RESEARCH PAPER

Impact of Dual task training vs single task training on balance, gait speed and cognitive function in Post stroke patients: A systematic review

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ABSTRACT

Background: Stroke is a leading cause of long-term disability worldwide and is commonly associated with impairments in gait, balance, mobility, and cognitive function. Many activities of daily living require the simultaneous performance of motor and cognitive tasks, known as dual-task performance. Following stroke, deficits in cognitive-motor integration often result in reduced functional independence and increased fall risk. Dual-task training has emerged as a promising rehabilitation strategy aimed at improving both motor and cognitive abilities simultaneously. However, the comparative effectiveness of dual-task training over conventional single-task training remains uncertain.

Aim: The aim of this systematic review was to compare the effects of dual-task training and single-task training on balance, gait speed, dual-task performance, and cognitive function in post-stroke patients.

Methodology: This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and was prospectively registered with PROSPERO (Registration No. CRD420251180959). A systematic literature search was performed using electronic databases including PubMed, PEDro, Scopus, Cochrane Library, MEDLINE, Web of Science, and EMBASE, along with grey literature sources. Studies involving adult stroke patients receiving dual-task or single-task interventions were considered for inclusion. Methodological quality was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist, while the certainty of evidence was evaluated using the GRADE approach. A total of 30 studies involving approximately 1,525 participants were included in the review.

Results: The findings demonstrated that dual-task training was generally more effective than single-task training in improving functional outcomes following stroke. Moderate evidence supported improvements in gait speed, dual-task performance, and cognitive function, while high-quality evidence supported improvements in balance outcomes. Participants receiving dual-task interventions showed greater gains in gait velocity, postural stability, reduction in dual-task interference, and enhancement of executive function and attention compared with those receiving conventional single-task training. Although some studies reported mixed findings for cognitive outcomes, the overall direction of evidence favored dual-task rehabilitation approaches.

Conclusion: Dual-task training appears to be a superior rehabilitation strategy compared with single-task training for improving gait speed, balance, dual-task ability, and cognitive performance in individuals with stroke. Incorporating cognitive demands into motor rehabilitation may better simulate real-life activities, improve functional independence, and reduce fall risk in post-stroke patients. Further high-quality randomized controlled trials with standardized intervention protocols are recommended to strengthen the current evidence base.

Keywords: Stroke, Dual-task training, Single-task training, Gait speed, Balance, Cognitive function, Rehabilitation, Systematic review.

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INTRODUCTION:

Stroke is a pervasive global health issue, stands as a leading cause of enduring disability, inflicting a range of motor impairments that include muscle weakness, vexing spasticity, coordination loss, and precarious balance deficits. These impairments following a stroke significantly affect activities of daily life, increasing the likelihood of falls and limiting functional mobility. Stroke rehabilitation programs center their efforts on evaluating and addressing these mobility challenges.[1]. Its common causes include stenosis, occlusion, or rupture of intracranial and extracranial arteries, which results in impaired cerebral blood flow circulation, brain tissue damage and various functional impairments. Stroke is characterized by high morbidity, mortality, and disability. A survey has shown that 1 in 6 people worldwide has suffered from stroke, and about 90% of these stroke survivors will have varying degrees of functional impairment, of which walking dysfunction is one of the major ones. It not only reduces patients' ability to perform daily activities but also increases the risk of falls. Therefore, it is crucial to restore walking

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ability. Walking is a rhythmic movement and is the basis of activity, and its basic motor pattern arises in the spinal cord and is achieved through the control of muscles, while its initiation and fine regulation involve the synergistic action of different brain regions such as the cerebral cortex, cerebellum and brainstem. Current methods to improve walking ability after stroke are mostly based on the plasticity of the central nervous system and promote the improvement of motor ability after brain injury by improving patients' lower limb muscle strength and walking ability through single-task training including standing, walking, and balancing. However, more researchers have seen the importance of cortical function for walking and have placed more emphasis on some methods to improve walking ability by activating cognitive processes in the cortex [2

Many activities of daily living require the performance of more than one task at a time and include dual tasks that involve the simultaneous performance of two movement tasks. Performing one task while simultaneously performing another task or performing two or more tasks continuously and simultaneously is referred to as "dual-task performance". When put into a situation of dual-task performance, people whose cognitive or physical functions are not smooth, such as stroke patients and the aged, lose their physical abilities or experience physical injuries, such as falls. For this reason, studies are being conducted on the application of dual-task performance for subjects such as stroke patients and aged people. [6]. To this end, clinicians employ standardized clinical tests to assess various aspects of mobility in stroke recovery. For instance, the Timed Up and Go test (TUG)measures transitional movements, the Sit to Stand test (STS) evaluates sit-to-stand transfers, and standing balance assessments scrutinize the equilibrium provided by the neuromusculoskeletal system. Moreover, the 10 m Walk Test (10MWT) quantifies gait speed, shedding light on functional independence.

Regrettably, stroke survivors (SS) often exhibit significantly poorer performance on these tests compared to their healthy peers, starkly underscoring the profound impact of stroke on mobility .With efforts toward recovery, healthcare professionals employ these assessments as indispensable tools to guide rehabilitation, striving to restore not just physical abilities but also the quality of life of stroke survivors.[1]

Dual-task training usually includes motor or balance tasks and secondary tasks that required for distraction, and is divided into two main types: motor-motor dual-task and motor-cognitive dual-task. Motor-motor dual-task refers to the simultaneous execution of motor training and postural control training, such as walking while tapping or kicking a ball. In contrast, MCDTT refers to performing motor training along with cognitive training tasks, such as counting or reciting poetry while walking. In recent years, there has been an increasing recognition of the importance of MCDTT in stroke rehabilitation.

Among the many functional walking rehabilitation treatments, the cognitive walking dual task combines motor and cognitive tasks simulating walking in a realistic environment, which can compensate for the current single walking training treatment in stroke rehabilitation and is more relevant to daily life. There are a wide variety of cognitive tasks, and researchers have categorized five main types of cognitive tasks: differentiation and decision-making tasks, information tracking tasks, reaction time tasks, verbal fluency tasks, and working memory tasks. However, different cognitive task types also produce different training effects. Several studies have confirmed that two or more cognitive training tasks performed simultaneously with motor training can effectively improve balance and gait in stroke patients, which in turn can effectively improve walking dysfunction in stroke patients.[2][3] Motor-cognitive interference is that when an individual performs two or more tasks simultaneously, which may produce a reduction in the performance of one or more of these tasks. Bottlenecking occurs if two tasks require the same mechanism at the same time, which results in behavioural impairment in one or all the tasks. There are often different patterns of performance, where reduced performance on motor tasks only is referred to as cognitive-related motor interference, and conversely reduced performance on cognitive tasks only is referred to as motor-related cognitive interference, or mutual interference if both motor and cognitive performance are reduced.[2][3] Decreased lower-limb coordination is one of the reasons for the increased risk of falls in stroke patients. Lower-limb coordination refers to the ability of joints and segments of the lower limbs to harmoniously complete target movements, helping maintain stability during walking and playing an important role in walking ability. Approximately 63.8 % of stroke patients experience hemiplegia which impairs lower-limb coordination and significantly increases the risk of falling. Falls are the leading cause of injury-related deaths worldwide. Therefore, effective rehabilitation therapy is essential to restoring coordination in stroke patients, thereby preventing falls. Dual-task training has been shown to improve walking ability in stroke patients. It is typically classified into motor-motor dual-task training (two motor tasks performed together) and cognitive-motor dual-task training (a cognitive task performed alongside a motor task). Previous studies indicates that dual-task training can effectively improve walking speed, balance, and dual-task performance in stroke patients. Additionally, cognitive-motor dual-task training can also improve cognitive function. However, the specific effects of these two training types on lower-limb coordination during walking in stroke patients remain unclear. Traditional scales or coordination tests offer qualitative assessments but cannot precisely quantify lower-limb coordination Therefore, we used Mean continuous relative phase (MCRP) and mean continuous relative phase variability (MCRPV) to quantitatively describe and evaluate coordination. MCRP integrates the temporal and spatial information

