ORIGINAL ARTICLE

Effects of exergame on kinesiophobia, depression, and physical parameters in kinesiophobic older adults: a pilot study

Exergame 'in kinezyofobik yaşlı yetişkinlerde kinezyofobi, depresyon ve fiziksel parametreler üzerine etkisi: pilot çalışma

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Abstract

Purpose: It is known that virtual reality applications applied to older adults are effective on balance and mobility. Exergames is a virtual reality-based exercise. The aim of the study was to investigate the effects of exergames on kinesiophobia, balance, lower extremity muscle strength, depression and cognitive function in older adults with kinesiophobia.

Methods: The older adults over the age of 65 living in Nursing Home and Elderly Care Center were included in the study. Exergames were played for 30 minutes per week for 8 weeks and the participants who participated in the study were given rehabilitation. Before starting the application, the demographic information form, Tampa Kinesiophobia Scale, BeCure Balance Assessment System, Geriatric Depression Scale-Short Form, Mini Mental State Test and 5 Times Sit to Stand Test were applied to the participants. The assessments were performed pre- and post-treatment (8 weeks).

Results: 13 geriatric adults who completed an exergame-based rehabilitation program were included in the study. When the pre- and post-treatment evaluations were made; statistically significant differences were found in kinesiophobia, balance and depression (p<0.05). There was no statistically significant difference in functional muscle strength and cognitive status (p>0.05).

Conclusion: Exergames reduce kinesiophobia and depression and improve balance in older adults, however more studies are needed to investigate their effects on cognitive status and lower extremity muscle strength.

Keywords: Exergame, Older adults, Kinesiophobia, Balance, Depression.

Öz

Amaç: *Geriatrik bireylere uygulanan sanal gerçeklik uygulamalarının denge ve mobilite üzerinde etkili olduğu bilinmektedir. Exergame sanal gerçeklik tabanlı bir egzersizdir. Çalışmanın amacı kinezyofobisi olan geriatrik bireylerde exergame'in kinezyofobi, denge, alt ekstremite kas kuvveti, depresyon ve bilişsel işlev üzerindeki etkilerini araştırmaktır.*

Yöntem: *Çalışmaya huzurevi ve yaşlı bakım merkezinde yaşayan 65 yaş üstü geriatrik bireyler dahil edildi. 8 hafta boyunca haftada 30 dakika egzersiz oyunları oynandı ve çalışmaya katılan katılımcılara rehabilitasyon verildi. Uygulamaya başlamadan önce katılımcılara demografik bilgi formu, Tampa Kinezyofobi Ölçeği, BeCure Denge Değerlendirme Sistemi, Geriatrik Depresyon Ölçeği-Kısa Form, Mini Mental Durum Testi ve 5 Tekrar Otur Kalk Testi uygulandı. Değerlendirmeler tedavi öncesi ve sonrası (8 hafta) yapıldı.*

Bulgular: *Çalışmaya exergame tabanlı rehabilitasyon programını tamamlayan 13 geriatrik birey dahil edildi. Tedavi öncesi ve sonrası değerlendirmeler yapıldığında; kinezyofobi, denge ve depresyonda istatistiksel olarak anlamlı farklılıklar bulundu (p<0,05). Fonksiyonel kas gücü ve bilişsel durumda istatistiksel olarak anlamlı bir fark görülmedi (p>0,05).*

Sonuç: *Exergame yaşlı bireylerde kinezyofobi ve depresyonu azalttığı ve dengeyi iyileştirdiği gösterilmiştir, ancak bilişsel durum ve alt ekstremite kas gücü üzerindeki etkilerini araştırmak için daha fazla çalışmaya ihtiyaç vardır.*

Anahtar kelimeler: *Exergame, Yaşlı yetişkinler, Kinezyofobi, Denge, Depresyon.*

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INTRODUCTION

Geriatrics is a field of medicine that is related to older adults. According to the World Health Organization (WHO), old age is defined as a decrease in the ability to adapt to environmental factors. WHO classifies persons aged 65 and over as elderly and persons aged 85 and over as multi-age.[1] In older adults, physiological changes occur with advancing age and functional dependence increases gradually.[2]

