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ARTICLE

Effect of Motor-Cognitive Dual Task Training on Cognitive Function in patients with Dementia

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Abstract

Dementia is a progressive neurological condition characterised by a decline in cognitive function, memory and behaviour, which significantly affects an individual's activities of daily living. As the number of elderly increases, the prevalence of dementia also shows an increasing trend and is a major challenge in geriatric health services. This study aims to evaluate the effectiveness of *Motor-Cognitive Dual Task Training* in improving cognitive function in the elderly with dementia. This research uses a case study method on one subject who meets the inclusion and exclusion criteria. The intervention was conducted for four weeks, totalling 12 sessions with a frequency of three times per week. Each session lasted 30-45 minutes and consisted of a combination of physical activities performed in conjunction with cognitive tasks. The exercises were designed to stimulate various domains of cognitive function as measured by the Mini Mental State Examination (MMSE), including orientation, attention and calculation, short-term memory, language, and visuospatial abilities. Evaluation of cognitive function was conducted using the MMSE before and after the intervention. The results showed an increase in MMSE score from 21 to 24, indicating an improvement in cognitive function by 14.3%, although still in the mild dementia category. These findings support that *Motor-Cognitive Dual Task Training* can be an effective physiotherapy approach to improve cognitive function in patients with dementia.

Keywords: Dementia, Cognitive Function, Motor-Cognitive Dual Task Training, MMSE

1. Introduction

Ageing is a multidimensional, continuous and natural process that occurs throughout human life (Huang et al., 2023). In this context, from the age of 60, there are biological, social, and personal changes that mark the beginning of the advanced age stage (Quigley et al., 2020). The United Nations (UN) reports that by 2050, 16% of the world's population will be over the age of 65, compared to 9% today. In addition, the number of people over the age of 80 is projected to reach 426 million by 2050. (Cerda-Vega et al., 2024).. Based on data from the Central Statistics Agency (2020), the percentage of the elderly population in Indonesia is at a percentage of 10.7% to 12.5%, this figure has increased from 2015, which was around 8.6% (Celsis et al., 2023).

Physiologically, the aging process is characterised by a decrease in brain volume, an increase in cerebrospinal fluid, focal neuronal loss, as well as changes in neuronal branching that are non-generalised (Chen et al., 2020; Pahlavani, 2023). These changes result in decreased levels of *brain-derived neurotrophic factor* (BDNF), an important protein that supports brain plasticity and neuronal

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survival. (Kim et al., 2022). At the functional level, the elderly experience a decline in cognitive function, a slowdown in information processing, impaired working memory, and a decline in motor skills (Hua & Sun, 2024).

Dementia is a neurocognitive syndrome characterised by a progressive decline in brain function across a range of cognitive domains, such as memory, language, attention, executive function and visuospatial abilities. This can lead to a decline in an individual's ability to carry out activities of daily living independently (Frisoni et al., 2023). Early symptoms of dementia generally include impaired short-term memory, disorientation to time and place, difficulty in constructing sentences, making decisions, or understanding instructions. As it progresses, the patient experiences complete dependence on the help of others in carrying out basic functions such as eating, dressing, or maintaining personal hygiene (Cipriani et al., 2020). Globally, there are an estimated 47 million people living with dementia, and this number is predicted to triple by 2050 (Li et al., 2021). The prevalence of dementia in Indonesia increases every 5 years by 2 times in the population aged over 60 years making it the 16th highest number of sufferers in Asia, an estimated 1.2 million people in Indonesia had dementia in 2016 and is predicted to increase to 2 million by 2030 and 4 million by 2050 (Celsis et al., 2023). This suggests that dementia is a serious challenge in geriatric healthcare in Indonesia, and effective interventions are needed to delay the progression of cognitive impairment in the elderly.

Cognitive function is a neural function that is very important in everyday life because it allows a person to interact socially and process information by considering context and personal experience(Jiménez-Maldonado et al., 2024). These functions include perception, attention, memory, language, and executive functions(Frisoni et al., 2023). In adulthood, cognitive function begins to experience a decline that becomes more pronounced with age (Gerten et al., 2022)This can lead to difficulties in socialising, decreased energy and independence, impairment in activities of daily living, social participation, and reduced quality of life. This can lead to difficulties in socialising, decreased energy and independence, impairment in activities of daily living, social participation, and reduced quality of life(Zhao et al., 2022), as well as an increased risk of neurocognitive impairment (Cerda-Vega et al., 2024).. Currently, there are no treatments available that can reverse the pathological changes in the brain associated with degenerative dementia. Therefore, it is crucial to devise strategies that can delay and/or halt cognitive decline in patients with dementia conditions(C. Yang et al., 2020).