of two joints to describe coordination patterns, including in-phase, anti-phase, and out-of-phase coordination. The closer the relative phase is to 0◦, the more the two joints approach in-phase or anti-phase movement, meaning the movement of one joint induces the same-direction or opposite-direction movement of the other joint. The closer the relative phase is to 90◦, the more the two joints approach out-of-phase movement, indicating the movements of the two joints are not temporally or spatially related. MCRPV represents coordination variability, reflecting the stability of the coordination pattern. Previous studies have shown that stroke patients exhibit more in-phase or anti-phase coordination patterns between the affected joints, which may indicate poor neuromuscular control ability. Their coordination variability is also higher than that of healthy individuals, indicating less efficient lower-limb control during walking, which could increase the risk of falling.[4] stroke neurorehabilitation focuses on gait and thus improvements in the patients' survival, personal autonomy, social inclusion, and quality of life (QoL), Although gait rehabilitation (GR) is effective for motor impairments, falls remain a major risk factor for stroke complications. The development of effective methods for balance and mobility rehabilitation is a priority for stroke patients, their caregivers, and healthcare professionals. Although GR is often effective for gait during rehabilitation sessions, the transfer of gait skills to daily living is more challenging; this discrepancy can be due to a change in attention, which is focused on gait during the training session but not on gait in everyday life. Tese observations suggest that cognitive-motor interference (CMI) is a major contributor to activities of daily living after stroke. It is known that CMI is abnormally frequent among stroke victims. Dual-task (DT) walking can be used to evaluate CMI and attention-demanding mobility functions after stroke. Community ambulation, social inclusion, and QoL require the ability to simultaneously walk and execute one or more cognitive tasks. Poor functional mobility after stroke appears to be linked to worsened DT ability and attentional impairments. CMI can account for the greater relative deterioration in DT performance than in single task (ST) performance. Tis DT deterioration has been attributed to the greater attentional allocation needed to compensate for the gait impairment (requiring functional executive networks). Executive functions are often impaired after a stroke, and these higher cognitive processes (e.g., volition, planning, purposive action, action monitoring, and cognitive inhibition) are required for the coordination. [5] This study aims to provide evidence-based insights to guide clinical decision-making and optimize rehabilitation strategies for enhancing functional recovery after stroke. It further seeks to evaluate the impact of stroke and concurrent motor–cognitive dual-tasking on commonly used clinical assessments, including the Timed Up and Go test (TUG), Sit to Stand test (STS), standing balance tests, and the 10 m Walk Test (10MWT). Additionally, the study aims to compare single-task and dual-task performance between stroke survivors and healthy controls, and to examine the interaction effects of stroke and dual-task conditions on overall functional outcomes. By addressing inconsistencies in existing evidence and identifying deficits in motor and cognitive performance, this study intends to contribute to a better understanding of mobility impairments, particularly those related to lower limb coordination and balance. Ultimately, the findings are expected to support the development of more effective, task-specific rehabilitation approaches for improving walking ability and reducing fall risk in individuals after stroke.

METHODOLOGY:

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a transparent and standardized reporting process. A systematic literature search was performed across multiple electronic databases including PubMed, PEDro, Scopus, Cochrane Library, MEDLINE, Web of Science, and EMBASE. Grey literature sources such as Google Scholar and ClinicalTrials.gov were also searched to identify additional relevant studies. Three independent reviewers screened the titles, abstracts, and full texts of the retrieved studies and extracted data related to participant characteristics, intervention details, study methodology, outcome measures, and key findings. The methodological quality of the included studies was assessed using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist, while the certainty of evidence was evaluated using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach. The study selection process was documented using a PRISMA flow diagram. The review protocol was prospectively registered with PROSPERO (Registration No. CRD420251180959).

Search strategy-

The search strategy included the following keywords: Hemorrhagic stroke, brain hemorrhage, cerebral hemorrhage, midlife adults, late middle age, senior adults, dual task training, single task training, physiotherapy rehabilitation, using Boolean words: AND and OR

Eligibility Criteria:

Studies were considered eligible for inclusion in this systematic review if they involved adult participants diagnosed with stroke at any stage of recovery, including acute, subacute, or chronic phases. The review included studies that investigated the effects of dual-task training, cognitive-motor dual-task training, or compared dual-task interventions with conventional single-task training. Eligible studies reported outcomes related to gait speed, balance, functional mobility, cognitive performance, or dual-task ability. Randomized controlled trials, quasi-experimental studies, pilot studies, and observational studies published in peer-

reviewed journals and written in English were included. Studies were excluded if they involved participants with neurological disorders other than stroke, did not assess dual-task interventions, lacked relevant outcome measures, were review articles, case reports, conference abstracts, or if the full text was unavailable.

Data extraction process:

Prospero registration id - CRD420251180959

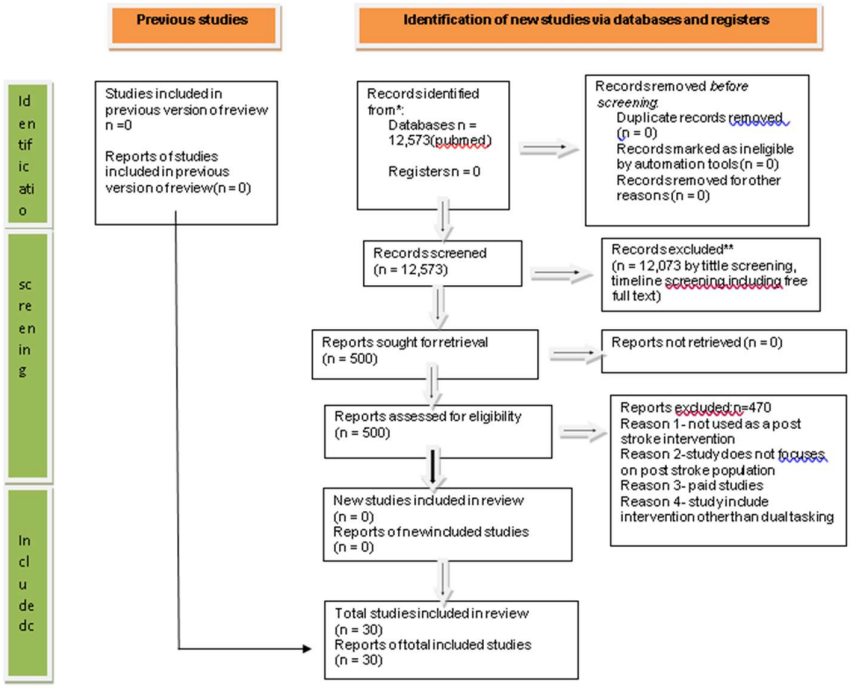

Diagram – PRISMA flow chart

Table1: Methodological quality assessment of studies using JBI Joanna briggs Institute Critical Appraisal Checklist

	True randomization used	Allocation concealed	Rx grp similar at baseline	Blinding participants	Blinding therapist	Rx grp treated identically	Blinding assessor	Outcome measured same way	Outcome measured reliable way	Follow up	Participants analysed in randomised way	Appropriate Ststistical analysis	Appropriate trial design
Guibin et al	1	na	1	0	0	0	1	1	1	1	1	1	1
Liang–chuanlai et al	1	1	1	0	0	1	1	1	1	1	1	1	1
Ruifeng sun et al	1	na	1	0	0	1	na	1	1	1	1	1	1
Marcoyiu chunk et al	1	1	1	0	0	1	1	0	0	1	1	1	1

Kyung hun kim et al	1	na	1	0	0	1	0	1	1	1	1	1	1
Sophie tasseel [a protocol]	1	na	1	0	0	1	0	1	na	na	1	1	1
Umair ahmed et al	1	na	1	1	0	1	1	1	na	1	1	1	1
Prudence plummer d amato	1	na	1	1	0	1	1	1	na	1	1	1	1
Jun hwan choi et al	1	na	1	0	0	1	1	1	0	1	1	1	1
Kim KJ et al	1	na	1	0	0	1	na	1	1	1	1	1	1
Liang chuan lai et al	1	na	1	0	0	1	1	1	1	1	1	1	1
Kyung hun kim	1	na	1	0	0	1	1	1	1	1	1	1	1
Chuang yoon baek et al	1	0	1	0	0	1	1	1	1	1	1	1	1
Gye yeop kim et al	1	na	1	0	0	1	1	1	1	1	1	1	1
Derrick T wade et al	1	na	1	1	0	1	1	1	na	1	1	1	1
Wayne PM et al	1	na	1	0	0	1	1	1	na	na	1	1	1
Sun R et al	1	na	1	0	0	1	1	1	1	1	1	1	1
Dorit hyndman et al	1	0	1	0	0	1	1	1	1	1	1	1	1
Yan ci liu et al	1	na	1	0	0	1	1	1	1	na	1	1	1
Su yeon	1	0	1	0	0	1	1	1	1	1	1	1	1

hong et al													
Chen huimeng et al	1	na	1	0	0	1	1	1	1	na	1	1	1
Muhammad iqbal et al	1	na	1	0	0	1	1	1	1	na	1	1	1
Masoud abdollahi et al	1	0	1	0	0	1	1	1	1	1	1	1	1

