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Single case experimental design as a tool for assessing individuals with Alzheimers's disease

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Abstract

OBJECTIVE: This article presents the findings of a research study on a selected patient diagnosed with Alzheimer's disease. The objective of the research was to showcase the single case experimental design as an effective method for qualitative and detailed observation of individual progression in patients with specific neurodegenerative conditions. The paper highlights examples of best practices from the perspective of caregiving professions.
METHODS: In our research, we employed the single case experimental design method, allowing for a detailed examination of the effects of our intervention strategies on an individual subject (N = 1). This approach utilized the ABAB model, where phase A represents a period without intervention and phase B signifies a period with intervention. This methodology facilitated a comprehensive analysis of the intervention's impact. The preliminary study was conducted over the course of 2021, involving regular sessions held three times a week for approximately 50 minutes each, tailored to the subject's individual needs. This method provided a robust foundation for designing interventions in the main study.
RESULTS: The presented results demonstrate that when the intervention was intentionally omitted, the patient regressed to the baseline levels assessed in the initial tests.
CONCLUSION: The utilization of the single case experimental design highlighted its utility in providing insightful, granular data on the regression and progression patterns of Alzheimer's patients, offering vital insights for developing targeted interventions. These findings underscore the importance of continuous and structured intervention to sustain improvements in patients with neurodegenerative diseases.

Introduction

Globally, approximately 50 million individuals currently suffer from various forms of dementia, with projections indicating an increase to 152 million by 2050, particularly in low to middle-income countries (Kosmidis *et al.* 2018; Kisvetrová *et al.* 2020). This increase in prevalence presents not only a significant personal and familial burden but also a substantial economic challenge, with annual global costs related to dementia care exceeding USD 1 trillion (Pettersson *et al.* 2017). Dementia is a chronic and progressive neurodegenerative condition characterized by the insidious onset of cognitive impairments that are not part of normal aging. This condition represents a serious clinical syndrome resulting from various neuropathological insults to the cerebral cortex and subcortical structures, leading to a decline in cognitive functions including memory, executive function, attention, language, and visuospatial skills. These cognitive deficits are substantial enough to interfere with daily functioning and independence. The pathophysiology of dementia involves complex neurodegenerative processes that result in neuronal loss and brain atrophy, particularly noted in Alzheimer's disease – the most common form of dementia. This degeneration is often accompanied by the accumulation of pathologic proteins such as beta-amyloid plaques and tau neurofibrillary tangles, which disrupt neural communication and contribute to the progressive nature of the syndrome (Jirák 2013; Hosák *et al.* 2019; Tariq & Barber 2018).

In younger individuals, dementia can be precipitated by secondary causes such as neuroinflammation from HIV/AIDS, consequences of cerebral tumors, or hereditary neurodegenerative disorders. The term 'dementia' originates from the Latin 'de mens' (de – from, mens – mind), which aptly describes the gradual erosion of cognitive faculties, essentially translating to a "loss of mind." Dementia typically evolves due to chronic or progressive brain diseases, impacting higher cortical functions—critical for memory, reasoning, orientation, and learning capabilities. The clinical manifestations of dementia include not only cognitive decline but also often neuropsychiatric symptoms, which can present as behavioral and psychological changes such as depression, anxiety, delusions, and agitation. These symptoms are challenging for caregivers and are central to the management strategies, which aim to maintain quality of life and functional independence for as long as possible (Amaral-Carvalho & Caramelli 2012; Barnes & Yaffe 2011). Given the increasing prevalence and significant impact of dementia, it is imperative to pursue rigorous diagnostic evaluations and develop multimodal treatment strategies that address both the cognitive and neuropsychiatric symptoms of the disease, thereby easing the substantial societal and economic burden it imposes (Bennett *et al.* 2014; Amanzio *et al.* 2018).