Kinesiophobia means 'fear of moving', which is formed by the combination of the words 'kinesis = movement, phobus = fear'. In addition to the concept of fear of movement, re-injury anxiety is also used for the definition of kinesiophobia.[3] In the long term, consequences such as receding from movement and activity, decreased physical activity, functional limitation, decreased quality of life and depression emerge.[4] Older adults with kinesiophobia avoid physical activity because of their sensitivity. They have the idea that physical activity can harm them.[5]

Studies have indicated that virtual reality interventions implemented in geriatric individuals are effective in enhancing balance and mobility. Additionally, video game–based approaches may serve as an effective strategy for fall prevention. It leads older adults to adapting exercises and increase their functional output. The fact that the practice is fun and motivating as it allows individuals to fully focus their attention on the exercise. Studies releaved that virtual reality applications improve physical functionality in older adults with a history of falls.[6,7,8] Virtual reality games can reduce the fear of falling in the elderly and improve their balance and mobility.[9]

Exergames is a virtual reality-based exercise and may be a good alternative to increase the level of physical activity, since they have a greater component of fun. Exergames are defined as video games that promote (either via using or requiring) players' physical movements (exertion) that is generally more than sedentary and includes strength, balance, and flexibility activities. The exergames require digital devices, such as computers or game consoles and their accessories, as balance boards.[10]

There are studies on virtual reality and kinesiophobia in the literature. However, there is no study that directly applies to older adults as a population. Xbox 360 KinectTM games were used in this study for virtual reality. The study was conducted using the Xbox 360 Kinect™ and various games in older adults; however, the participants did not include geriatric individuals with kinesiophobia.[10] Although older adults are sometimes considered as a single group, previous studies have evaluated specific subgroups, such as balance in healthy older adults, cognitive function in individuals with cognitive impairment, and kinesiophobia.[11]

The aim of this study was to investigate the effects of an exergame-based rehabilitation program on kinesiophobia, balance, lower extremity muscle strength, depression, and cognitive function in older adults. To the best of our knowledge, this is the first study to evaluate the effects of exergaming specifically in older adults with kinesiophobia.

Hypotheses

H0: Exergame-based rehabilitation program will not improve kinesiophobia, balance, lower extremity muscle strength, depression, and cognitive function in older adults with kinesiophobia.

H1: Exergame-based rehabilitation will significantly reduce kinesiophobia in older adults with kinesiophobia.

H2: Exergame-based rehabilitation will improve balance performance in older adults with kinesiophobia.

H3: Exergame-based rehabilitation will reduce depressive symptoms in older adults with kinesiophobia.

H4: Exergame-based rehabilitation will increase lower extremity muscle strength in older adults with kinesiophobia.

H5: Exergame-based rehabilitation will improve cognitive function in older adults with kinesiophobia.

METHODS

Participants and study design

The study included older adults over the age of 65 living in the Kızılay Zeynep Nedim Oyvar Nursing Home and Elderly Care Center. The ethics committee of the Istanbul Gedik University Ethics Committee dated 17/01/2023 and numbered E-56365223-050.01.04-2023.137548.27-433 was recruited. A written

consent form was signed by older adults who met the conditions of this study. Inclusion and exclusion criteria of the study:

Inclusion criteria:
- Getting 38 or above on the Tampa Kinesiophobia Scale
- Mini-Mental State Test Score ≥20 (no or minimal cognitive impairment, sufficient cognitive capacity for understanding and performing the exercises)
- Being physically competent to apply the scales to be used
- Being 65 years and older
- Volunteering to participate in the study

Exclusion criteria:
- Having mental and psychiatric problems diagnosed by the physician
- Having a serious neurological and orthopedic problem diagnosed by the physician
- Having serious hearing and vision problems
- Having uncontrollable diabetes and hypertension
- Using a walking device other than a cane (crutches, walkers, etc.)
- Using drugs that increase the risk of falling (to be determined with information obtained from nurses and physiotherapists working in the nursing home)

Power analysis
In this study, a power analysis was conducted using G*Power 3.1.9.7 software to examine whether the difference between the dependent variables was statistically significant. The analysis was designed to test the difference between two means for paired samples, with the kinesiophobia measurement as the criterion. According to the analysis results, with a sample size of 13, the critical t-value was calculated as 2.17881, degrees of freedom as 12, and power (1-ß error probability) as 0.9107085. The effect size was found to be 1.54. These results indicate that the sample size and effect size were sufficient and that a statistically significant difference could be detected.

