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Effectiveness of Dual-Task Training for Cognitive Function in Mild Cognitive Impairment: A Systematic Review

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Abstract

Background: Mild cognitive impairment (MCI) represents a transitional stage between normal aging and dementia, characterized by progressive cognitive decline. Dual-task training (DTT), which integrates simultaneous motor and cognitive activities, has emerged as a promising non-pharmacological intervention to improve cognitive function in older adults.

Objective: This systematic review aimed to evaluate the effectiveness of dual-task training in improving cognitive function among older adults with MCI.

Methods: A systematic review was conducted in accordance with the PRISMA 2020 guidelines. Literature searches were performed across Scopus, PubMed, ScienceDirect, ProQuest, and Google Scholar databases for studies published between 2020 and 2025. Randomized controlled trials (RCTs) investigating DTT interventions and reporting cognitive outcomes were included. Methodological quality was assessed using the Physiotherapy Evidence Database (PEDro) scale.

Results: Seven RCTs involving 710 participants were included, with PEDro scores ranging from 6 to 7, indicating moderate to high methodological quality. DTT interventions (6–12 weeks, 2–3 sessions per week) consistently demonstrated significant improvements in global cognitive function (e.g., MoCA increase up to +2.47 points; $p<0.001$) and executive function compared with control groups. Several studies reported moderate to large effect sizes ($\eta^2 = 0.161–0.442$).

Conclusion: Dual-task training is an effective intervention for improving cognitive function, particularly global cognition and executive function, in older adults with MCI. Further research with standardized protocols and long-term follow-up is required to strengthen clinical recommendations.

Keywords

Aged; Mild Cognitive Impairment; Cognition; Dual-Task Training

Introduction

The global increase in the older adult population is a direct consequence of advancements in healthcare, technology, and social welfare, leading to a substantial rise in life expectancy.[1] This demographic transition has significantly altered the global population structure and presents major challenges for healthcare systems worldwide.[2] Aging is inherently associated with progressive physiological changes, including declines in neurological, musculoskeletal, and cognitive functions, which may adversely affect independence and quality of life.[3] Therefore, understanding age-related cognitive decline and identifying effective preventive and therapeutic strategies have become critical priorities in gerontology and public health.

Cognitive decline in older adults exists along a continuum, ranging from normal age-related changes to severe neurodegenerative disorders. Mild cognitive impairment (MCI) represents an intermediate clinical stage between normal cognitive aging and dementia.[4] It is characterized by measurable impairments in memory, attention, learning, and executive function that may begin to interfere with daily functioning, although not to the extent observed in dementia.[5] Epidemiological evidence indicates a growing global burden of cognitive impairment, with prevalence expected to increase substantially in the coming decades.[1] Consequently, early identification and targeted intervention in individuals with MCI are essential to delay or prevent progression to dementia.

Among emerging non-pharmacological approaches, dual-task training (DTT) has gained increasing attention as a potentially effective intervention for improving cognitive function in older adults with MCI. DTT involves the simultaneous performance of motor and cognitive tasks, thereby reflecting the complex demands of real-life activities.[2] Previous studies have demonstrated that DTT can produce moderate improvements in cognitive function, particularly in executive function and memory domains, with reported effect sizes ranging from 0.45 to 0.62.[1,6] Compared with single-task interventions, DTT may offer superior benefits by engaging multiple neural systems concurrently, thereby enhancing neuroplasticity. This mechanism is supported by evidence indicating that combined motor-cognitive stimulation promotes increased cerebral blood flow, synaptic connectivity, and neural network integration.[7]

Despite the growing body of evidence supporting the effectiveness of DTT, several important limitations remain in the current literature. First, substantial heterogeneity exists in intervention protocols, including variations in duration, frequency, intensity, and types of cognitive tasks applied. Second, outcome measures differ considerably across studies, encompassing global cognition, executive function, memory, and attention, thereby limiting comparability. Third, many studies report overall cognitive improvements without clearly identifying which cognitive domains are most responsive to DTT. These inconsistencies hinder the development of standardized clinical recommendations and reduce the generalizability of findings.

