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Effects of Exergaming on Cognitive Function in Older Adults with Dementia: A Literature Review

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Abstract

Introduction. As the world population is ageing, it is expected that the number of many chronic diseases common for elderly age will rise, including different forms of dementias. Dementias are a global problem, considering there are no effective medication or cure to date, and there is a need to develop new tools that would be used to slow down or postpone symptoms, of which one of the most pronounced is cognitive decline. The use of exergaming has been proved to improve cognitive functioning in healthy elderly people and in those suffering from various diseases.

Aim. The aim of this review was to present research on the impact of this intervention on the cognitive abilities of older adults suffering from dementia.

Methods. A literature search was conducted in PubMed and Scopus for articles published between 2015 and February 7, 2025. Predefined search strings and inclusion/exclusion criteria based on the PICO framework were applied to identify relevant studies.

Results. A total of 213 papers were identified through database search, using search strings. Following duplicate removal and study selection, 8 studies were included in this review.

Conclusion. Only a few randomized controlled studies have been conducted researching into the effectiveness of exergaming on cognition in people with dementia. Findings indicate that exergaming may be a promising tool for improving cognition in this population, but more well-designed studies are needed to confirm its efficacy.

Introduction

As the world population is ageing, the number of people suffering from major neurocognitive disorders, including different forms of dementias is expected to rise even more in the following years (1). Dementia is a syndrome characterized by progressive brain damage, affecting cognitive function and difficulty performing everyday activities. 60–70% of all dementia cases are Alzheimer's disease, which is the most common form of the condition. According to World Health Organization (WHO) data from 2023, an estimated 55 million people worldwide are currently living with different forms of dementia, and projections from WHO Global action plan on the public health response to dementia 2017 – 2025, suggest that this number will nearly triple by year 2050 to 132 million. These numbers have a great effect on healthcare systems and overall society, and there is a great need for action on a global plan (2,3). Regarding the European Union (EU) and according to data from Eurostat and the Organisation for Economic Co-operation and Development (OECD) in 2018, the number of people with dementia was 9.1 million. Projections estimate that this number will double by 2050, reaching 18.7 million (4). The most common dementias have no cure and there is no effective disease-modifying medication, therefore one of the alternatives is definitely to develop and implement non-pharmacological interventions (5). We now know that physical exercise has a positive effect on cognition in elderly people without dementia, and, the lack of physical activity during earlier life is a risk factor for developing dementia. We are living in an era of rapid technological advancement and the rise of new interventions in healthcare and social care systems, and one of these new interventions is exergaming.

Studies in this field have already been conducted, and have shown that among healthy older adults and in patients with mild cognitive impairment, multiple sclerosis, schizophrenia, and Parkinson's disease, exergames compared to physical exercise training alone have a better effect in improving global cognitive function (6). Exergaming refers to playing videogames that involve physical movement (7). To play these games users need to use various equipment like VR headsets, motion sensors, balance boards, controllers etc. (8). At present, there is growing interest in researching the effects of exergaming on improving cognitive functions in older adults with mild cognitive impairment and dementia. Various studies suggest that exergaming could have a positive impact on cognitive abilities but it is important to say that it is difficult to draw general conclusions because of the differences in study designs, intervention protocols, and participant characteristics (8,9). In order to prevent cognitive decline, physical exercise alone may be insufficient. Interventions which combine physical activity and cognitive stimulation seem to be more effective in maintaining cognitive functions (10,11).

Aim

The aim of this literature review is to examine the effects of exergaming on cognitive functioning of elderly people with dementia.

Methods

A search of the PubMed and Scopus databases was conducted on February 7, 2025, to identify studies relevant in the field of research on the effects of exergaming on cognition in older adults with dementia. The search was conducted using search strings combining terms related to dementia, aging, cognitive function, and exergaming, refined with Boolean operators (AND, OR), and limited to articles published between January 2015 and February 2025. The search targeted titles, abstracts, and keywords in the databases mentioned above. The full search strategies for each database, including the exact keyword combinations, are shown in Table 1. Search was conducted following predefined inclusion and exclusion criteria as shown in Table 2, which were based on the PICO framework shown in Table 3. The target population included individuals aged 65 and older diagnosed with dementia, while the intervention of interest was exergaming. Exergaming is a relatively new intervention so both full-scale randomized controlled trials (RCTs), and pilot RCTs were included to have a more detailed review. Risk of bias was not assessed in this review, as it is a narrative review and focused on summarizing available evidence.