Motor Cognitive Dual Task Training is an exercise that combines motor and cognitive simultaneously(Ali et al., 2022; Park & Lee, 2018). Regular physical activity has been shown to increase blood flow to the brain and maintain brain plasticity(Ercan Yildiz et al., 2024). This process is crucial in preventing hypertrophy of brain tissue that can lead to neuronal degeneration, thus negatively affecting cognitive function (Xiao et al., 2023). The synergistic effect of motor training activates neurophysiological mechanisms that significantly enhance neuroplasticity(Nam & Kim, 2021). In a study conducted by Parvin (2020), it was found that there was a significant change in the average short-term memory in the elderly when the *Motor Cognitive Dual Task Training* intervention was carried out(Parvin et al., 2020).

Globally, digital transformation is driven by the demand for adaptive, efficient services that keep pace with technological developments and patient expectations. The implementation of electronic health records and the integration of clinical and social data contribute to the personalisation of services, particularly in reaching underserved populations through innovations such as telemedicine(Katapally, 2024;Elendu et al., 2024)In Indonesia, the Digital Health Transformation policy is an important foundation for the development of health information systems. One of its main initiatives is the SATUSEHAT platform, which is designed to integrate health data from various service facilities(Mulyana et al., 2021; Supian et al., 2024). The digitisation of medical records through the implementation of Electronic Medical Records (EMR) is also an important pillar in efforts to improve the quality and efficiency of services(Darianti et al., 2021; Mulyana et al., 2021; Ningsih et al., 2022).

The digital transformation initiative also includes efforts to facilitate data integration across healthcare facilities, ensuring that patient information can be accessed quickly and efficiently(Asgiani et al., 2024; Mulyana et al., 2021; Supian et al., 2024)With these steps, it is hoped that the healthcare system in Indonesia can be more responsive to patient needs and improve data-driven decision-making in

healthcare services(Darianti et al., 2021; Ningsih et al., 2022)In the context of hospitals, digital readiness is crucial to ensuring the successful integration of information systems. The Indonesian Ministry of Health has developed the Hospital Digital Maturity Assessment Instrument version 1.1, which covers seven main components: (1) information systems and infrastructure, (2) standards and interoperability, (3) management and governance, (4) data analytics, (5) human resources, (6) information security and data privacy, and (7) utilisation of EMR and patient-centred services(Alotaibi et al., 2024; Hourani et al., 2021;Ferreira et al., 2025).

Digital transformation also requires human resource competencies that encompass not only technical skills but also an understanding of information systems in daily service practices (Ferreira et al., 2025). On the other hand, interoperability between systems remains a major challenge, especially in supporting cross-facility data integration (Asgiani et al., 2024). To date, academic studies on the digital maturity of hospitals in Indonesia have been dominated by studies on vertical hospitals and education. Unlike previous research, this study specifically evaluates the digital readiness of private hospitals at the district level, which have their own characteristics and challenges. Research on regional private hospitals is still rare, yet the digital disparity between hospital types is a critical issue in achieving an inclusive and equitable digital health system.

This study aims to assess the level of digital maturity at Citra Husada Hospital in Jember using an official instrument from the Indonesian Ministry of Health. A descriptive approach was used to map the hospital's position based on seven main components of digitalisation. The results of this study are expected to form the basis for the hospital's strategic planning and serve as a reference for policy makers in designing interventions that support the acceleration of national health digital transformation.