Furthermore, methodological differences across studies, including variations in study design, outcome measurement tools, and analytical approaches, contribute to inconsistencies in reported results. The lack of a structured synthesis focusing specifically on randomized controlled trials (RCTs) further limits the ability to draw robust conclusions regarding the effectiveness of DTT in this population. Therefore, a systematic synthesis of high-quality RCTs is required to clarify the effectiveness of dual-task training and to identify consistent patterns related to intervention characteristics and cognitive outcomes.

Accordingly, this systematic review aims to evaluate the effectiveness of dual-task training in improving cognitive function among older adults with mild cognitive impairment. Specifically, this review seeks to determine whether DTT, compared with single-task interventions or usual care, leads to improvements in cognitive outcomes and to identify which cognitive domains are most responsive to this intervention.

Methods

This study was designed as a systematic review conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The review process followed a structured approach based on the PICOS framework, which included older adults with mild cognitive impairment (MCI) as the population, dual-task training (DTT) as the intervention, comparison with other interventions or usual care, and cognitive function as the primary outcome.

A comprehensive literature search was conducted across five electronic databases, namely Scopus, PubMed, ScienceDirect, ProQuest, and Google Scholar. The search was limited to studies published between January 2020 and December 2025, with the final search conducted in January 2026. The search strategy was developed using combinations of keywords and Boolean operators. An example of the search string applied in PubMed was as follows: ("dual-task training" OR "motor-cognitive training" OR "cognitive-motor training") AND ("mild cognitive impairment" OR "MCI") AND ("older adults" OR elderly OR aging). The search terms were adapted for each database to ensure comprehensive coverage. In addition, the reference lists of included studies were manually screened to identify potentially relevant articles that were not captured in the initial search.

The inclusion criteria were defined as randomized controlled trials involving older adults diagnosed with MCI, published in English between 2020 and 2025, with full-text availability, and implementing DTT as the primary intervention. Studies were required to report cognitive function outcomes using valid and reliable measurement instruments. Studies were excluded if they used non-randomized designs, involved populations other than older adults with MCI, did not apply DTT as the main intervention, did not report quantitative cognitive outcomes, were not published in English, or were not available in full text.

All identified records were imported into reference management software (Mendeley) for duplicate removal. The study selection process was conducted in two stages, consisting of title and abstract screening followed by full-text eligibility assessment. Screening was performed independently by two reviewers to minimize selection bias. Any discrepancies were resolved through discussion until consensus was achieved.

Data extraction was carried out using a standardized data extraction form to ensure consistency. The extracted data included study characteristics such as authors, publication year, and country, as well as participant characteristics, including sample size and age. Detailed information on intervention protocols, including type, duration, frequency, and intensity, was also collected, along with comparison groups, outcome measures, and main findings.

The methodological quality of the included studies was assessed using the Physiotherapy Evidence Database (PEDro) scale. Studies with scores of six or higher were considered to have moderate to high methodological quality. In addition to the PEDro assessment, potential sources of bias were evaluated qualitatively, including selection bias related to randomization and allocation concealment, performance bias due to lack of blinding of participants and therapists, detection bias associated with blinding of outcome assessors, and attrition bias related to incomplete outcome data. These considerations were taken into account when interpreting the overall findings.

Data synthesis was conducted using a narrative synthesis approach. The included studies were organized based on key characteristics, including intervention type, duration, frequency, and cognitive domains assessed. The synthesis involved systematically comparing similarities and differences across studies and identifying patterns in outcomes, particularly in global cognitive function and executive function. The findings were interpreted qualitatively to provide an integrated understanding of the effectiveness of dual-task training in older adults with mild cognitive impairment.