Table 1. **Databases with search string and number of hits**

Core collection	PubMed	Scopus
Search string	((“dementia”[Title/Abstract] OR “Alzheimer Disease”[Title/Abstract] OR “cognitive impairment”[Title/Abstract] OR “major neurocognitive disorder”[Title/Abstract]) AND (“older adult*”[Title/Abstract] OR “elder*”[Title/Abstract] OR “aged”[Title/Abstract] OR “senior*”[Title/Abstract] OR “geriatrics”[Title/Abstract]) AND (“cognition”[Title/Abstract] OR “cognitive function”[Title/Abstract] OR “cognitive decline”[Title/Abstract] OR “cognitive performance”[Title/Abstract])) AND (“exergame*”[Title/Abstract] OR “active video game*”[Title/Abstract] OR “interactive video game*”[Title/Abstract] OR “serious game*”[Title/Abstract])	TITLE-ABS-KEY ((“dementia” OR “Alzheimer Disease” OR “cognitive impairment” OR “major neurocognitive disorder”) AND (“older adult*” OR “elder*” OR “aged” OR “senior*” OR “geriatrics”) AND (“cognition” OR “cognitive function” OR “cognitive decline” OR “cognitive performance”) AND (“exergame*” OR “active video game*” OR “interactive video game*” OR “serious game*”))
Number of hits	52	168

Table 2. **Criteria for including and excluding results**

Criteria	Inclusion	Exclusion
Population	Adults ≥65 years diagnosed with dementia	Other
Language	English	Other languages
Text Availability	Full-text available	Abstract only, no full text
Article Type	Randomized controlled trials (RCTs), pilot RCTs	Other study designs

Table 3. **PICO Framework for study selection**

Component	Description
Population (P)	Older adults (≥65 years) diagnosed with dementia
Intervention (I)	Exergaming interventions that incorporate physical activity as a core component (e.g., VR-based exercises, interactive motion-controlled games, active video games).
Comparison (C)	Standard care (no intervention), conventional exercise programs, or other control conditions used in included RCTs.
Outcome (O)	Cognitive function (e.g., memory, executive function, psychomotor speed, global cognition).

Results

A total of 213 articles were obtained by searching both databases, of which 52 by searching the PubMed database and 161 by searching the Scopus database. The distribution of published articles by publication year is shown in Figure 1, showing the number of studies published by year prior to applying inclusion and exclusion criteria.

Fifty duplicate articles were removed using Zotero, resulting in 163 remaining articles. After screening titles and abstracts following the inclusion and exclusion criteria listed in Table 2, 119 articles were excluded for not being RCTs, 33 for not meeting population criteria, and 3 for not meeting the exergame intervention.

The process of the extraction of the final articles is shown in Figure 1, following the PRISMA flow diagram (12). After the final selection of studies, in this literature review we included 8 relevant articles that matched our predefined search strategy. An overview of included articles by publication year is shown in Table 4. Most of the included studies reported

some cognitive benefits from exergaming, particularly improvements in psychomotor speed and global cognition, while effects on certain specific cognition domains such as memory were less consistent. Several studies also noted physical or mood benefits in the exergaming groups.

Regarding effects of exergaming on cognitive functions, five out of eight included studies have shown explicit benefits. One study showed improvements in psychomotor speed, though it did not show improvements in memory or executive processes, and two studies primarily investigated outcomes that were not related to cognition, such as neuropsychiatric symptoms.

Discussion

Overall, the evidence from observed studies suggests thar exergaming has beneficial effects on certain cognitive functions in older adults with dementia, along with improvements in related areas such as motor skills and even neuropsychiatric symptoms.

Regarding quality of life, majority of included studies that investigated this aspect, did not show significant improvements.

