recovery and accessibility in diverse settings.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Compartive Study Between Pilates Balance Traning And Task Oriented Balance Training In Sub Acute MCA Stroke Among Young Adult"

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ABSTRACT

Stroke, especially involving the middle cerebral artery (MCA), remains a leading cause of adult disability worldwide. In recent years, its occurrence in young adults has been on the rise, resulting in long-term impairments during the most productive phase of life. Among the common post-stroke complications, balance impairment and reduced functional mobility are major concerns, often limiting independence and quality of life. Traditional rehabilitation focuses on strength and mobility, but newer approaches like Pilates and Task Oriented Training (TOT) are gaining recognition. Pilates emphasizes core stability, postural alignment, and neuromuscular control, while TOT targets functional activities based on real-world tasks. Despite their individual benefits, limited evidence exists comparing their effectiveness in young stroke survivors. This study investigates the comparative impact of these two interventions on balance, motor function, and recovery outcomes in individuals with sub-acute MCA stroke. Need of Study Young adults with sub-acute MCA stroke often face motor impairments and reduced independence. While task-oriented training is effective, Pilates offers potential benefits for core stability and posture. However, there is no research comparing these two approaches. This was a randomized comparative study conducted on young adult patients diagnosed with sub-acute MCA stroke. 30 participants were randomly assigned into 3 groups: Group A received Pilates Balance Training (N=10), and Group B received Task-Oriented Balance Training(N=10) Group C received Conventional Physiotherapy (N=10). Each group underwent a structured intervention for a fixed duration, four sessions per week, over period of 6 weeks. Both Pilates-balance and task-oriented balance training significantly improved balance, gait, and lower limb function in young adults with sub-acute MCA stroke ($p < 0.05$), with Pilates favouring balance and TOT enhancing motor recovery. Both Pilates-based and task-oriented training significantly enhance functional recovery in young adults with sub-acute MCA stroke, with Pilates improving balance and TOT enhancing gait and lower limb function.

KEY WORDS: BALANCE TRAINING, PILATES BALANCE TRAINING, STROKE BALANCE TRAINING, SUB ACUTE MCA STROKE, TASK ORIENTED BALANCE TRAINING,

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Received 12/04/2026 Accepted after revision 17/07/2026
Page Number- 141-146
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.27

INTRODUCTION

The etiological profile of stroke in younger adults often differs from that in older individuals. Based on the Trial of Org 10172 in Acute Stroke Treatment (TOAST)

classification, strokes of "other determined" causes (21.6%–26.0%) and "undetermined" etiology (33.0%–39.6%) are more prevalent in this age group1. In contrast, large-artery atherosclerosis (LAA) accounts for only about 7.5%–9.3% of cases.

These statistics highlight the diagnostic complexity and variability in younger stroke patients, where conventional risk factors may not always be evident2. In the Indian context, the burden of stroke among younger individuals has become a growing public health concern. Recent systematic evidence indicates that approximately 16%–20% of all stroke cases in India occur in young adults, reflecting a notable rise compared to global averages [3].

This trend underscores the urgent need for greater awareness, early identification, and targeted prevention strategies focused on modifiable risk factors such as hypertension, diabetes, dyslipidemia, smoking, and sedentary behavior4. Stroke, medically termed as a CVA, is characterized by the sudden onset of neurological dysfunction resulting from an interruption of cerebral blood flow. This disruption may occur due to either ischemia, caused by a blockage in a cerebral artery, or haemorrhage, resulting from the rupture of a blood vessel.

Among these, ischemic strokes account for the majority of cases, representing approximately 80–85% of all strokes worldwide [5]. Trunk function plays a pivotal role in the rehabilitation and functional recovery of individuals following a stroke. After a stroke, impairments in trunk muscle performance—encompassing strength, endurance, and neuromuscular control— can severely compromise a patient's ability to regain independence6.

Moreover, the impact of trunk dysfunction extends to respiratory health. Stroke can result in partial or complete paralysis of the respiratory musculature, including the inter-costal muscles and diaphragm, particularly when the trunk is affected. This leads to reduced lung expansion and thoracic mobility, which in turn impairs pulmonary ventilation. If not addressed, such complications can contribute to secondary respiratory issues, such as atelectasis or pneumonia, which are common causes of morbidity in post-stroke patients [7].

In a comparative study, the effectiveness of three different therapeutic approaches—Pilates-based exercises, task-oriented training, and conventional physiotherapy—were evaluated in stroke survivors with impaired trunk control. Each of these interventions employs a unique methodology: Pilates emphasizes controlled breathing, alignment, and deep core engagement; task-oriented training focuses on practicing functional activities relevant to daily life; and conventional therapy typically includes general strength, flexibility, and balance exercises.

This study aimed to determine which of these methods offers the greatest benefit for improving trunk stability, gait parameters, and overall functional recovery in post-stroke individuals. Given Pilates' emphasis on core strength, body control, and balance, it holds potential as an adjunct intervention in neurorehabilitation settings, particularly for post-stroke patients who commonly present with impairments in trunk stability, gait, and posture [7,8]. TOT is a rehabilitation approach centered on the repetitive practice of meaningful, goal-directed tasks or components of tasks within a real or simulated functional context. It is primarily designed to promote the acquisition of efficient and effective motor skills by engaging the individual in activities that closely resemble the movements and challenges encountered in daily life.

MATERIAL AND METHODS

It's a comparative study and randomized sampling technique. The total number of subjects in the study was 30, aged between 30- 40 years. Ethical clearance was obtained from the institutional ethical committee (REF NO.- SCOP/OCT-24/ECN-94510023679) prior to the commencement of the study. The data were selected according to inclusion and exclusion criteria. The intervention duration of the study was 6 weeks. And the study duration was 6 months. Data were collected from outpatient department of Santosh hospital, Ghaziabad.

The subjects were included if 1) age between 30- 40 year (young adulthood) both male and female both; 2) having a sub-acute MCA stroke; 3) modified ashworth scale with grade 1-3 ;4) berg balance scale with score 21 to 40: 5) Time Up & Go greater than 20 sec9.

6) Fugl-meyer assessment lower extremity with score 15 -20. The subjects were excluded if they have Acute medical problems, Any surgical treatment during last year, Presences of any artificial prosthesis, Visual field deficits, Anterior cerebral artery stroke, Posterior cerebral artery stroke, Dyspraxia. All the subject provides their demographic detail and written informed consent prior to collection of baseline data.

