

Neuropsychological intervention in dementia associated with new technologies: a systematic literature review

Intervención neuropsicológica en la demencia asociada a nuevas tecnologías: una revisión sistemática de literatura

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ABSTRACT

Dementia is a growing and significant problem affecting the elderly population worldwide, standing out both for its frequency and its clinical and functional impact. This study focused on identifying new technologies used in neuropsychological intervention for this condition. By applying the PRISMA model, relevant studies published in English and Spanish between the years 2014 and 2023 were reviewed in various academic databases such as Redalyc, Pubmed, Science Direct, DOAJ and Springer Link, resulting in the selection of 14 studies. Most of these studies focus on patients with Mild Cognitive Impairment (MCI) or Alzheimer's Disease (AD). The results indicate that the main technologies employed include tele-rehabilitation platforms and the use of mobile technologies. The conclusion of the study highlights that these technologies represent an emerging field that offers new opportunities for implementing neuropsychological intervention programs, which could significantly improve the quality of life of older adults and their families.

Keywords: Older adult, Mild Cognitive Impairment (MCI), Alzheimer's Disease (AD), dementia, neuropsychological intervention, technologies.

RESUMEN

La demencia es un problema creciente y significativo que afecta a la población de adultos mayores a nivel mundial, destacándose tanto por su frecuencia como por su impacto clínico y funcional. Este estudio se enfocó en identificar las nuevas tecnologías utilizadas en la intervención neuropsicológica para esta condición. Mediante la aplicación del modelo PRISMA, se revisaron estudios pertinentes publicados en inglés y español entre los años 2014 y 2023 en diversas bases de datos académicas como Redalyc, Pubmed, Science Direct, DOAJ y Springer Link, resultando en la selección de 14 estudios. La mayoría de estos estudios se centran en pacientes con Deterioro Cognitivo Leve (DCL) o Enfermedad de Alzheimer (EA). Los resultados indican que

las principales tecnologías empleadas incluyen plataformas de tele rehabilitación y el uso de tecnologías móviles. La conclusión del estudio subraya que estas tecnologías representan un campo emergente que ofrece nuevas oportunidades para implementar programas de intervención neuropsicológica, los cuales podrían mejorar significativamente la calidad de vida de los adultos mayores y sus familias.

Palabras clave: adulto mayor, deterioro cognitivo leve (DCL), enfermedad de Alzheimer (EA), demencia, intervención neuropsicológica, tecnologías.

INTRODUCTION

The increase in life expectancy, known as the "longevity revolution," has been one of the most impactful social phenomena of the 20th century. This increase has led to a significant growth in the population of older adults, projected to increase from 900 million in 2015 to approximately 1400 million by 2030 (Flores-Villavicencio et al., 2017; PAHO, 2021; WHO, 2016).

Aging, inherent to the natural cycle of human life, manifests itself through physical, physiological, psychological, cognitive and socio-affective changes. These changes increase the prevalence of diseases, reduce productivity and raise dependency among older adults (González and de la Fuente, 2014). This demographic transition has sparked particular interest in studying the epidemiological behavior of older adults, especially in chronic diseases such as cognitive impairment (CI) and dementia, which have a significant frequency and clinical impact (Calderón, 2018; ADI, 2016; Díaz et al., 2013; Márquez et al., 2020).

Dementia is a complex neurological condition that impairs crucial functions such as memory, language, and reasoning ability. Its etiology is multifactorial, including advanced age, genetic diseases, and brain trauma, among others (Allegri et al., 2011; Allegri et al., 2015; Iadecola et al., 2019; Custodio et al., 2018; WHO, 2023). It currently affects about 50 million people globally, with projections indicating an increase to 152 million by 2050 (WHO, 2023).

Alzheimer's disease is the most prevalent cause of dementia in the older population, followed by other neurodegenerative diseases such as Parkinson's and Huntington's (Barragán et al., 2019; PAHO, 2022; Toro et al., 2022; Allegri et al., 2015; Moya and Mamani, 2013). The consequences of dementia on quality of life are profound, affecting memory, communication skills, and personal autonomy, and increase the risks of falls and other complications (Hall, 2022; Canary Health Service, 2011; Iribarnea et al., 2020; Olazarán and Muñiz, 2017).