Wiloth et al. in their research concluded that exergaming can improve motor-cognitive functions in people with dementia. In their intervention group (IG), they used exergame system Physiomat that combines balance tasks with cognitive challenges. Their study showed positive impact in the duration and accuracy of task execution in the exergame IG compared to the control group (CG). After 3 months, a follow-up was conducted. The benefits diminished, but remained higher in the IG group. However, they point out several limitations, such as not having a non-intervention control group, a possible Hawthorne effect, and a short follow-up period (13). Werner et al. in their research also used Physiomat system to analyse the time course of improvement in motor-cognitive functions. Their research also showed positive effects of exergaming, which plateaued after the first 3 weeks of intervention. This could suggest that initial motor-cognitive improvements in exergame may be rapid, but for maintaining progress it may require a gradual increase in exercise difficulty. Best improvements were identified in participants with initially lower cognitive abilities. Regarding limitations, this study lacked a CG for comparison and had a relatively small

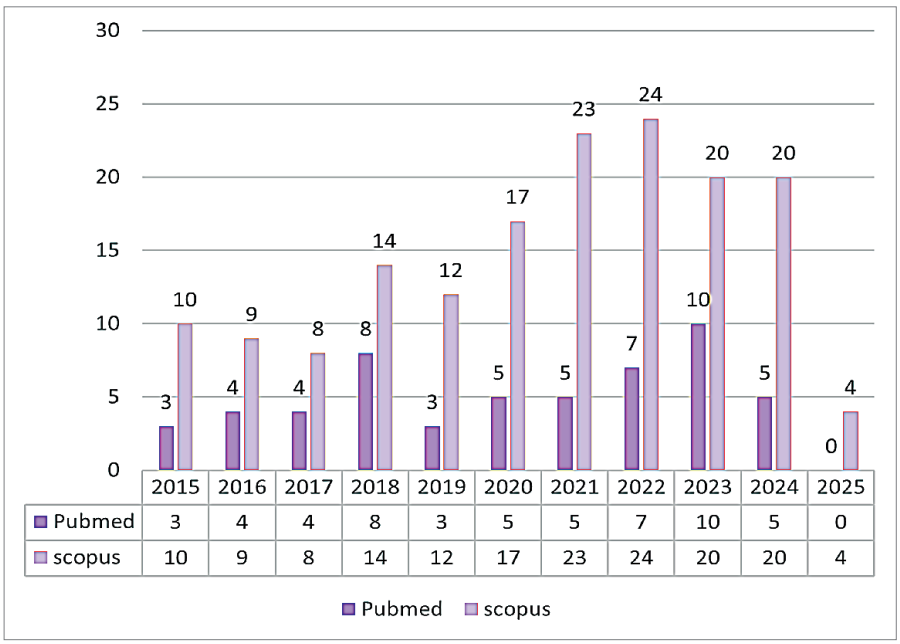

Figure 1. **Distribution of published articles by publication year prior to applying inclusion and exclusion criteria**

