

Original Article

Feasibility of interactive video games for influence on balance in institutionalized elderly people

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Abstract:

Purpose: The purpose is related to the assumption that the application of interactive video games will positively affect the functional balance reactions in institutionalized older individuals.

Material and Methods: Ten institutionalized elderly people with an average age of 80.6 years \pm 7.25, two men and eight women were included. All of them had to meet the inclusion and exclusion criteria. The intervention program included interactive video games, for 5 days per week, for one month. Berg Balance Scale, Timed Up and Go and Mini Mental State Examination tests were considered.

Results: Including commercial games in physical therapy sessions have a positive effect on dynamic postural control and functional ability in institutionalized elderly. Application of virtual reality possibly maintains cognitive function. Comparison between initial and final measurement revealed statistically significant differences for Berg Balance Scale and Mini Mental State Examination ($p < 0.005$) and for Timed Up and Go ($p < 0.001$).

Conclusion: The application of virtual reality (including commercial video games) is feasible in institutionalized elderly people. Suitable selection of computer games may improve balance and maintain cognitive function.

Key words: physical therapy, virtual reality, geriatry.

Introduction

Physical activity programs are aimed at reducing the age decline in functional capacity in elderly people. Especially, trainings to improve strength, balance and coordination are highly effective in reducing the incidence of falls (Nelson et al. 2007). It is important for elderly with low risk of falling to do regular physical activity, to improve dynamic balance and motor functions. Application of physical therapy for treatment of sensory disorders (in particular visual and vestibular disorders) is also important, as well as specific motor tasks to improve different aspects of balance, strength, flexibility, sensory integration, tasks which require attention (Shimada, 2004; Silsupadol, 2006).

There are number of studies on application of virtual reality (even in the form of commercial games) in neurological, traumatic, pediatric and other patients (Lohse et al., 2014; Darekar et al., 2015). Some researchers have used virtual reality technology to immerse the users in the virtual environment; others use standard display technology (computer monitors and TVs). The study of Burke et al. (2009) is addressing the design of computer-based games and functional recovery effect. A major highlight is the possibility of commercial computer games to provoke a high level of interest in our patients. To achieve this it is necessary to comply with some basic points: the game is meaningful; it is feasible for those with relevant dysfunction and is appropriately increasing the level of difficulty. According to same authors there are many features in the design and application of computer games for specific therapeutic purposes: to be on the optimal cognitive level; to be understandable and relevant; to exist sufficiently effective feedback; to have an element of social activity; to meet the specific therapeutic goals and objectives; to be available to comply with the specific problem.

Unfortunately, development of game software for therapeutic purposes depends on both the presence of specialists in this field and on the financial capacity. But it is possible to use in the rehabilitation process available commercial devices which allow prolonging the rehabilitation at home. Lohse et al. (2014) do not establish significant differences in the effect of commercially-based video game systems and specific rehabilitation virtual reality systems in terms of functional recovery after stroke. There are numbers of data on positive effect in cognitive and motor functions for different medical conditions, including stimulation of neuroplasticity. The computer games have a potential in improving motor skills.

Consensus on the importance and positive impact of purposeful physical activity in institutionalized adults and older people is established.

Purpose: Our purpose is related to the assumption that the application of interactive video games will positively affect the functional balance reactions in institutionalized older individuals.

Method

Participants

This study involved 10 Bulgarian institutionalized older individuals, all participants were voluntarily attended. Eight women and two men of average age of 80.6 ± 7.25 years have been monitored. The most common diseases in the studied group were coronary artery disease and degenerative joint problems. Including and excluding criteria were determined and participants were selected by them. Including criteria are: no previous experience with physical therapy programs with activity promoting video games; willingness to participate; to be able to follow instructions; to be able to walk independently with or without assistive device more than 10 meters. Excluding criteria are: severe sensory deficits; patients whose visual or hearing impairment does not allow possibility of interaction; ataxia or other cerebellar symptoms; severe deformities or locomotion problems; uncontrolled hypertension, decompensated diabetes or high functional class heart failure. Before therapy, all subjects had been given verbal explanations and had signed informed consent statement.

Measurements

For the purpose of the study following functional measurements were monitored twice – at the beginning and at the end of the intervention:

Berg Balance Scale (BBS) - was developed to measure balance among older people with impairment in balance function by assessing the performance of functional tasks (Berg et al. 1992). It is a 14-item objective measure designed to assess static balance and fall risk in adult populations with maximum score 56, higher values indicate better balance. It consists of static and dynamic activities of varying difficulty. A score of 0 is given if the participant is unable to do the task, and a score of 4 is given if the participant is able to complete the task based on the criterion that has been assigned to it.

Timed Up and Go (TUG) - assesses mobility, balance, walking ability, and fall risk in older adults. The measured time (sec) for rising from a chair, walking 3 meters at a comfortable and safe pace, turning, walking back and sitting down is monitored. Lower values on the TUG indicate better mobility (Brooks et al. 2006).

Mini Mental State Examination Test (MMSE) - The MMSE consists of 11 simple questions or tasks grouped into 7 cognitive domains with maximum score of 30 points. The test is used to provide information about individual's present cognitive performance based on direct observation of completion of test items/tasks (Andrew, 2008).