Participants in the study were played exergame games for 30 minutes once a week for 8 weeks and rehabilitation was applied. Before starting the application, Demographic Information Form, Tampa Kinesiophobia Scale for kinesiophobia, BeCure Balance Assessment System for balance measurement, Geriatric Depression Scale-Short Form for depression, Mini Mental Status Test for cognitive functions and 5 Times Sit to Stand Test for lower extremity functional strength and fall risk were applied to the participants. These tests were repeated at the end of 8 sessions, and the values before and after were measured.

Applied evaluation parameters
1. Demographic Information Form
It is the form in which the frequency of sociodemographic characteristics such as name, surname, age, diseases and/or surgeries, drugs used, concomitant diseases, balance problem and history of falling is questioned.

2. Tampa Kinesiophobia Scale
It measures fear of movement and fear of re-injury. 4-point Likert scoring (1= Strongly disagree, 4= Strongly agree) is used. It consists of 17 questions. The total score is calculated after the reversal of items 4, 8, 12, and 16. It has a total score between 17 and 68. The high score indicates that kinesiophobia is also high.[12]

3. Geriatric Depression Scale - Short Form
Its validity and reliability were determined by Burke et al. in 1991. It consists of 15 questions questioning the mood in the last week. The primary goal of this 15-question self-report scale is to include questions that are easy for older adults to answer. This scale, which consists of only "yes" or "no" questions, is scored with 1 point for each response suggestive of depression, and 0 points for all other responses. The final score is considered the depression score. A score of 0-4 indicates that there is no depression, 5-8 indicates mild depression, 9-11 indicates moderate depression, and 12-15 indicates severe depression.[13]

4. Mini Mental State Test
It was first published in 1975 by Folstein et al. The test was develop because the tests used to quantitatively evaluate cognitive performance contain too many questions and take more than 30 minutes in practice. It is a cognitive test applied to the elderly, especially those with delirium and/or dementia.[14]

5. 5 Times Sit to Stand Test
It is a test used to evaluate the functional strength, balance, and risk of falling of the lower extremities. Individuals were asked to sit and stand up as fast and straight as possible 5 times in a row with their hands crossed on their breasts, and this time was measured with a stopwatch and recorded in seconds. The test was

performed with 3 repetitions and the average value of the recorded times was calculated.[15]

6. BeCure Balance Assessment System

This system is basically adapted to the balance platform of the Nintendo Wii Fit system. In the system, balance center change, balance center position, weight, and weight pressure data taken from the 4 corner points of the device are obtained by using the BalanceBoard. Includes Image/Non-Image, Eyes Open/Closed, and Intermittent Measurement parameters. To start the measurement, press the green "Start" button located in the middle under the parameterization fields. After pressing the Start button, the measurement-taking screen appears. When all measurements are completed according to the parameters we have determined, a BalanceSystem Sample PDF Report can be created.[16] The BeCure Balance Assessment System is shown in Figure 1.

The BeCure Balance Evaluation System protocol used in this study was planned to determine the amount of center of gravity change in the x and y axes and the position of the body's center of gravity while standing on the board for 15 seconds with eyes open and images.

Applied exergame games

Geriatric adults participated in an exergame-based rehabilitation program, which is exercise implemented with virtual reality technology. The intervention included game-supported therapeutic exercises designed to improve strength, balance, postural control, and functional mobility. The Nintendo Wii games used in the study are presented in Figure 2.[9,16]

The Xbox Kinect 360™ games used in the study are presented in Figure 3.[9,16]