Qiu and Fratiglioni (2018) discuss in their article that brain damage and progressive age-related neuronal loss can be mitigated through lifelong engagement in activities such as active leisure pursuits, which thus serve as mechanisms to delay the onset of dementia. Most risk factors can also be addressed through quality therapeutic rehabilitation, which marginally falls into the realm of special education. If we focus thematically on the chosen issue, we base it on the fact that achieving a higher level of education can be considered a representative of lifelong activity, and we also count on this activity to maintain cognitive functions into later life. This can delay the onset of dementia, thereby extending the quality of life for individuals (Berggren *et al.* 2018; Beishon *et al.* 2021). Late age thus appears as a crucial period for developing protective factors against the onset of dementia. The combination of education and other activities appears to be the primary prevention of dementia onset. However, many authors agree that the chances of reducing the onset of dementia are associated with lifelong education, a healthy lifestyle, an active life, etc. The later we incline to these activities, the lower their effectiveness (Wang *et al.* 2019; Ward *et al.* 2018).

Methodology

Aims

Alzheimer's disease presents significant challenges not only for patients but also for caregivers and family members. It leads to impairments in cognitive processes, memory, mobility, and social interactions. Without proper intervention, these impairments can result in the social isolation of the affected individuals. To address these issues, this study employs the single case experimental design method, focusing on the long-term effects of integrated therapeutic interventions. This approach allows for a detailed examination of changes in cognitive and communicative abilities over an extended period. *The aim is to evaluate the effectiveness of a comprehensive therapy regimen, which includes specialized educational support, occupational therapy, and psychological care, in improving the overall functionality and social adaptability of Alzheimer's patients.*

Methods

Within our project, we opted for a single case experimental design, specifically utilizing the ABAB model. This method allowed for an intensive examination of the impacts of intervention procedures on a specifically chosen subject (N = 1) who was not part of the main experimental or control groups. In the ABAB model, "A" represented periods without intervention and "B" periods with intervention. The goal was to deeply analyze how the subject responded to the established intervention procedures and the effects of these procedures on his condition. The preliminary

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Tab. 1. Schedule of the preliminary study conducted throughout the year 2023 (source: own)

(A)			(B)			(A)			(B)		
Januray	February	March	April	May	June	July	August	September	October	November	Decemeber

study was conducted throughout 2023, with interventions and testing carried out three times a week for approximately 50 minutes each session. This approach not only enabled us to evaluate the effectiveness of the intervention procedures but also to identify potential ambiguities that could affect the implementation of the main study. The interventions were paused in July and August 2023, but testing continued monthly, providing data for an objective assessment of the efficacy of our interventions.

Participant

The subject was selected through a purposeful sampling method. The subject met predetermined relevant characteristics, such as the duration of the disease (4.9 years since diagnosis, Alzheimer's disease – mild stage). Additionally, the length of stay in a facility providing social services was 1.2 years. Demographic data further characterize the subject: living in a partnership, no impaired food intake, unemployed (retired), regular family involvement, and no limiting secondary diagnosis. Regarding pharmacotherapy, the subject takes standard medications that do not restrict daily activities.

Assessment Tools

The assessment employed two standardized tests widely recognized and frequently utilized within the Czech Republic, designed to provide a comprehensive evaluation of the subject. The first test, the Addenbrooke's Cognitive Examination, is a detailed assessment tool that measures cognitive functions across five domains: memory, verbal production, language abilities, visuospatial skills, and orientation. This examination offers an in-depth analysis of the subject in each specified area and quantifies the extent of cognitive impairment present. For the purposes of this study, we reported the overall results of this examination to provide a holistic view of cognitive function, rather than focusing on the specific outcomes within each subdomain. The second test, the Barthel Index, is utilized to assess the subject's level of dependency in performing everyday activities. This test evaluates essential daily functions such as personal hygiene, eating, mobility, and communication, providing a metric of the subject's ability to function independently. By using this test, we aimed to ascertain the degree to which the subject relies on the assistance of others for basic activities, thus reflecting their level of self-sufficiency. Both tests were meticulously chosen to align with our research objectives, which focus on evaluating the subject's autonomy and overall capability to manage daily tasks without external support.