Total 30 participant with MCA stroke were randomly selected on the basis of inclusion and exclusion criteria. These 30 participants were divided into 3 groups; Group A (PBT), Group B (TOT), Group C control group (CBT). All the subjects were evaluating the functional balance and spasticity. We evaluate functional balance with berg balance scale and TUG test and spasticity with MAS & ADL with FMA-LE. The group A received PBT (Table 1) focusing on lower limb strength, flexibility and co-ordination. Exercises or movements were done on a mat, on an exercise ball or in standing position while emphasizing on spinal and pelvic alignment, maintaining core contraction and the rhythm of respiration [9].

The group B received TOBT (table 2) where the intended movements were reinforced to be done correctly through terminal, sensory-augmented (delivery of additional task-related sensory cues, e.g., via clear and simple auditory, tactile, or visual modalities) feedback that conveys pertinent information about body orientation for balance with caution not to overload the patient with excessive or wordy commands10.

Table 1. Pilates Balance training9

PILATES EXERCISES

Hundred (with head down): Performed on mat in supine, both lower limb is raised together off the mat to about 30 degrees (initially with knee flexion and later progressed with knee extension)
Shoulder bridge: Performed on the mat in crook lying and lifting the pelvis off the mat; progressed with the use of exercise ball placing below lower leg and lifting the pelvis
Single leg circles: Performed in supine on mat & making circles with lower limb (one after another)
Alternate toe tap: performed on mat with both hips & knees in 90 degree flexion & alternately touching the toes on the mat
Leg pull front (beginner): Performed on the mat in quadruped position with the use of exercise ball placed under one lower leg by pulling it front and back
Spine twist: Performed in kneel standing on mat with Upper limb abducted to 90 degree & twisting the spine from side to side
Ball leg lift: Performed by sitting on the exercise ball and alternately lifting one leg off the floor
Standing side splits: Performed in standing on one leg with the other leg placed on exercise ball & performing side splits by rolling the ball away and close to the stance leg
Ball wall squat: Performed in standing against a wall with the exercise ball in the lumbar region & performing semi squats
Tandem walking: Walk heel-to-toe in a straight in 5 meter and turnaround, and tandem walk back to the starting position.
Sidestep walking: 5 meter to the left side and then 5 meter to right side, return to the starting position (make sure each foot lifts of the floor).
Backward walking: 5 meter and turn around, and backward walk back to the starting position.
Balance training section
Single-leg stance and three-direction tapping Three directions consist of forward, sideward and backward direction.
Standing on two legs in facing the wall position about 1 meter. Lift right foot off of the floor and tap in forward (distance of tapping equal1 phase of leg.) and return to starting position. Following this process in the sideward and backward direction (when participants finish the three directions will be counted as one time). 10 time per set. And following this process in the left
leg. Perform 3 set per leg.
Modified Chair Stand exercise :- Sitting on the chair with both foot contacts the floor. Standing up from the chair but don't full stand (height of rise from the chair is about 15 centimeter). And return to sitting position. Following this process in 10 times per set and perform 3 sets.

Table 2. Task oriented balance training10

Reaching from side to side
Forward and backward in sitting
Picking an object off the floor reaching to the side when standing up
Standing and looking behind (dual tasking)
Standing with one leg forward and looking behind (dual tasking)
Standing with narrow base of support
Tandem and semi-tandem stance with and without head turns
Standing on one leg with support; marching on the spot
Standing and bouncing a ball with two hands while counting down (dual tasking).
Sitting and reaching up and down
Sitting and reaching to the affected side
Kicking ball against the wall
Perturbations on Swiss ball
Obstacle walking

The group C (control group) received conventional therapy (table 3) intervention in the form of five minutes warm up followed by 12 minutes of walking at their comfortable pace, and active range of motion exercise of lower limb with weight training and concluded with five minutes cool down. All the groups received the above-mentioned interventions for a 40 min, thrice in a week for a period of 6 weeks [10].

Statistical Analysis: In this study, SPSS software were used and G* power3.1.9.7 was used to evaluate sample size; descriptive statistic was used calculated frequency, percentage, mean & Standard deviation.

Graph 1: Descriptive statistic of gender and age of young adults with subacute MCA stroke N=30

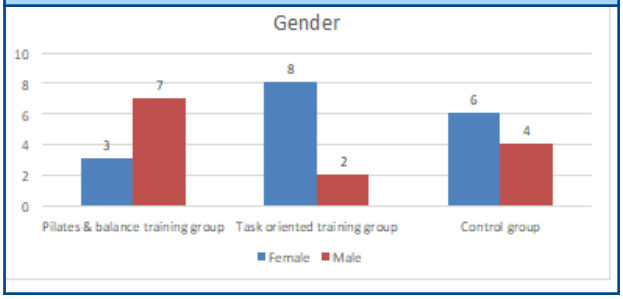

Table 3. Comparison between 3 follow up weeks of berg balance scale & modified Ashworth scale score of young adults with sub-acute MCA stroke in Pilates & balance training group, Task oriented training group and control group N=30

BERG BALANCE SCALE						
Berg Balance scale (Mean ± SD)	At starting	At 2nd week	At 4th week	At 6th week	Friedman test	Pvalue
Pilates & balance training group	23.30 ± 3.683	27.40 ± 3.438	35.40 ± 6.077	40.50 ± 4.625	30	0.001 (Sig.)
Task oriented training group	21.80 ± 1.033	27 ± 2.539	33.70 ± 2.627	39.50 ± 2.273	30	0.001 (Sig.)
Control group	23.70 ± 4.347	26.10 ± 1.969	29.80 ± 1.874	31.30 ± 3.433	19.20	0.001 (Sig.)
MODIFIED ASHWORTH SCALE						
Modified Ashworth scale (Median rank)	At starting	At 2nd week	At 4th week	At 6th week	Friedman test	Pvalue
Pilates & balance training group	3.70	3.10	1.95	1.25	25.871	0.001 (Sig.)
Task oriented training group	3.80	2.80	2.10	1.30	23.045	0.001 (Sig.)
Control group	3.65	2.85	2.30	1.20	24.114	0.001 (Sig.)

Kruskal-Wallis H Test: Applied for between-group comparisons at each time point (baseline, 2nd, 4th, and 6th weeks) for continuous outcome variables (BBS, TUG, FMA-LE). Chi-Square Test (χ^2): Utilized for categorical data analysis, particularly the Modified Ashworth Scale, to assess differences in spasticity classification between the three group. Friedman Test: A non-parametric equivalent of repeated measures ANOVA, used to assess within-group changes over time across all outcome measures.