Table2: Summary of GRADE certainty of Evidence for included outcomes

OUTCOMES	NO. OF STUDY	NUMBER OF PARTICIPANTS	EFFECT ESTIMATES	CERTAINTY OF EVIDENCE	COMMENTS
GAIT SPEED	18	1,134 participants	the majority of studies demonstrated statistically significant improvement in gait speed, with only a few showing small or no effect. The direction of effect was consistently positive across studies.	MODERATE ⨁⨁⨁◯	Certainty is moderate due to consistent positive findings across most studies. However, some uncertainty exists because a few studies reported small or no effects, and variability in intervention protocols and outcome measures was observed.
BALANCE	18	1248 participants	almost all studies showed improvement in balance, with only one study reporting deterioration under dual-task conditions. The findings indicate a strong and consistent positive effect of intervention on balance	HIGH ⨁⨁⨁⨁	High certainty of evidence due to strong and consistent improvement reported in nearly all studies. Minimal uncertainty, though one study showed no effects under dual-task conditions, possibly due to task complexity.
DUAL TASK	30	1,815 participants	dual-task training demonstrated a consistent positive effect, with moderate to large improvements in performance across most studies, although not uniformly in all.	MODERATE ⨁⨁⨁◯	Moderate certainty as the majority of studies showed significant improvements with moderate to large effect sizes. Some uncertainty remains due to heterogeneity in study designs and a few non-significant findings.
COGNITION	17	1,114 participants	the findings indicate a mixed but generally positive effect of dual-task training on cognition. Improvements were	MODERATE ⨁⨁⨁◯	Moderate certainty with an overall positive trend. However, uncertainty is present due to mixed findings, variability in cognitive domains

			commonly seen in executive function, attention, and global cognition, though results were not consistent across all studies.		assessed, and some studies showing minimal or negative effects

Table 3:Summary of findings of all studies

SL. NO	AUTHOR	STUDY DESIGN	INTERVENTION	DURATION	OUTCOME MEASURES	YEAR	CONCLUSION
1	Gui bin Song et al	RCT	Dual task training, single task training	training 30 min per day, five times per week, for eight weeks	Balance , dual task , anterior limit of stability, posterior limit of stability,	2015	dual-task training and single-task training were effective in improving balance in stroke patients, dual task training is more effective for increasing balance ability.
2	Liang-Chuan Lai et al	RCT	Cognitive-Motor Multi-Task, Cognitive Dual-Task, or Motor Dual-Task training	60-minute training sessions per week for four weeks.	Gait speed,Cognitive score, dual-task Timed Up and Go test (TUG), Functional Gait Assessment (FGA), and Activities-specific Balance Confidence scale (ABC	2025	Balance training combined with Cognitive-Motor Multi-Task enhances immediate and retained effects on cognitive and motor dual-task walking in ambulatory patients after stroke.
3	Sophie Tasseel-Ponche1 et al	RCT protocol	DTs (phasic, executive function, praxis, memory, and spatial cognition tasks during gait) in the DT (experimental) group and gait exercises only in the ST (control) group	30 min three times a week, for 4 weeks	gait speed, post-stroke impairments, mobility anddynamic balance, ST and DT cognitive function, personal autonomy,restrictions in participation, health-related quality of life	2023	The trial focuses on a new GR program applicable at various stages after stroke and during neurological disease.
4	Marco Yiu Chung Pang, PhD et al	RCT	mobility tests (forward walking, timed-up-and-go,	three 60-minute sessions per week for 8 weeks.	Dual-task interference (%),balance , cognitive function	2018	The dual-task program was effective in improving dual-task mobility,

			and obstacle crossing) and for the correct response rate during serial-3-subtractions and verbal fluency task				reducing falls and fall-related injuries in ambulatory chronic stroke patients with intact cognition. It had no significant effect on activity participation or quality of life.
5	Park J et al	RCT	Dual task training,	for 5 days a week for 3 weeks	Balance, hand function	2017	dual task training is effective for the enhancements of the hand function and the balancing ability of the stroke patients
6	Derick T Wade et al	RCT	treadmill program at an aerobic training intensity (55-85% heart rate maximum), either with, or without simultaneous cognitive demands	a 10 week, bi-weekly, 30 minutes treadmill program	two-minute-walk tests with and without cognitive distraction, dual task effect on walking and cognition; SF-36, EuroQol-5D-5L, Physical Activity Scale for Elderly (PASE), and step activity.	2019	Walking with specific additional cognitive distraction (dual-task training) might increase activity more over 12 weeks
7	Umair Ahmed1 et al	RCT	high-intensity training, multiplanar trunk movements, and dual-task practice	12 months	trunk impairment scale (TIS) scores. scores on the Berg balance scale, 10-meter walk test, Timed-up-and-go test, timed-Up-Go–cognitive, and Stroke Impact Scale-16	2021	Intensive multiplanar trunk movements coupled with dual-task practice promoted trunk control, balance, and functional recovery in patients with stroke, reduced fall risk, and improved independent mobility
8	Kyung-Hun Kim 1 et al	RCT	task-specific training (TST) combined with cognitive sensorimotor exercise (CSE)	eight weeks	Gait speed, cognitive function, balance	2021	These findings suggest that the TST combined with CSE provided

			on proprioception, spasticity and gait speed				significant improvements in proprioception, spasticity, and gait speed
9	Prudence Plummer et al	RCT	Single task training, dual task training	times a week for 4 weeks.	dual-task effect on gait speed (DTEg, %) and cognitive task performance (DTEc, %), gait speed, cognitive performance, balance	2021	DTGT and STGT improved single and dual-task gait speed but did not change the amount of relative interference
10	Masoud Abdollahi et al	Observational study	Timed Up and Go (TUG), Sit-to-Stand (STS), balance, and 10-Meter Walk (10MWT) tests under single and dual-task (counting backward) conditions		Cognition, Gait Speed, Balance Steps ,dual task	2024	Stroke survivors showed poorer performance than healthy controls in mobility tests, with slower movement and greater balance instability, especially under dual-task conditions. These findings highlight the importance of dual-task assessment in stroke rehabilitation to better detect impairments and guide targeted interventions.
11	Huimeng Chen1 et al	RCT	Cognitive and motor dual task, task specific dual task	4 weeks	Lower-limb coordination during dual-task, gait parameters	2026	dual-task gait training improves lower-limb coordination and balance in stroke patients
12	Yan-Ci Liu1 et al	RCT	cognitive dual task gait training (CDTT), motor dual task gait training (MDTT), or conventional physical therapy (CPT)	30 min/session , 3 sessions/week for 4 weeks	gait speed, dual task cost of gait speed (DTC-speed), cadence, stride time, and stride length, cognition, balance.	2017	different types of dual task gait training can be adopted to enhance different dual task gait performance in stroke.

			strengthening, balance, and gait training				
13	Su-Yeon Hong [1] et al	Experimental study	Single task training, dual task training, cognitive therapy	30 min a day, 3 times a week, for 4 weeks	Gait ability, balance, cognitive function, dual task, postural balance	2020	Cognitive task training could be used in clinical rehabilitation as a more effective intervention method to improve balance and gait ability of stroke patients.
14	Chen Huimeng a et al	RCT	cognitive dual-task gait training and motor dual-task gait training	three times a week for 4 weeks	Lower limb coordination, walking ability, rehabilitation effects of dual task, cognition	2025	cognitive dual-task gait training and motor dual-task gait training can effectively improve lower-limb coordination in subacute stroke patients, and there is no difference in the effects of the two training methods.
15	Muhammad Iqbal1 et al	RCT	Dual task training, conventional physiotherapy	8 months	spatial and temporal variable of gait, 10-meter walk,cadence, step length, stride and cycle time, dual task	2020	Conventional physical therapy and dual task training effectively improved gait ability of chronic stroke patients, and the latter showed significant improvement in all spatial and temporal gait variables compared to former.
16	Chang Yoon Baek, PT, MS Et al	RCT	Dual and single task training on treadmil	for 60 minutes, twice a week, for a period of 6 weeks	Gait speed Stride length Gait variability Cadence Single-task condition Dual-task condition Fall Efficacy	2022	Dual-task gait treadmill training was more effective in improving gait ability in dual-task training and dual-task interference