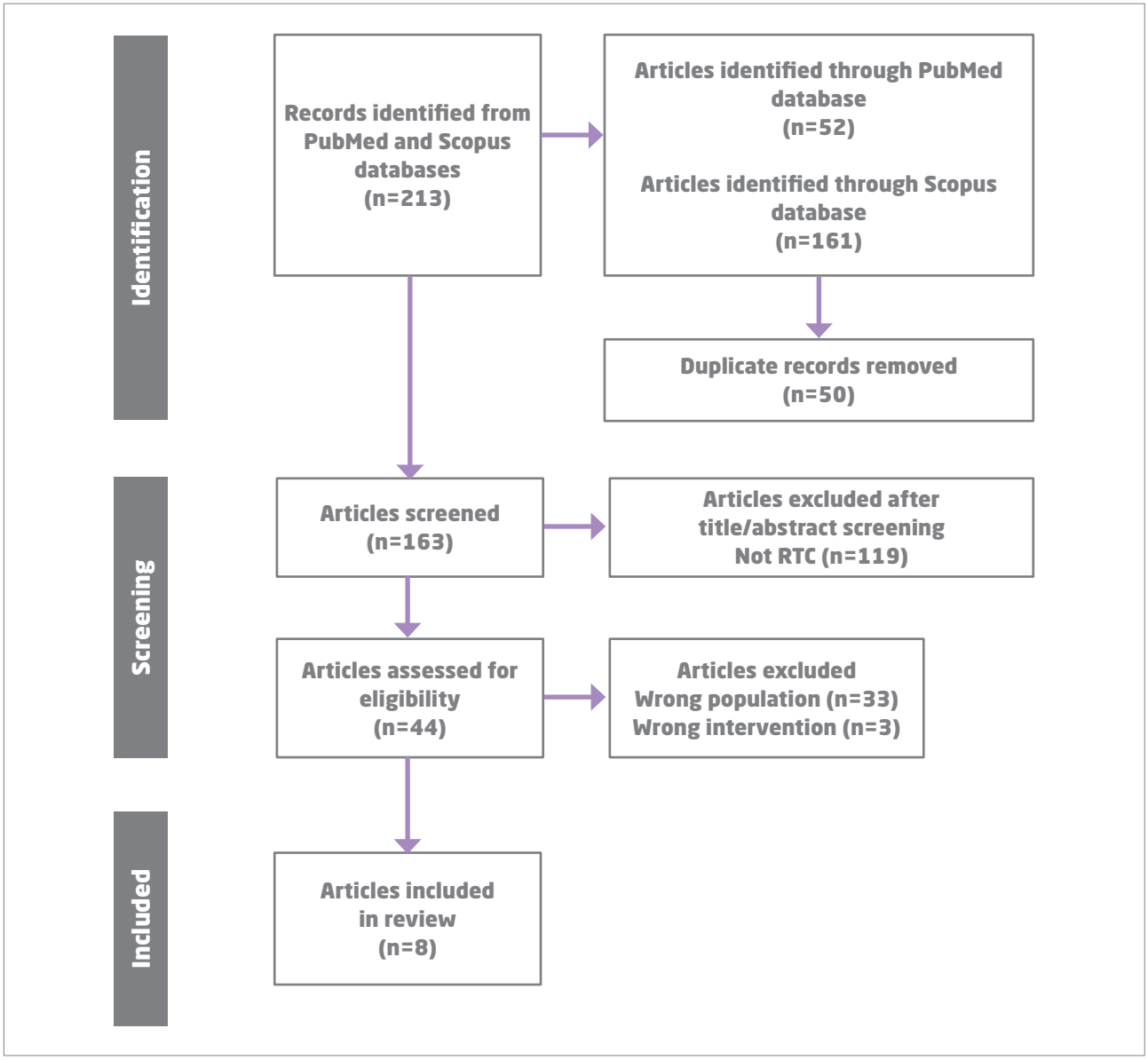

Figure 2. **PRISMA flow diagram**

sample, which limits the applicability of the results to the wider population of people with dementia (14). Furthermore, two studies by Karssemeijer et al. conducted in 2019 were included. Both studies investigated the effects of Bike Labyrinth exergaming on physical and cognitive functions in people with dementia. This exergame combines cycling on a stationary bike with a virtual surrounding where participants drive through cities while solving cognitive tasks, including response inhibition, switching between tasks, and speed of information processing. The first study investigated the effects on frailty and showed that IG significantly reduced frailty compared to the CG although there was no improvement in motor skills, physical activity or activities of daily living. Second study examined the effects on cognitive functions and showed that IG group had improvements in psychomotor speed, and this effect was maintained after 24 weeks, compared to CG. However, there were no significant improvements in executive functions, episodic memory, or working memory. Their results could be clinically important, as it is known that in patients

Table 4. **An overview of articles by publication year identified in the literature review**

Authors	Methods	Intervention duration (IG and CG)	Purpose	General outcomes	Follow up	Limitations
Wiloth et al. 2017 (13)	RCT (10 weeks, 99 participants, 2 groups: IG-exergame, CG-low intensity strength and flexibility while seated	10 weeks, IG: 2x per week, 1.5h CG: 2x a week, 1 hour	To evaluate effects of Physiomat exergaming on motor-cognitive functions in older adults with dementia	Significant improvement in duration and accuracy of task execution in motor-cognitive functions, improvement in transfer also to untrained tasks	After 3 months, improvements in the IG group declined, but remained superior to those in the CG	No usual care group included, no long-term follow up
Werner et al. 2018 (14)	Secondary analysis of RCT (10 weeks, 56 participants, IG group only)	IG: 10 weeks, 2x per week, 10 min	To analyse time course of motor-cognitive improvements and predictors of early training response	Significant improvements in exergame-based motor-cognitive performances within 3 weeks, benefits plateaued later, lower baseline cognitive ability predicted greater improvements	No follow up	No control group comparison, small sample size, focus on short-term improvements, limited generalization to severe dementia cases
Karssemeijer et al. 2019 (15)	RCT (12 weeks, 3 groups 115 participants: IG -exergame, CG1-aerobic training, CG2-active control)	12 weeks, 3x per week IG: Exergaming (30–50 min per session, cycling with cognitive tasks) CG1: Aerobic training (30–50 min per session, cycling without cognitive tasks) CG2: Active control (30 min per session, relaxation & flexibility exercises	To examine whether exergaming can reduce frailty in older adults with dementia	Exergaming reduced frailty compared to the control group. No major effects on physical function or daily activities	After 24 weeks	No blinding, only mobile participants included, some tests not feasible for all participants
Karssemeijer et al. 2019 (16)	RCT (12 weeks, 3 groups, 115 participants: IG -exergame, CG1-aerobic training, CG2-active control)	12 weeks, 3x per week IG: Exergaming (30–50 min per session, cycling with cognitive tasks) CG1: Aerobic training (30–50 min per session, cycling without cognitive tasks) CG2: Active control (30 min per session, relaxation & flexibility exercises)	To examine the effects of exergaming on executive functions in older adults with dementia	Both exergaming and aerobic training improved psychomotor speed compared to the active control group, with effects sustained at the 24-week follow-up. No significant improvements were observed in executive functions, episodic memory, or working memory	After 24 weeks	No blinding, only mobile participants included, short intervention period (12 weeks), cognitive improvements may require longer training duration, possible floor effect