RESULTS

In this study with 30 subjects who were randomized in to three groups 10 in Group A(Pilates Balance training) , 10 in Group B (task Oriented Training) and 10 in Group C (conventional physiotherapy).

Above table shows that there was statistical comparison between 3 follow up weeks of berg balance scale score with $p<0.05$ in all three groups Pilates & balance training group, Task oriented training group and control group. Score was increasing in all three groups but Pilates & balance training group 'and Task oriented training group was performing score better than control group.

Above table shows that there was statistical comparison between 3 follow up weeks of modified Ashworth scale score with $p<0.05$ in all three groups Pilates & balance training group, Task oriented training group and control group. Score was decreasing in all three groups but Pilates & balance training group was decreasing score better than Task oriented training group and control group.

Table 4. Comparison between 3 follow up weeks of time up and go scale & Fugl Myer Assessment for lower limb score of young adults with sub-acute MCA stroke in Pilates & balance training group, Task oriented training group and control group N=30

TIME UP AND GO						
Time up and go (Mean ± SD)	At starting	At 2nd week	At 4th week	At 6th week	Friedman test	P value
Pilates & balance training group	28.84 ± 4.985	25.78 ± 5.049	22.34 ± 4.713	19.85 ± 3.761	30	0.001 (Sig.)
Task oriented training group	28.87 ± 5.861	26.39 ± 5.069	21.65 ± 2.966	19.64 ± 1.759	30	0.001 (Sig.)
Control group	28.85 ± 1.918	26.41 ± 1.884	24.29 ± 2.120	22.44 ± 2.295	30	0.001 (Sig.)
FUGL MYER ASSESSMENT FOR LOWER LIMB						
Fugl Myer Assessment for lower limb (Mean ± SD)	At starting	At 2nd week	At 4th week	At 6th week	Friedman test	P value
Pilates & balance training group	17.70 ± 1.829	20.60 ± 1.430	24 ± 2.055	27.50 ± 2.014	30	0.001 (Sig.)
Task oriented training group	17.40 ± 2.271	20.50 ± 2.273	24.30 ± 2.541	28.40 ± 2.547	30	0.001 (Sig.)
Control group	16.80 ± 2.486	19.20 ± 2.251	21.60 ± 2.757	23.50 ± 3.536	29.418	0.001 (Sig.)

Above table shows that there was statistical comparison between 3 follow up weeks of time up and go scale score with $p<0.05$ in all three groups Pilates & balance training group, Task oriented training group and control group. Score was decreasing in all three groups but Pilates & balance training group and Task oriented training group was decreasing score better than control group.

Above table shows that there was statistical comparison between 3 follow up weeks of Fugl Myer Assessment for lower limb scale score with $p<0.05$ in all three groups Pilates & balance training group, Task oriented training group and control group. Score was increasing in all three groups but Pilates & balance training group and Task oriented training group was performing score better than control group.

DISCUSSION

This study evaluated the effectiveness of Pilates-Based Training (PBT) and Task-Oriented Training (TOT) on functional recovery in young adults recovering from sub-acute Middle Cerebral Artery (MCA) stroke. Stroke often leads to impaired balance, weakness, spasticity, and difficulty performing daily activities. Rehabilitation approaches that restore mobility, independence, and prevent falls are essential [11].

The results showed that both PBT and TOT were beneficial, but with distinct strengths. PBT led to the greatest improvement in balance, particularly by the fourth and sixth weeks. The Pilates group's Berg Balance Scale (BBS) score reached 40.5 by week six, slightly outperforming the TOT group (39.5) and clearly surpassing the control group (31.3). Pilates likely improved postural stability through continuous activation of core muscles, emphasizing controlled movement, core stability, and posture alignment—principles supported by previous research [8].

TOT also improved balance, but showed superior results in lower limb function and real-world activities. On the Fugl-Meyer Assessment for the Lower Extremity (FMA-LE), TOT scored 28.4, higher than Pilates (27.5) and the control group (23.5). TOT's emphasis on practicing meaningful, everyday tasks like walking and stair climbing appears to encourage neuro-plasticity and relearning of lost motor skills12. Recent clinical protocols reinforce this evidence showing that such structured task-specific interventions significantly enhance motor performance, daily living activities, and balance in stroke patients. Their findings highlight TOCT's ability to utilize neuroplasticity through repetitive, functional task practice—further supporting the TOT outcomes observed in the present study [13].

The control group, which received general physiotherapy (stretching, mat work, basic strength exercises), made some gains, but progress was less substantial compared to PBT and TOT. This suggests that while standard therapy supports recovery, targeted interventions are more effective.

Walking ability, measured via the Timed Up and Go (TUG) test, improved significantly in both intervention groups. By week six, participants in the PBT and TOT groups walked more confidently and quickly than controls, suggesting reduced fall risk and better mobility. These findings align with prior studies, such as those by Khallaf et al., showing task-specific training enhances trunk control and movement efficiency9.

Spasticity, as measured by the Modified Ashworth Scale (MAS), all intervention groups demonstrated slight improvement; however, the differences were not statistically significant. This finding suggests that although Pilates-based and task-oriented training effectively enhance functional performance, their influence on muscle tone reduction appears limited. Comparable outcomes were observed by [14,15], who reported functional and balance improvements following Neuropilates and task-oriented robotic training, respectively, without significant changes in spasticity levels.

Pilates' effectiveness is attributed to its integration of controlled breathing, body awareness, and slow, deliberate movements, which likely contribute to improvements in balance and posture. Recent evidence indicates that combining mindful breathing with targeted movement enhances postural stability, coordination, and functional outcomes in stroke rehabilitation [14,15]. In contrast, TOT excels in functional mobility and daily-life skills. Because it mimics real-life challenges, it promotes better adaptation, confidence, and independence. Research confirms that real-world task practice fosters motor recovery and functional autonomy, particularly in young stroke survivors [11].

CONCLUSION

In conclusion, both Pilates with balance training and task-oriented training are effective rehabilitation strategies for enhancing post-stroke functional recovery in young adults. Pilates training appears to be particularly beneficial for balance improvement, while task-oriented training may offer marginally better outcomes in motor recovery of the lower limb. These findings support the inclusion of structured, targeted rehabilitation protocols in post-stroke management to facilitate optimal recovery.