							than single-task training involving gait and cognitive task separately in people with chronic stroke
17	Wayne PM et al	Observational study	Single-Task Walking (ST) Dual-Task Walking		on lower extremity muscle co-contraction during single- and dual-task gait, balance	2021	Lower extremity muscle co-contraction may play a role in the observed benefit of longerterm TC training on gait and postural control
18	Rita Chiaramonte, MD1 Et al	Observational study	Single and dual task proprioceptive training		Balance, gait, fall risk, cognition	2024	goal-oriented proprioceptive training improved balance , cognition and reduces fall risk.
19	Mona Mahmoud Ali1* et al	Quasi-experimental study	Dual-task exercises, combining motor and cognitive challenges,	8 weeks	Balance Risk of fall Activities of daily living (ADL dependency) Dual task performance	2025	Dual-task exercise training significantly improves balance, reduces fall risk, and enhances independence in ADLs among stroke patients
20	Lei Yang1,2,3 et al	Observational measurement study with a test-retest design	walking tasks (walking forward at self-selected and maximal speed, walking backward at self-selected speed, and crossing over obstacles), attention-demanding tasks	tested twice within 3–4 days	psychometric properties of dual-task, Walking Task. Cognitive Task Outcomes, Manual Task Outcomes, Dual-Task Effect (DTE)	2016	The walking time derived from the various dual-task assessments generally demonstratedgood to excellent reliability. Relatively low reliability was shown in the cognitive outcomes and DTE, which may not be preferred measurements for assessing

							dual-task performance
21	Sungbae Jo et al	RCT	Dual task exergame training, balance training, cognitive training	20 sessions over 4 weeks	Cognitive function, motor function, dual task, balance, gait, ADLs	2026	Dual-task exergaming is a feasible and effective approach for enhancing both motor and cognitive functions in chronic stroke survivors, yielding superior outcomes compared to conventional balance training
22	Hee-Su An1 et al	RCT	Dual task training, conventional therapy	for 30 minutes per session, 5 times per week for 5 weeks.	Cognition Dual-task Upper extremity function QOL	2021	dual-task training that combined attention and executive function with daily living activities was found to be meaningful
23	Li-Ling Chuang et al	RCT	dual-task , single-task training	4 weeks	Gait Speed (DTE) Cognition (DTE) Balance Gait Speed (Absolute)	2024	Dual-task training enhances immediate and retained effects on the dual-task effects of gait speed in individuals with stroke, not by cognitive-motor trade-offs.
24	Liang-Chuan Lai et al	RCT	Cognitive-Motor Multi-Task, Cognitive Dual-Task, or Motor Dual-Task training, single task	4 weeks	gait speed and cognitive score ,single-and dual-task conditions.	2025	Balance training combined with Cognitive-Motor Multi-Task enhances immediate and retained effects on cognitive and motor dual-task walking in ambulatory patients after stroke
25	Hogene Kim1 Et al	RCT	dual-task , single-task		Motor Speed Motor Accuracy, Cognitive Speed,	2021	speed and accuracy were complementary

			training, cognitive task		Cognitive Accuracy, cognitive motor interference, dual task		parameters that may indicate clinical effectiveness in motor and cognitive outcomes in individuals with stroke.
26	Anne Deblock-Bellamy et al	Pilot Observational Study	Assessment-based protocol using Virtual Reality (VR):Walking in a virtual shopping mall corridor. Simultaneous cognitive task (memorizing & recalling a 5-item shopping list) Two difficulty levels: walking with or without obstacle, cognition with or without list modification	2 sessions (~90 minutes each)	Locomotor performance, Cognitive performance: , Dual-task cost (DTC): %	2022	Stroke survivors showed significant dual-task interference, especially in complex tasks, affecting both cognitive and walking performance. VR-based assessment is useful for understanding real-life dual-task abilities but needs further validation before clinical use
27	Jody A. Feld, DPT1 et al	Observational study	Single task walking, dual task walking		Daily ambulatory activity, single and dual task gait speed, cognitive performance	2018	Dual task gait speed better explains daily walking activity than single task gait speed;
28	Jun Hwan Choi et al	RCT	Dual task training, single task training	4 weeks	Balance, cognition	2015	dual-task training could be as effective as conventional balance training for improving balance and cognition in subacute post-stroke patients
29	Keun-Jo Kim et al	RCT	treadmill cognitive dual-task gait training and single task training	5 times per week, for a total of 4 weeks	Gait Speed Gait velocity Balance	2018	progressive treadmill cognitive dual-task gait training had a positive in-fluence on the gait and clinical gait index in chronic stroke patients

30	Ruifeng Sun1 et al	RCT	cognitive-motor dual-task (CMDT)	2 years	cognitive function, neuron electrophysiology, and frontal lobe hemodynamics	2022	CMDT training in patients with PSCI improved global cognitive function, which was supported by the improved neural e_ciency of associated brain areas

Table 4:GRADE evidence profile of included outcomes

OUTCOMES	NO. OF STUDY	STUDY DESIGN	QUALITY OF EVIDENCE FACTORS	ASSUMED RISK	CORRESPONDING RISK	OVERALL QUALITY OF EVIDENCE	IMPORTANCE
GAIT SPEED	17 with 962 participants	14 RCT + 3 observational study	Risk of Bias There is moderate concern for risk of bias. Some studies had small sample sizes, unclear allocation concealment, and limited blinding. However, most studies still reported consistent positive effects, which reduces the overall impact of bias on findings. Inconsistency There is no serious inconsistency. Almost all studies reported improvement in gait	The assumed risk reflects baseline gait speed before intervention. Across studies, participants generally showed reduced gait speed due to underlying clinical conditions, indicating impaired mobility at baseline.	After intervention, gait speed improved in most studies. Several trials reported statistically significant improvements, including meaningful increases in walking speed and moderate-to-large effect sizes, indicating better post-intervention mobility	The overall certainty of evidence for gait speed is MODERATE, mainly due to some risk of bias but otherwise strong consistency and sufficient data	Gait speed is considered a critical outcome because it reflects functional mobility, independence, and overall physical performance in clinical populations.

			speed, and the direction of effect was consistent across the evidence base Indirectness There is no serious indirectness. The populations, interventions (dual-task or related training), and outcome measures directly match the research question Imprecision There is no serious imprecision. The total sample size is large Publication Bias / Other Considerations There is no strong evidence of publication bias, although it cannot be fully excluded.				
BALANCE	14 with 1,039 participants	11 RCT+ 2 observational study+ 1 experimental study	Risk of Bias the majority of studies consistently reported positive effects, which reduces the	The assumed risk represents baseline balance performance before intervention.	After intervention, most studies demonstrated clear improvement in balance outcomes. Several trials reported clinically	The overall certainty of evidence for balance outcomes is HIGH, indicating strong confidence	Balance is a critical outcome because it directly reflects postural stability, fall risk reduction, and

			overall impact of bias on the pooled evidence. Inconsistency There is no serious inconsistency. Most studies reported improvement in balance outcomes, with only isolated findings of temporary worsening under dual-task conditions. Overall, the direction of effect is consistently positive across studies. Indirectness There is no serious indirectness. The included studies directly assessed balance as a primary or secondary outcome in relevant clinical populations undergoing similar interventions Imprecision There is no serious imprecision. The total	Across included studies, participants generally showed impaired balance ability at baseline, as reflected by reduced balance scores, increased sway, and poorer functional mobility measures.	meaningful gains in balance scores such as BBS improvements, reduced postural sway, and better functional mobility tests like TUG, indicating overall enhancement in postural control following intervention.	that the intervention improves balance performance.	functional independence in daily activities.

			sample size is large Publication Bias / Other Considerations There is no strong evidence of publication bias. While some variation exists in reporting of effect sizes, the presence of both large and small effect studies reduces concern for selective publication				
COGNITION	17 with 1,114 participants	14 RCT+ 2 observational study+ 1 experimental study	Risk of Bias There is moderate concern for risk of bias. Many studies are randomized controlled trials, but some include quasi-experimental designs and limited blinding. These methodological limitations may influence the strength of reported effects, although overall trends remain informative.	The assumed risk represents baseline cognitive performance before intervention. Across studies, participants commonly showed mild to moderate cognitive impairment, particularly in domains such as executive function, attention, and processing speed, as measured	After intervention, several studies demonstrated improvements in cognitive outcomes. These included gains in executive function, global cognition, attention, and processing speed. However, the magnitude of improvement varied across studies, with some showing clear benefits and others showing minimal or no change.	The overall certainty of evidence for cognition outcomes is MODERATE, due to variability in results across studies and moderate risk of bias, despite meaningful improvements in several trials.	Cognition is considered a critical outcome because it directly affects attention, executive function, and the ability to perform dual-task activities and daily living functions safely and independently.

