

COGNITIVE-MOTOR DUAL TASK TRAINING VERSUS COGNIFIT APPLICATION TRAINING IN POST-CONCUSSION SYNDROME: A PILOT RANDOMIZED CONTROLLED TRIAL

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Abstract: Post-Concussion Syndrome (PCS) is characterized by persistent cognitive, balance, and functional impairments following mild traumatic brain injury, necessitating effective rehabilitation strategies. This pilot randomized controlled trial compared the effectiveness of Cognitive-Motor Dual Task Training (CMDT) and CogniFit Application Training in improving cognitive function, balance, and post-concussion symptoms among 20 middle-aged adults with PCS. Participants were randomly assigned to either CMDT or CogniFit training and received supervised intervention for 8 weeks (3 sessions/week, 60 minutes/session). Outcome measures included the Montreal Cognitive Assessment (MoCA), Berg Balance Scale (BBS), and Rivermead Post-Concussion Symptoms Questionnaire (RPQ), assessed before and after the intervention. Both groups demonstrated significant improvements following treatment ($p < 0.001$); however, participants receiving CMDT showed significantly greater improvements in cognitive performance, balance, and reduction of post-concussion symptoms compared with those receiving CogniFit training ($p < 0.001$). These findings suggest that CMDT is a more effective rehabilitation approach for enhancing cognitive-motor performance and functional recovery in middle-aged adults with Post-Concussion Syndrome and may be recommended as an effective outpatient physiotherapy intervention.

INTRODUCTION

Mild traumatic brain injury (mTBI), commonly referred to as concussion, is among the most prevalent acquired neurological conditions worldwide. Defined by the American Congress of Rehabilitation Medicine (ACRM) and the World Health Organization (WHO) as an injury-related disturbance of cerebral function with transient loss of consciousness (< 30 minutes), post-traumatic confusion (< 24 hours), and a Glasgow Coma Scale (GCS) score of 13–15 at initial assessment, mTBI accounts for approximately 80–90% of the estimated 50–60 million traumatic brain injury cases reported annually. Although most individuals recover within two weeks, approximately 10–43% continue to experience persistent physical, cognitive, emotional, and behavioral symptoms beyond three months, a condition known as Post-Concussion Syndrome (PCS). In India, the prevalence of persistent PCS remains considerable, with a significant proportion of patients reporting long-term cognitive impairment, balance deficits, headaches, dizziness, and reduced functional capacity.

Middle-aged adults (35–55 years) represent a particularly vulnerable and understudied population because occupational responsibilities, family commitments, and social participation require efficient integration of cognitive processing and motor

performance. Persistent impairments in attention, executive function, memory, and postural control can substantially affect work productivity, independence, and quality of life. These deficits are primarily attributed to diffuse axonal injury, neurometabolic dysfunction, neuroinflammation, and disrupted connectivity within cognitive-motor neural networks, leading to impaired dual-task performance in everyday activities.

Cognitive-Motor Dual Task Training (CMDT) is a rehabilitation approach that simultaneously combines motor activities with cognitive tasks to improve divided attention, executive function, balance, and functional mobility through task-specific neuroplastic adaptations. Conversely, CogniFit is a computerized cognitive training application that targets attention, working memory, processing speed, and executive function using adaptive digital exercises. Although CogniFit has demonstrated benefits in improving cognitive abilities, its screen-based approach does not adequately address the motor and balance impairments that commonly limit functional recovery in individuals with PCS.

Despite growing evidence supporting both dual-task rehabilitation and computerized cognitive training, direct comparisons between these interventions in individuals with Post-Concussion Syndrome are limited, particularly among middle-aged adults in the Indian population. Furthermore, there is insufficient evidence regarding which intervention provides greater improvements in cognitive function, balance, and post-concussion symptom burden under routine clinical rehabilitation. Addressing this knowledge gap is essential for developing evidence-based physiotherapy protocols that optimize functional recovery, improve quality of life, and support successful reintegration into daily activities. Therefore, the present study was undertaken to compare the effectiveness of Cognitive-Motor Dual Task Training and CogniFit Application Training on cognitive function, balance, and post-concussion symptom burden in middle-aged adults with Post-Concussion Syndrome.

Aim and Objectives of the Study

Aim:

To compare the effectiveness of Cognitive-Motor Dual Task Training and CogniFit Application Training on cognitive function, balance, and post-concussion symptom burden in middle-aged adults with Post-Concussion Syndrome.