Although there is no cure for dementia, neuropsychological interventions, such as cognitive stimulation therapy, offer improvements in affected functions. These interventions are being revolutionized by the use of new technologies, such as mobile applications and virtual reality, which provide additional tools to improve the effectiveness of treatments (OPS, 2020; Arroyo et al., 2012; Gajardo, 2016; Hall, 2022; Barrio et al., 2019; Fernandez et al., 2020; Garcia-Alberca, 2015; Ortega et al., 2015; Aldana et al., 2012; Fajardo and Guzman, 2016; Fernandez et al., 2018; Fernandez et al., 2020). The integration of these

technologies into clinical practice represents an important step towards improving dementia management, crucial to meet the future challenges of global aging.

METHODS

The systematic literature review was developed according to the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) model, guided by the research questions:

- What are the technologies that have been incorporated for neuropsychological intervention in older adults with dementia in the last ten years?
- What are the areas or tasks that the technologies focus on within the field of neuropsychological rehabilitation in dementia?

Literature search

Based on the research questions, search terms or keywords were selected to find relevant studies in two languages: English and Spanish. The search strings were constructed according to these terms, adding the Boolean operators AND and OR and quotation marks (") to indicate specific phrases in the databases, specifically in the title, abstract and keywords, performing a manual review of the articles that met the search terms (Table 1).

Table 1. Search terms

"technology" AND "dementia neuropsychological intervention"
"technology" + "dementia" + "neuropsychological intervention"
"technology AND dementia neuropsychological intervention"
"technology in dementia neuropsychological intervention"
"tecnología" + "intervención neuropsicológica" + "demencia"
"technology" + "neuropsychological rehabilitation" + "dementia"

The search was conducted between May 20, October 20 and June 18, 2023 in the following academic databases: Redalyc, Pubmed, Science Direct, DOAJ and Springer Link.

Search criteria

The search criteria considered in this research process include:

- Type of text: current empirical studies, with application of specific technologies, use of appropriate methods and impact on the study population, due to scientific rigor.
- Year of publication: studies published in the last 10 years (between 2014 and 2023).
- Language: articles published in English or Spanish.

Subsequently, the summary of each study was read to verify that the following inclusion and exclusion criteria were met:

- Inclusion criteria: accurate empirical studies in which technology is applied in neuropsychological intervention in older adult patients with dementia.

- Exclusion criteria: systematic reviews or literature reviews on the use of technology in the neuropsychological intervention of dementia. Empirical studies applied in professional or family caregivers.

Data extraction strategy

Data extraction was carried out through a matrix of categories designed for this purpose, which included: an article identifier, year of publication, author(s), country, study title, population, DOI, objective, results and main conclusions.

After extracting the data, the results went through a process of reading, analysis and synthesis. The diagram below shows the process of identifying the studies to be included in the literature review.

Initially, the title and abstract of each study were reviewed to determine whether the article was relevant, taking into account the research questions. If the abstract did not provide sufficient information to establish whether it was a study on the application of technology in neuropsychological intervention in patients with dementia, it was necessary to review the methodology and results, so that it could be clarified whether or not the inclusion and exclusion criteria were met.

RESULTS

The aim of this study was to review the literature to learn about new technologies being used for neuropsychological intervention in dementia in older adults. Thus, the overall results of the selected studies are presented first, and then the results that answer the research questions are presented:

Table 2. Studies by year and country of publication

Category	Number of Studies	Study code
Year of publication		
2014	1	E8,
2015	1	E11,
2016	1	E10,
2017	1	E7,
2018	1	E4,
2019	1	E5,
2020	3	E1, E6, E14
2021	2	E2, E13,
2022	1	E12,
2023	2	E3, E9,
Country		
USA	5	E7, E10, E11, E12, E13
Italy	4	E1, E4, E8, E9
Australia	2	E6, E14
Spain	1	E2
United Kingdom	1	E5
South Korea	1	E3

After the search process in the six databases consulted, 101 studies were selected, three duplicate studies were eliminated, as well as 82 studies that did not meet the inclusion and exclusion criteria, and 2 studies that were not suitable for full-text reading. A total of 14 studies were obtained.