			Inconsistency There is moderate inconsistency. While several studies report significant improvements in cognition, other studies show no significant effect or minimal change. Indirectness There is no serious indirectness. The included studies directly assessed cognitive outcomes using validated measures such as MMSE, MoCA, and executive function tests, making the evidence applicable to the target population. Imprecision There is no serious imprecision. The total sample size is reasonably large. Publication Bias / Other Considerations	by tools like MMSE, MoCA, and Stroop test.			

			There is no strong evidence of publication bias, although selective reporting of positive cognitive outcomes cannot be fully excluded.				
DUAL TASK145	28 with 1458 participants	18 RCT+ 6 observational studies(including pilot/measurement)+2 experimental study + 2 quasi-experimental study	Risk of Bias There is moderate concern for risk of bias. Many studies are randomized controlled trials, but some lack blinding and include quasi-experimental or non-randomized designs. These methodological limitations may slightly overestimate the effect, although overall findings remain consistent. Inconsistency There is no serious inconsistency. Most studies report a positive direction of effect favoring improvement in dual-	The assumed risk reflects baseline dual-task performance before intervention. Across studies, participants typically showed impaired dual-task ability, including reduced coordination, slower gait under dual-task conditions, and higher dual-task cost, indicating difficulty in performing simultaneous cognitive and motor tasks	After intervention, most studies demonstrated improvement in dual-task performance. This included reduced dual-task cost, improved dual-task gait speed, and better coordination during simultaneous tasks. Several studies reported statistically significant improvements and moderate to large effect sizes, indicating clinically meaningful benefits of dual-task training.	The overall certainty of evidence for dual-task performance is MODERATE, mainly due to some risk of bias from non-randomized designs and limited blinding, despite strong consistency and large sample size.	Dual-task performance is a critical outcome because it reflects real-world functional ability, combining motor and cognitive control required for safe walking, balance, and daily activities.

			task performance. Indirectness There is no serious indirectness. All studies directly assessed dual-task performance in relevant populations using appropriate clinical and functional measures. Imprecision There is no serious imprecision. The total sample size is large Publication Bias / Other Considerations There is no strong evidence of publication bias.				

RESULTS

Study Selection and Characteristics

A total of 30 studies were included in this systematic review following a comprehensive search of electronic databases and grey literature. These studies involved approximately 1,525 participants diagnosed with stroke across acute, subacute, and chronic stages. The majority of the included studies were randomized controlled trials, while a few were quasi-experimental, observational designs and one methodological study. Sample sizes varied across studies, ranging from small groups of around 2 participants to larger trials including over 300 participants. The duration of interventions ranged from 2 weeks to 2 years, with most studies implementing training sessions two to five times per week, and session durations ranging between 20 and 60 minutes. The interventions were broadly categorized into single-task training, which focused solely on motor components such as gait and balance; in some studies it solely involves cognitive performance with its functional timing. and dual-task training, which combined motor tasks with cognitive or additional motor activities. Outcome measures across studies included standardized clinical tools such as the Timed Up and Go test, Berg Balance Scale, 10-Meter Walk Test, Sit-to-Stand Test, and cognitive assessments including the Mini-Mental State Examination, Montreal Cognitive Assessment, and Stroop test.

Gait Speed

Gait speed was evaluated in 17 studies involving a total of 962 participants and was identified as a key indicator of functional mobility and independence following stroke. The majority of studies demonstrated improvements in gait speed following dual-task training interventions. Several studies reported statistically significant improvements, while others showed moderate to large effect sizes, indicating clinically meaningful gains. Improvements were reflected in enhanced performance on the 10-Meter Walk Test, with

some studies reporting increases in gait velocity that are sufficient to improve community ambulation. In many cases, both dual-task and single-task groups showed improvement; however, the magnitude of improvement was generally greater in the dual-task groups, suggesting additional benefits of incorporating cognitive demands into motor training. Both single task and dual task intervention groups showed improvement in gait speed under dual-task conditions post-treatment and at follow-up. However, the multimodal dual-task training group demonstrated superior outcomes, which emphazised significant improvement in dual-task gait speed compared to single-task training. Clinically meaningful increases in gait speed exceeding the minimum detectable change. Sustained improvements at follow-up, indicating retention of training effects in dual task training. Additionally; Improvements were consistent with previous studies, reinforcing that task-specific dual-task training is more effective than single-task training. These findings suggest that dual-task training enhances gait automaticity and attentional resource allocation, enabling better performance under cognitively demanding walking conditions. A small number of studies reported minimal or no significant differences between the two approaches, which may be due to variations in intervention protocols, participant characteristics, or baseline performance levels. Overall, the findings suggest that dual-task training has a positive effect on gait speed, with a moderate level of evidence supporting its effectiveness.

Balance

Balance outcomes were assessed in 14 studies including 1,039 participants and demonstrated the most consistent and robust improvements across all domains. The majority of studies reported significant improvements in balance following dual-task training interventions. These improvements were commonly measured using the Berg Balance Scale, Timed Up and Go test, and assessments of postural stability and sway. Although improvements were observed in both intervention and control groups in some studies, the dual-task groups consistently demonstrated greater gains in balance performance. This indicates that integrating cognitive or additional motor tasks into rehabilitation enhances postural control and functional stability. Although balance was also measured as an independent outcome in some studies, it was an integral component of the multimodal training program, which included standing balance control, sit-to-stand training, functional mobility exercises. The improvements observed in gait speed and dual-task performance indirectly suggest enhanced postural control and balance function, as these are essential for safe and efficient dual-task walking. Furthermore, the structured progression of task difficulty and inclusion of safety measures (e.g., supervision, harness use) contributed to improved functional balance. Enhanced dual-task walking capacity may reduce fall risk while improving balance, particularly in complex, real-world environments requiring simultaneous cognitive engagement. Some studies also reported clinically meaningful reductions in fall risk, highlighting the functional importance of these improvements. Only one study reported a negative or interference effect where balance performance worsened under dual-task conditions; however, this finding was not commonly observed. The consistency of positive findings and the relatively large cumulative sample size support a high level of evidence for balance improvement.

Dual-Task Performance

Dual-task performance was examined across 28 included studies, involving approximately 1,458 participants. This domain reflects the ability to perform motor and cognitive tasks simultaneously, which is essential for real-life functional activities. Dual-task performance, measured using dual-task effects (DTEs), which revealed that a negative DTE indicated deterioration in dual-task performance compared to single-task conditions. Only the multimodal training with dual-task group and also solely the dual task group showed significant improvement in DTE, particularly in gait-related outcomes. Specifically DTE on gait speed improved significantly after dual-task training, these improvements were retained at follow-up, suggesting sustained benefits. In contrast, the single-task training group showed no significant changes in DTE for either gait or cognition. Analysis of dual-task patterns revealed that; at baseline, participants exhibited mutual interference (decline in both cognitive and motor performance). Post-intervention, the dual-task group shifted toward a gait-priority pattern, indicating improved task prioritization without compromising cognition. Stroke survivors demonstrated greater dual-task interference compared to healthy individuals, particularly in complex task combinations, where cognitive interference and mutual interference patterns were more prominent. The majority of studies reported significant improvements in dual-task performance following intervention. These improvements were characterized by reductions in dual-task cost, indicating improved efficiency in managing simultaneous tasks. Several studies reported improvements in coordination, gait stability, and the ability to maintain walking performance while performing cognitive tasks such as counting, speaking, or responding to external stimuli. Moderate to large effect sizes were observed in multiple studies, further supporting the clinical relevance of these findings. Dual-task training was shown to reduce cognitive-motor interference, thereby improving attentional resource allocation during functional activities. However, a small number of studies reported mixed or non-significant results, and some studies found no significant difference between dual-task and single-task training. These inconsistencies may be attributed to methodological limitations such as small sample sizes, variability in training protocols, and differences in outcome measures. Therefore, the overall level of

evidence for dual-task performance was considered moderate.