This approach ensures that the assessments not only measure specific cognitive and functional abilities but also contribute valuable insights into the effectiveness of ongoing therapeutic interventions in enhancing the subject's quality of life.

Intervention Approaches

The intervention targeted at a specific subject was designed to provide a comprehensive and personalized program that exceeded the activities typically offered in the facility. This program integrated special educational and occupational therapy approaches, enhanced with modern technologies, and aimed at developing fine and gross motor skills, communication abilities, social adaptability, and cognitive functions. Within the intervention, several types of activities were implemented, including graphomotor exercises using the "pencil-paper" approach and worksheets designed to improve fine motor skills. Additionally, psychomotor therapy and physical therapy targeted the development of gross motor skills and were tailored to the individual needs and health status of the subject. These physical activities were supplemented with virtual reality and motion sensors to ensure variety and prevent potential dizziness. To support communication and social skills, individual and group discussions were conducted, combined with motor therapy. Activities were also introduced to promote social rehabilitation and adaptability of the subject in various locations within the facility, as well as integration into the daily operations of the facility. Cognitive functions were fostered through orientation training within and around the facility, working with "blind" maps, and discussions about route planning. Appropriate aids were used for structuring daily and weekly plans and visualizing specific activities, designed to enhance the subject's memory, attention, and verbal production. Overall, the program was carefully structured and visualized, helping the subject orient throughout the day and increasing their ability to adapt to new situations. This personalized approach not only stimulated the subject's development but also ensured their comfortable participation in all activities, with relaxation phases included to unwind and regenerate after each intervention. Interventions were conducted with an emphasis on ethics and informed consent, and were divided into individual and group sessions, typically with two individual therapies per week and one group therapy.

Ethical Considerations

The study adheres to ethical guidelines for case studies, ensuring the anonymity and privacy of the partici-

Tab. 2. Addenbrooke's Cognitive Test scores overall results (source: own)

(A)			(B)			(A)		(B)			
Januray	February	March	April	May	June	July	August	September	October	November	Decemeber
11	11	10	11	13	13	12	11	11	12	12	13
16	16	16	17	18	17	17	15	15	16	16	18
9	9	9	10	11	12	12	12	12	13	13	12
17	17	18	18	18	20	20	18	18	19	18	19
11	11	11	12	12	13	12	12	12	13	14	13
64	64	64	68	72	75	73	68	68	73	73	75

pant. All personal information has been de-identified, and the presentation of the case study emphasizes the protection of the patient's confidentiality.

Results

Table No. 2 presents the overall results of the Addenbrooke's test, where the maximum possible score is 100 points. Initially, before any interventions began, the subject scored 64 points. Once interventions commenced, this result began to improve, as evidenced by the scores of the various subdomains of the test. At the end of the first phase of the interventions, the subject's score increased to 75 points, reflecting an improvement of 11 points. During a period when the intervention was paused, the subject's performance decreased by 7 points. Upon resuming the interventions, the scores began to improve again. The final testing was conducted in December 2023, with the subject reaching 75 points again. This score development is illustrated in Graph No. 1, which shows an overall improvement of 11 points compared to the initial assessment.

Table No. 3 displays the results of the standardized Barthel Index. In this test, the subject can score from 0 to 100 points, with individual subdomains rated at 0, 5, 10, or 15 points, where 0 indicates full dependency and 10 or 15 points complete independence. Initially, the subject scored 45 points, indicating a moderate level of dependency. After starting the intervention, slight improvements began to emerge by the second month, primarily in stair climbing, one of the subdomains. This trend slightly declined after the intervention was paused. Upon resuming the intervention, the subject's condition improved, reaching up to 60 points. Primary improvements were noticeable in personal hygiene, eating, and mobility. The score development is illustrated in Graph No. 2, which shows the improvements in the observed areas compared to the initial assessment. Overall, the subject improved by 15 points. They are still in the category of moderate dependency but are now on the border of moving towards mild dependency.