Results

A total of 715 records were identified through database searching. After the removal of duplicates, 600 records remained and were screened based on titles and abstracts. Of these, 510 records were excluded due to irrelevance to the study objectives. The remaining 90 articles were assessed for full-text eligibility, resulting in the exclusion of 83 studies based on predefined criteria. Ultimately, seven randomized controlled trials (RCTs) met the inclusion criteria and were included in the qualitative synthesis. The study selection process is illustrated in Figure 1.

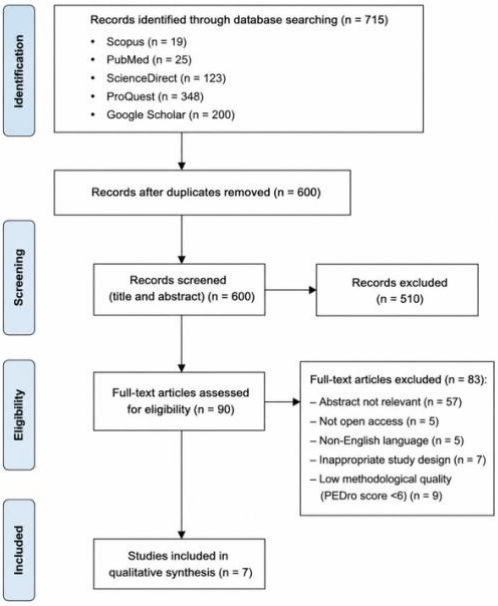

Figure 1. PRISMA 2020 flow diagram of study selection

The methodological quality of the included studies was assessed using the Physiotherapy Evidence Database (PEDro) scale. All studies achieved scores ranging from 6 to 7, indicating moderate to high methodological quality. Most studies fulfilled key criteria such as random allocation, baseline comparability, and between-group comparisons. However, several studies did not report blinding of participants or therapists, and some lacked allocation concealment and intention-to-treat analysis. Detailed PEDro scores are presented in Table 1.

Table 1. Methodological Quality Assessment of Included Studies Using the PEDro Scale

Study	Eligibility Criteria	Random Allocation	Concealed Allocation	Baseline Comparability	Blinding of Subjects	Blinding of Therapists	Blinding of Assessors	Adequate Follow-up	Intention-to-Treat Analysis	Between-Group Comparisons	Point Estimates & Variability	Total Score
Kwan et al.[8]	Yes	Yes	Yes	Yes	No	No	Yes	No	Yes	Yes	Yes	7
Kim et al.[9]	Yes	Yes	No	Yes	No	No	Yes	Yes	No	Yes	Yes	6
Muñoz-Perete et al.[10]	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	7
Caballero et al.[11]	Yes	Yes	Yes	Yes	No	No	No	Yes	No	Yes	Yes	6
Tao et al.[12]	Yes	Yes	No	Yes	No	No	Yes	Yes	No	Yes	Yes	6
Baek et al.[13]	Yes	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	7
Kim & Park[14]	Yes	Yes	No	Yes	No	No	Yes	Yes	No	Yes	Yes	6

Abbreviations: PEDro = Physiotherapy Evidence Database

The included studies comprised a total of 710 participants, with sample sizes ranging from 42 to 293 individuals. All participants were older adults diagnosed with mild cognitive impairment, and most studies recruited community-dwelling populations. Baseline cognitive status was commonly assessed using standardized instruments such as the Montreal Cognitive Assessment (MoCA) and the Mini-Mental State Examination (MMSE).

Dual-task training interventions varied across studies in terms of type, duration, and frequency. Interventions generally combined motor and cognitive components performed simultaneously, including cognitive–physical dual-task training, cognitively loaded physical exercise, and virtual reality-based motor–cognitive training. The duration of interventions ranged from 6 to 12 weeks, with frequencies of 2 to 3 sessions per week and session durations between 30 and 60 minutes. Comparison groups included usual care, cognitive training, health education, or single-task physical interventions. Detailed study characteristics are presented in Table 2.