Cognitive Function

Cognitive function was evaluated in 17 studies involving approximately 1,114 participants. The findings demonstrated a mixed but generally positive trend in cognitive outcomes following dual-task training. Several studies reported significant improvements in cognitive domains such as attention, executive function, and global cognitive performance. These improvements were assessed using standardized tools such as the Mini-Mental State Examination, Montreal Cognitive Assessment, and Stroop test. Some studies also reported moderate effect sizes, indicating clinically meaningful improvements. However, not all studies showed consistent results, and a number of studies reported minimal or no significant changes in cognitive performance. In some cases, cognitive performance declined under dual-task conditions, which may be explained by cognitive-motor interference, where simultaneous tasks compete for limited attentional resources. Variability in cognitive outcomes may also be due to differences in baseline cognitive status, the complexity of tasks used, and variations in intervention duration. The effects of interventions on cognitive performance demonstrated mixed outcomes. Under single-task conditions**,** improvement was observed only in the serial-three subtraction task, while no significant change was noted in the Stroop task. Additionally, evidence from other findings demonstrated that combined motor-cognitive dual-task (CMDT) training significantly improved global cognitive function, as reflected by improvements in MMSE and MoCA scores**,** along with neurophysiological changes such as reduced P300 latency and improved cerebral oxygenation. These findings suggest enhanced neural efficiency following dual-task interventions. Despite these inconsistencies, the overall evidence suggests that dual-task training has the potential to improve cognitive function, particularly in attention and executive processes, with a moderate level of evidence. Overall, the results of this systematic review indicate that dual-task training is generally more effective than single-task training in improving functional outcomes in post-stroke patients. The strongest evidence was observed for improvements in balance, while moderate evidence supports improvements in gait speed, dual-task performance, and cognitive function. The integration of cognitive and motor tasks appears to enhance functional recovery by simulating real-life situations that require simultaneous task performance. These findings highlight the importance of incorporating dual-task training into stroke rehabilitation programs to improve mobility, reduce fall risk, and enhance functional independence in individuals after stroke.

DISCUSSION:

Stroke is one of the leading causes of long-term and short-term disability worldwide and often results in impairments in mobility, balance, coordination, fatigue and cognitive function; ultimately affect the functional independence of stroke survivors. Stroke disrupts neural networks responsible for attention and motor coordination which restricts community participation and quality of life. It has been reported that approximately 80% of stroke survivors experience gait and balance problems within three months after stroke. Gait disorders are considered as a key marker of recovery and are strongly associated with disability, institutionalization and mortality among stroke population. Therefore, improving gait and functional mobility has become a central focus of stroke rehabilitation programs, as it directly influences survival, independence, and social participation. However, walking in real-life situations requires not only motor control but also cognitive processing and concentration to manage environmental distractions and perform simultaneous tasks. Many daily activities require performing motor and cognitive tasks at the same time; for example, walking while talking, carrying objects or navigating crowded environments. These activities involve dual-task performance, where both motor and cognitive systems must operate simultaneously. After stroke, the ability to perform dual tasks is frequently impaired due to reduced attentional capacity and disrupted neural networks responsible for executive functioning and motor coordination. As a result, stroke survivors often face reduction in gait speed, cadence, and stride length during dual-task conditions compared with single-task walking. This phenomenon is described as cognitive-motor interference, which occurs when two simultaneous tasks compete for limited attentional resources, leading to deterioration in performance of one or both tasks. It highlights the importance of effective rehabilitation strategies targeting mobility and functional recovery. These strategies therefore aim not only to restore motor ability but also to improve cognitive-motor integration.

Dual-task training has become a significant rehabilitation approach that integrates cognitive and motor tasks simultaneously to improve functional performance. As reported in present studies, “Dual-task training improved cognitive and walking abilities, and dual-task training subjects’ performance was better than single-task training subjects’ performance”. This indicates that integrating cognitive tasks during motor training may provide additional benefits in stroke rehabilitation. another randomized trial demonstrated that dual-task training improved walking ability and reduced fall incidence in individuals with chronic stroke by enhancing their ability to manage attention-demanding mobility tasks.

Gait speed

Gait speed is an important indicator of functional mobility and independence after stroke. In the present review, most of the included studies showed improvement in gait speed under dual-task training. Gait speed was evaluated across 18 studies involving

1134participants and the massive findings indicated that dual-task training generally improved walking performance compared with control or conventional rehabilitation. Several studies emphasize improvement in walking ability following the intervention; the studies states that "dual-task training improved cognitive and walking abilities". Similarly, other studies reported significant improvements in walking speed and gait velocity among the participants undergoing dual-task training compared with conventional therapy. For example, one study reported that gait speed increased by approximately 0.35 m/s ($p < 0.001$) through dual-task intervention, indicating a statistically significant improvement. Other studies also reported significant improvements in walking performance, including enhanced 10-Meter Walk Test results ($F = 14.688$, $p = 0.000$) and a greater gain in gait velocity in the intervention group compared with control groups. In one study, a moderate effect size (Cohen's $d \approx 0.50$) was reported; although the confidence interval crossed zero which indicates moderate but imprecise effects. In an average most of the studies consistently favoured the dual-task intervention, demonstrating improvement in gait speed after dual-task training. When evaluating the certainty of evidence, several factors were considered. There were no major inconsistency and imprecision as almost all studies reported positive directional effects favouring dual-task intervention. Additionally, the total sample size was relatively large; it reduces the concern for imprecision, effect size and confidence interval. Also, there was no significant indirectness as all studies directly investigated stroke populations undergoing dual-tasking rehabilitation. Some methodological limitations such as small sample sizes in individual studies and unclear allocation concealment increased the risk of bias. Considering these factors, the overall level of evidence for gait speed was graded as moderate.

Balance

Balance outcomes were evaluated in 18 studies with a total of 1248 participants, and the results of the studies included here consistently demonstrated improvement through dual-task interventions. Most studies reported significant improvements in balance performance when dual-task training was added into rehabilitation. For example, several studies showed significant improvement in Berg Balance Scale scores ($p < 0.05$) with relatively narrow confidence intervals which indicates reliable treatment effects. Another study concluded approximately 25% reduction in fall risk; it indicates clinically significant improvement in postural stability and balance control and functional performance. In many of the included studies both intervention and control groups showed improvements. But the dual-task groups consistently showed greater gains in balance performance; there is also has an additional benefit while integrating cognitive tasks during motor training. On evaluation of the certainty of evidence the direction of effect was highly consistent across all the studies; almost all the studies reported positive outcomes that supports dual-task intervention therefore it indicates no inconsistency. There was also no indirectness, as all studies directly assessed balance outcomes in stroke rehabilitation. Confidence intervals reported in several studies (e.g., 1.82–6.69) also indicated improvement in balance and the range did not cross a null or zero effect, it defines valid and reliable treatment effects. Some studies reported imprecision or small sample sizes, but the overall number of participants was large which helps in reducing the concerns regarding imprecision at the overall evidence level. Based on these considerations we can conclude the evidence for balance outcomes was considered high-quality evidence.

Dual task performance

Dual-task performance was examined in 30 studies including approximately 1815 participants, it focuses on the ability of stroke survivors to simultaneously perform motor and cognitive tasks. Several studies reported significant improvements in dual-task gait performance ($p < 0.05$) with reductions in cognitive-motor interference during walking tasks. Along with this some studies observed reductions in dual-task interference percentages about 9–16%; defines improvement in the ability to manage cognitive and motor demands simultaneously. Dual-task gait parameters and functional mobility measures also showed improvement clinically; it indicates increased integration between cognitive and motor processes.

On evaluation of the certainty of evidence the direction of effect was consistent while most studies Favor the intervention group. It confirms minimal inconsistency across all the findings. But there were certain methodological limitations get identified such as small sample sizes and limited reporting of allocation concealment in some studies which may increase the potential risk of bias in the study. Although most studies showed positive results, but these methodological limitations reduced the certainty of the evidence. Therefore, considering the consistency of results but the methodological limitations; we can conclude the overall level of evidence for dual-task performance was graded as moderate.