The results obtained from our research show improvement in the experimental group. Our goal was not to evaluate the quality of provided services, but rather to assess our chosen intervention that went

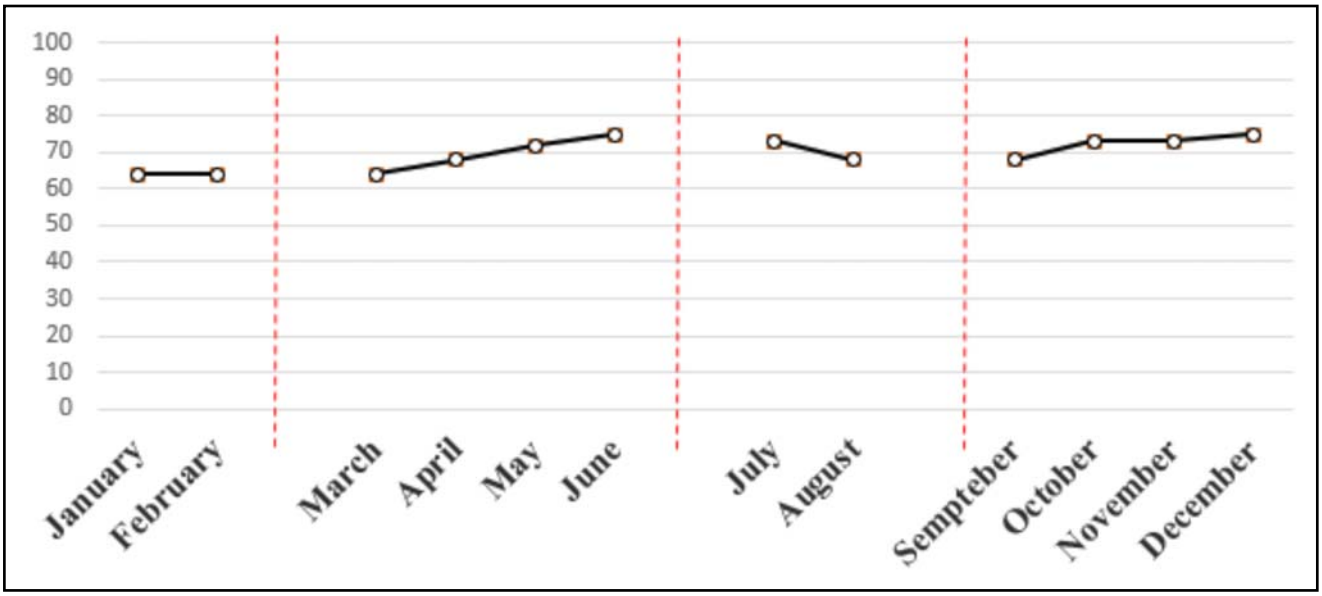

Fig. 1. Distribution of scores during th pre-test in the period with and without intervention (source: own)

Tab. 3. Barthel index scores overall results (source: own)

(A)			(B)			(A)			(B)		
Januray	February	March	April	May	June	July	August	September	October	November	Decemeber
45	45	45	45	50	50	50	45	50	50	55	60