Table 4. **An overview of articles by publication year identified in the literature review**

Authors	Methods	Intervention duration (IG and CG)	Purpose	General outcomes	Follow up	Limitations
Robert et al. 2021 (17)	Cluster RCT (12 weeks, 125 participants, 2 groups: IG-exergame CG- standard care)	12 weeks, 2x per week for 15 minutes IG: X-Torp exergame (combined motor and cognitive tasks) CG: standard care	To examine the efficacy of serious exergames in improving neuropsychiatric symptoms in people with neurocognitive disorders	X-Torp significantly improved apathy and prevented worsening of neuropsychiatric symptoms, while symptoms worsened in the control group. There were no significant improvements in cognitive function	24 weeks	Small sample size, heterogeneous participants, different levels of stimulation, possible medication effects
Swinnen et al. 2021 (18)	Pilot RCT (8 weeks, 55 participants, 2 groups: IG – exergaming, CG – music intervention)	8 weeks, IG 3 times a week, 15 min per session, CG: 3 times a week, 15 min per session	To examine the effects of exergaming on cognitive, motor and neuropsychiatric outcomes in people with dementia in long-term care	Improved gait speed, mobility, balance and cognitive function, reduced depressive symptoms, no significant effect on quality of life or ability to perform activities of daily living	No follow up	Small sample, only motived patients included, short intervention period, no evaluated standardized protocol, no active control group, no follow up
Swinnen et al. 2023 (19)	Pilot RCT (12 weeks, 18 participants: IG-exergaming, CG-traditional exercise)	12 weeks, 3 times a week for 30 min	To examine the feasibility and preliminary effectiveness of the VITAAL exergame prototype in people with severe neurocognitive disorder	Exergame group had better results in cognitive and physical functions then CG. There were no significant differences in neuropsychiatric symptoms, depression and quality of life	No follow up	Small sample size, only volunteers included, no control in medication effects, potential social desirability bias, low adherence rate, no follow up
Wu et al. 2023(20)	RCT (12 weeks, 2 groups, 52 participants initially, 24 completed: IG-exergaming, CG-cycling)	12 weeks, IG: 3 times a week, initially 30 min, gradually increased to 50 min), CG cycling with increasing resistance	To examine the effects of exergaming on cognitive and physical functions in older adults with dementia	Exergaming improved executive function (shorter reaction times, increased neural activity in attention and working memory) and enhancement of lower body strength and cardiorespiratory endurance compared to CG	No follow up	Small sample size (24 participants), high dropout rate, no nonexercise CG, MMSE not measured post intervention