2. Materials and Methods

2.1 Research Design

This study utilised a quasi-experimental design with a case study approach, aiming to evaluate the effect of Motor-Cognitive Dual Task Training on cognitive function improvement in elderly individuals with mild dementia. Case studies were chosen because they allow for in-depth observation of a single individual in a real-world context over time. The study was conducted over a four-week period, consisting of three main phases: initial measurement *(pre-test),* intervention implementation, and final measurement *(post-test).*
The study began with a screening process to determine subject eligibility based on inclusion and exclusion criteria. Once subjects were selected, initial cognitive function was measured using the Mini Mental State Examination (MMSE) to obtain baseline scores. Subsequently, subjects underwent a 4-week *Motor-Cognitive Dual Task Training* intervention programme, with a frequency of 3 times a week and a total of 12 sessions. Each session lasted 30–45 minutes and consisted of motor exercises combined with cognitive tasks (such as counting backwards, naming objects, or remembering word sequences), performed simultaneously(Lee & Song, 2025; Zhen & Peng, 2023).

2.2 Research Subject

The subject of this study was a 70-year-old female elderly person with mild dementia based on an examination using the Mini Mental State Examination (MMSE) with an initial score of 21 (mild dementia category) conducted by a licensed professional physiotherapist. This diagnosis was made based on standard cognitive measurements taken prior to the intervention. The MMSE instrument has been proven to be valid and reliable for use in the elderly population in Indonesia and is widely used in clinical practice and local research. For example, a study by Okvitasari and colleagues (2024) utilised the MMSE in a community-based elderly study with a clear scientific protocol, and the instrument was deemed suitable for use with adequate internal consistency(Okvitasari et al., 2024).
Subjects were selected using purposive sampling with the following inclusion criteria: age ≥60 years, MMSE score between 21–24 (mild dementia category), no severe hearing or vision impairment, able to walk with or without assistive devices, and willing to participate in all intervention sessions during the study period. Exclusion criteria included the presence of other progressive neurological disorders

(such as Parkinson's disease or severe stroke), acute mental disorders, or unstable cardiopulmonary conditions.
Pemilihan subjek secara purposif memungkinkan penelitian memfokuskan pada kasus yang benar-benar merepresentasikan populasi sasaran, yakni lansia dengan gangguan kognitif ringan yang masih memiliki kapasitas mengikuti pelatihan. Sebelum memulai intervensi, subjek diberikan penjelasan menyeluruh mengenai tujuan, manfaat, dan prosedur pelatihan yang akan dilakukan. Subjek dan keluarga diminta menandatangani lembar informed consent untuk memastikan partisipasi yang sukarela dan sesuai dengan prinsip etika penelitian. Peneliti juga memantau kondisi medis dan psikologis subjek sebelum setiap sesi untuk menjamin keamanan intervensi.

2.3 Intervensi

The intervention provided was *Motor-Cognitive Dual Task Training*, which was conducted over 4 weeks, 3 times per week, for a total of 12 sessions. Each session lasted 30–45 minutes and included a combination of physical activities and cognitive tasks performed simultaneously. Physical activities included walking 3 metres, walking in a diagonal pattern, walking in tandem, and walking in tandem with a diagonal pattern. Cognitive tasks included counting backwards, naming fruits or animals based on categories, reciting the alphabet backwards, and remembering the order of words.

The selection of this type of exercise is based on the principle that combining motor and cognitive tasks simultaneously can stimulate broader brain activation, including the prefrontal cortex, parietal cortex, and executive system, which play an important role in memory, attention, orientation, and visuospatial functions. Walking exercises with specific patterns stimulate coordination and executive function, while cognitive tasks such as categorisation, memory, and calculation are designed to improve attention, orientation, calculation, and short-term memory, all of which are domains assessed in the *Mini Mental State Examination* (MMSE).

The exercises are conducted gradually from low to high levels of difficulty, taking into account the subject's tolerance and capacity. In the first week, the combination of exercises focuses on simpler forms with light cognitive loads. Subsequently, the difficulty level of the exercises is progressively increased both in terms of motor and cognitive aspects to enhance neuroplastic adaptation and mental engagement of the subject. All intervention sessions are conducted under the direct supervision of a professional physiotherapist to ensure the accuracy of techniques, safety of implementation, and achievement of dual-task stimulation goals in accordance with the plan.

