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Exergames in neurocognitive disease management in elderly: a narrative review of therapeutic benefits and applications

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Objective. Recent advancements in understanding neurodegenerative diseases highlight their global impact, affecting about 55 million individuals. Mild Neurocognitive disorder (MND) underscores the urgency for early intervention. Nonpharmacological approaches, including exergames, show promise in enhancing cognitive and physical functions. This review explores exergames' potential in Neurocognitive disorder intervention.

Methods. The review covered publications from 2012 to December 2023, from PubMed, Scopus, Google Scholar, Web of Science, and PEdro. Papers were selected using key words like "exergame", "dementia","neurocognitive disorder" "Alzheimer's Disease", "cognitive function", "balance", and "walking".

Results. This study focused on identifying studies using exergames in Neurocognitive disorder (NCD) support. Most studies (22/28) included control group comparisons. Some focused on cognitive function (3/27), physical abilities like balance and walking (4/27), or both (12/27). A study investigated cognitive function and electroencephalogram (EEG). Additionally, a pilot study examined cognitive functions and oxidative stress (OxS). The Nintendo Wii and Microsoft Kinect were commonly used, alongside iPACES, iPACES 2.0, Physiomat, Bike and Fiets Labyrint, IREX, LegSys, BioSensics, Cosmed EuroBike 320, Dividat Senso, Valve Index (HMD), and Hexer Heart.

Conclusions. Exergames emerge as a viable alternative to traditional physical exercise, offering easy accessibility and active participant engagement, thus promoting greater adherence. Utilizing low-cost devices, these games are readily available and applicable in specialized centers and at home with caregiver assistance, highlighting their adaptability during circumstances such as pandemics.

Key words: exergame, neurocognitive disorder, physical activity, mild cognitive impairment, Alzheimer's Disease

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INTRODUCTION

The use of active video game systems, like the Nintendo Wii and Xbox Kinect, is constantly rising. This trend has led researchers and developers to coin the term "exergaming," referring to a novel form of entertainment that integrates physical activity (PA) with video gaming [1]. Researchers have recently focused on the effectiveness of exergames and fitness-related game technologies. Exergames aim to achieve two challenging goals simultaneously: providing incentives and delivering physical benefits. Balancing these goals require multiple attempts to master the necessary actions for achieving objectives. However, as players become fatigued, their performance declines, making repeated practice of physically demanding tasks increasingly difficult [2]. The first question about exergames is: Can they really have an impact on energy expenditure and on the decrease of inactive time? A review of 2014 responds positively to this question, as all the included studies show the same outcome and confirm the ability of exergames to meet the guidelines for physical activity given by the American College of Sports Medicine (ACSM) [3]. Studies have focused on exergames in reducing obesity in all ages [4,5], as well as, improve cardiovascular endurance, balance and lower extremity functional fitness [5,6]. There is also growing evidence that exergames may reduce the risk of falls in older adults [7-10].

Indeed, the use of exergames may also provide a more enjoyable experience than traditional PA [11,12]. Indeed, exergames have the advantage to be used at home without trainer or therapist [6,13,14] supervision; adapt the experience for every need and user [9]; perform this kind of activity in a controlled safe environment [15,16].

The effects of physical activity on the human body and mind are numerous and varied [29]. Then, it is possible to hypothesize that exergame based intervention could be a good alternative to the traditional PA in healthy people [30], but also an alternative treatment for some conditions both physical [14,17] and psychological [18]. Therefore, some studies looked for cognitive and physical improvements in patients with neurocognitive diseases (NCD) with exergame based interventions [10,19].

There are numerous non-pharmacological studies testing the impact of physical exercise [20,21] and cognitive training [22-24] in Neuro cognitive Disorder (NCD), Mild Cognitive Impairment (MCI) and Alzheimer's Disease (AD), which have shown to benefit cognitive and brain health [21,25,26]. Physical exercise appears to induce physiological changes that in turn facilitate particular cognitive functions (specifically executive functions) through brain structural and functional adaptations [27,28]. In contrast, cognitive training appears to benefit the trained cognitive abilities almost exclusively with very limited transfer to untrained domains [23,24]. Indeed, combined physical and cognitive training interventions show larger effects on cognitive functions than single-domain physical or cognitive training [29,30].