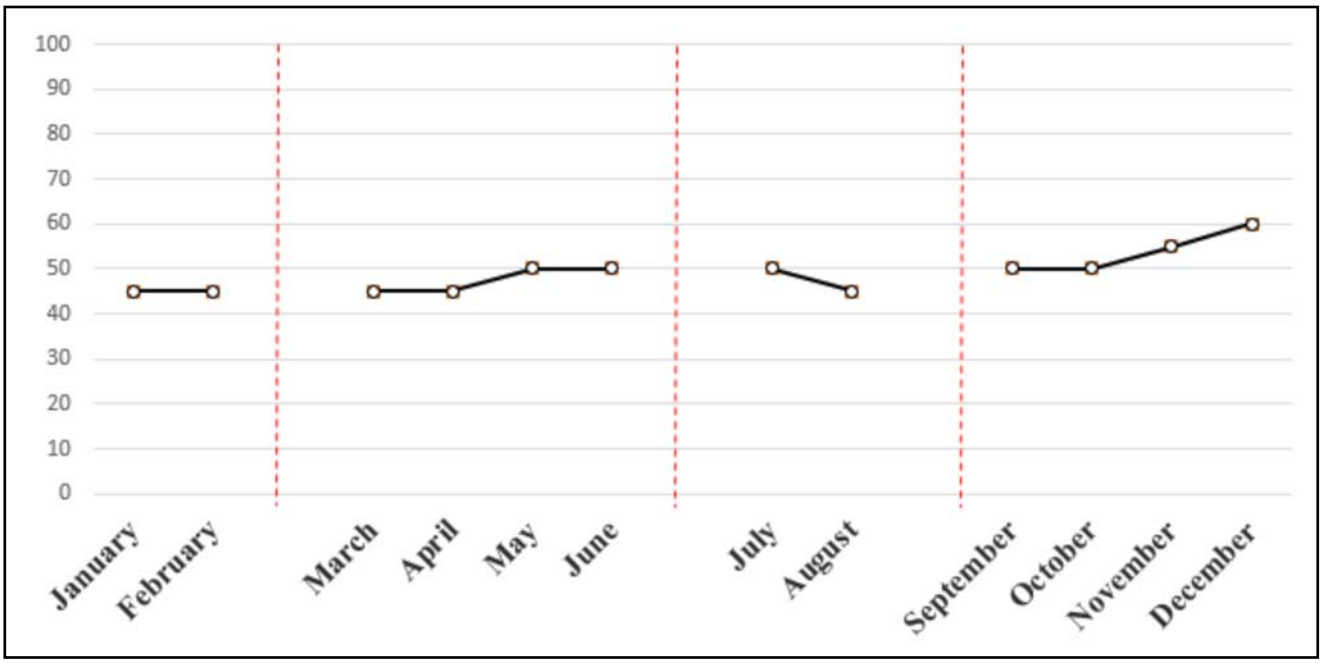

Fig. 2. Distribution of scores during th pre-test in the period with and without intervention (source: own)

beyond the usual activities offered to the subjects in these facilities. By presenting the results, we demonstrated that if subjects have a regular and varied program nearly every day, their condition can be somewhat improved. It is important to realize that the progression of the disease is relentless, and as the disease progresses to more severe stages (i.e., the longer the subjects have been diagnosed), we will see smaller gains in scores, more likely stagnation, and even a gradual loss of scores in the monitored indicators. The main recommendation we can make is to primarily target individuals who are in the early stages of mild dementia, diagnosed within three years. Based on the fact that dementia lasts about nine years and ends in death, the early stage (mild form) lasts three years, and here intensive comprehensive cases are needed. Early detection of the disease is crucial. The sooner the condition is identified, the sooner necessary cooperation with the patient can be established. Through this cooperation, activities can be created that may help extend the quality of life of the senior. In the previous chapter, we presented the results of our research focused primarily on the development of the subjects' cognitive functions. Cognitive functions are weakened by this disease, and this process gradually leads to complete immobility and permanent bed placement along with all-day care by others. The results of the survey thus confirm our hypothesis that the intervention created under special educational and occupational therapeutic interventions would lead to improvement in the monitored areas. As an accompanying second standardized test, we used the Activities of Daily Living test. Here too, we demonstrated that the subjects slightly improved in these areas as well. By linking these tests, we wanted to establish a logical connection, i.e., if cognitive functions improve, this improvement will also manifest in the management of everyday activities, thus in social adaptability.