Objectives:

1. To evaluate the effect of Cognitive-Motor Dual Task Training on cognitive function, balance, and post-concussion symptom burden in middle-aged adults with Post-Concussion Syndrome.
2. To evaluate the effect of CogniFit Application Training on cognitive function, balance, and post-concussion symptom burden in middle-aged adults with Post-Concussion Syndrome.
3. To compare the effectiveness of Cognitive-Motor Dual Task Training and CogniFit Application Training using the Montreal Cognitive Assessment (MoCA), Berg Balance Scale (BBS), and Rivermead Post-Concussion Symptoms Questionnaire (RPQ).

METHODOLOGY

This pilot randomized controlled trial employed a pre-test and post-test experimental design to compare the effectiveness of Cognitive-Motor Dual Task Training (CMDT) and CogniFit Application Training in middle-aged adults with Post-Concussion Syndrome (PCS). The study was conducted at the Outpatient Rehabilitation Department of Watrap Government Hospital after obtaining approval from the Institutional Ethics Committee of Meenakshi College of Physiotherapy, Meenakshi Academy of Higher Education and Research (MAHER), Chennai. Written informed consent was obtained from all participants before enrolment.

A total of 20 participants aged between 35 and 55 years with clinically diagnosed PCS persisting for at least three months following mild traumatic brain injury were recruited. Participants with a Montreal Cognitive Assessment (MoCA) score of 18 or above and who were able to understand English or Tamil were included in the study. Individuals with moderate or severe traumatic brain injury, other neurological or psychiatric disorders, severe visual, auditory, or musculoskeletal impairments, concurrent rehabilitation programmes, or medications affecting cognitive or motor performance were excluded.

Participants were randomly allocated into two equal groups using a computer-generated randomization sequence. Group A (n = 10) received Cognitive-Motor Dual Task Training, while Group B (n = 10) received CogniFit Application Training. Both interventions were administered for eight weeks, three sessions per week, with each session lasting 60 minutes.

The CMDT programme consisted of progressively challenging dual-task activities combining balance and gait exercises with cognitive tasks such as serial subtraction, memory recall, verbal fluency, Stroop exercises, and executive function tasks. The CogniFit group underwent adaptive computerized cognitive training using the CogniFit application, which included exercises targeting attention, memory, processing speed, executive function, and problem-solving abilities under therapist supervision.

Outcome measures were assessed at baseline and after completion of the eight-week intervention using the Montreal Cognitive Assessment (MoCA) to evaluate cognitive function, the Berg Balance Scale (BBS) to assess functional balance, and the Rivermead Post-Concussion Symptoms Questionnaire (RPQ) to determine the severity of post-concussion symptoms.

Data were analysed using IBM SPSS Statistics Version 25.0. Normality of the data was assessed using the Shapiro–Wilk test. Descriptive statistics were expressed as mean and standard deviation. Within-group comparisons were performed using the paired t-test, while between-group comparisons were analysed using the independent t-test. A p-value of less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

A total of 20 participants completed the study, with 10 participants each in the Cognitive-Motor Dual Task Training (CMDT) group and the CogniFit Application Training group. Both groups showed significant improvements in cognitive function, balance, and post-concussion symptoms after the 8-week intervention. However, the CMDT group demonstrated greater improvement than the CogniFit group across all outcome measures.

Table 1. Comparison of outcome measures before and after intervention

Outcome Measure	Group	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	p-value
MoCA	CMDT	21.73 ± 1.22	26.47 ± 1.51	<0.001*
	CogniFit	21.13 ± 1.68	23.33 ± 1.84	<0.001*
BBS	CMDT	44.73 ± 1.22	53.00 ± 1.93	<0.001*
	CogniFit	43.87 ± 2.07	46.13 ± 2.33	<0.001*
RPQ	CMDT	25.47 ± 3.14	9.53 ± 3.02	<0.001*
	CogniFit	25.73 ± 3.67	22.73 ± 3.84	<0.001*

Significant at $p < 0.001$.

The CMDT group demonstrated greater improvements in cognitive function, balance, and post-concussion symptom reduction than the CogniFit group.

Table 2. Between-Group Comparison of Post-test Outcome Measures

Outcome Measure	CMDT (Mean ± SD)	CogniFit (Mean ± SD)	Mean Difference	p-value
MoCA	26.47 ± 1.51	23.33 ± 1.84	3.13	<0.001*
BBS	53.00 ± 1.93	46.13 ± 2.33	6.87	<0.001*
RPQ	9.53 ± 3.02	22.73 ± 3.84	13.20	<0.001*

Independent t-test; $p < 0.001$.

The between-group comparison confirmed that participants who received Cognitive-Motor Dual Task Training achieved significantly better outcomes than those who received CogniFit Application Training.

The findings of the present study are supported by previous research. **Silsupadol et al. (2009)** reported that dual-task training significantly improved balance and functional mobility in comparison with single-task training by enhancing divided attention and postural control. These findings are consistent with the present study, where the CMDT group demonstrated greater improvement in Berg Balance Scale scores and overall functional performance.

