The Academic
International Journal of Multidisciplinary Research

An Online Peer Reviewed / Refereed Journal
Volume 4 | Issue 5 | May 2026
ISSN: 2583-973X (Online), SJIF IF: 5.6
Website: www.theacademic.in

Effect of Dual-Task Training on Balance, Functional Mobility, and Quality of Life in Patients with Neurological Disorders: A Review

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DOI : https://doi.org/10.5281/zenodo.20682226

ARTICLE DETAILS

Research Paper

Accepted: 21-05-2026

Published: 10-06-2026

Keywords:

Dual-task training, single-task training, neurological disorders

ABSTRACT

Background: Neurological disorders are conditions that impact the central and peripheral nervous systems, including the brain, spinal cord, nerves, and muscles, and often lead to impairments in both motor and cognitive functions. Disorders such as Parkinson's disease, traumatic brain injury, cerebellar ataxia, and stroke can significantly affect balance, mobility, and overall quality of life. Dual-task training (DTT), involving simultaneous performance of motor and cognitive tasks, has emerged as a promising physiotherapeutic intervention that mirrors real-world functional demands. DTT has been found to be effective in improving motor-cognitive coordination, reducing fall risk, and enhancing independence. Objective: To evaluate the effect of dual-task training on balance, functional mobility, and quality of life in individuals with neurological disorders. Method: A literature review was conducted using Google Scholar, PubMed, ResearchGate, and Cochrane Library databases, limited to English-language articles published within the last fifteen years.

Keywords included 'neurological disorders' and 'dual-task training.' Seventy-six articles were identified, and eight studies met inclusion criteria based on relevance and outcome measures. Results: The reviewed studies demonstrated that dual-task training led to significant improvements in balance control, postural stability, gait performance, and cognitive-motor integration across various neurological patient populations. DTT was shown to reduce fear of falling and improve quality of life, particularly in patients with cerebellar ataxia, acquired brain injury, Parkinson's disease, and chronic cerebrovascular disease. While results varied depending on training protocols and participant characteristics, DTT consistently outperformed single-task or standard physiotherapy interventions in enhancing functional outcomes Conclusion: Dual-task training is a viable, secure, and effective intervention for individuals with neurological impairments. It has been found to be an effective intervention in improving balance, functional mobility, and quality of life in patients with neurological disorders. The review supports the incorporation of DTT into rehabilitation programs for neurological populations to reduce the risk of falls and functional decline and improve quality of life

Introduction

Neurological disorders are diseases that affect the central and peripheral nervous system, including the brain, spinal cord, nerves, and muscles. [1] Many neurological conditions commonly involve both mobility and cognitive impairments, causing movements that were once automatic to require more conscious effort and attention. [2] Physiotherapy is essential in managing neurological disorders, addressing impairments in movement, coordination, balance, and overall functional independence. Physiotherapy techniques include neurodevelopmental approaches, proprioceptive neuromuscular facilitation, dual-task training (DTT) and single-task training (STT), task-specific training, gait and balance exercises, functional electrical stimulation, etc., all of which contribute to restoring or compensating for lost motor abilities. DTT involves performing a motor task (e.g., walking) simultaneously with a cognitive task (e.g., counting or memory recall). This approach has been found highly relevant in neurological conditions where automatic motor functions become increasingly attention-demanding due to both cognitive and motor impairments. [2]

Parkinson's disease is a progressive brain disorder marked by tremors, stiffness, slow movement, and balance problems, caused by the loss of dopamine-producing neurons. [3] Parkinson's disease affects 1–2

per 1,000 people, rising to 1% over age 60, with higher prevalence in men, and 5–10% having a genetic predisposition. [4] Traumatic brain injury (TBI) results from an external force to the head, leading to a range of cognitive, motor, and behavioral impairments depending on the severity and location of the injury. [5] In 2021, there were approximately 20.84 million new cases and 37.93 million existing cases of traumatic brain injury (TBI) worldwide. [6] Cerebellar ataxia involves dysfunction of the cerebellum, leading to unsteady gait and difficulty with precise movements, often caused by genetic conditions, stroke, or tumor. [7] Recent global epidemiological studies reported a childhood ataxia prevalence of 26/100,000, with dominant and recessive hereditary cerebellar ataxia at 2.7/100,000 and 3.3/100,000, respectively. [8] Stroke occurs when blood flow to a part of the brain is interrupted due to a blockage or hemorrhage, resulting in sudden neurological deficits such as weakness, speech difficulties, and impaired balance or coordination. [9] Between 2018 and 2019, the pooled crude incidence rate of stroke was 138.1 per 100,000 people. The overall age-standardized incidence rate was found to be 103.4 per 100,000, with 125.7 for males and 80.8 for females. [10]