with dementia, psychomotor speed is an important predictor of functional decline, and that effects of exergaming on cognitive functioning should be further researched and studied. Authors point out that people with more severe forms of dementia will have a harder time achieving improvement in cognitive function using exergaming, than people with milder forms or healthy older adults (15,16). These findings are consistent with previous research which also indicate greater benefits of exergaming in populations with milder cognitive impairment (13,14). Another included study is by Robert et al. that researched the effect of X-Torp exergame on neuropsychiatric symptoms in people with neurocognitive disorders. Their results showed a reduction in apathy in the IG, while symptoms worsened in the CG. No significant improvement in cognitive functions was found (17), which distinguishes this study from some earlier research (13,14,15,16). The findings support the thesis that exergaming can have a broader therapeutic effect but point out that there is a need for additional research with larger samples (17). Furthermore, two included studies were authored by Swinnen et al. First study is from 2021, and second from 2023 and both examined the effects of exergaming on cognitive and motor functions in people with dementia in long-term care facilities. It is important to highlight that different intervention systems and protocols were used. In a study from 2021, the IG used pressure-sensitive platform that detects steps in four directions called "Dividat Senso" stepping exergame. Games were designed to train selective attention, flexibility, postural control and visuospatial working memory, and the level of difficulty was automatically adjusted to the participants capabilities. The results showed improvements in gait speed, balance, mobility and cognitive function with a reduction in depressive symptoms compared to CG that watched music videos. Regarding quality of life and activities of daily living there were no significant changes. In their second study in 2023, the IG group used the "VITAAL stepping exergame," a system with wearable foot sensors that combined balance exercises and cognitive tasks. The results showed that the IG group maintained or improved MMSE score while the CG had a deterioration. Also, motor functions were stable in the exergaming group, while they significantly decreased in the control group. Together, these studies suggest that exergaming may play an important role in preserving cognitive and motor skills in people with dementia (18,19). Furthermore, in a recent study by Wu et al., the IG used a device called ExerHeart in which players played interactive game called Alchemist's Treasure. In order to progress in the game participants had to run, avoid obstacles and collect objects, thereby incorporating physical and cognitive stimulation at the same time. Their results showed that exergame is superior to exercise alone in improving reaction speed, attention and working memory. Also, they concluded that exergame had a significant effect on muscle mass increase, lower extremity strength, and cardiovascular endurance. Regarding limitations, there was a high dropout rate of participants and a small sample size (20). In general, the studies mentioned above show that the use of exergame could have a beneficial effect on the cognitive, motor and neuropsychiatric functions in people with dementia. Most improvements have been shown in psychomotor speed, balance, mobility and motivation, while effects on executive function and memory are less consistent.

Similar conclusions have been described in previous systematic literature reviews, which highlighted the similar effects of exergaming on cognitive and motor functions in people with dementia like the results from the studies above (21,22). This further confirms the need for future work with larger and more diverse samples to better understand the cognitive impact of exergaming interventions.

Identified gaps

The most obvious gap in this literature review is the small number of studies conducted in this field of research, particularly those conducted on people with serious cognitive impairment. Also, despite the fact that the majority of these studies have shown improvements both in physical and cognitive functions, the long-term sustainability of these effects is still unclear due to the limited duration of the interventions. Most interventions lasted about 12 weeks, and there is a lack of follow up after the therapy ended. Also, it is important to know that the use of exergaming in treating people with dementia has many practical challenges, particularly due to different degrees of cognitive impairment and the need for expert supervision. Some of the participants have had difficulties in accepting and using the technology needed for the application of exergames, which suggests that there is a need for additional adaptations to ensure better compliance and easier wider application in everyday care. Also, there is a problem of a high rate of participant dropout, which also indicates the

above-mentioned challenges in implementing exergaming-based interventions. Finally, there is a lack of control groups, which makes it difficult to compare exergaming with other forms of therapy.

Conclusion

According to the data shown in the research included in this literature review, it was found that the use of exergames could be a potentially useful intervention that positively affects the cognitive and motor abilities of elderly people with dementia. Given that the ageing population, particularly those suffering from various forms of dementias, is expected to grow, this will pose challenges for socioeconomic systems globally. There is a need to develop instruments that can slow down or delay the progression of the disease and exergaming has shown great potential to do so. Further studies should be conducted on larger number of participants, including different groups of people with dementia (mobile, immobile, those housed in institutions and those living in their own homes, etc.) in order to better develop and adjust such technologies. By putting this issue in the focus of researchers, substantial progress could be achieved in a short period of time, and it is important to note that further research is certainly needed to identify the best ways to implement these new technologies as a tool for slowing down cognitive decline in patients with dementia. Also, it is worth noticing that all included studies were conducted in controlled settings, which limits the generalization of the findings to home use without supervision.

Author contributions

Conceptualization and methodology (BS, JP); Data curation and formal analysis (FL, SL, BI, AM,); Investigation and project administration (BS, FL); Writing – original draft (BS, FL) and Review & editing (BI, JP, SL). All authors have approved the final manuscript.

Conflict of interest

The authors declare no conflicts of interest.

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