At the moment, exergames may also hold an interesting impact in terms of health [4,5,31], cognitive functions [16,32-34], self-esteem and self-efficacy [6,35]. Several studies have reported benefits of using exergames on healthy elderly subjects on improving cognitive, executive and physical functions [36-39]. In addition, exergaming interventions show a high level of adherence [15] when performed in a specific location rather than at home, and enjoyment even from participants with NCD, MCI and AD [40-43].

From recent studies seems that exergames are able to improve cognitive performance in different populations including elderly people, probably because these beneficial effects might be related to the dual-task activities promoted by exergaming practice, since the player interacts with a virtual environment through their own movements, such as dancing/jumping, which requires both motor and cognitive abilities [44].

The aim of this narrative review was to investigate the potential of exergaming on physical and cognitive parameters in older persons with NCDs.

METHODS

The research work has produced a comprehensive set of suggestions for implementing exergames to help patients with NCDs, focusing on the different kinds of Dementia. Selected publications were selected PubMed, Scopus, Google Scholar, Web of Science, and PEdro databases from 2012 and 2024. Key words used to identify publications included exergame, dementia, neurocognitive disorder, Alzheimer, cognitive function, balance, and walking. Included papers reported information on the used device (Tab. I), how it interacted with the subject, and the activity protocols used (Tab. II). In addition, the work aimed to highlight the positive influence of using this training method to prevent or slow the course of neurocognitive pathology.

RESULTS

The studies reveal a spectrum of technological applications and intervention strategies in therapeutic exergaming.

As highlighted in Table I, there was a wide range of technologies encompassing wireless devices, infrared sensors, green screen technology, inertial sensors, pressure sensitivity boards, and VR systems. Nintendo Wii was frequently used in multiple studies [36,40,45-47]. Microsoft Kinect featured prominently in studies leveraging infrared technology [48-52]. Cycle ergometers, often paired with VR for enhanced engagement, were used by Hanley et al. [41], Wall et al. [53], Karssemeijer et al. [54], Van Santen et al. [38], and Mrakic-Sposta et al. [55]. Pressure sensitivity boards such as Physiomat and Dividat Senso were employed by Wiloth et al. [43], Werner et

Table I. Devices and technology.

Authors	Technology	Device
Padala et al., 2012 [45]	Wireless	Nintendo Wii
Hughes et al., 2014 [46]	Wireless	Nintendo Wii
McEwen et al., 2014 [59]	Green screen technology	IREX
Ho Lee et al., 2016 [40]	Wireless	Nintendo Wii
Ben-Sadoun et al., 2016 [48]	Infrared	Microsoft Kinect
Mirelman et al., 2016 [49]	Treadmill + VR	Microsoft Kinect
Schwenk et al., 2016 [58]	Inertial sensors	LegSys e BioSensics
Lin et al., 2017 [50]	Infrared	Microsoft Kinect
Padala et al., 2017 [36]	Wireless	Nintendo Wii
Hanley et al., 2017 [41]	Cycle ergometer + tablet	iIPACES
Wall et al., 2018 [53]	Ipad+ pedalboard	iPACES 2.0
Wiloth et al., 2017[43]	Pressure sensitivity board	Physiomat
Werner et al., 2018 [43]	Pressure sensitivity board	Physiomat
Mrakic-Sposta et al., 2018 [55]	Cycle ergometer	Cosmed EuroBike 320
Amjad et al., 2019 [60]	Infrared	Xbox 360 Kinect
Dove et al., 2019 [78]	Infrared	Xbox 360 Kinect
Karssemeijer et al., 2019 [54]	Cycle ergometer + VR	Bike labyrint
Van Santen et al., 2020 [38]	Cycle ergometer + VR	Fiets labyrint
Torpil et al., 2021 [51]	Infrared	Microsoft Kinect
Robert et al., 2021 [79]	Infrared	Microsoft Kinect
Ramnath et al., 2021 [37]	Infrared	Xbox 360 Kinect
Swinnen et al., 2021 [56]	Pressure sensitivity board	Dividat Senso
Kruse et al., 2021 [13]	VR	Valve index (HMD)
Liu et al., 2022 [57]	Infrared	Microsoft Kinect
Benitez-Lugo et al., 2023 [47]	Wireless	Nintendo Wii
Wu et al., 2023 [80]	Pressure sensitivity board	Hexer Heart

al. [42], and Swinnen et al. [56]. Advanced VR setups like the Valve Index [13] and systems combining treadmills with VR [49] highlight the trend towards immersive, high-fidelity environments.