Discussion

Building on our previous discussion on comprehensive rehabilitative approaches for Alzheimer's disease, it is evident that modern times have significantly improved the quality of life and health conditions, leading to an increasing average lifespan. According to Eurostat (2021), the average life expectancy for women in the Czech Republic was 80.2 years in 2007 and 82.2 years on a European average. For men, it was 73.8 years in the Czech Republic and 76.0 years in Europe during the same year. By 2017, average life expectancy for women in the Czech Republic had risen to 82 years, and to 83.5 years on the European average, with men reaching 76.1 years and 78.3 years respectively. This upward trend is expected to continue, with projec-

tions for 2050 estimating average life expectancies of 86.7 years for women and 82.1 years for men. This fact indicates an increasing number of retirees who often remain economically active, dedicating their lives to work, which provides them with purpose and contentment (Vostrý *et al.* 2021). However, there is a frequent encounter with health issues that disrupt both the work habits of these individuals and their overall quality of life. Health issues are often associated with the aging population in both professional discourse and among the general public. With age, the incidence of many diseases related to physical or mental health increases, including strokes, arthritic conditions, multiple sclerosis, and Parkinson's disease. In recent years, there has been a notable increase in dementia syndromes, primarily Alzheimer's disease, a genetic and sporadic neurodegenerative condition. This disease causes amnestic, and less frequently, non-amnestic cognitive disorders in individuals. Alzheimer's disease has become a common condition in middle to late life (Knopman *et al.* 2021), marked by a progressive decline in memory functions, followed by other cognitive dysfunctions such as visuospatial abnormalities, disorientation (in place, time, and later person), or language disorders. These impairments significantly affect daily functioning and the ability to perform everyday activities.

This clinical picture is often accompanied by behavioral and psychological symptoms (Huang *et al.* 2020), constituting a global socioeconomic issue. Estimates suggest that by 2050, there will be 100 million people suffering from Alzheimer's disease. According to the Czech Statistical Office (2021), the Czech society is aging, which demographically means an increasing number of people over the age of 65. This increase confirms the previously mentioned rule. For example, between 2010 and 2019, the number of people over 65 years of age rose by nearly half a million (from 1.64 million to 2.13 million), making up one-fifth of the Czech Republic's population. According to a press release from the Ministry of Health (2019), referring to the Institute of Health Information and Statistics, approximately 102,000 people in the Czech Republic are diagnosed with dementia, of which 62,000 have diagnosed Alzheimer's disease. Per 100,000 inhabitants, there are actually 582 people suffering from this disease. More precise data is provided by the Czech Alzheimer's Society (2020), stating that as of 2019, there are 149,633 people (1.41% of the population) in the Czech Republic suffering from some form of dementia. In Europe, this number reaches 9,780,677 (1.57% of the population). Our study builds on initial investigations which were conducted with three specific dependent variables. The primary variable was aimed at enhancing the social adaptability of those afflicted with Alzheimer's disease. The other two variables focused on the enhancement of motor skills and cognitive functions. Typically, our analyses were grounded on the principles of comprehensive rehabilitation and the impact of sustained, combined therapeutic interventions, adjusted for varying durations based on our selected intervention strategies. We drew inspiration from scholarly debates concerning cognitive rehabilitation, particularly whether it proves beneficial. The discussion in the article by Nilius and Nikolai (2018) deeply analyzes this controversy, presenting opposing viewpoints—one author advocates for cognitive rehabilitation, while the other disputes its effectiveness—thereby showcasing the divergent perspectives on cognitive rehabilitation in patients with cognitive impairments. The authors conclude with the observation that sufficient evidence to substantiate the benefits of such rehabilitation is still lacking. This perspective is supported by Clare *et al.* (2010), who highlighted the broad spectrum of approaches utilized in cognitive rehabilitation tailored to specific cognitive function components. This controversy is also noticeable in global discussions, such as those by the Medical Research Council, which notes that the development of complex interventions necessitates the identification of evidence and the modeling of processes and outcomes according to practical requirements.

The challenge of providing evidence for the positive impact of interventions on dementia patients is frequently undermined by the absence of a conceptual consensus. Some studies indicate that multimodal non-pharmacological interventions might be effective, yet evidence for such claims is relatively weak. Specific evidence has been noted for physical education, memory training, occupational therapies, and cognitive stimulation therapy (Poulos *et al.* 2017; Kroll & Naue 2011; Pitkälä *et al.* 2013; Van't Leven *et al.* 2013; Ravn *et al.* 2019). After reviewing numerous sources, we deduced that our selected topic is crucial for advancing understanding and elucidating issues regarding comprehensive rehabilitative approaches in individuals with Alzheimer's disease. Our focus is on special educational and occupational therapeutic intervention approaches, as these are pivotal fields that can be effectively employed in the education and development of these individuals. Through this investigation, we aim to address the noticeable gap in current research with our in-depth study and findings.