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Efficacy of Myofascial Release Using IASTM Tool Versus Conventional Physiotherapy in Chronic Plantar Fasciitis

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ABSTRACT

Plantar fasciitis is a prevalent cause of heel pain, often affecting individuals engaged in prolonged standing or physical activity. Conservative physiotherapy remains a preferred management approach, with myofascial release and static stretching being common techniques. Despite their widespread use, direct comparative evidence regarding their effectiveness is limited. To compare the effectiveness of myofascial release using an IASTM tool ,in conjunction with conventional treatment, in reducing pain ,improving functional outcomes and enhancing mobility of ankle in chronic plantar fasciitis patients. A randomized controlled trial was conducted on 30 individuals diagnosed with plantar fasciitis. Participants were randomly allocated into two groups. Group A received myofascial release therapy along with conventional physiotherapy, while Group B received static stretching in addition to the same physiotherapy protocol. The interventions were administered thrice weekly over four weeks. Outcome measures included the Numerical Pain Rating Scale (NPRS), Foot Function Index (FFI), and goniometric measurements of ankle dorsiflexion and plantarflexion. Pre- and post-intervention data were statistically analysed. Both groups showed significant improvements in pain reduction, functional outcomes, and ankle mobility from baseline to post-intervention. However, Group A exhibited more pronounced improvements in NPRS, FFI scores, and ankle range of motion. The between-group comparison revealed statistically significant differences in favour of the myofascial release group. The study findings suggest that both interventions are effective in managing plantar fasciitis, but myofascial release, when combined with conventional physiotherapy, is superior in reducing pain and enhancing foot function and mobility. It may therefore be considered a more effective conservative approach for patients with plantar fasciitis.

KEY WORDS: PLANTAR FASCIITIS, MYOFASCIAL RELEASE, STATIC STRETCHING, FOOT FUNCTION, ANKLE RANGE OF MOTION, PHYSIOTHERAPY.

Article Information: *Corresponding Author: deepak.raghav@santosh.ac.in
Received 05/02/2026 Accepted after revision 18/08/2026
Page Number- 148-152
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.28

INTRODUCTION

Plantar fasciitis is one of the most frequent causes of heel pain that clinicians come across in daily

physiotherapy practice. It usually happens because of repeated strain or overuse of the plantar fascia, which is a thick fibrous tissue running from the heel bone to the toes.

This fascia helps to support the arch of the foot and maintain stability while walking or standing. When it is stressed for a long time, tiny tears appear near its attachment on the heel, and the person starts feeling pain or stiffness, mostly during the first few steps after rest [1]. In the past, plantar fasciitis was thought to be an inflammatory problem, but newer evidence shows that it is more of a degenerative process.

The collagen fibres lose their normal pattern, and the fascia becomes thick and weak due to continuous mechanical stress [2]. Tightness in the calf muscles, especially the gastrocnemius and soleus, increases this load further because both muscles act through the Achilles tendon and pull on the plantar fascia whenever a person walks or stands3. There are several risk factors linked to this condition such as increased body weight, prolonged standing hours, reduced ankle movement, or wearing footwear that does not support the arch well. Flat feet and poor posture of the foot are also common findings [4,5]. People between the ages of thirty and fifty, and those whose jobs need long standing, are affected most.

Imaging with ultrasound or MRI often shows thickened fascia or mild swelling around the heel6. Conservative care is still the first line of management. Stretching of the plantar fascia and calf muscles, strengthening, use of heel pads or orthoses, ultrasound and other electrotherapy methods are usually given. Though these help in pain relief for some time, the improvement often does not last long7. Because of this, soft-tissue-based treatments are now getting more attention as they aim to correct the real fascial restrictions rather than only control symptoms.

Myofascial Release (MFR) is a manual therapy method where the therapist applies slow and gentle pressure on the tight fascial tissues. This helps in reducing adhesions, improving blood flow, and restoring smooth movement of the fascia. Many clinical reports have found that MFR can lessen heel pain and improve function in plantar fasciitis8,9. Instrument-Assisted Soft Tissue Mobilization (IASTM) is another technique that uses specially designed tools to mobilize the fascia. It stimulates fibroblast activity, promotes new collagen formation, and helps the tissue heal better [10].

Combining MFR with IASTM may give better results because both techniques target different layers of fascia. Together they help restore flexibility, reduce tightness, and improve overall foot mechanics. Recent research suggests that people receiving such combined soft-tissue therapy show greater improvement in pain, gait, and plantar flexor strength than those getting only conventional therapy [11,12].

Even though the results are promising, very few studies have explored this combined approach in chronic plantar fasciitis. The present study therefore aims to find out how Myofascial Release used together with IASTM, along with conventional physiotherapy, affects pain, functional recovery, and mobility in individuals suffering from chronic plantar fasciitis.

METHODS

Study Design and participants: This randomized controlled trial was conducted at Santosh Hospital , Ghaziabad. A total of 30 participants (15 in each group) were selected based on specific inclusion and exclusion criteria. Ethical clearance was obtained from the institutional ethical committee (REF NO.- SCOP/OCT-24/ECN-94510023667) prior to the commencement of the study.

Participants included both male and female individuals between the ages of 25 and 50 years who presented with unilateral plantar fasciitis for more than 4 weeks. All participants demonstrated pain on the first step in the morning and had a minimum score of 4 on the Numeric Pain Rating Scale (NPRS). Participants with recent fractures around the foot and ankle, open wounds, systemic conditions like rheumatoid arthritis, or any known neurological disorders were excluded from the study.

Written informed consent was obtained from all eligible individuals after explaining the study objectives and procedures. All participants were instructed to avoid taking any NSAIDs or muscle relaxants during the intervention period. Following baseline assessment, participants were randomly assigned into two groups: Group A (received Myofascial Release therapy) combined with conventional physiotherapy, and Group B received static stretching exercises along with the same conventional physiotherapy. The intervention lasted for 4 weeks, with participants attending three sessions per week under supervised conditions.

For Group A, the Myofascial Release technique focused on the gastrocnemius-soleus complex and plantar fascia. The therapist applied a low-load, sustained pressure using hands and fingers along the tight fascial regions to facilitate tissue release. Each session lasted for 30 minutes, including 15 minutes of MFR followed by 15 minutes of conventional physiotherapy. Group B underwent static stretching exercises targeting the gastrocnemius, soleus, and plantar fascia.