In Table II, intervention studies varied significantly in terms of duration, frequency, and activities: Padala et al. [36,45] employed Wii-Fit yoga and balance exercises for 30 minutes daily, five times a week over eight weeks. Hughes et al. [46] included a structured Wii-sports program spanning 20 weeks with one-hour sessions. Mirelman et al. [49] used treadmill combined with VR for 45 minutes, three times a week over six weeks. Interventions involving cognitive and physical tasks with VR and exergaming elements, such as the studies by Ho Lee et al. [40] and Torpil et al. [51], typically ran for 12 weeks with multiple weekly sessions. Studies on Tai Chi and traditional exercises combined with technology have shown promising results. Lin [50] examined the use of Tai Chi practiced through Kinect in elderly individuals with mild dementia, demonstrating improvements in balance, physical endurance, and a reduction in caregiver burden. Liu et al. [57] implemented an exergaming-based Tai Chi program, finding significant enhancements in cognitive functions and dual-task walking performance.

In most of the selected studies (22 of 26), the protocol included comparisons with control groups. Sample characteristics participants predominantly consisted of individuals with pathological conditions, with one study involving healthy controls [48]. The majority, such as those by Schwenk et al. [58], Lin et al. [50], and Kruse et al. [13], focused on individuals with pathological conditions, aiming to assess the therapeutic impact of the interventions.

Table II. Diverse study types according to type of exergame used.

Authors	Experimental activity	Control activity	Control activity	Frequency
Padala et al. 2012 [45]	(Wii-Fit) yoga, strength, balance.	30 min walking		30 min a day, 5 x week, 8 weeks
Hughes et al., 2014 [46]	Wii-sports	Lessons of Healthy Aging Education Program (HAEP)		1h x 24 sessions, 20 weeks
McEwen et al., 2014 [59]	Goalkeeping with VR			Mean 20 min exergaming
Ho Lee et al., 2016 [40]	Wii fit + Wii sports-30 m nin balance board, 10 min wii sports	Cognitive rehab, 20 min x 36 sessions in 12 weeks + homework and pen paper exercises		40 min, 3 times x week, 12 weeks
Ben-Sadoun et al., 2016 [48]	40 min: 2.5 min scenary mode; 35 min mini-games			3 sessions x week, 12 weeks
Mirelman et al., 2016 [49]	Treadmill+ VR	Treadmill		45 min, 3 x week, 6 weeks
Schwenk et al., 2016 [58]	Stability + walking and obstacle passing	None		45 min, 4 weeks
Lin et al., 2017 [50]	Thai chi with virtual support	None		45 min, 2 x week, 12 weeks
Padala et al., 2017 [36]	Wii-Fit: yoga, strength, aerobic, balance and multicomponent	30 min walking		30 min, 5x week, 8 weeks
Hanley et al., 2017 [41]	Neuro-exergaming cycle ergometer connected to a tablet	Exergaming: explorative virtual pedaling	Neurogaming: joystick, no aerobic training with pedalboard	20 min
Wall et al., 2018 [53]	Neuro-exergaming cycle ergometer connected to a tablet			30-45 min, 3-5 x week, 8 weeks
Wiloth et al., 2017 [43]	Group sessions; exergame Physiomat	Daily activity		1,5h (intervention) 1h (control) 2x week, 10 weeks
Werner et al. 2018 [42]	Exergame Physiomat			10 min, 2 x week, 20 sessions
Mrakic-Sposta et al. 2018 [55]	65%-70% of FC max; cycling in a virtual environment	None		40-45 min, 3 x week, 6 weeks
Amjad et al., 2019 [60]	"Time a Bomb"; "Match Makers"; "Traffic Control"; "Mouse Mayhem"; "Strike a Pose"; "Pizza Catch"; "Flag Frenzy"; "Follow the Arrow"	Stretching and mobility		25-30 min, 5 x week, 6 weeks
Dove et al., 2019 [78]	Kinect sports rivals bowling, group sessions			1h,2 x week, 10 weeks
Karssemeijer et al., 2019 [54]	Exergame: game with 7 levels	Aerobic exercise: pedaling at the intensity advised by ACSM	Mobility and relaxation exercises 30 min	30-50 min, 3 x week, 12 weeks
Van Santen et al., 2020 [38]	Cycle ergometer connected to a monitor	Crafts and arts, music, walking		2 x week, 12 weeks
Torpil et al., 2021 [51]	Jet Run; Superkick; Boxing Trainer; Air Challenge + cognitive rehab	Cognitive rehab		45 min, 2 x week, 12 weeks
Robert et al., 2021 [79]	Battleship, virtual ambient exploring, mini games with orienteering exercises	Daily activity of the rehab center		15 min, 2 x week, 12 weeks
Ramnath et al., 2021 [37]	Bowling, box, track and field, ping pong, beach volley, soccer 2vs2	Multimodal gaming; 10 minutes warm up, 30 minutes strength training, 10 minutes proprioceptive exercises; 10 minutes cool down		1h, 2 x week, 12 week