Conclusion

Our empirical findings suggest a spectrum of possible interventions that could influence current special educational approaches, particularly in modifying approaches to individuals with certain forms of dementia. The results, however, do not allow us to make recommendations for other unverified knowledge in other groups. The essence of this work was primarily to confirm the potential cooperation of selected helping professions and to formulate suitable recommendations for both theory and practice. We found almost perfect agree-

ment in the approaches and potential risks involved in working with these individuals across key fundamental areas. This similarity in approaches to individuals with mental disabilities can be effectively applied to seniors diagnosed with dementia, particularly emphasizing the importance of early disease detection. Early detection allows for the initiation of necessary cooperation with the patient sooner, which can help create activities that may extend the quality of life. Furthermore, integrating special educational and occupational therapy approaches has shown significant benefits. These approaches not only develop cognitive and motor functions but also assist in managing everyday activities, utilizing various compensatory aids.

These aids are complemented by special educational tools (e.g., daily or weekly schedules, structured learning boxes, process schema cards) and occupational therapy aids (e.g., non-slip mats, ergonomic handles, educational boards primarily for fine motor skills development). The study highlights the potential of comprehensive approaches through cooperation of related helping professions. Cognitive rehabilitation is seen as a diverse therapy that supports the development of individual cognitive components and overall social adaptability. This multimodal intervention is crucial in cognitive rehabilitation for dementia, which includes cognitive stimulation and training aimed at improving specific cognitive functions and general mental activation. Ultimately, special education's potential in supporting the development of cognitive functions and social interaction, alongside occupational therapy's focus on managing daily activities, suggests a synergistic approach to supporting and developing individuals diagnosed with dementia. This integration emphasizes the need for a single case research design to rigorously evaluate the impacts of interventions, ensuring a tailored approach that considers the progression and individual needs of patients with dementia.

Declaration of competeting interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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REFERENCES

1 Amanzio M, Palermo S, Zucca M, Rosato R, Rubino E, Leotta D, et al. (2018). Neuropsychological correlates of instrumental activities of daily living in neurocognitive disorders: a possible role for executive dysfunction and mood changes. *Int Psychogeriatr.* **30**(12): 1871–1881.

2 Amaral-Carvalho V & Caramelli P (2012). Normative data for healthy middle-aged and elderly performance on the Addenbrooke Cognitive Examination-Revised. *Cogn Behav Neurol.* **25**(2): 72–76.

3 Barnes DE & Yaffe K (2011). The projected effect of risk factor reduction on Alzheimer's disease prevalence. *Lancet Neurol.* **10**(9): 819–828.

4 Beishon L, Haunton V, Subramaniam H, Mukaetova-Ladinska EB, Panerai RB, Robinson T, et al. (2021). Qualitative analysis of the Cognition and Flow (CoGFlowS) Study: An individualized approach to cognitive training for dementia is needed. *J Alzheimer's Dis.* **83**(1): 209–225.

5 Bennett DA, Arnold SE, Valenzuela MJ, Brayne C, Schneider JA (2014). Cognitive and social lifestyle: links with neuropathology and cognition in late life. *Acta Neuropathol.* **127**(1): 137–150.

6 Berggren R, Nilsson J, Lövdén M (2018). Education does not affect cognitive decline in aging: A Bayesian assessment of the association between education and change in cognitive performance. *Front Psychol.* **9**: 1138.

7 Clare L, Linden DE, Woods RT, Whitaker R, Evans SJ, Parkinson CH, et al. (2010). Goal-oriented cognitive rehabilitation for people with early-stage Alzheimer disease: a single-blind randomized controlled trial of clinical efficacy. *Am J Geriatr Psychiatry.* **18**(10): 928–939.