Each muscle group was stretched for 30 seconds, with 3 repetitions per session. Like Group A, this group also received 15 minutes of conventional physiotherapy including ultrasound therapy, strengthening of intrinsic foot muscles, and heel cord stretching. Outcomes measures included the Numeric Pain Rating Scale (NPRS) for pain intensity, Foot Function Index (FFI) for disability and functional limitations, and the Roles and Maudsley Score (RMS) for patient satisfaction. Assessments were carried out at baseline and after 4 weeks of intervention.

5.Statistical Analysis: The data were analyzed using SPSS software version [insert version number]. Descriptive statistics were used to summarize demographic details.

Within-group and between-group comparisons were performed using paired and unpaired t-tests respectively, with the level of significance set at $p < 0.05$.

Table 1. The pre-treatment data reveals key baseline characteristics across pain, function, and range of motion measures.

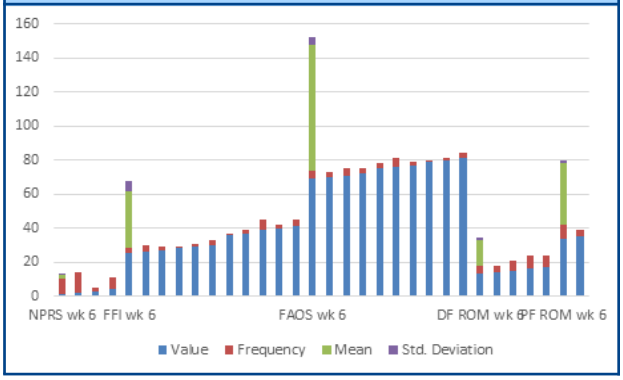
Measure	Value	Frequency	Mean	Std. Deviation
NPRS	6	4	7.67	0.884
	7	6		
	8	16		
	9	4		
FFI	60	2	65.67	2.746
	61	2		
	62	1		
	63	1		
	64	2		
	65	5		
	66	2		
	67	6		
	68	5		
	69	4		
FAOS	40	2	46.83	4.426
	41	1		
	42	4		
	43	3		
	46	4		
	47	5		
	48	1		
	49	2		
	51	2		
	53	4		
	54	2		
DF ROM	8	3	9.23	0.626
	9	17		
	10	10		
PF ROM	27	1	28.67	0.758
	28	12		
	29	13		
	30	4		

RESULTS

water contaminant constituents such Phenol and resorcinol the pollution of industrial wastewater, which can reduce the concentration of pollutants discharged into the plant (Agency for Toxic Substances and Disease Registry (ATSDR).

For pain levels measured by NPRS, the mean score was 7.67 (SD=0.88), with the majority of patients reporting scores of 7 (n=6) or 8 (n=16), indicating consistently moderate-to-high pain levels in the cohort. Only a few patients reported slightly lower (6, n=4) or higher (9, n=4) pain scores, demonstrating relatively homogeneous baseline pain severity.

Figure 1



Functional outcomes revealed continued enhancement. The FFI improved to a mean of 33.23 (SD=6.31), showing a 49% total improvement from baseline. While scores remained somewhat variable (25-41), there was a clear trend toward better function, with 16 patients scoring ≤30. The FAOS reached a mean of 73.87 (SD=4.02), a 58% improvement, with most patients (n=19) scoring between 69-77, and four patients achieving scores of 79-81, indicating near-normal or normal foot and ankle function.

Table 2. Shows differentiation of data a significant improvement in all the scales are noticed after the intervention.

Measure	Effect Size	Point Estimate	95% CI (Lower - Upper)
NPRS	Cohen's d	-0.831	-1.541 to -0.050
	Hedges' g	-0.854	-1.500 to -0.049
	Glass's delta	-0.756	-1.654 to -0.084
FFI	Cohen's d	-2.389	-1.941 to -0.385
	Hedges' g	-2.456	-1.889 to -0.374
	Glass's delta	-1.335	-3.132 to -1.030
FAOS	Cohen's d	2.768	1.504 to 3.433
	Hedges' g	2.845	1.463 to 3.340
	Glass's delta	2.53	1.472 to 3.923
DF ROM	Cohen's d	-0.613	-1.268 to 0.191
	Hedges' g	-0.63	-1.234 to 0.186
	Glass's delta	-0.507	-1.402 to 0.108
PF ROM	Cohen's d	0.772	-0.716 to 0.716
	Hedges' g	0.793	-0.696 to 0.696
	Glass's delta	0.488	-0.716 to 0.716

Range of motion measures showed substantial gains. Dorsiflexion ROM increased to a mean of 15.27° (SD=1.41°), a 65% improvement from baseline, with most patients (n=21) achieving

15° or greater. Plantarflexion ROM also improved significantly to 36.03° (SD=1.56°), a 26% increase, with the majority of measurements (n=22) at 35° or higher. Table 3 showing the 6-week follow-up, highly significant differences ($p < 0.001$) were maintained between the two treatment groups across all outcome measures, with the IASTM group (Group B) continuing to demonstrate superior clinical outcomes compared to conventional physiotherapy.

Table 3

Measure	t-value	DF	Sig. (2-tailed)	Mean Difference	95% CI (Lower - Upper)
NPRS wk 6	5.94	28	0	1.667	1.092 to 2.241
FFI wk 6	18.72	28	0	11.933	10.628 to 13.239
FAOS wk 6	-10.51	28	0	-7.067	-8.444 to -5.689
DF ROM wk 6	-9.081	28	0	-2.4	-2.941 to -1.859
PF ROM wk 6	-10.25	28	0	-2.733	-3.280 to -2.187

DISCUSSION

This study found that Instrument-Assisted Soft Tissue Mobilization (IASTM) was more effective than conventional physiotherapy in managing chronic plantar fasciitis. Participants in the IASTM group (Group B) experienced greater reductions in pain, better functional mobility, and improved ankle range of motion compared to those receiving conventional therapy alone.

Pain relief was more notable in Group B, with significant drops in NPRS scores by both the third and sixth week assessments, indicating quicker and longer-lasting symptom relief. Functional scores, as measured by FFI and FAOS, also improved more significantly in the IASTM group, suggesting better performance in daily and recreational tasks. Gains in ankle dorsiflexion and plantarflexion further support the role of IASTM in restoring soft tissue flexibility and improving gait mechanics.in terms of functional mobility, Group B participants shows better outcomes in both the Foot Function Index and foot and ankle outcome scores.