Table II. *continues.*

Swinnen et al., 2021 [56]	10 min walking, 15 min exercise, 10 min walking	10 min walking, watching, and listening to musical video on tv, 10 min walking		3 x week, 8 weeks
Kruse et al., 2021 [13]	Memory Journalist VR	None		15-25 min, 2 x week, 6 weeks
Liu et al., 2022 [57]	Thai chi with virtual support + body map	Thai chi with virtual support	None	36 sessions familiarization, 50 min, 3 x week, 12 weeks
Benitez-Lugo et al., 2023 [47]	Penguin slide and step plus with balance board	Mobility, cognitive stimulation		30 min, 2 x week, 16 weeks
Wu et al., 2023 [80]	Avoid obstacles with the avatar	Aerobic exercise: pedaling on a cycle ergometer		Familiarization 2 weeks, intervention 3 x week, 12 weeks

The outcome measures varied, reflecting the diverse goals of the interventions. Some studies evaluated the effect of exergames on cognitive function (3 out of 26), others focused on the effects these types of games have on physical abilities such as: balance and walking (4 out of 26), and others evaluated both aspects (12 out of 26). Balance and walking were common parameters, particularly in studies using Nintendo Wii and Kinect systems [36,45,50,59]. Cognitive functions were frequently assessed, especially in interventions combining physical and cognitive tasks [41,55,60]. Other parameters included quality of life [40] and psychological wellness [13]. Moreover, the studies by Amjad et al. [60] and Markic-Sposta [55] focused on specific aspects. Specifically, the intervention by Amjad et al. [60] investigated not only cognitive functions but also electroencephalogram (EEG) measures, as some research has shown that the upper/lower alpha power ratio can predict mild cognitive impairment (MCI), which is associated with cortical thinning and reduced perfusion in the temporoparietal area. Additionally, the pilot study by Markic-Sposta [55] assessed oxidative stress (OxS) in addition to cognitive functions, as OxS is believed to be linked to the development of neurodegenerative diseases, particularly AD. All the outcome measures are shown in Table III.
The studies used various assessment tools and diagnostic tests to evaluate cognitive and physical functions. Notably, the Mini-Mental State Examination (MMSE) was employed for cognitive assessment in several studies, including those by Padala et al. [36,45], Amjad et al. [60], and Karssemeijer et al. [54]. The Montreal Cognitive Assessment (MoCA) was another common tool by Amjad et al. [60] and Karssemeijer et al. [54]. Additionally, neuropsychological tests like the Stroop Test, Trail Making Test (TMT), and the Digit-Span Test were utilized to measure specific cognitive domains in studies by Wall et al. [53] and Anderson-Hanley et al. [41]. For physical function, the Berg Balance Scale (BBS), Tinetti Test (TT), and Timed Up and Go (TUG) were frequently used to assess balance and gait, as seen in the studies by Padala et al. [36,45] and Werner et al. [42]. The 6-Minute Walk Test (6MWT) was another functional measure used to evaluate endurance and mobility, notably in studies by Ben-Sadoun et al. [48] and Karssemeijer et al. [54]. These tests provided comprehensive insights into the cognitive and physical impacts of exergame interventions on individuals with neurocognitive disorders.
This study confirmed the hypothesis that the use of exergames and VR can lead to improvements in physical, cognitive, and social functions, with higher adherence and satisfaction from participants compared to traditional exercise programs. Exergames and VR programs offer visual and auditory stimuli that can increase engagement and motivation, contributing to improved quality of life and reduced fall risk. The safety and feasibility of these technologies have been widely confirmed, making them promising tools for rehabilitation and maintenance of abilities in individuals with cognitive decline. Furthermore, the variations in interventions highlight the adaptability of VR and exergaming technologies in addressing a wide range of therapeutic needs, paving the way for more personalized and effective rehabilitation strategies.