Cognitive performance

The synthesis of the included studies examining cognitive performance following dual-task training comprises approximately 10 studies with a total sample of around 1,114 participants. These studies primarily assessed cognitive outcomes using standardized measures such as the Stroop test (executive function and attention), Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MoCA), and other domain-specific neuropsychological tests. Collectively, these tools evaluated key aspects of cognition including attention, executive function, processing speed, and global cognitive status. Across the included studies, the direct effect estimates indicate a mixed but overall positive trend. Several studies reported statistically

significant improvements in cognitive performance, particularly in executive function and attention (e.g., significant Stroop test improvements with $p < 0.05$, and notable gains in MMSE and MoCA scores). Some studies also demonstrated moderate effect sizes, suggesting meaningful clinical improvement. However, not all studies showed consistent benefits; a few reported non-significant results, and in certain cases, cognitive performance declined under dual-task conditions, indicating possible cognitive-motor interference. Despite this variability, most studies favoured dual-task interventions, supporting their role in enhancing cognitive function post-stroke. The overall quality of evidence can be interpreted as moderate, based on a balanced consideration of strengths and limitations within the body of literature. This evaluation reflects the inclusion of multiple randomized controlled trials, which strengthens confidence in the findings, alongside some methodological concerns such as limited blinding and inclusion of quasi-experimental designs, which may introduce bias. Additionally, variability in study outcomes contributes to some uncertainty in the consistency of effects. Nevertheless, the large cumulative sample size and the use of direct, clinically relevant cognitive measures reduce concerns regarding precision and applicability. Therefore, while the evidence supports the effectiveness of dual-task training for cognitive improvement, further rigorously designed studies are needed to enhance consistency and strengthen the overall confidence in these findings. The findings of this review highlight the importance of integrating cognitive tasks with motor rehabilitation for stroke population which will mimic the activities of daily living. Dual-task training may help patients improve their ability to manage real-world situations which requires simultaneous motor and cognitive processing such as walking while talking or navigating complex environments or calculating or singing. Rehabilitation programs that incorporate task-specific and cognitively challenging activities may therefore enhance functional independence and mobility outcomes in stroke patients. Many included studies had methodological weaknesses such as small sample sizes, lack of blinding, and unclear allocation concealment, which may increase the risk of bias. Additionally, there was considerable heterogeneity in intervention protocols, including variations in types of dual-task training, duration, intensity, and outcome measures, making direct comparisons difficult. Most studies focused on short-term outcomes, with limited evidence on long-term effectiveness and real-world applicability. Cognitive outcomes were also inconsistent, with some studies reporting minimal or negative effects due to cognitive-motor interference. Furthermore, the evidence on upper extremity function remains limited compared to lower limb outcomes. Future research should focus on conducting large-scale, high-quality randomized controlled trials with standardized intervention protocols and longer follow-up periods to improve the strength of evidence. There is also a need to identify the optimal type, intensity, and combination of cognitive and motor tasks for different stages of stroke recovery. Greater emphasis should be placed on upper extremity rehabilitation, use of objective outcome measures, and exploration of underlying neurophysiological mechanisms. Clinically, incorporating dual-task training into rehabilitation programs may better simulate real-life activities and enhance functional recovery, but interventions should be individualized based on patient capacity and cognitive status.

References

1. Abdollahi M, Kuber PM, Rashedi E. Dual Tasking Affects the Outcomes of Instrumented Timed up and Go, Sit-to-Stand, Balance, and 10-Meter Walk Tests in Stroke Survivors. Sensors (Basel). 2024 May 9;24(10):2996. doi: 10.3390/s24102996. PMID: 38793850; PMCID: PMC11125653
2. Zhi-Quan Yang a, Meng-Fan Wei a, Lin Chen b, Jia-Ning Xi (2022) Research progress in the application of motor-cognitive dual-task training in rehabilitation of walking function in stroke patients. Journal of Neurorestoratology 11 (2023) 100028
3. Yishai Bachar Kirshenboim, OT, MSc1, Shir Tzur Lebovich, OT, MSc1,2, Tal Weitzer, OT, MSc1, Dana Doron, MD3, Moshe Bondi, MD4,5, Ron Cialic, MD6, and Debbie Rand, OT, PhD1 (2025) Upper Extremity-Cognitive Dual-Task Capacity Post-Stroke. Neurorehabilitation and Neural Repair 2025, Vol. 39(5) 365–376
4. Chen Huimeng a, c, Wan Xianglin a, c, Xu Feng d, Liu Hui a, b, c, Li Qiujie (2025) The effects of cognitive dual-task gait training and motor dual-task gait training on lower-limb coordination during walking in subacute stroke patients: A randomized controlled trial. Gait & Posture 120 (2025) 17–24
5. Tasseel-Ponche S, Roussel M, Toba MN, Sader T, Barbier V, Delafontaine A, Meynier J, Picard C, Constans JM, Schnitzler A, Godefroy O, Yelnik AP. Dual-task versus single-task gait rehabilitation after stroke: the protocol of the cognitive-motor synergy multicenter, randomized, controlled superiority trial (SYNCOMOT). Trials. 2023 Mar 8;24(1):172. doi: 10.1186/s13063-023-07138-x. PMID: 36890548; PMCID: PMC9994785.
6. Song GB, Park EC. Effect of dual tasks on balance ability in stroke patients. J Phys Ther Sci. 2015 Aug;27(8):2457-60. doi: 10.1589/jpts.27.2457. Epub 2015 Aug 21. PMID: 26357425; PMCID: PMC4563289.
7. Lai LC, Hsu AL, Hu GC, Ou YC, Chen AC, Chuang LL. Cognitive and motor multi-task balance training improves dual-task walking performance in ambulatory patients after stroke: a randomized controlled trial. Disabil Rehabil. 2026 Mar;48(6):1617-1635. doi: 10.1080/09638288.2025.2564287. Epub 2025 Sep 30. PMID: 41027832

8. Pang MYC, Yang L, Ouyang H, Lam FMH, Huang M, Jehu DA. Dual-Task Exercise Reduces Cognitive-Motor Interference in Walking and Falls After Stroke. Stroke. 2018 Dec;49(12):2990-2998. doi: 10.1161/STROKEAHA.118.022157. PMID: 30571419
9. Kim GY, Han MR, Lee HG. Effect of Dual-task Rehabilitative Training on Cognitive and Motor Function of Stroke Patients. J Phys Ther Sci. 2014 Jan;26(1):1-6. doi: 10.1589/jpts.26.1. Epub 2014 Feb 6. PMID: 24567664; PMCID: PMC3927016.
10. Meester D, Al-Yahya E, Dennis A, Collett J, Wade DT, Ovington M, Liu F, Meaney A, Cockburn J, Johansen-Berg H, Dawes H. A randomized controlled trial of a walking training with simultaneous cognitive demand (dual-task) in chronic stroke. Eur J Neurol. 2019 Mar;26(3):435-441. doi: 10.1111/ene.13833. Epub 2018 Nov 25. PMID: 30308699; PMCID: PMC6824903.
11. Ahmed U, Karimi H, Amir S, Ahmed A. Effects of intensive multiplanar trunk training coupled with dual-task exercises on balance, mobility, and fall risk in patients with stroke: a randomized controlled trial. J Int Med Res. 2021 Nov;49(11):3000605211059413. doi: 10.1177/03000605211059413. PMID: 34812070; PMCID: PMC8647262
12. Kim KH, Jang SH. Effects of Task-Specific Training after Cognitive Sensorimotor Exercise on Proprioception, Spasticity, and Gait Speed in Stroke Patients: A Randomized Controlled Study. Medicina (Kaunas). 2021 Oct 13;57(10):1098. doi: 10.3390/medicina57101098. PMID: 34684135; PMCID: PMC8541560.
13. Plummer P PhD, PT, Zukowski LA PhD, Feld JA PhD, PT, Najafi B PhD. Cognitive-motor dual-task gait training within 3 years after stroke: A randomized controlled trial. Physiother Theory Pract. 2022 Oct;38(10):1329-1344. doi: 10.1080/09593985.2021.1872129. Epub 2021 Jan 18. PMID: 33459115.
14. Hyndman D, Pickering RM, Ashburn A. Reduced sway during dual task balance performance among people with stroke at 6 and 12 months after discharge from hospital. Neurorehabil Neural Repair. 2009 Oct;23(8):847-54. doi: 10.1177/1545968309338192. Epub 2009 Jun 25. PMID: 19556368.
15. Liu YC, Yang YR, Tsai YA, Wang RY. Cognitive and motor dual task gait training improve dual task gait performance after stroke - A randomized controlled pilot trial. Sci Rep. 2017 Jun 22;7(1):4070. doi: 10.1038/s41598-017-04165-y. PMID: 28642466; PMCID: PMC5481328.
16. Hong SY, Moon Y, Choi JD. Effects of Cognitive Task Training on Dynamic Balance and Gait of Patients with Stroke: A Preliminary Randomized Controlled Study. Med Sci Monit Basic Res. 2020 Aug 10;26:e925264. doi: 10.12659/MSMBR.925264. PMID: 32773732; PMCID: PMC7439598.
17. Huimeng C, Xianglin W, Feng X, Hui L, Qiujie L. The effects of cognitive dual-task gait training and motor dual-task gait training on lower-limb coordination during walking in subacute stroke patients: A randomized controlled trial. Gait Posture. 2025 Jul;120:17-24. doi: 10.1016/j.gaitpost.2025.03.021. Epub 2025 Mar 26. PMID: 40179653.
18. Iqbal M, Arsh A, Hammad SM, Haq IU, Darain H. Comparison of dual task specific training and conventional physical therapy in ambulation of hemiplegic stroke patients: A randomized controlled trial. J Pak Med Assoc. 2020 Jan;70(1):7-10. doi: 10.47391/JPMA.10443. PMID: 31954014.
19. Baek CY, Chang WN, Park BY, Lee KB, Kang KY, Choi MR. Effects of Dual-Task Gait Treadmill Training on Gait Ability, Dual-Task Interference, and Fall Efficacy in People With Stroke: A Randomized Controlled Trial. Phys Ther. 2021 Jun 1;101(6):pzab067. doi: 10.1093/ptj/pzab067. Erratum in: Phys Ther. 2022 Jul 4;102(7):pzab184. doi: 10.1093/ptj/pzab184. PMID: 33611557.
20. Wayne PM, Gow BJ, Hou F, Ma Y, Hausdorff JM, Lo J, Rist PM, Peng CK, Lipsitz LA, Novak V, Manor B. Tai Chi training's effect on lower extremity muscle co-contraction during single- and dual-task gait: Cross-sectional and randomized trial studies. PLoS One. 2021 Jan 22;16(1):e0242963. doi: 10.1371/journal.pone.0242963. PMID: 33481829; PMCID: PMC7822271.
21. Chiaramonte R, D'Amico S, Caramma S, Grasso G, Pirrone S, Ronsisvalle MG, Bonfiglio M. The Effectiveness of Goal-Oriented Dual Task Proprioceptive Training in Subacute Stroke: A Retrospective Observational Study. Ann Rehabil Med. 2024 Feb;48(1):31-41. doi: 10.5535/arm.23086. Epub 2024 Feb 28. PMID: 38433007; PMCID: PMC10915301.
22. Ali MM, Abdelatief DA, Saad MM, Elfeky HA. Effect of dual-task exercises on balance, risk for fall and activities of daily living dependency of patients with stroke: a quasi-experimental study. Front Rehabil Sci. 2026 Jan 20;7:1709213. doi: 10.3389/fresc.2026.1709213. PMID: 41641361; PMCID: PMC12864473.
23. Yang L, He C, Pang MY. Reliability and Validity of Dual-Task Mobility Assessments in People with Chronic Stroke. PLoS One. 2016 Jan 25;11(1):e0147833. doi: 10.1371/journal.pone.0147833. PMID: 26808662; PMCID: PMC4726712.
24. Sun R, Li X, Zhu Z, Li T, Zhao M, Mo L, Li W, Xi X, Huang P, Gong W. Effects of dual-task training in patients with post-stroke cognitive impairment: A randomized controlled trial. Front Neurol. 2022