2.4 Analisis Data

Cognitive function was evaluated using the Mini Mental State Examination (MMSE) at the beginning (pre-test) and end (post-test) of the intervention period. The MMSE is a cognitive assessment tool consisting of 11 items, with a maximum score of 30 points, covering aspects of time and place orientation, registration, attention and calculation, short-term memory, language, and visuospatial ability(Nam & Kim, 2021). MMSE scores before and after the intervention were compared descriptively and quantitatively, by assessing the difference in scores and changes in cognitive status categorisation to determine the direction and magnitude of the intervention's impact. In this study, no inferential statistical tests were conducted because the sample size of only one subject did not meet the criteria for parametric or non-parametric statistical analysis. The analysis focused on changes in absolute MMSE scores to describe the potential effects of the intervention in the context of a case study. However, the use of the MMSE as the sole measurement tool has limitations, including the potential for ceiling/floor effects, low sensitivity to small changes in executive function, and the influence of educational and cultural background on score outcomes. Therefore, the interpretation of results was conducted cautiously, taking these limitations into account when concluding the effectiveness of the intervention.

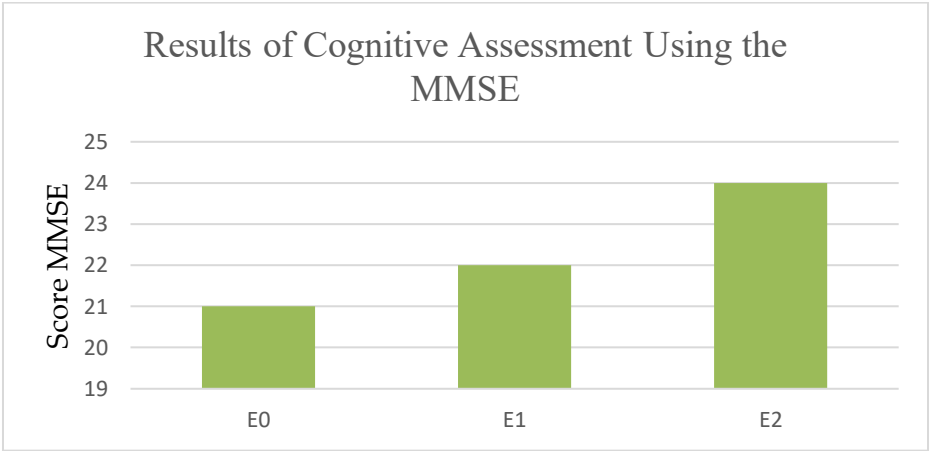
3. Results and Discussion

3.1 Results

The general description of the sample in this case study is a 70-year-old female elderly patient with

mild dementia. The patient agreed to participate in the study for health maintenance and improvement. The study, examination, and treatment were conducted using the *Motor Cognitive Dual Task Training* intervention to improve cognitive abilities. The examination process begins with an assessment and concludes with the final results or evaluation.

The research process lasted for 4 weeks and was conducted 3 times a week. After the researchers examined the patient's symptoms and signs and conducted special examinations, it was determined that the patient had mild dementia, as measured by the Mini Mental State Examination (MMSE). The initial measurement before the Motor Cognitive Dual Task Training yielded a score of 21 (mild dementia). In the first evaluation, the result was 22 points (mild dementia). In the final evaluation, the result was 24 points (mild dementia). Therefore, it can be concluded that there was an improvement in cognitive ability in the elderly from 21 points to 24 points; however, the dementia is still categorised as mild dementia.



Explanation: E0 = Initial evaluation, E1 = Evaluation, 1 E2 = Evaluation 2

Figure 1. Cognitive Function Measurement Results using MMSE

Changes in subjects' cognitive function scores were analysed quantitatively using the percentage change in MMSE scores from pre-test to post-test. The initial MMSE score (before intervention) was 21 points, categorised as mild dementia. After six therapy sessions, the mid-term evaluation showed an increase in the score to 22 points, or an increase of 4.8%. After the entire series of 12 intervention sessions, the MMSE score increased to 24 points, reflecting a total increase of 14.3% from the initial value. This increase in scores indicates an improvement in cognitive function, particularly in the domains of orientation, short-term memory, and attention, which are components stimulated through *Motor-Cognitive Dual Task Training*. Although the MMSE clinical category still indicates "mild dementia," a 3-point increase in scores over four weeks is a functionally meaningful achievement. This improvement indicates that the subject has enhanced capacity to perceive, process, and respond to information, as well as increased attention and cognitive flexibility during daily activities.