The exergame-based rehabilitation program consisted of nine different games, each targeting specific functional outcomes such as balance, lower and upper extremity strength, postural control, and cognitive engagement. Each game was played for approximately 3 minutes per session, resulting in a total session duration of 27 minutes. While minor adjustments were made to accommodate individual participants' abilities, the sequence and duration of the games were standardized for all participants.
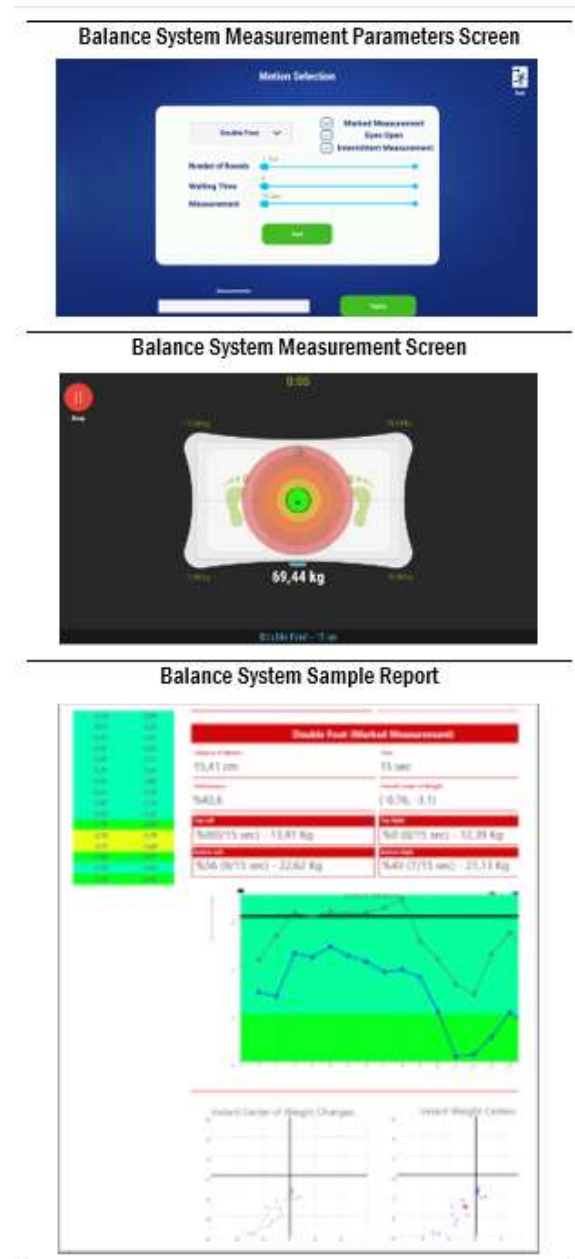

Figure 1. BeCure Balance Assessment System.[16]

Data analysis

The data analysis of the study was performed using the statistical program "Statistical Package for Social Sciences" (SPSS version 20.0 (SPSS Inc., Chicago, IL USA). The One-Sample Kolmogorov–Smirnov test was used to The One-Sample Kolmogorov–Smirnov test was used to investigate the suitability
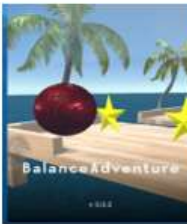
Balance System Assessment System and Active Video Games
Center of balance position, instantaneous change and balance distance (cm)Measuring and reporting front, back and lateral weight transfer movements, postural control and using them for exercise purposes

Game Name	Game Description
Traffic	Stepping and weight-shifting
BalanceBowling	Bowling simulation to improve coordination and lower limb strength
BalanceAdventure	Virtual obstacle courses for balance and mobility
BalanceSurf	Surfing simulation to enhance balance and postural control

Figure 2. Used Nintendo Wii Games.[9,16]

Upper Extremity
Xbox Kinect 360 TM Games
Upper extremity strength and functional mobility

Game Name	Game Description
Gates	Stepping through virtual gates to improve lower limb strength and coordination
uBall	Upper and lower limb coordination through ball-catching tasks
SmartClean	Virtual cleaning activities to engage core and upper limbs
SmartBubblePop	Interactive bubble-popping to enhance upper limb mobility and reaction time

Lower Extremity
Xbox Kinect 360 TM Games
Lower extremity strength and functional mobility

Game Name	Game Description
KneeUp	Knee-lifting exercises to strengthen lower extremities and improve balance

Figure 3. Xbox Kinect 360 TM Games Used. [9,16]

of the variables for normal distribution. Demographic characteristics were expressed as number, percentage, medium, and standard deviation. Student's-t paired test was applied for the group's numerically normally distributed evaluation results, and Wilcoxon signed rank test was applied for the non-normally distributed evaluation results. The level of p<0.05 was considered statistically significant.