These improvements indicates that IASTM reduces discomfort and enhance patients Ability to perform daily activities. Overall the findings highlight the clinical advantage of IASTM into treatment protocols for the patients with chronic plantar fasciitis. The technique appears to promote faster symptoms and functional recovery, offering a valuable alternative to conventional physiotherapy treatment. The findings of the present study align with expand upon previous research emphasizing the superiority of myofascial release techniques, particularly when administered using instrument assisted soft tissue mobilization (IASTM), in managing chronic plantar fasciitis.

Similarly to the current results, previous studies have demonstrated that myofascial release techniques significantly reduced heel pain and improved foot function, as measured by the Foot Function Index (FFI) and pain scales. Patients receiving myofascial release showed greater improvements in functional mobility and symptom relief compared to those undergoing only conventional therapy [13,14]. Furthermore, [15,16] found myofascial release to be effective in reducing plantar heel pain and Associated disability, reinforcing its role in targeting fascial restrictions that contribute to chronic symptoms.

Additionally, the use of IASTM, as observed in this study, findings by other studies highlighted that IASTM led to a significant increase in pressure pain thresholds and ankle range of motion, which are important outcomes in rehabilitation of plantar fasciitis. Previous studies have also demonstrated that myofascial release effective decreased heel pain intensity and improved mobility, suggesting it's clinical superiority over conventional modalities [17–19].

CONCLUSION

This study demonstrates that Instrument-Assisted Soft Tissue Mobilization (IASTM) is more effective than conventional physiotherapy for treating chronic plantar fasciitis. The IASTM group showed significant improvements in pain reduction, functional mobility, and overall foot function, as evidenced by better scores on the Numeric Pain Rating Scale (NPRS), Foot Function Index (FFI), and improved Ankle Range of Motion (ROM).

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SSN Journal of Management & Technology Research Communications

Vol 3 No (4) 2026 CrossRef DOI: https://dx.doi.org/10.21786/mntrc

Published by Society for Science and Nature Bhopal India E-ISSN : 3049-0014

Effect of Instrument-Assisted Soft Tissue Mobilization on Pain, Calf Flexibility, and Ankle ROM in Postnatal Women with Chronic Calf Pain: An Immediate Response Study

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ABSTRACT

The postnatal period often brings about musculoskeletal discomfort in women, with calf pain being a significant concern for many. This pain can arise due to various physiological changes during pregnancy and childbirth. Instrument-Assisted Soft Tissue Mobilization (IASTM) is a manual therapy technique that utilizes specialized tools to address soft tissue restrictions and improve tissue healing. The study evaluated the immediate effects of Instrument-Assisted Soft Tissue Mobilization (IASTM) on ankle dorsiflexion range of motion and self-reported functional disability in postnatal women who suffered from chronic calf pain. The research targeted 50 women aged between 20 and 40 years who were between 6 weeks and 6 months postpartum and experienced persistent calf pain that intensified with physical activity. Participants were rigorously screened, excluding those with neurological conditions, suspected deep vein thrombosis (DVT), or those who were undergoing other treatments. By implementing IASTM—a technique known for stimulating soft tissue healing—the study aimed to determine its effectiveness in improving mobility and reducing pain. The thesis described an experimental study involving 50 subjects. Post-intervention results demonstrated a noticeable improvement in ankle range of motion (ROM), which increased from 9.02 to 16.92. There was a reduction in pain scores on the Numeric Pain Rating Scale (NPRS), decreasing from 7.14 to 2.60, and an increase in calf muscle flexibility from 6.522 to 12.246. These outcomes indicated the positive immediate effect of the Instrument-Assisted Soft Tissue Mobilization (IASTM) technique. A single session of IASTM had shown significant immediate benefits in reducing chronic calf pain, enhancing ankle mobility, and improving muscle flexibility in postnatal women. These findings suggested that IASTM could be a useful therapeutic option in early postpartum rehabilitation protocols. IASTM technique was a very effective treatment for chronic calf pain in post - natal women. Further studies can explore long- term effects and combinations with other therapies.

KEY WORDS: CHRONIC CALF PAIN, EVIDENCE BASED, FUNCTIONAL DISABILITY, INVESTIGATION, NEUROLOGICAL CONDITIONS, , PHYSICAL ACTIVITY, POST-NATAL WOMEN, SOFT TISSUE.

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Received 17/02/2026 Accepted after revision 25/04/2026
Page Number- 153-157
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Available at: https://mntrc.in/
DOI: http://dx.doi.org/10.21786/mntrc/3.4.29

INTRODUCTION

Chronic calf pain in this population can impact their functional abilities, daily activities, and overall quality of life. Instrument-Assisted Soft Tissue Mobilization (IASTM) is a manual therapy technique that utilizes specialized tools to address soft tissue restrictions and improve tissue healing [1]. The theoretical basis of IASTM lies in its ability to detect and treat fascial restrictions, break down scar tissue and adhesions, and promote a cascade of healing responses at the tissue level.

The use of Instrument Assisted Soft Tissue Mobilization (IASTM) has become common by sports medicine professionals for treatment of myofascial restrictions [2]. IASTM is a soft-tissue treatment technique where an instrument is used to provide a mobilizing stimulus to positively affect scar tissue and myofascial adhesion [3].

By applying controlled micro trauma, IASTM aims to stimulate fibroblast activity, increase blood flow, and facilitate the remodelling of affected soft tissue structures. While IASTM has been explored for various musculoskeletal conditions, its immediate effect on chronic calf pain specially in women warranty investigation [4].

However not many studies have been conducted to determine the aetiology of non-specific calf pain and the treatment. Also, since it is a self-limiting pain; many women do not seek medical aid for the same5. However, there are several physiotherapeutic interventions which can treat non specific calf pain such as soft tissue mobilisation techniques, massage, exercise programs, ultrasound, transcutaneous electrical stimulation etc6.

There is a paucity of evidence analysing the effectiveness of the various physiotherapeutic modalities in the treatment of non-specific calf pain. Thus, this case study was conducted to determine the effectiveness of IASTM using Edge tool. The controlled micro trauma to affected soft tissue structure causes the stimulation of local inflammatory response. Micro trauma initiates reabsorption of inappropriate fibrosis or excessive scar tissue and facilitates a cascade of healing activities resulting in remodelling of affected soft tissue structures.