The theoretical foundation for dual-task training comes from the capacity-sharing theory and bottleneck models of attention, developed in the mid-20th century in cognitive psychology. [2] The capacity-sharing theory suggests that attentional resources are limited, meaning that performing two attention-demanding tasks simultaneously will lead to a decline in performance on at least one of them. As the interval between the presentations of multiple stimuli decreases, processing time increases due to the constraints of these shared attentional resources. [11] The bottleneck theory suggests that when two tasks rely on the same neural processor or network, a bottleneck occurs in information processing. As a result, the second task is delayed until the processor has completed handling the first task. This accounts for the observed delays in reaction time for the second task, which vary depending on the time gap between the two stimuli. [11, 12]

In physiotherapy and neurology, dual-task training gained prominence in the 1990s and early 2000s, particularly through studies on Parkinson's disease and geriatric fall prevention, where walking while performing a cognitive task (like counting backwards) led to noticeable changes in gait and stability. [2]

Dual-tasking is by definition conducted when two tasks with distinct goals are performed simultaneously. [10] People with neurological disorders typically experience greater difficulties while dual-tasking compared to healthy controls. A dual task requires subjects to perform complex tasks simultaneously and emphasizes the role of cognition and concentration using a dual-task method that involves a cognitive

task combined with postural and walking control. There are two types of dual-task training: cognitive-motor and motor-motor dual-task training.

In cognitive-motor dual-task training, cognitive tasks are performed with motor tasks (e.g., solving math problems while doing sit-to-stand or telling a story while doing tandem walking). In motor-motor dual-task training, two motor tasks are performed simultaneously (e.g., carrying a tray with a glass of water while doing sit-to-stand or playing with a ball while walking). DTT involves performing motor tasks while engaging in cognitive tasks; hence, it mirrors real-life challenges more accurately.

Methodology

A literature review was conducted using Google Scholar, PubMed, ResearchGate, and Cochrane Library databases, limited to English-language articles published within the last fifteen years. Keywords included 'neurological disorders' and 'dual-task training.' The search was limited to peer-reviewed articles published in the English language within the past fifteen years (2010–2024) to ensure the inclusion of the most recent and relevant evidence. An initial total of 76 articles were retrieved based on title and abstract screening. These articles were then subjected to more rigorous inclusion and exclusion criteria based on relevance to the research topic, methodological quality, and availability of full text. The studies were included in this review have neurological disorders and dual task training is given as intervention. Other than this were excluded. After this critical appraisal process, eight articles were deemed to meet all inclusion criteria and were subsequently included in this review. The characteristics of the included studies are presented in table 1.

Table 1 – Characteristics of the included studies

Study author, year & location	Study design and study population	No. of patients	Intervention and duration	Outcome	Outcome measures	Findings

Veldkamp et al. (2019) Belgium[20]	RCT - Multiple sclerosis	N=40 - EG = 20 - CG = 20	Experimental group = DTT Control group = Single mobility training 45 min every day for 8 weeks	Dual task performance Gait analysis Cognitive function Mobility and balance	Dual task cost Gait speed Symbol digit modalities test, TUG test, DGI, FES1	DTT was more effective than SMT in improving dual-task walking. Both DTT and SMT improve mobility and cognitive test scores.
Wong et al. (2019) China[14]	RCT -Older adults at risk of fall	N = 105 STWG = 35 DTWG = 35 AGWG = 35	Balance training, body transport training, and walking training with various difficulties in 10 meters walkway with different instruction allocated group -6 days a week for 4 weeks	Primary outcome : Reinvestment propensity Secondary outcomes: Walking ability, balance, fear of falling and fall incidence	MSRS-C, 10 m walk test, Tinetti balance scale, TUG test, Berg balance scale, FES 13	Dual-task training significantly enhanced certain functional aspects of gait, mobility, and balance. It did not significantly improve walking abilities. Analogy training has more benefits in improving walking performance in older adults at risk of falling.
Elwishy et al. (2020) Egypt[19]	RCT - Relapsing-remitting multiple sclerosis (RRMS)	N = 30 - EG = 15 - CG=15	Group 1: Dual-task training Group 2. Physical rehabilitation -60 mins/3 times a week for 8 weeks	Cognitive performance and walking abilities	MMSE, 10 meter walk test	DDT showed more improvement in cognitive and walking abilities in individuals with RRMS when compared to physical