RESULTS

There were 46 older adults in the nursing home. Fifteen older adults who met the inclusion and exclusion criteria were included in the study. Two older adults left the study due to health problems during the rehabilitation process and the study was completed with 13 older adults The older adults included in the rehabilitation program were evaluated before
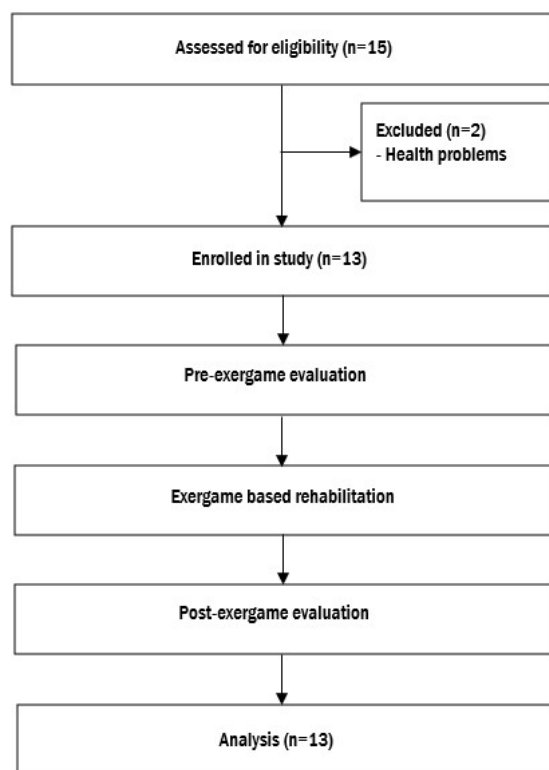
Figure 4. Flowchart of the study.

Table 1. Descriptive characteristics of the older adults.

	Mean±SD
Age (year)	78.69±7.96
Weight (kg)	74.00±12.58
Height (m)	1.62±0.09
	n (%)
Gender	
Female	8 (61.5)
Male	5 (38.5)
Educational status	
Secondary school	5 (38.5)
High School	4 (30.8)
University	4 (30.8)
Falling History	
Yes	6 (46.2)
No	7 (53.8)

DISCUSSION

The decline in physiological reserves associated with aging can trigger the development of kinesiophobia in older adults by creating a fear of movement and reinjury.[3] Virtual reality-based exercise games can support physical and psychological functions in older individuals by providing real-life experiences.[17] In this study, exergame-based rehabilitation resulted in a significant reduction in kinesiophobia and significant improvements in depression and balance scores in older adults. These findings suggest exergame may provide both physical and psychological benefits for older adults.

Virtual reality reduces pain and kinesiophobia in individuals with chronic pain.[18] Morales Tejera et al.[19] argued that virtual reality was more effective in reducing kinesiophobia compared to exercise in patients with chronic neck pain. Although there are studies stating that virtual reality applications have a reducing effect on kinesiophobia, there are also inconsistent studies.[20] In this study, it was concluded that exergame games applied to individuals with kinesiophobia over the age of 65 in the nursing home reduced their fear of moving. The fact that the games motivated and encouraged the person to act and that they believed that they could act more confidently

and after the exergame program. The participant selection and study process are illustrated in the flow chart (Figure 4).

Descriptive characteristics of the older adults participating in the study are shown in Table 1. Tampa Kinesiophobia Scale, Geriatric Depression Scale-Short Form, Mini Mental State Test, 5 Times Sit to Stand Test and BeCure Balance Assessment System Results are shown in Table 2. Normality of the data from these tests was assessed using One-sample Kolmogorov-Smirnov test. The results indicated that the data were not normally distributed (p<0.05). Consequently, non-parametric statistical tests were applied for analyses. Kinesiophobia of the participants decreased (p=0.006). Depression levels decreased (p=0.007). There was no improvement in cognitive performance (p=0.073). There was no progress in lower extremity muscle strength (p=0.650). There was an improvement in balance parameters (p=0.023) (Table 2).

Table 2. Scores of Tampa Kinesiophobia Scale, Geriatric Depression Scale-Short Form, Mini Mental State Test, 5 Times Sit to Stand Test and BeCure Balance Assessment System (N=13).

	Before	After	
	Mean±SD	Mean±SD	p
Tampa Kinesiophobia Scale	46.76±6.02	38.69±4.42	0.006*
Geriatric Depression Scale-Short Form	5.30±1.31	3.15±1.90	0.007*
Mini Mental State Test	24.84±2.79	26.15± 2.44	0.073
5 Times Sit to Stand Test	25.34±20.22	23.59±14.51	0.650
BeCure Balance Assessment System	3.46±2.25	1.74±0.77	0.023*

*p<0.05.

with positive increases in their balance, was effective in making the result meaningful.