The practical implications of these results are quite significant. Although there was no change in dementia category, the increase in MMSE scores indicates that the *Motor-Cognitive Dual Task Training* programme was able to optimise the subjects' remaining cognitive capacity. This can be interpreted as an improvement in the ability to perform daily functional activities such as recognising the environment, following instructions, and performing simple multitasking tasks. Additionally, the stability of the score increase in the mid- and end-evaluations suggests that this training not only provides short-term effects but also has the potential for a maintenance effect (*maintenance effect*), provided it is performed regularly.

3.2 Discussion

Dementia is a medical condition that affects a person's cognitive function, memory, and behaviour, thereby interfering with their daily activities and abilities. Age plays a major role in the onset of

dementia. In addition, this condition can also be caused by various diseases and injuries that affect the brain(Villamil-Cabello et al., 2023). Motor Cognitive Dual Task Training is a form of exercise used to investigate the interaction between cognitive processing and motor performance(Nam & Kim, 2021). Motor Cognitive Dual Task Training aims to improve gait patterns, cognitive function, automatic skills, and learning transfer in patients(Z. Q. Yang et al., 2023).

Motor tasks performed regularly can improve blood flow to the brain and help maintain brain flexibility. This process plays an important role in preventing brain tissue enlargement, which can cause nerve cell damage and affect cognitive function. Motor exercises also have a synergistic effect that triggers neurophysiological mechanisms to support increased neuroplasticity(Hao et al., 2025). Meanwhile, *Cognitive Task* can support the process of neuroplasticity by stimulating the formation of new brain cells. This process is related to the activation of newly formed synapses and neurons, so that cognitive training is able to activate connections between nerve cells(Mancioppi et al., 2021). It can therefore be concluded that combining *Motor Tasks* and *Cognitive Tasks* can increase neuroplasticity, whereby neurotransmitters will increase and form new nerve cells, particularly in the cerebral cortex and hippocampus(Kuo et al., 2022).

This type of exercise was chosen because, based on literature and the principles of neuroplasticity, dual-task training stimulates a wider area of the brain, including the prefrontal cortex, parietal lobe, and limbic structures, which are related to cognitive functions assessed by the Mini Mental State Examination (MMSE). Motor activities such as walking and movement coordination support the domains of orientation, attention, and visuospatial ability, as they involve perception of direction, space, and the ability to maintain focus while moving. Verbal and numerical cognitive tasks administered simultaneously contribute to the domains of registration, calculation, short-term memory, and language, as they require information processing, memory retrieval, and active use of vocabulary(Kuo et al., 2022). This combination of exercises is not only aimed at improving memory and concentration, but also at training sensorimotor integration and dual attention responses, which are major challenges for elderly people with mild dementia. In addition, this intervention approximates real-life situations in which a person often performs physical activities and thinks at the same time, thus having high functional and transfer value to daily activities(Z. Q. Yang et al., 2023).

In this study, an increase in MMSE scores from 21 to 24 reflects an improvement in the subjects' cognitive function after undergoing intervention for 4 weeks. However, it should be noted that despite a 3-point increase in scores, the final results still fall within the mild dementia category according to the MMSE classification. This indicates that the changes that occurred were positive but not sufficient to shift the clinical diagnostic category. Therefore, while the intervention shows promising potential, the score improvement should be interpreted cautiously and not regarded as full recovery of cognitive function. This reflection is important to prevent the research findings from leading to exaggerated claims about the therapy's effectiveness and to serve as a basis for further efforts to evaluate long-term impacts and more intensive intervention combinations.

Various studies show that *MotorCognitive Dual Task Training* is effective in improving cognitive function, particularly executive function in elderly people with cognitive impairment and dementia(Hao et al., 2025). This intervention has also been shown to improve walking speed, postural stability, and reduce cognitive load when performing two tasks simultaneously (*dual-task cost*)(Jardim et al., 2021). Compared to single cognitive training, the *motor-cognitive dual-task* approach provides a more comprehensive effect because it involves the simultaneous integration of physical and mental activities(Yokoyama et al., 2015). Its effectiveness also includes improvements in daily activities, quality of life, and a reduction in mild depressive symptoms in patients(Tao et al., 2022). These results indicate that *dual-task training* is not only beneficial for cognitive aspects but also supports motor function, which is an important component of elderly independence. Therefore, *Motor-Cognitive Dual-Task Training* can be recommended as a promising holistic rehabilitative approach in the management of cognitive decline and dementia.