Similarly, **Kim and Park (2023)** found that combined cognitive-physical dual-task training produced significantly greater improvements in cognitive function and daily functional performance than conventional cognitive training alone. This supports the present findings, in which participants receiving CMDT showed superior improvement in Montreal Cognitive Assessment scores and a greater reduction in post-concussion symptoms compared with the CogniFit group.

Overall, the results suggest that Cognitive-Motor Dual Task Training is a practical and effective rehabilitation approach for improving cognitive function, balance, and symptom recovery in middle-aged adults with Post-Concussion Syndrome. Its integration of simultaneous cognitive and motor activities may enhance neuroplasticity and facilitate better functional recovery than computerized cognitive training alone.

CONCLUSION

The findings of this pilot randomized controlled trial demonstrate that both Cognitive-Motor Dual Task Training and CogniFit Application Training significantly improved cognitive function, balance, and post-concussion symptoms in middle-aged adults with Post-Concussion Syndrome. However, Cognitive-Motor Dual Task Training produced significantly greater improvements across all outcome measures. The integration of cognitive and motor tasks appears to enhance functional recovery and reduce symptom burden more effectively than computerized cognitive training alone. Therefore, Cognitive-Motor Dual Task Training may be considered an effective, practical, and cost-efficient rehabilitation strategy for the management of Post-Concussion Syndrome in outpatient physiotherapy settings. Further studies with larger sample sizes and long-term follow-up are recommended to validate these findings.

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REFERENCES

- [1] Consensus statement on concussion in sport: the 6th International Conference on Concussion in Sport. Patricios JS, Schneider KJ, Dvorak J, et al. *Br J Sports Med.* 2023;57(11):695–711.
- [2] Nasreddine ZS, Phillips NA, Bédirian V, et al. The Montreal Cognitive Assessment (MoCA): A brief screening tool for mild cognitive impairment. *J Am Geriatr Soc.* 2005;53(4):695–699.
- [3] Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: Validation of an instrument. *Can J Public Health.* 1992;83(Suppl 2):S7–S11.
- [4] King NS, Crawford S, Wenden FJ, Moss NEG, Wade DT. The Rivermead Post-Concussion Symptoms Questionnaire: A measure of symptoms commonly experienced after head injury. *J Neurol.* 1995;242(9):587–592.
- [5] Silsupadol P, Shumway-Cook A, Lugade V, van Donkelaar P, Chou LS, Mayr U, Woollacott MH. Effects of single-task versus dual-task training on balance performance in older adults. *Arch Phys Med Rehabil.* 2009;90(3):381–387.
- [6] Woollacott M, Shumway-Cook A. Attention and the control of posture and gait: A review of an emerging area of research. *Gait Posture.* 2002;16(1):1–14.
- [7] Broglio SP, Pontifex MB, O'Connor P, Hillman CH. The persistent effects of concussion on neuroelectric indices of attention. *J Neurotrauma.* 2009;26(9):1463–1470.
- [8] Mooney G, Speed J, Sheppard S. Factors related to recovery after mild traumatic brain injury. *Brain Inj.* 2005;19(12):975–987.
- [9] Embon-Magal S, Krasovsky T, Doron I, Asraf K, Haimov I, Gil E, Agmon M. The effect of co-dependent (Thinking in Motion) versus single-modality (CogniFit) interventions on cognition and gait among community-dwelling older adults with cognitive impairment: A randomized controlled study. *BMC Geriatr.* 2022;22:720.
- [10] Bryk KN, Passalugo S, Chou LS, Reisman DS. Dual task cost in adults with persistent concussion symptoms. *Gait Posture.* 2023;101:120–123.
- [11] Shumski EJ, Schmidt JD, Lynall RC, et al. Cognition uniquely influences dual-task tandem gait performance among athletes with a concussion history. *Sports Health.* 2023;16(4):542–550.

- [12] Bherer L, Kramer AF, Peterson MS, Colcombe S, Erickson K, Becic E. Transfer effects in task-set cost and dual-task cost after dual-task training in older and younger adults. *Exp Aging Res*. 2008;34(3):188–219.
- [13] Giza CC, Kutcher JS, Ashwal S, et al. Summary of evidence-based guideline update: Evaluation and management of concussion in sports. *Neurology*. 2013;80(24):2250–2257.
- [14] World Health Organization. *International Statistical Classification of Diseases and Related Health Problems (ICD-10)*. Geneva: World Health Organization; 1992.
- [15] Gururaj G. Epidemiology of traumatic brain injuries: Indian scenario. *Neurol Res*. 2002;24(1):24–28.

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