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COMPARISON OF SINGLE-TASK TRAINING VERSUS DUAL-TASK TRAINING IN PARKINSON'S DISEASE: A REVIEW

Physiotherapy & Rehabilitation

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ABSTRACT

Parkinson's disease (PD) profoundly affects gait, balance, cognition, and quality of life, with dual-task interference representing a critical barrier to safe daily mobility. This review synthesises evidence comparing single-task training (STT) with dual-task training (DTT) across these domains. Meta-analytical data indicate that DTT yields superior improvements in dual-task gait speed (standardised mean difference [SMD] = 0.48), stride length (mean difference [MD] = 0.09 m), and cadence (MD = 5.45 steps/min) compared with STT. However, findings for balance and cognitive outcomes remain equivocal, with some systematic reviews reporting no clear superiority. DTT has shown promise in enhancing cognitive composite scores and quality of life, though the overall certainty of evidence is low to very low according to GRADE criteria. The task-specificity principle and the promotion of motor automaticity provide theoretical support for DTT, yet substantial heterogeneity in training protocols limits definitive clinical recommendations.

KEYWORDS

Parkinson's disease, dual-task training, single-task training, gait, cognition, rehabilitation.

INTRODUCTION

PD, the second most common neurodegenerative disorder (1,2), affects >2% of those ≥65 years, with rising prevalence (4). Motor symptoms are hallmark, but gait and cognitive decline equally impair independence (5). Dual-task interference-worsened performance when walking with concurrent cognitive task-is challenging. Fronto-striatal dysfunction impairs automatic movement, forcing attentional reliance (6). Two approaches exist: STT (isolated training) and DTT (concurrent motor-cognitive training). DTT is grounded in task-specificity (7) and hypothesized to re-automate gait, reduce prefrontal over-activation, and enhance executive function (8). Whether DTT confers clinical advantages over STT remains debated. This review compares their efficacy across gait, balance, cognition, and quality of life.

Pathophysiological Basis of Dual-Task Interference in Parkinson's Disease

Dopaminergic depletion in the substantia nigra disrupts basal ganglia–thalamocortical loops subserving automatic motor programmes (6). Individuals with PD recruit prefrontal and parietal regions to maintain gait, consuming executive resources, reducing cognitive reserve for secondary tasks. Neuroimaging confirms altered prefrontal activation during dual-task walking, correlating with greater gait variability and fall risk (6). This maladaptive over-recruitment reflects reduced cortico-striatal efficiency. DTT may counteract this by repeatedly pairing motor execution with cognitive challenges, promoting re-automatisation and strengthening neural pathways via enhanced dopaminergic and cholinergic modulation (8).

Comparative Effects on Gait Parameters

Gait is primary rehabilitation target where DTT shows strongest superiority. A 2024 meta-analysis (14 RCTs, n=548) found DTT superior to STT for dual-task gait speed (SMD=0.48, 95%CI 0.20–0.77), stride length (MD=0.09m, 95%CI 0.04–0.14), and cadence (MD=5.45 steps/min, 95%CI 3.59–7.31), plus dual-task cost and quality of life, but not balance confidence (1). A 2025 RCT (Zhou et al.) confirmed 8-week DTT reduced step-length variability, decreased DST, and increased SST-effects most pronounced in the more affected limb across both cognitive and motor secondary tasks (9). However, a 2024 systematic review (5 trials, n=214) found DTT failed to surpass STT for dual-task walking and balance, except for double-support time (Hedges' g=0.34) and stride-time variability (Hedges' g=0.18) (2). Discrepancies reflect differing inclusion criteria, outcomes, training duration, and paradigms. The DUALGAIT trial reported functional DTT improved gait velocity and stride length over standard physiotherapy (10).DTT confers gait benefits-especially with task-specific, progressive training.

Effects on Balance and Postural Control

Balance impairment in PD is multifactorial—deficits in postural reflexes, sensory integration, and anticipatory adjustments. Balance evidence is less conclusive than for gait. Lin et al. (2024) found DTT superior on laboratory balance measures (Hedges' g=0.18–1.25) but not clinical scales (Berg Balance Scale, Timed Up-and-Go), attributing this to higher instrumented sensitivity versus clinical scales lacking granularity to detect subtle changes (2). The ongoing AquaDualPark RCT (aquatic vs. land-based STT/DTT) will assess Mini-BESTest, Dynamic Gait Index, and Activities-specific Balance Confidence scale (11). Aquatic environments may potentiate balance effects via proprioceptive/sensory stimulation. A pilot study (n=15) reported DTT superiority for static postural control, but small sample precludes firm conclusions (12). Overall, balance evidence remains preliminary, and no robust DTT superiority can be asserted.

Cognitive Outcomes and Executive Function

Executive dysfunction and attention deficits, common non-motor PD features, critically determine dual-task performance; cognitive improvements may stem from domain-specific training or dual-task demands. Lin et al. (2024) reported inconclusive between-group cognitive differences, with no significant DTT superiority over STT, possibly due to limited studies and heterogeneous cognitive assessments (2). However, their separate RCT found DTT uniquely improved cognitive composite scores under single- and dual-task conditions, alongside UPDRS-III, Falls Efficacy Scale, and PDQ-39 (13). A meta-analysis confirmed significant MoCA improvements with DTT (MD=2.05, 95%CI 0.38–3.73, P=0.02), especially with interventions >3 months (14). Thus, DTT may enhance executive functions without compromising motor performance, likely via divided-attention practice; however, cognitive test heterogeneity and low-certainty evidence warrant caution.