This study has several limitations that need to be considered when interpreting the results. First, the use of a single-subject case study design means that the findings cannot be generalised to a wider population, as responses to the intervention may vary between individuals. Second, the short duration of the intervention, which lasted only four weeks, limits our understanding of the long-term effects of

Motor-Cognitive Dual Task Training on cognitive function. Third, the evaluation instrument used was only the *Mini Mental State Examination* (MMSE), which has limitations in detecting more complex cognitive changes, such as executive function and working memory. Fourth, the absence of a control group makes it difficult to rule out the possibility that improvements in cognitive function were due to external factors outside the intervention. Therefore, these findings should be viewed as preliminary and exploratory results, and further research with an experimental design, larger sample size, and longer intervention duration is needed to comprehensively test the effectiveness of the therapy.

The findings of this study have relevant clinical implications for geriatric physiotherapy practice, particularly in the management of elderly individuals with mild dementia. *Motor-Cognitive Dual Task Training* can be used as an intervention approach that stimulates brain activity through the simultaneous engagement of motor and cognitive functions. This approach supports the concept of neuroplasticity, which forms the basis of rehabilitation therapy for progressive cognitive disorders. In practice, this intervention can be flexibly applied in clinics, elderly care centres, or at home under the supervision of caregivers or trained healthcare professionals. Structured and sustained implementation has the potential to slow cognitive decline and maintain patients' functional capacity. Therefore, this intervention can be part of a non-pharmacological rehabilitation protocol that is preventive, supportive, and promotive in the clinical management of dementia.

4. Conclusion

This study shows that *Motor-Cognitive Dual Task Training* has the potential to improve cognitive function in elderly people with mild dementia, as indicated by an increase in MMSE scores, although they remain in the same clinical category. These findings are preliminary and cannot yet be generalised due to the limitations of the single-case study design and the absence of a control group. Therefore, this intervention requires further testing through larger-scale studies with experimental designs and multidimensional evaluations to comprehensively confirm its effectiveness and clinical significance.

References

Ali, N., Tian, H., Thabane, L., Ma, J., Wu, H., Zhong, Q., Gao, Y., Sun, C., Zhu, Y., & Wang, T. (2022). The Effects of Dual-Task Training on Cognitive and Physical Functions in Older Adults with Cognitive Impairment; A Systematic Review and Meta-Analysis. *Journal of Prevention of Alzheimer's Disease*, *9*(2), 359–370. [Crossref] [Publisher]

Celsis, P., Hendro, B., & Kristamuliana. (2023). Hubungan Tingkat Demensia dengan Risiko Jatuh Pada Lanjut Usia di Panti Werda Kota Manado. *Mapalus Nursing Science Journal*, *1*(2), 65–71. [Publisher]

Cerda-Vega, Irarrázabal-Guerra, C., Sabja-Sepúlveda, L., Guajardo-Sandoval, N., Roa-Chiarleoni, N., Morales-Sánchez, V., Reigal, R. E., & Pérez-Romero, N. (2024). Effects of aerobic, strength, and combined exercise on cognitive functions in older adults: a systematic review. *Retos*, *60*, 1341–1355. [Crossref]

Chen, F. T., Hopman, R. J., Huang, C. J., Chu, C. H., Hillman, C. H., Hung, T. M., & Chang, Y. K. (2020). The effect of exercise training on brain structure and function in older adults: A systematic review based on evidence from randomized control trials. *Journal of Clinical Medicine*, *9*(4). [Crossref] [Publisher]

Cipriani, G., Danti, S., Picchi, L., Nuti, A., & Di Fiorino, M. (2020). Daily functioning and dementia. *Dementia e Neuropsychologia*, *14*(2), 93–102. [Crossref] [Publisher]

Ercan Yildiz, S., Fidan, O., Gulsen, C., Colak, E., & Genc, G. A. (2024). Effect of dual-task training on balance in older adults: A systematic review and meta-analysis. *Archives of Gerontology and Geriatrics*, *121*(November 2023), 105368. [Crossref] [Publisher]