8 Česká alzheimerovská společnost. (2020, January 14). Prevalence demence v Evropě.

9 Eurostat (2021, May 19): Life expectancy at birth by sex. European Commission.

10 Hosák L, Hrdlička M et al. (2019). Psychiatry and pedopsychiatry. Karolinum Press, 514 p..

11 Huang LK, Chao SP, Hu CJ (2020). Clinical trials of new drugs for Alzheimer disease. *J Biomed Sci.* **27**(18): 1–13.

12 Jirák R et al. (2013). Gerontopsychiatrie. Galén, ISBN 9788072628735, 350 p.

13 Kisvetrová H, Školoudík D, Herzig R, Vališ M, Jurašková B, Tomanová J, et al. (2020). Vliv demence na trajektorie kvality života seniorů. *Cesk Slov Neurol.* **83/116**: 298–304.

14 Knopman DS, Amieva H, Petersen RC, Chételat G, Holtzman DM, Hyman BT, et al. (2021). Alzheimer disease. *Nat Rev Dis Primers.* **7**(33): 1–21.

15 Kosmidis MH, Vlachos GS, Anastasiou CA, Yannakoulia M, Dardiotis E, Hadjigeorgiou G, et al. (2018). Dementia prevalence in greece. *Alzheimer Dis Assoc Disord.* **32**(3): 232–239.

16 Kroll T & Naue U (2011). The state and context of evidence production and knowledge translation in the rehabilitation of people with Alzheimer's disease. *Dementia.* **10**(1): 19–34.

17 Nilius P & Nikolai T (2018). Kognitivní rehabilitace. *Neurologie pro praxi.* **19**(1): 65–66.

18 Pettersson AF, Wahlund LO, Bronge L, Olsson E, Amberla K, Baezner H, et al. (2017). Physical activity level in people with age related white matter changes correlates to better motor performance, lower comorbidity and higher cognitive level. *BMC Geriatrics.* **17**(1): 142.

19 Pitkälä K, Savikko N, Poysti M, Strandberg T, Laakkonen ML (2013). Efficacy of physical exercise intervention on mobility and physical functioning in older people with dementia: a systematic review. *Exp Gerontol.* **48**(1): 85–93.

20 Poulos CJ, Bayer A, Beaupre L, Clare L, Poulos RG, Wang RH, et al. (2017). A comprehensive approach to reablement in dementia. *Alzheimer's & Dement: Trans Res Clin Interv.* **3**(3): 450–458.

21 Qiu C & Fratiglioni L (2018). Aging without dementia is achievable: current evidence from epidemiological research. *J Alzheimer's Dis.* **62**(3): 933–942.

22 Ravn MB, Petersen KS, Thuesen J (2019). Rehabilitation for people living with dementia: A scoping review of processes and outcomes. *J Aging Res.* **2019**: 1–8.

23 Tariq S & Barber PA (2018). Dementia risk and prevention by targeting modifiable vascular risk factors. *J Neurochem.* **144**(5): 565–581.

24 Van't Leven N, Prick AEJ, Groenewoud JG, Roelofs PD, de Lange J, Pot AM (2013). Dyadic interventions for community-dwelling people with dementia and their family caregivers: a systematic review. *Int Psychogeriatr.* **25**(10): 1581–1603.

25 Vostrý M, Veteška J, Fischer S, Lanková B, Škoda J, Zemanová P, Pančocha K (2021). Kognitivní rehabilitace seniorů: Psycho-sociální a edukační souvislosti. Grada, ISBN 9788027128662,176 p.

26 Wang Y, Du Y, Li J, Qiu C (2019). Lifespan intellectual factors, genetic susceptibility, and cognitive phenotypes in aging: implications for interventions. *Front Aging Neurosci.* **11**: 1–11.

27 Ward A, Alberg Sorensen K, Kousgaard H, Schack Thoft D, Parkes J (2018). Going back to school–An opportunity for lifelong learning for people with dementia in Denmark (Innovative practice). *Dementia.* **19**(7): 2461–2468