Kim et al.[21] reported that personalized virtual reality–based cognitive training reduced depression levels in middle-aged women. Similarly, exergame interventions have been shown to improve depressive symptoms in older adults (aged 70–91) residing in long-term care facilities with neurocognitive impairment.[22] In our study, it was concluded that Nintendo Wii and Xbox Kinect 360TM games reduced depression in elderly individuals with kinesiophobia. The fact that they moved away from the negativities and problems while playing games in the virtual reality environment and carried out physical activity in a fun way has been effective in producing positive results in depression levels.

In a study conducted on older adults without cognitive problems, it was concluded that exergame games improved cognitive function and that long-term exergame games positively affected working memory.[23] In a study conducted on 55 elderly individuals, positive results were found that the Nintendo Wii application improved executive functions.[24] The effects of exergame applications on physical functions in older adults who have been in nursing homes for a long time have been proven, but many studies are needed to prove their effects on cognitive function.[25] In this study, cognitive functions were evaluated with the mini-mental state test, however, no significant change was observed in Mini Mental State Test scores. This may be attributed to several factors. First, the duration and intensity of the program may have been insufficient to produce measurable cognitive gains. Second, the Mini Mental State Test is a general cognitive screening tool and may lack the sensitivity to

detect subtle improvements in specific cognitive domains over a short intervention period. Additionally, baseline cognitive function and age-related variability among participants may have limited detectable changes. Similar findings have been reported in previous studies, suggesting that longer or more targeted interventions may be necessary to achieve significant cognitive improvements in older adults.

Many studies in the literature have shown that exergame games have positive effects on balance and muscle strength. Kinect-based exercise games applied to 57 healthy elderly individuals in 2015 were found to have positive results on lower extremity muscle strength, balance and walking.[26] In the study conducted on elderly individuals over 65 years of age, the participants were divided into two groups as the exergame group and the home exercise group. After the 6-week program, more positive results were observed in the balance parameter of the participants in the exergame group compared to the home exercise group.[27] In a study conducted in 2022 in older adults, it was concluded that exergame games had positive effects on lower extremity strength and balance.[28] In this study, while positive results were found in the balance parameters according to the results of the BeCure Balance Evaluation System, no increase was found in the lower extremity muscle strength compared to the sitting and getting up test 5 times. The lack of improvement in lower extremity muscle strength, as measured by the 5 Times Sit to Stand Test, may be attributed to several factors. The duration and intensity of the intervention might not have been sufficient to elicit measurable strength gains, and the exergame content was primarily focused on balance and coordination rather than targeted

lower-limb strengthening. Additionally, the functional nature of the Sit to Stand Test may have limited sensitivity in detecting subtle strength changes. Variability in participants' baseline physical capacity and adherence to the intervention may also have contributed to the absence of significant improvement.

Limitations

The study is a cross-sectional study on the effects of exergame on kinesiophobia, balance, lower extremity muscle strength, depression and cognitive function in older adults. This study has some methodological limitations. First, the single-group design without a comparison group limits the ability to directly evaluate the effectiveness of the exergame intervention relative to other exercise programs. Second, the relatively short duration of the intervention may have restricted the observation of longer-term or more pronounced effects. Third, the small sample size may limit the generalizability of the findings. Future research with randomized controlled trials, longer intervention periods, and larger samples is warranted to confirm these results and provide more robust evidence regarding the benefits of exergame interventions in older adults with kinesiophobia. Another limitation may be the inclusion criterion for the study. The older adults in the study have kinesiophobia. With exergame, the older adults' mobility increased and their fear of movement decreased because they moved. This situation may have created a selection bias. Another limitation of the study is the potential selection bias arising from the recruitment process. Since the sample was drawn from a single institution and participation was based on voluntary involvement, the characteristics of the individuals who agreed to participate may differ from those who declined. This may limit the generalizability of the findings to the broader geriatric population.

Conclusion

Exergames used in geriatric rehabilitation are effective in reducing kinesiophobia and depressive symptoms, and they also improve balance in older adults. The adaptability and accessibility make them a promising tool for older adults potentially enabling specialized interventions to complement traditional rehabilitation programs. Long-term exergame-based rehabilitation is needed in future studies to investigate the extent of improvement in muscle strength and cognitive functions.

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