						rehabilitation.
Chan et al. (2021) Hong Kong[13]	RCT - cerebellar ataxia	N = 24 Group 1 = 12 Group 2 = 12	Group 1 = DTT Group 2 = STT - 60 min, 2 sessions/week for 4 weeks	Balance, ataxia severity, Quality of life	TUG test, BBS, SARA scale, EuroQol 5D5L	Dual-task training significantly improved balance and increased the efficacy of fall prevention in the experimental group.
Spano et al. (2022) Italy[18]	Cross-sectional observational study	N = 95 CVD=31 - PD = 20 TBI=23 OND=21	-DTT -40 min/day, 3 sessions/week for 5 weeks	Balance and gait Walking endurance and speed Fear of falling, fall risk	POMA, 6MWT, 10MWT, FES, Fall history	The study found that the motor cognitive dual-task training improved balance, gait, endurance, and speed and reduced fall fear, especially in cerebrovascular and Parkinson's disease patients.
Spano et al. (2022) Italy[16]	Pilot RCT - Cerebrovascular patients	N = 26 Mix T= 13 (mixed motor & cognitive training) DTT=13	MixT-30 motor training & 30 min cognitive training separately. DTT 40 mins 3 sessions/week for 5 weeks	Balance and gait, fear of falling, physical performance, and gait speed	POMA, FES-1, 6MWT	Dual-task training improves walking balance, gait, walking speed and reduces fear of falling in chronic CVD.
Wiśniowska et al. (2023) Poland[15]	RCT - Elderly adult	N = 65 - CM=19 - MT=19 - CT=20 - C=20	- Group 1: Dual task training (CM) Group 2: Cognitive training (CT) -Group 3: Motor training (MT) -Control group = no -30 min/3 times/week for 4 weeks	Orientation and planning, number of errors, postural balance	Specialized game-based software, Wii balance board	Dual-task cognitive motor training in the elderly initially increased errors but effectively reduced the interference effect over time, enhancing cognitive and motor performance.

Winser et al. (2024) China[17]	RCT - cerebellar ataxia	N = 32 EGCIBT = 16 STT = 16	couple-induced balance training—cognitive tasks during physical tasks . STT 60 min/3 times/week for 4 weeks	Physical and cognitive tasks Performance, functional balance, dynamic stability, cognitive function, number of falls, and quality of life	TUG test, BBS, SARA scale, LOS, MOCA, EQ-5D-5L	CIBT significantly improve dynamic balance (p=0.04) and dual tasking ability (p=0.01), no significant difference in fear of fall, disease severity, and quality of life between both groups.

EG = Experimental group, CG = Control group, DTT = Dual task training, STT = Single task training, BBS = Berg balance scale, TUG = Timed up and go test, SARA = Scale for the assessment and rating of ataxia

Results

In neurological populations, dual-task training (DTT) has been demonstrated to greatly enhance balance, gait performance, postural control, and cognitive-motor integration. Patients with multiple sclerosis, Parkinson's disease, cerebellar ataxia, traumatic brain injury, and chronic cerebrovascular illness had increased mobility and reduced fear of falling as compared to those who underwent single-task or conventional physiotherapy. Despite variations in training schedules and participant characteristics affecting the degree of effects, DTT consistently outperformed traditional approaches in promoting functional independence and improving quality of life.

Discussion

These results demonstrated that DTT was a viable and safe rehabilitation approach that concurrently treated cognitive and motor deficiencies, more accurately mirroring functional demands in the real world than single-task physiotherapy. Studies showed better balance, gait walking speed, postural stability and reduced fear of falling in patients with Cerebellar ataxia, Parkinson’s disease, Multiple sclerosis and Stroke compared to single task training or conventional physiotherapy. One of the key strengths of DTT lies in its ability to enhance both motor performance and cognitive-motor coordination. By training

patients to divide attention and manage competing demands, DTT may improve neural efficiency and adaptability. This is particularly relevant for reducing fall risk, as many falls occur during multitasking situations in daily life. Furthermore, improvements in psychosocial outcomes such as increased confidence, reduced anxiety related to movement, and greater participation in daily activities suggest that DTT contributes not only to physical recovery but also to overall quality of life. Incorporating DTT into rehabilitation programs may lower fall risk and promote independence in neurological populations, according to the consistent gains in mobility, balance and psychosocial outcomes. However, in order to validate these findings and develop more robust clinical guidelines, bigger, standardized studies with long-term evaluation are required due to the variety of study designs, small sample sizes, and short follow-up periods.

Conclusion

This review highlights the growing body of evidence supporting the effectiveness of dual-task training intervention in improving functional outcomes among individuals with neurological impairments and older adults at risk of falls. The reviewed studies consistently demonstrate that combining cognitive and motor tasks can lead to significant improvements in balance, gait, postural control, cognitive performance and reduced fear of falling. While the magnitude and longevity of benefits may vary across populations and study designs, dual-task training appears to be a feasible, safe and impactful strategy. Particularly notable are its applications in conditions such as cerebellar ataxia, acquired brain injury and chronic cerebrovascular disease, where it addresses both physical and cognitive deficits. These findings underscore the potential for dual-task rehabilitation protocols to enhance the quality of life and independence of affected individuals.

Miscellaneous

Study limitation : small sample sizes and short follow up periods
Scope of further studies : population specific protocol and long term assessment
Funding : No source of funding
Conflict of interest : None
Ethical clearance : Not required

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