Frisoni, G. B., Altomare, D., Ribaldi, F., Villain, N., Brayne, C., Mukadam, N., Abramowicz, M., Barkhof, F., Berthier, M., Bieler-Aeschlimann, M., Blennow, K., Brioschi Guevara, A., Carrera, E., Chételat, G., Csajka, C., Demonet, J. F., Dodich, A., Garibotto, V., Georges, J., … Dubois, B. (2023). Dementia prevention in memory clinics: recommendations from the European task force for brain health services. *The Lancet Regional Health - Europe*, *26*, 1–15. [Crossref] [Publisher]

Gerten, S., Engeroff, T., Fleckenstein, J., Füzéki, E., Matura, S., Pilatus, U., Vogt, L., Pantel, J., &

Banzer, W. (2022). Deducing the Impact of Physical Activity, Sedentary Behavior, and Physical Performance on Cognitive Function in Healthy Older Adults. *Frontiers in Aging Neuroscience*, *13*(January). [Crossref] [Publisher]

Hao, Y., Zhao, Y., Luo, H., Xie, L., Hu, H., & Sun, C. (2025). Comparative effectiveness of different dual task mode interventions on cognitive function in older adults with mild cognitive impairment or dementia : a systematic review and network meta - analysis. *Aging Clinical and Experimental Research*. [Crossref] [Publisher]

Hua, Z., & Sun, J. (2024). Investigating Morphological Changes of the Hippocampus After Prolonged Aerobic Exercise in Mice: Neural Function and Learning Capabilities. *International Journal of Morphology*, *42*(3), 614–622. [Crossref] [Publisher]

Huang, B., Chen, K., & Li, Y. (2023). Aerobic exercise, an effective prevention and treatment for mild cognitive impairment. *Frontiers in Aging Neuroscience*, *15*(August), 1–11. [Crossref] [Publisher]

Jardim, N. Y. V., Bento-Torres, N. V. O., Costa, V. O., Carvalho, J. P. R., Pontes, H. T. S., Tomás, A. M., Sosthenes, M. C. K., Erickson, K. I., Bento-Torres, J., & Diniz, C. W. P. (2021). Dual-Task Exercise to Improve Cognition and Functional Capacity of Healthy Older Adults. *Frontiers in Aging Neuroscience*, *13*(February), 1–16. [Crossref] [Publisher]

Jiménez-Maldonado, A., Rentería, I., Johnson, D. K., Moncada-Jiménez, J., & García-Suárez, P. C. (2024). Physical exercise and cognition in older adults, a scientific approach scanty reported in Latin America and Caribbean populations. *Frontiers in Sports and Active Living*, *6*(March), 1–7. [Crossref] [Publisher]

Kim, H.-J., Lee, D., & Lee, Y. (2022). The Effect of Aerobic Exercise on Brain-Derived Neurotrophic Factor (BDNF) in Individuals with Mild Cognitive Impairment: a Systematic Review and Meta-Analysis of a Randomized Controlled Trials. *Physical Therapy Rehabilitation Science*, *11*(3), 304–310. [Crossref] [Publisher]

Kuo, H. T., Yeh, N. C., Yang, Y. R., Hsu, W. C., Liao, Y. Y., & Wang, R. Y. (2022). Effects of different dual task training on dual task walking and responding brain activation in older adults with mild cognitive impairment. *Scientific Reports*, *12*(1), 1–11. [Crossref] [Publisher]

Lee, S., & Song, C. (2025). *Effect of Cognitive Control and Dual-Task Training on Gait Stability and Fall Risk In Older Adults : A Cross-Sectional Study*. 332–342. [Publisher]

Li, B., Luo, Y., & Lin, M. (2021). A systematic review of the use of play in dementia care. *Alzheimer's & Dementia : The Journal of the Alzheimer's Association*, *17*, e057509. [Crossref] [Publisher]

Mancioppi, G., Fiorini, L., Rovini, E., Zeghari, R., Gros, A., Manera, V., Robert, P., & Cavallo, F. (2021). Innovative motor and cognitive dual-task approaches combining upper and lower limbs may improve dementia early detection. *Scientific Reports*, *11*(1), 1–9. [Crossref] [Publisher]

Nam, S.-M., & Kim, S. (2021). Dual-Task Training Effect on Cognitive and Body Function, β-amyloid Levels in Alzheimer's Dementia Patients: A Randomized Controlled Trial. *The Journal of Korean Physical Therapy*, *33*(3), 136–141. [Crossref] [Publisher]