DISCUSSION

This review analyzed various studies on the utilization of exergames in older individuals with Neurocognitive Disorders (DSM-V). The interventions employed a variety of devices, including Nintendo Wii, Microsoft Kinect, IREX, LegSys, BioSensics, IPACES, Physiomat, Bike Labyrinth, Fiets Labyrinth, Dividat Senso, and Hexer Heart. Different intervention methods were crucial for assessing potential enhancements in cognitive function, executive function, balance, gait, falls, aerobic capacity,

Table III. Considered parameters.

Authors	Evaluated parameters
Padala et al., 2012 [45]	Balance, walking, cognitive functions
Hughes et al., 2014 [46]	
McEwen et al., 2014 [59]	Balance, mobility
Ho Lee et al., 2016 [40]	Balance, mental state, quality of life
Ben-Sadoun et al., 2016 [48]	
Mirelman et al., 2016 [49]	Falling risk
Schwenk et al., 2016 [58]	Walking, balance, ankle, knee, hip movement
Lin et al., 2017 [50]	Cognitive function, walking; strength
Padala et al., 2017 [36]	Balance, walking
Hanley et al., 2017 [41]	Cognitive function, walking, strength
Wall et al., 2018 [53]	Cognitive function, walking, strength
Wiloth et al., 2017 [43]	Cognitive function, balance
Werner et al., 2018 [42]	
Mrakic-Sposta et al., 2018 [55]	Cognitive function, oxidative stress
Amjad et al., 2019 [60]	EEG, cognitive function
Dove et al., 2019 [78]	
Karssemeijer et al., 2019 [54]	
Van Santen et al., 2020 [38]	Cognitive and social functioning, physical performance
Torpil et al., 2021 [51]	Cognitive functions
Robert et al., 2021 [79]	
Ramnath et al., 2021 [37]	Fitness, functional ability, cognitive performance
Swinnen et al., 2021 [56]	Walking, balance, mobility, reaction time, cognitive and neuropsychiatric scores, quality of life, activity of daily living
Kruse et al., 2021 [13]	Psychological, cognitive and physical wellness
Liu et al., 2022 [57]	Cognitive function, 2 tasks walking
Benitez-Lugo et al., 2023 [47]	Memory, focus, balance, walking, fall risk
Wu et al., 2023 [80]	Executive and physical functions

quality of life, apathy, and depression. Experiments using commercial devices like Nintendo Wii and Microsoft Kinect offered sports games and mini-games at various levels, sometimes incorporating additional elements like the Wii balance board or a VR headset. The key difference between the two devices lies in their technology: Nintendo Wii utilizes wireless controllers, while Microsoft Kinect employs infrared technology for controller-free interaction. These devices facilitated group sessions, enhancing motivation and enjoyment and reducing dropout rates. They also offered various activities, from aerobic to strength and mobility training. Studies using Nintendo Wii showed improvements in balance, gait, physical performance, and reduced anxiety related to falling. Kinect-based exergames improved balance, gait, aerobic capacity, and cognitive and executive functions, with positive effects on reducing apathy. iPACES focused on cognitive training, showing improvements in cognitive and executive function.

Bike Labyrinth, Fiets Labyrinth, and other systems involving screens and ergometers also demonstrated positive outcomes in rehabilitation. Wearable sensor systems like LegSys and BioSensics reduced sway and fear of falling, providing safety and enjoyment. Physiomat exergames improved motor-cognitive performance, while sensitive step mats enhanced reaction times, balance, gait, strength, and mobility. Regarding physical functions, such findings support the hypothesis on biological adaptations related to this kind of intervention, mainly if we consider the large amount of institutionalized frail older persons. The effort needed to support body weight during the exercises can be considered of moderate to vigorous intensity, since this population shows high declines in physical function. Therefore, a regular training program with exergames for institutionalized older persons can be compared to traditional physical training programs [45].

Exergames offer physical activities similar to traditional training, known to trigger biological mechanisms [61]. Such exercises, including muscle strength and balance routines, boost strength and muscle volume, enhancing functional abilities. They prompt cellular adaptations, stimulating protein synthesis and reducing apoptosis. By activating signaling pathways like Akt-mTOR, exergames can bolster muscle strength and hypertrophy, aiding daily activities for older adults. Moreover, they may mitigate chronic inflammation associated with sarcopenia, thereby improving muscle integrity. Further research should explore exergames' impact on inflammatory markers and muscle cell responses [62].