Adhesions within the soft tissue which may have developed as a result of surgery, immobilization, repeated strain or other mechanisms, are broken down allowing full functional restoration to occur. Researchers have hypothesized that utilizing IASTM will improve muscular efficiency and performance; yet previous Investigations has been focused on treating injury [7].

An array of physiological changes occurs due to IASTM. Fibroblasts which are mechanosensitive cells respond to mechanical external loading which occurs with the application of IASTM1. The mechanism underlying the beneficial effects is mechanotransduction which causes tissue repair and remodelling [8]. musculoskeletal pain is commonly reported by pre- and postnatal women.

METRIALS AND METHODS

The study design for this research was a pre- and post-test experimental study in nature. Ethical clearance was obtained from the institutional ethical committee (REF NO.- SCOP/OCT-24/ECN-94510023675) prior to the commencement of the study. This approach allowed for the assessment of the immediate effect of the Instrument-Assisted Soft Tissue Mobilization (IASTM) technique on pain, flexibility, ROM in chronic calf pain among postnatal women. Key components of the study design included the identification and recruitment of eligible participants, baseline evaluations of pain intensity, ankle range of motion, and calf muscle flexibility, followed by the administration of a single IASTM intervention session.

Post-intervention assessments were then conducted to measure changes in the targeted outcomes, enabling a comparative analysis of pre- and post-treatment data to determine the effectiveness of the technique. The study included postnatal women aged 20–40 years, 6 weeks to 6 months postpartum, with chronic calf pain lasting over three months and NPRS scores between 7 and 8. Participants gave informed consent.

Those with deep vein thrombosis or active skin infections were excluded. Limited ankle dorsiflexion and reduced calf flexibility impaired mobility and delayed recovery. These biomechanical issues emphasized the need for individualized care and thorough screening. Sample collected from local outpatient physiotherapy departments and community clinics, with a sample size of 50 women appropriate for a pre post experimental study to assess feasibility and immediate response.

Procedure: Postnatal women who met the inclusion criteria were recruited from local physiotherapy clinics, community clinics, and postnatal care centres. Written informed consent was obtained before participation. Baseline assessment included recording demographic data and obstetric history, along with measuring initial pain levels using the Numeric Pain Rating Scale (NPRS) [9].

Calf flexibility was evaluated using the Calf Flexibility Measurement Scale, and ankle range of motion (ROM), including dorsiflexion and plantar flexion, was documented using a goniometer [10]. For the intervention, participants underwent a single session of Instrument-Assisted Soft Tissue Mobilization (IASTM) targeting the affected calf muscles.

They were positioned comfortably in prone lying or long sitting with slightly flexed knees, and a lubricant such as massage cream or oil was applied to minimize skin friction. A stainless steel IASTM tool was used, and the session was conducted under standardized conditions for all participants to ensure consistency. Immediately following the treatment, NPRS was repeated to assess changes in pain intensity, calf flexibility was re-evaluated using the same scale, and ankle ROM was measured again with the goniometer to identify any immediate improvements [11].

Table 1. Comparison between pre and post-test of NPRS in chronic calf pain among post-natal women

NPRS	Mean ± Std. Deviation	Paired t test value	DF	P-value	Result
Pre test	7.14 ± 1.246	22.425	49	0.001	Significant
Post test	2.6 ± 0.881				

Above table shows that there was statistically significant comparison between pre -test and post-test of NPRS score with P<0.05. here pain is decreasing in post-test after giving intervention.

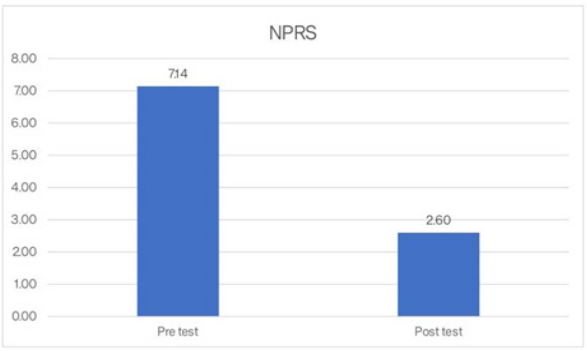


Table 2: Comparison between pre and post-test of Calf Flexibility in chronic calf pain among post-natal women N=50

Calf Flexibility	Mean ± Std. Deviation	Paired t test value	DF	P-value	Result
Pre test	6.522 ± 1.7622	11.057	49	0.001	Significant
Post test	12.246 ± 3.5596				

Pain intensity was evaluated using the Numeric Pain Rating Scale (NPRS), where participants rated their discomfort on a scale from 0, indicating no pain, to 10, representing the worst imaginable pain. These ratings were recorded immediately before and after the Instrument-Assisted Soft Tissue Mobilization (IASTM) session to assess changes in perceived pain levels. Calf muscle flexibility was measured using a standardized method such as the weight-bearing lunge test, which determines the stretch length or angle of the calf muscles by assessing the distance from the wall to the big toe or the degree of dorsiflexion achieved while maintaining heel contact.

Informed Consent: Participants were provided with the study's purpose, benefits, risks, and confidentiality agreements. Informed consent was obtained.

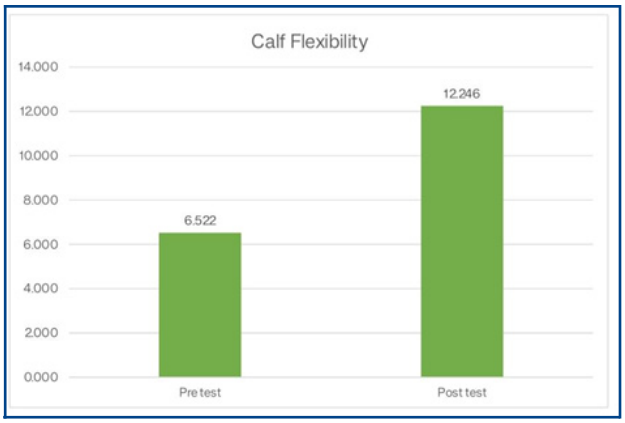
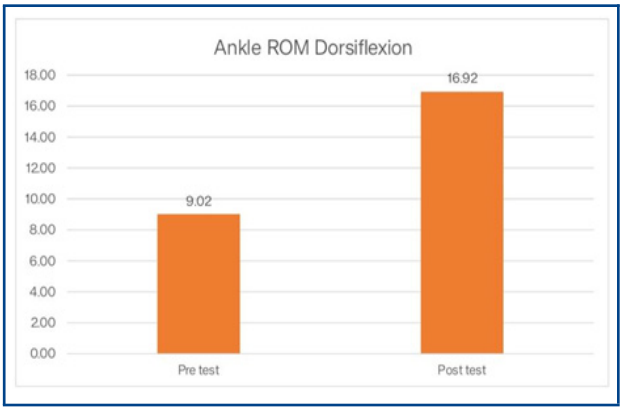