Okvitasari, Y., Kliviana, O., Hamidah, W., Verawanty, & Pauria. (2024). Pengkajian Mini Mental Status Examination (Mmse) Pada Lansia Di Musholla Al-Anshor Rt 15 Banjarmasin. *Janaloka*, *03*(01), 34. [Publisher]

Pahlavani, H. A. (2023). Exercise therapy to prevent and treat Alzheimer's disease. *Frontiers in Aging Neuroscience*, *15*(August). [Crossref] [Publisher]

Park, M. O., & Lee, S. H. (2018). Effects of cognitive-motor dual-Task training combined with auditory motor synchronization training on cognitive functioning in individuals with chronic stroke. *Medicine (United States)*, *97*(22), 1–6. [Crossref] [Publisher]

Parvin, E., Mohammadian, F., Amani-Shalamzari, S., Bayati, M., & Tazesh, B. (2020). Dual-Task Training Affect Cognitive and Physical Performances and Brain Oscillation Ratio of Patients With Alzheimer's Disease: A Randomized Controlled Trial. *Frontiers in Aging Neuroscience*, *12*(December), 1–13. [Crossref] [Publisher]

Quigley, A., MacKay-Lyons, M., & Eskes, G. (2020). Effects of Exercise on Cognitive Performance in Older Adults: A Narrative Review of the Evidence, Possible Biological Mechanisms, and Recommendations for Exercise Prescription. *Journal of Aging Research*, *2020*. [Crossref] [Publisher]

Tao, X., Sun, R., Han, C., & Gong, W. (2022). Cognitive-motor dual task: An effective rehabilitation method in aging-related cognitive impairment. *Frontiers in Aging Neuroscience*, *14*. [Crossref] [Publisher]

Villamil-Cabello, E., Meneses-Domínguez, M., Fernández-Rodríguez, Á., Ontoria-Álvarez, P., Jiménez-Gutiérrez, A., & Fernández-del-Olmo, M. (2023). A Pilot Study of the Effects of Individualized Home Dual Task Training by Mobile Health Technology in People with Dementia. *International Journal of Environmental Research and Public Health*, *20*(8). [Crossref] [Publisher]

Xiao, Y., Yang, T., & Shang, H. (2023). The Impact of Motor-Cognitive Dual-Task Training on Physical and Cognitive Functions in Parkinson's Disease. *Brain Sciences*, *13*(3). [Crossref] [Publisher]

Yang, C., Moore, A., Mpofu, E., Dorstyn, D., Li, Q., & Yin, C. (2020). Effectiveness of Combined Cognitive and Physical Interventions to Enhance Functioning in Older Adults with Mild Cognitive Impairment: A Systematic Review of Randomized Controlled Trials. *Gerontologist*, *60*(8), E633–E642. [Crossref]

Yang, Z. Q., Wei, M. F., Chen, L., & Xi, J. N. (2023). Research progress in the application of motor-cognitive dual-task training in rehabilitation of walking function in stroke patients. *Journal of Neurorestoratology*, *11*(1), 100028. [Crossref] [Publisher]

Yokoyama, H., Okazaki, K., Imai, D., Yamashina, Y., Takeda, R., Naghavi, N., Ota, A., Hirasawa, Y., & Miyagawa, T. (2015). The effect of cognitive-motor dual-task training on cognitive function and plasma amyloid β peptide 42/40 ratio in healthy elderly persons: A randomized controlled trial. *BMC Geriatrics*, *15*(1), 1–10. [Crossref] [Publisher]

Zhao, Y., Li, Y., Wang, L., Song, Z., Di, T., Dong, X., Song, X., Han, X., Zhao, Y., Wang, B., Cui, H. X., Chen, H., & Li, S. (2022). Physical Activity and Cognition in Sedentary Older Adults: A Systematic Review and Meta-Analysis. *Journal of Alzheimer's Disease*, *87*(3), 957–968. [Crossref] [Publisher]

Zhen, W., & Peng, D. (2023). Effects of motor-cognitive dual task training on cognitive and motor performance in patients with dementia: A systematic review. *Journal of the Neurological Sciences*, *455*, 121478. [Crossref] [Publisher]