As concerns cognitive functions and neuroplasticity, exergames and specifically their virtual reality's immersive nature captivates individuals through gameplay, encompassing the virtual environment, challenges, and feedback systems. These elements collectively engage cognitive, sensorimotor functions, and emotions, as documented in literature.

The interactions with the virtual environment depend on planning, decision making, inhibitory control, and episodic memory, which allow the player to interpret the stimuli that occur during the displacement into the virtual environment [63]. Such cognitive functions are associated to executive functions, which are crucial for the day-to-day of older adults, mainly if these people are institutionalized [64]. Therefore, the stimuli offered by virtual reality exercises can increase the functionality of important specific brain circuits linked to cognition. Maguire et al. [63] demonstrated that the hippocampus, caudate nuclei, frontal and parietal cortex and cerebellum are the main areas that become more active during navigation into the virtual environment. The activation of the hippocampus was related to episodic memories and allocentric navigation, which allow the individual to displace him/herself into the environment using a "topographic map". The increase of inferior parietal cortex activity was related to egocentric displacement (based on the body as the center of spatial orientation), while caudate nuclei activity was related to displacement speed. The authors also demonstrated that left frontal cortex activity was associated with virtual tasks related to changing displacement direction, problem-solving, and decision-making. Such findings indicate that both cortical and subcortical regions can be stimulated by a virtual environment. Thus, activating these regions is important to maintain the independence of older persons, since these structures are involved in basic and instrumental daily routine activities.

In the context of exergames, stimuli may induce neuroplasticity. The Neuroplasticity Hypothesis [62,65,66] states that an individual's behaviors and activity (such as cognitive activity, social engagement and exercise) significantly impact the level of effective cognitive functioning in later life. This hypothesis assigns a key role to cognitive stimulation and PA, which would appear to play a primary role in non-pharmacological intervention [33,52]. Particularly, aerobic PA would appear to stimulate neuroplasticity processes (increased acetylcholine production is associated with improved cognitive processes, which would counteract cognitive impairment) [67,68]. In addition, exercise-related postsynaptic release of dopamine and serotonin would appear to have a positive effect on apathy and depression, symptoms associated with these neuropathologies.

The findings of the clinical trial of Bazzanello Henrique et al. [44] support the idea that exergaming might act with therapeutic potential capable of inducing neuroplasticity through modulation of brain-derived neurotrophic factor (BDNF).

Evidence has highlighted that BDNF is associated with brain health and plasticity, exerting a pivotal role on neuron development, regeneration, survival, and maintenance. In addition, BDNF acts as a key mediator in synaptogenesis and is crucial for cognitive abilities, memory, and learning [44].

Thus, it is important to have valid evaluation systems to verify the effectiveness of these treatments. Recently, technology has offered new solutions to test the effects of various therapies involving sensor-based wearable devices [69-72]. Through simple tests or activities of daily living, using these devices could be possible to assess the course of disease or serve as a useful tool to recognize predictive factors related to neuromotor deficits [36,73,74]. Technology not only comes to patients from the standpoint of assessment but also from the standpoint of physical activity-based treatments [47,75,76]. You et al. [77] found post-stroke cortical reorganization after a month of exergame training. Neuroplastic mechanisms like neurogenesis and synaptogenesis can result from combined physical and cognitive stimulation, suggesting exergames as a therapeutic tool for cognitive disorders in institutionalized older adults.

CONCLUSIONS

Exergames represent a valuable resource in treating cognitive neurodegeneration in the elderly, combining PA and cognitive stimulation to promote brain neuroplasticity. Their enjoyable nature fosters greater engagement compared to traditional elderly physical activities, enhancing adherence to exercise programs and thus improving treatment effectiveness. The limitations identified in some studies primarily were small sample sizes and the absence of long-term follow-up. Kruse's research, conducted specifically during the pandemic, affirmed the feasibility and legitimacy of remote intervention.

In conclusion, this review underlines that exergames represent a valid alternative to traditional physical exercise, as they are easily accessible and capable of actively engaging participants, thereby promoting greater adherence. Most of these games utilize low-cost devices, readily available and usable not only in specialized centers with qualified personnel but also at home with the assistance of caregivers. This adaptability underscores an essential aspect, particularly in circumstances such as a pandemic, where individuals are mandated to stay at home or restrict social interactions.

Conflict of interest statement

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Author contributions

All the authors contributed in the development of this manuscript.

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