Oct 24;13:1027104. doi: 10.3389/fneur.2022.1027104. PMID: 36353135; PMCID: PMC9639668

25. An HS, Kim DJ. Effects of activities of daily living-based dual-task training on upper extremity function, cognitive function, and quality of life in stroke patients. Osong Public Health Res Perspect. 2021 Oct;12(5):304-313. doi: 10.24171/j.phrp.2021.0177. Epub 2021 Sep 13. PMID: 34719222; PMCID: PMC8561019
26. Chuang LL, Hsu AL, Lin YH, Yu MH, Hu GC, Ou YC, Wong AM. Multimodal training with dual-task enhances immediate and retained effects on dual-task effects of gait speed not by cognitive-motor trade-offs in stroke survivors: a randomized controlled trial. Disabil Rehabil. 2025 Mar;47(5):1194-1203. doi: 10.1080/09638288.2024.2365986. Epub 2024 Jun 17. PMID: 38885066.
27. Lai LC, Hsu AL, Hu GC, Ou YC, Chen AC, Chuang LL. Cognitive and motor multi-task balance training improves dual-task walking performance in ambulatory patients after stroke: a randomized controlled trial. Disabil Rehabil. 2026 Mar;48(6):1617-1635. doi: 10.1080/09638288.2025.2564287. Epub 2025 Sep 30. PMID: 41027832.
28. Kim H, Kim HK, Kim N, Nam CS. Dual Task Effects on Speed and Accuracy During Cognitive and Upper Limb Motor Tasks in Adults With Stroke Hemiparesis. Front Hum Neurosci. 2021 Jun 17;15:671541. doi: 10.3389/fnhum.2021.671541. PMID: 34220473; PMCID: PMC8250862.
29. Bachar Kirshenboim Y, Tzur Lebovich S, Weitzer T, Doron D, Bondi M, Cialic R, Rand D. Upper Extremity-Cognitive Dual-Task Capacity Post-Stroke. Neurorehabil Neural Repair. 2025 May;39(5):365-376. doi: 10.1177/15459683251317192. Epub 2025 Feb 11. PMID: 39932232; PMCID: PMC12065953.
30. Deblock-Bellamy A, Lamontagne A, McFadyen BJ, Ouellet MC, Blanchette AK. Dual-Task Abilities During Activities Representative of Daily Life in Community-Dwelling Stroke Survivors: A Pilot Study. Front Neurol. 2022 May 3;13:855226. doi: 10.3389/fneur.2022.855226. PMID: 35592466; PMCID: PMC9110886.
31. Feld JA, Zukowski LA, Howard AG, Giuliani CA, Altmann LJP, Najafi B, Plummer P. Relationship Between Dual-Task Gait Speed and Walking Activity Poststroke. Stroke. 2018 May;49(5):1296-1298. doi: 10.1161/STROKEAHA.117.019694. Epub 2018 Apr 5. PMID: 29622624; PMCID: PMC6034633
32. Choi JH, Kim BR, Han EY, Kim SM. The effect of dual-task training on balance and cognition in patients with subacute post-stroke. Ann Rehabil Med. 2015 Feb;39(1):81-90. doi: 10.5535/arm.2015.39.1.81. Epub 2015 Feb 28. PMID: 25750876; PMCID: PMC4351499
33. Kim KJ, Kim KH. Progressive treadmill cognitive dual-task gait training on the gait ability in patients with chronic stroke. J Exerc Rehabil. 2018 Oct 31;14(5):821-828. doi: 10.12965/jer.1836370.185. PMID: 30443529; PMCID: PMC6222158.
34. Sun R, Li X, Zhu Z, Li T, Zhao M, Mo L, Li W, Xi X, Huang P, Gong W. Effects of dual-task training in patients with post-stroke cognitive impairment: A randomized controlled trial. Front Neurol. 2022 Oct 24;13:1027104. doi: 10.3389/fneur.2022.1027104. PMID: 36353135; PMCID: PMC9639668.
35. Chen, Huimeng, et al. "The effects of different types of dual-task gait training on lower-limb coordination during dual-task gait in patients with stroke: a single-blind randomized controlled trial." *BMC Sports Science, Medicine and Rehabilitation* 18 (2026): 68.
36. Sefastsson, Annika, et al. "Positive effects of lower extremity constraint-induced movement therapy on balance, leg strength and dual-task ability in stroke patients: a longitudinal cohort study." *Journal of rehabilitation medicine* 56 (2024): 24168.
37. Aderinto N, Abraham IC, Olatunji G, Kokori E, Yusuf IA, Adejumo FA, Olatunbosun JO, Bukky SO, Akintepede FO, Olawade DB, Babalola AE, Asifat O, Morawo A. Efficacy and safety of dual-task training in enhancing cognitive and motor recovery for post-stroke rehabilitation. Ann Med Surg (Lond). 2025 Nov 27;88(1):569-579. doi: 10.1097/MS9.0000000000004458. PMID:
38. Plummer P, Eskes G. Measuring treatment effects on dual-task performance: a framework for research and clinical practice. Front Hum Neurosci. 2015 Apr 28;9:225. doi: 10.3389/fnhum.2015.00225. PMID: 25972801; PMCID: PMC4412054.
39. Bachar Kirshenboim Y, Tzur Lebovich S, Weitzer T, Doron D, Bondi M, Cialic R, Rand D. Upper Extremity-Cognitive Dual-Task Capacity Post-Stroke. Neurorehabil Neural Repair. 2025 May;39(5):365-376. doi: 10.1177/15459683251317192. Epub 2025 Feb 11. PMID: 39932232; PMCID: PMC12065953.
40. Park J. Dual task training effects on balance and hand functions of stroke patients. J Phys Ther Sci. 2017 Oct;29(10):1878-1880. doi: 10.1589/jpts.29.1878. Epub 2017 Oct 21. PMID: 29184311; PMCID: PMC5684032.
41. Jo S, Kim H, Song C. Dual-task exergaming to enhance motor and cognitive function in chronic stroke: a prospective, assessor-blinded, parallel group randomized controlled trial. J Neuroeng Rehabil. 2026 Feb 19;23(1):103. doi: 10.1186/s12984-026-01913-y. PMID: 41715216; PMCID: PMC13019995.