The studies were mostly developed between the years 2020 to 2023; that is, there is a greater progress in the field of

research on technologies for neuropsychological intervention in older adults with dementia during the last few years. In addition, there is greater interest in the study of this topic in countries such as the United States and Italy.

Table 3 presents a summary of the resulting studies with respect to the characteristics of the population and the clinical conditions of the participants in the different studies selected. With respect to gender, the vast majority of studies include both female and male patients; whereas, only one study does not specify the gender of older adults, because this population is intervened indirectly, collecting results through neuropsychological professionals.

The average age in most cases ranges between 71 and 80 years of age; the majority clinical condition refers to patients with mild cognitive impairment (MCI) or Alzheimer's disease (AD). The intervened older adults

represent significantly non-institutionalized cases, with interventions applied at home.

The use of technologies reported for neuropsychological intervention in older adults is mostly focused on tele-rehabilitation platforms and the use of mobile technologies (cell phone or Tablet) specially designed to address health issues, especially reminders; digital resources for the application of serious games are also reported. Regarding the areas of neuropsychological intervention, holistic approaches covering all areas (cognitive, emotional, sensory, physical and functional) are mostly observed, and specifically, the area most included in the studies is the cognitive (language skills and memory function) combined with the physical and functional dimension, especially for activities of daily living. These results are recorded in Table 4.

Table 3. *Characterization of the study population*

Category	Number of Studies	Study code
Gender		
Mixed (men and women)	13	E1, E2, E3, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14
Not specified	1	E4
Average age		
63 – 70 years	2	E6, E11
71 – 80 years	9	E1, E2, E3, E5, E9, E10, E12, E13, E14
81- 90 years	2	E7, E8
Not specified	1	E4
Clinical condition		
Mild cognitive impairment	7	E1, E3, E4, E6, E11, E12, E13
Mild to moderate cognitive impairment	1	E7
Alzheimer's disease (AD)	4	E8, E9, E10, E14
Mild cognitive impairment and AD	2	E2, E5,
Residence		
Institutionalized	4	E6, E7, E8, E11
Non-institutionalized	9	E1, E2, E3, E4, E9, E10, E12, E13, E14
Mixed	1	E5

Table 4. *Technologies reported in the studies*

Category	Number of Studies	Study code	ICT description
ICT			
Serious games with simulations	2	E1, E11	Smart Aging Serious Game (SASG) BrightBrainer. Simulations
Tele rehabilitation	4	E2, E4, E8, E9,	Platform GRADIOR 4.5. Telecommunications (LSS-tele). Telerehabilitation ABILITY
Eye-tracking	1	E3	Computerized Eye-tracking
Tele assistance	1	E5	ATTILA
Computerized and simulated training	1	E6	No name specified
Robotic therapy	1	E7	PARO robotic pet
Mobile health technology	4	E10, E12, E13, E14	Accelerometer mHealth. Reminder SmartPrompt. App. Usage (Android) or Moment (iOS)
Intervention area			
Cognitive rehabilitation (linguistic skills and memory function)	3	E1, E4, E8,	
Global/Holistic: cognitive, emotional, sensory, physical and functional	3	E2, E7, E11	
Early identification	1	E3,	
Functional in activities of daily living	3	E5, E12, E14	
Cognitive and physical	3	E6, E9, E10	
Cognitive and functional	1	E13	

DISCUSSION

Among the technologies that have been incorporated for neuropsychological intervention in older adults with dementia in the last ten years, tele-rehabilitation with tele-assistance stands out (Irazoki et al., 2021; Forsyth et al., 2019; Jelcic et al., 2014; Rossetto et al., 2023; Rosso et al., 2018), through various software that are applied through simulation in serious games (Burdea et al., 2015; Cabinio et al., 2020), mobile apps on smartphones (Hackett et al., 2022; Lai et al., 2020; Scullin et al., 2022; Vidoni et al., 2016). Similar studies agree with this criterion, noting that tele-rehabilitation occupies the first places (Arroyo et al., 2012; Garcia, 2016; Hernandez, 2019).