Quality of Life and Functional Outcomes

Rehabilitation targets functional independence and QoL beyond isolated gait or cognitive gains. Sarasso et al. (2024) confirmed DTT superiority over STT for QoL, though evidence certainty was low (1). The DUALGAIT trial similarly reported greater QoL improvements with functional DTT versus standard physiotherapy (10). Enhanced self-efficacy and reduced fear of falling are proposed mediators, supported by Falls Efficacy Scale improvements exclusive to DTT in one study (13); however, absent effects on balance confidence in the meta-analysis warrant further investigation (1). DTT's ecological validity—training under dual-task conditions resembling real-world activities—may facilitate greater transfer to daily functioning. DTT also improves upper extremity motor skills and activities of daily living, though less frequently reported (15).

Clinical Implications and Recommendations

DTT benefits gait and QoL primarily; balance and cognitive gains are uncertain. Use DTT for patients with pronounced dual-task interference who tolerate cognitive demands. Start with STT, progress gradually to reduce frustration (12). Choose ecologically valid tasks (e.g., carrying objects, conversation), progress intensity based on performance. Typical protocols: 3–5 sessions/week, 4–12 weeks (1). For severe cognitive impairment, begin with STT, introduce DTT as cognition improves. Individualise choice based on disease severity, dual-task costs, cognitive reserve, and goals.

LIMITATIONS

Limitations include few high-quality RCTs directly comparing STT and DTT, with small samples, heterogeneous outcomes, and variable protocols (2). GRADE certainty is low to very low for most outcomes (1,3).Optimal DTT parameters unstandardised, limiting generalisability; few studies assess long-term retention. Neuroimaging and Technology-enhanced interventions may improve accessibility and engagement (8).

CONCLUSION

DTT improves dual-task gait speed, stride length, cadence, quality of life, and dual-task cost, though balance and cognitive evidence remains less robust with low-to-very-low certainty. Task-specificity and motor automaticity provide theoretical support, yet protocol heterogeneity precludes universal recommendations. Clinicians should adopt individualised, progressive DTT within comprehensive rehabilitation.

Table 1. Summary of Key Studies, Outcome Effects, and Certainty of Evidence

Study / Review	Design	Sample (PD)	Intervention (DTT vs. STT)	Duration	Main Outcomes Favouring DTT	Effect Estimate (95% CI)	Certainty (GRADE)
Sarasso et al. (2024) (1)	SRMA	14 RCTs, n=548	Various motor−cognitive DTT vs. isolated STT	4–12 weeks	Dual−task gait speed	SMD = 0.48 (0.20–0.77)	Low
					Dual−task stride length	MD = 0.09 m (0.04–0.14)	Low
					Dual−task cadence	MD = 5.45 steps/min (3.59–7.31)	Low
					Quality of life (PDQ−39)	Significant ($P < 0.05$)	Low
Lin et al. (2024) (2)	Systematic review	5 RCTs, n=214	Motor−cognitive DTT vs. STT	4–8 weeks	Double−support time	Hedges' g = 0.34 (0.01–0.67)	Very low
					Stride−time variability	Hedges' g = 0.18 (0.02–0.35)	Very low
					(No superiority for other gait/balance measures)	–	–
Zhou et al. (2025) (9)	RCT	28	Treadmill DTT + cognitive tasks vs. treadmill STT	8 weeks	Step−length variability, DST, SST	Not reported (narrative)	–
Lin et al. (2024) (3)	RCT	16	Dual cognitive−walking treadmill vs. single treadmill	6 weeks	Cognitive composite score, UPDRS−III, Falls Efficacy Scale, PDQ−39	Not reported (narrative)	–
DUALGAIT trial (2021) (10)	RCT	60	Functional DTT (real−life tasks) vs. regular physiotherapy	6 weeks	Gait velocity, stride length, QOL	Not reported (narrative)	–
Li et al. (2023) (8)	Meta−analysis	Multiple RCTs	Motor−cognitive DTT interventions	Various	MoCA score	MD = 2.05 (0.38–3.73)	Low

Table 2. Typical Training Parameters for STT versus DTT Protocols in PD Rehabilitation

Parameter	Single−Task Training (STT)	Dual−Task Training (DTT)
Primary focus	Isolated motor (e.g., treadmill walking, balance board) or isolated cognitive (e.g., computerised attention tasks)	Concurrent motor + cognitive (e.g., walking while performing mental arithmetic, verbal fluency, or object manipulation)
Task progression	Increase speed, incline, resistance, or complexity of the single task	Increase difficulty of primary or secondary task; vary type of secondary task; reduce cueing
Session frequency	3–5 sessions per week	3–5 sessions per week
Session duration	30–60 minutes	30–60 minutes
Total intervention	4–12 weeks	4–12 weeks
Secondary task examples	Not applicable	Counting backwards, naming categories, carrying a tray, responding to auditory stimuli, obstacle negotiation
Setting	Treadmill, overground, seated, or standing	Overground walking, treadmill with cognitive board, virtual reality environments
Theoretical basis	Skill acquisition, strength/endurance, motor learning	Task−specificity, re−automatisation, executive engagement, divided−attention training
Suitability	Patients with severe cognitive impairment or those unable to tolerate dual−task demands	Patients with mild−to−moderate cognitive impairment and significant dual−task interference; after initial STT to build baseline

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