Table 3. Comparison between pre and post-test of Ankle ROM Dorsiflexion in chronic calf pain among post-natal women N=50

Ankle ROM Dorsiflexion	Mean ± Std. Deviation	Paired t test value	DF	P-value	Result
Pre test	9.02 ± 1.868	25.32	49	0.001	Significant
Post test	16.92 ± 1.627				



Analysis: T-TEST were performed to examine the immediate effect of the IASTM technique on chronic calf pain among postnatal women. Statistical methods assessed whether increased musculoskeletal symptoms were associated with lower quality of life, reduced physical activity, and greater functional disability. With a pre- and post-experimental design, the research provided a snapshot of the associations between these variables, laying the groundwork for future longitudinal or experimental studies to explore causal relationships.

The thesis described an experimental study involving 50 subjects. Post-intervention results demonstrated a noticeable improvement in ankle range of motion (ROM), which increased from 9.02 to 16.92. There was a reduction in pain scores on the Numeric Pain Rating Scale (NPRS), decreasing from 7.14 to 2.60, and an increase in calf muscle flexibility from 6.522 to 12.246. These outcomes indicated the positive immediate effect of the Instrument-Assisted Soft Tissue Mobilization (IASTM) technique.

A single session of IASTM had shown significant immediate benefits in reducing chronic calf pain, enhancing ankle mobility, and improving muscle flexibility in postnatal women. These findings suggested that IASTM could be a useful therapeutic option in early postpartum rehabilitation protocols.

DISCUSSION

This pre post experimental research demonstrates that the IASTM technique showed promising immediate effect in reducing chronic calf pain among Post-natal women. According to the study, the NPRS scores decreased significantly, indicating a reduction in pain, the ankle dorsiflexion ROM measurement showing improvement, suggesting increased flexibility and mobility. Additionally, the weight bearing lunge-test (WBLT) also demonstrates enhanced calf flexibility.

These findings suggest that IASTM can be an effective treatment modality for reducing pain and improving ankle mobility and calf flexibility in Post-natal women with chronic calf pain12. The dorsiflexion of ankle joints and calf flexibility are essential elements for daily activities, such as gait and sports activities, it has been shown that muscle tightness of the calf leads to a decrease in the range of motion for dorsiflexion, and the resulting pain and decreased performance can cause changes in the gait pattern [13,14].

Loghmani and Warden8 found IASTM-treated injured knee medial collateral ligaments demonstrated improved biomechanical properties and structure compared to contralateral uninjured ligaments in a rodent model. Follow-up studies demonstrated increased blood flow and possible angiogenesis in the vicinity of the IASTM-treated injured rat knee ligament as compared to the untreated limb [8]. More recent animal model studies have employed mechatronic IASTM devices to explore the time and dose-pressure dependent response of massage-based modalities; which have not been adequately considered in human subjects studies.

The treatment protocol used in this case showed good results. There was improvement in the symptoms. The patient could return to her active lifestyle and prior functional level. Instrument assisted soft tissue mobilisation helped in treatment of the soft tissue restrictions thereby allowing full muscle mobility and lengthening. Though a variety of tools can be used; Edge tool has several advantages thus was chosen in this case. This study established a normative range for calf muscle flexibility in the age group of 20-40 yrs.

Mean and standard deviation were calculated in post-natal women. There was a significant difference between pre and post IASTM intervention. According to our data set post IASTM treatment calf muscle flexibility increased.

Our findings support the recommendation from previous studies which used a 2 cm or greater lunge distance asymmetry on the WBLT to delineate subjects with clinically relevant impairments in ankle dorsiflexion. Based on our findings, these studies were likely including individuals with a pathologic impairment in dorsiflexion; however, studies which based subject inclusion on less than a 1.5 cm lunge distance asymmetry may not have been examining subjects with a true level of impairment. Therefore, future studies examining clinical populations with anticipated dorsiflexion deficits may want to use a >1.5 cm lunge distance asymmetry as inclusion criteria.

The pre post experimental research design provided preliminary evidence that the IASTM technique yielded immediate benefits in alleviating chronic calf pain among post-natal women. The significant reduction in NPRS scores suggested a measurable decrease in perceived pain levels. However, while the pain reduction was statistically significant, the study did not elaborate on the clinical relevance of the score changes, which could have strengthened the interpretation of its therapeutic impact [15].

Improvements in ankle dorsiflexion ROM and weight-bearing lunge test (WBLT) outcomes indicated enhanced flexibility and mobility. These findings aligned with the hypothesis that IASTM could positively influence musculoskeletal function. Nonetheless, the study lacked long-term follow-up, making it difficult to determine whether these improvements were sustained over time or merely short-term effects.

The researcher emphasized the importance of ankle dorsiflexion and calf flexibility in daily activities such as gait and sports. While this connection was valid, the manuscript did not account for potential confounding variables—such as participants' baseline activity levels, prior interventions, or biomechanical differences—that might have influenced the results.

Moreover, the sample size and demographic specificity (post-natal women) limited the generalizability of the findings. The absence of a placebo or sham treatment group also raised concerns about the potential influence of participant expectations or placebo effects.

In conclusion, although the study demonstrated promising outcomes for IASTM in managing chronic calf pain, its methodological limitations and lack of longitudinal data suggested that further research was necessary to confirm its efficacy and establish broader clinical applicability.

CONCLUSION

The Instrument-Assisted Soft Tissue Mobilization (IASTM) technique was found to be effective in reducing chronic calf pain and improving ankle mobility and calf muscle flexibility in postnatal women. The study observed significant immediate improvements following a single session of IASTM, which highlighted its potential as a valuable therapeutic intervention during the early postpartum period. These results supported the use of IASTM as part of rehabilitation strategies aimed at addressing musculoskeletal discomfort commonly experienced after childbirth.

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SSN Journal of Management and Technology Research Communications
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Cross Ref DOI: http://dx.doLorg/10.21786
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