A variety of options can be found on the Internet as cognitive training platforms, among which Smartbrain and Lumosity, Nintendo® Company Limited games (DS or Wii) or Brain Training programs, Sudoku, etc. stand out; however, classic ludic games (word search, crossword puzzles, strategy games, logic, calculation, attention, etc.) designed for general public without cognitive impairment, but, which have been adapted according to the needs and particularities of patients with dementia (Arroyo et al., 2012; Hernandez, 2019).

The tasks targeted by these technologies for neuropsychological rehabilitation in older adults with dementia are mainly to train memory and language (Cabinio et al., 2020; Jelcic et al., 2014; Rosso et al., 2018), executive functioning in activities of daily living (Burdea et al., 2015; Forsyth et al., 2019; Hackett et al., 2022; Irazoki et al., 2021; Lai et al., 2020; Petersen et al., 2017). In general, they seek to provide support for cognitive and functional rehabilitation therapy, so that it contributes to timely assessment of the cognitive profile (Cabinio et al., 2020; Opwonya et al., 2023); extend patients' treatment at home (Forsyth et al., 2019; Rosso et al., 2018) and intervene in daily functions to ensure a better lifestyle by extending their capacity for independence (Broadhouse et al., 2020; Forsyth et al., 2019; Jelcic et al., 2014; Lai et al., 2020; Scullin et al., 2022). Results consistent with similar studies that focus attention on improving memory, attention, language and other cognitive functions for improved quality of life (Fajardo and Guzman, 2016; Sastre, 2020).

The effectiveness of these intervention programs are expressed in their characteristics as flexible and adaptable tools to the needs of older adults (Rosso et al., 2018), ability to achieve neurostructural and functional changes after a time of use (up to one year later) (Broadhouse et al., 2020); reductions in the use of psychoactive medications and analgesics (Petersen et al., 2017); improvement in overall cognitive performance, especially in the domains of language, executive functions and memory (Hackett et al., 2022; Jelcic et al., 2014; Rossetto et al., 2023).

In general, it is observed that the use of technologies offers a positive experience and acceptability by patients, therefore, it could be systematically implemented to complement cognitive rehabilitation interventions for older adults with mild cognitive impairment and dementia (Irazoki et al., 2021). ICTs manage to increase users' interest, motivation, enthusiasm and enjoyment with tasks (Hernández, 2019). However, patients showed aversion to functions that they perceived as eroding their independence; that is, those that focused on caregivers monitoring older adults' movements; whereas, functions that were more closely

aligned with independence and autonomy were perceived as more acceptable (Irazoki et al., 2021; Lai et al., 2020).

The recommended technological equipment are tablets or cell phones that can be used personally and exclusively by each patient, ensuring the use of specialized software that also contributes to the enjoyment of the older adult. It is important that the application of a technological resource or software is accompanied by prior training for its correct use, aimed at both the patient and his caregiver or family.

CONCLUSION

Information and communication technologies offer new opportunities to support neuropsychological intervention programs to increase the quality of life of older adults with dementia or mild cognitive impairment, especially because they manage to capture the interest, motivation and enjoyment of tasks in older adults. In this sense, technologies become potential tools to increase the well-being of older adults, caregivers and family caregivers.

However, there are still barriers associated with socioeconomic factors, demographics, resistant attitudes and poor knowledge about technologies, which hinder their implementation in the treatment and daily life of older adults with dementia. In the face of this, current trends related to Artificial Intelligence (AI) can help develop alternatives to expand the options for more accessible technologies that enrich any intervention with people with dementia.

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