Table 2. Characteristics of Included Studies Based on the PICOS Framework

Study	Population (n)	Intervention (Type & Duration)	Comparison	Cognitive Outcomes	Key Findings
Kwan et al.[8]	293 older adults with cognitive frailty	VR-based motor–cognitive training, 8 weeks, 2 sessions/week	Usual care	MoCA, TMT, Stroop	Significant improvement in global cognition (ΔMoCA +0.97; p=0.03); marginal improvement in executive function
Kim et al.[9]	51 older adults with MCI	Cognitively loaded physical exercise, 8 weeks, 2 sessions/week	Conventional training	MoCA	Significant improvement in global cognition (p<0.001)
Muñoz-Perete et al.[10]	82 older adults with MCI	Cognitive stimulation + strength training, 8 weeks	Health education	MoCA, TMT, DSST	Significant improvement in global cognition (p<0.001; η^2=0.161)
Caballero et al.[11]	95 older adults with MCI	Combined physical–cognitive training, 12 weeks	Cognitive stimulation	MMSE, MoCA, TMT	Significant improvement in global cognition (p<0.001; η^2=0.321)
Tao et al.[12]	103 older adults with MCI	Motor–cognitive training, 12 weeks	Health education	MoCA, MMSE	Significant improvement with large effect sizes (p<0.001; η^2p=0.330–0.442)
Baek et al.[13]	44 older adults with cognitive impairment	Dual-task resistance + cognitive training, 6 weeks, 3 sessions/week	Resistance training	MMSE	Significant improvement in cognition (p=0.044; η^2p=0.094)
Kim & Park[14]	42 older adults with MCI	Cognitive–physical dual-task training, 8 weeks	Cognitive single-task	EFPT, FAB	Significant improvement in executive function (p<0.001; η^2=0.132–0.305)

Abbreviations: MoCA = Montreal Cognitive Assessment; MMSE = Mini-Mental State Examination; TMT = Trail Making Test; DSST = Digit Symbol Substitution Test; EFPT = Executive Function Performance Test; FAB = Frontal Assessment Battery

Across the included studies, dual-task training interventions were associated with improvements in cognitive function outcomes compared with control conditions. Improvements in global cognitive function were consistently reported, as measured by instruments such as MoCA and MMSE. Several studies also demonstrated significant improvements in executive function, assessed using tools such as the Trail Making Test (TMT), Frontal Assessment Battery (FAB), and Executive Function Performance Test (EFPT).

Effect sizes reported in the included studies ranged from moderate to large, indicating clinically meaningful changes in cognitive outcomes. However, the magnitude of improvement varied across studies, reflecting differences in intervention protocols and outcome measures. Other cognitive domains, including attention and memory, showed less consistent findings across studies.

Discussion

This systematic review synthesized evidence from seven randomized controlled trials evaluating the effectiveness of dual-task training (DTT) in older adults with mild cognitive impairment (MCI). Overall, the findings demonstrate that DTT is associated with consistent improvements in cognitive function, particularly in global cognition and executive function, compared with control interventions. These results reinforce the growing body of evidence supporting the superiority of combined motor–cognitive interventions over single-task approaches.[10–12,14]

Despite the overall positive findings, the magnitude and consistency of effects varied across studies. This variability is likely attributable to heterogeneity in intervention protocols, including differences in duration, frequency, intensity, and types of cognitive tasks applied. In addition, variations in outcome measures further limit direct comparability across studies. Such heterogeneity has

been widely reported in previous systematic reviews and remains a major challenge in establishing standardized dual-task training protocols.[15,16]

Executive function emerged as the most responsive cognitive domain to DTT. Several included studies reported significant improvements in executive function compared with single-task or conventional interventions.[10,12,14] This finding is theoretically plausible, as executive functions—such as attention shifting, inhibition, and working memory—are directly engaged during simultaneous motor and cognitive task performance.[17,18] The continuous requirement to manage dual-task demands likely enhances cognitive flexibility and attentional control, which are critical components of executive function.

In addition to executive function, improvements in global cognitive function were consistently observed across studies, particularly in those using standardized instruments such as the Montreal Cognitive Assessment (MoCA) and the Mini-Mental State Examination (MMSE).[12] However, other cognitive domains, including memory and attention, demonstrated less consistent findings. This inconsistency may be explained by differences in cognitive task specificity during training and the varying sensitivity of outcome measurement tools across studies.

The effectiveness of DTT can be further understood through underlying neurophysiological mechanisms. Simultaneous motor and cognitive stimulation is thought to activate multiple neural networks, particularly within the prefrontal cortex and hippocampus, which are essential for executive function and cognitive control.[15,17] This combined activation may enhance neuroplasticity, increase cerebral blood flow, and promote the release of neurotrophic factors such as brain-derived neurotrophic factor (BDNF), thereby facilitating synaptic plasticity and cognitive improvement.[19,20] These mechanisms provide a biological rationale for the observed benefits of dual-task interventions in individuals with MCI.

From a clinical perspective, the findings suggest that DTT represents a functionally relevant intervention, as it closely mimics real-life situations in which individuals are required to perform cognitive and motor tasks simultaneously.[8,14] This ecological validity may contribute to greater transfer of training effects to daily functional activities compared with single-task interventions. Furthermore, the intervention dosages reported in the included studies—typically ranging from 6 to 12 weeks, with 2 to 3 sessions per week and session durations of 30 to 60 minutes—appear to be sufficient to produce meaningful cognitive improvements.[10–12,14] These parameters may serve as a practical reference for clinical implementation in geriatric rehabilitation settings.

However, several limitations should be considered when interpreting the findings of this review. First, the heterogeneity in study designs, intervention protocols, and outcome measures limits the generalizability of the results. Second, methodological limitations were identified in several studies, including lack of blinding and limited use of intention-to-treat analysis, which may introduce potential bias. Third, the relatively small number of included studies restricts the strength of the conclusions.

In addition, the potential for publication bias cannot be excluded, as studies reporting positive outcomes are more likely to be published than those with null or negative findings. This may result in an overestimation of the effectiveness of dual-task training in the available literature. Therefore, the findings should be interpreted with caution.

Future research should aim to standardize dual-task training protocols, including clearly defined parameters for duration, frequency, and task complexity, to improve comparability across studies. Furthermore, studies incorporating long-term follow-up are needed to evaluate the sustainability of intervention effects. The inclusion of neurophysiological measures, such as neuroimaging or biomarkers, may also provide deeper insights into the mechanisms underlying cognitive improvements associated with DTT.

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Future research should aim to standardize dual-task training protocols, including clearly defined parameters for duration, frequency, and task complexity, to improve comparability across studies. Furthermore, studies incorporating long-term follow-up are needed to evaluate the sustainability of intervention effects. The inclusion of neurophysiological measures, such as neuroimaging or biomarkers, may also provide deeper insights into the mechanisms underlying cognitive improvements associated with DTT.

Conclusion

Dual-task training appears to be an effective non-pharmacological intervention for improving cognitive function in older adults with mild cognitive impairment, particularly in the domains of global cognition and executive function. The findings from the included randomized controlled trials consistently demonstrate positive effects compared with control interventions.

However, the heterogeneity in intervention protocols, outcome measures, and methodological quality across studies limits the generalizability of these findings. Therefore, the results should be interpreted with caution. From a clinical perspective, dual-task training offers a functionally relevant approach that reflects the cognitive and motor demands of daily activities. Standardized intervention protocols and well-designed studies with long-term follow-up are required to strengthen the evidence base and support its implementation in clinical practice.

Author Contribution

Winda Safitri Fakhira: Conceptualization, Methodology, Data curation, Formal analysis, Writing original draft.
Muhamad Elfitra Salam: Conceptualization, Writing, review & editing, Supervision.

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Conflict of Interest Statement

The authors declare that there is no conflict of interest.

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Ethics Statement

This study was a systematic review based on previously published data and did not involve direct interaction with human participants or animals. Therefore, ethical approval and informed consent were not required. All procedures were conducted in accordance with relevant guidelines for literature-based research.

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