Intervention program

The intervention program involved the participants in interactive video games using home video game console Xbox 360 with standard display technology (not developed to retrain a specific motor skill in a particular population). The following criteria were used for selection of games: meaningful, feasible and appropriate difficulty with avoiding frustration due to motor or cognitive disorders. Four games with proactive balance control were chosen – "Skiing", "Boxing", "Shootout" and "Dances". Each treatment was applied individually, performing all 4 games, from 20 to 30 minutes, for 5 days per week, for 4 weeks (Table 1). In standing position the participants performed the games, starting with "Skiing", then "Boxing", "Shootout" and at the end "Dances". The first are with longest duration, the following are less and gradually increasing the level of difficulty. Game results serve as motivation element.

Table 1. Games duration

Game	Duration (min)			
	5 days/week			
	1 st	2 nd	3 rd	4 th
Skiing	6	9	15	15
Boxing	5	8	12	12
Shootout	5	5	5	5
Dances	3	5	8	8

Statistical analysis

The analysis of the data was carried out with the support of the SPSS version 19.0. Descriptive statistic (mean and standard deviation), a parametric Student's t-test and nonparametric Wilcoxon test for paired samples to determine the significance of changes in outcome measures were used. The significance was set up at $p \leq 0.05$.

Results

The Berg Balance Scale (BBS) analysis was divided in two parts – static and dynamic. In the static 6 item were included – standing, sitting, standing with eyes closed, standing with feet together, standing with one foot in front, standing on one foot. The rest were included in the dynamic – sitting to standing, standing to

sitting, transfers, reaching, retrieving an object, turning and placing foot. The averages, standard deviation and the significance of differences in Berg Balance Scale (BBS), Timed Up and Go (TUG) and Mini-Mental State Examination (MMSE) are presented in Table 2. There are significant differences for all parameters between start and end values. Postural control improved in a variety of measures.

The baseline results of TUG test in mean values are 19.1 ± 1.2 sec and the final results decrease to 17.8 ± 1.22 sec in mean values. Significant change between them was observed.

Table 2. Changes in functional tests - Berg Balance Scale, Timed Up and Go and Mini-Mental State Examination

Variable	Measure	Mean	SD	Significance
BBS static (p)	Baseline	13.9	1.4	$p < 0.005$
	Final	19.2	1.1	
BBS dynamic (p)	Baseline	21.3	1.7	$p < 0.005$
	Final	27.6	1.8	
BBS total (p)	Baseline	35.2	1.9	$p < 0.005$
	Final	46.8	2.6	
TUG (sec)	Baseline	19.1	1.2	$p < 0.001$
	Final	17.8	1.2	
MMSE total (p)	Baseline	18.4	5.4	$p < 0.005$
	Final	22.9	3.4	

The MMSE consists of 11 simple questions or tasks grouped into 7 cognitive domains: orientation to time; orientation to place; registration of three words; attention and calculation; recall of three words; language; visual construction. Bravo and Hebert (1997) offer reference values according to age and level of education: for age 80 to 84 years – mean 26.5 points. Lancu and Olmer (2006), offer the following classification of the degree of cognitive impairments: 21-26 = minor impairment; 11-20 = moderate impairment; ≤ 10 = severe impairment; < 23 is generally accepted as indicating cognitive impairment and was associated with the diagnosis of dementia in at least 79% of cases. At the baseline the points for the group were mean 18.4 ± 5.46 , and at the end of the study the results increased to 22.9 ± 3.4 points. The participants were with minor impairments at the end of the program with small deviation. Significant differences between baseline and final measurements were detected.

Discussion

Due to the many problems associated with reduced balance and mobility in elderly, providing an effective program is essential in assisting with recovery and helping to prevent degradation of motor skills. The effect of digital interactive games on balance was studied in individuals with mobility disorders (Darekar et al. 2015) and older people (Bisson et al., 2007; Szturm et al., 2011). The whole body activity promoting video games were not used in Bulgarian institutionalized elderly people. The interactive balance games involved repetitive, voluntary, whole body movements, resulting in movements that varied in direction, speed, amplitude, and precision and may positively affect the postural control. The changes in Berg Balance Scale score are considered as a predictor of risk of falling in older people. In clinical practice a total cutoff score of 45 points is considered to divide patients of “falling” and “non-falling” (Boulgarides et al. 2003). The change of 5 points is required to reveal a genuine change in function between 2 assessments if the initial score is within 35-44 points (Donoghue, 2009). The baseline total points in this study group were mean 35.2 ± 1.93 which indicates medium fall risk and walking with assistance (Donoghue, Stokes, 2009). The final total points were mean 46.8 ± 2.61 which indicates low fall risk and independent walking. A change of 11.6 points observed in our study group revealed the positive influence of video games on static and dynamic balance.

Both BBS and TUG tests give information of balance performance and fall risk in this population group. TUG performance is related to multiple factors - lower limbs strength, balance abilities and sensorimotor function. The TUG provides information about mobility because it uses components of daily life - standing from a seated position, walking, changing the direction. The Timed Up and Go cutoff values associated with high fall risk is > 14 seconds in community dwelling frail older adults (Shumway - Cook et al. 2000). The final score in this group was 17.8 sec, still high, but some improvement is observed. Interactive video games treatment may increase functional activities performance by position changing movements and maintaining postural control. The increase could be due to high motivation and interest of the participants, led to awareness of their balance control (Tsimaras et al. 2014). General physical activity, including daily life-style, is important in maintaining balance function, especially in elderly, and gaming technology may play a role in achieving this goal. Cognitively impaired subjects took longer to perform the TUG than unimpaired subjects.

Lack of interest or an insufficient attention also can impair the potential effectiveness of the therapeutic exercises, in cases of many chronic neurological and musculoskeletal conditions when a lot of practice is essential. Intact cognitive function is associated with better mobility and control of posture. The MMSE allows assessing and recording cognitive changes after physical therapy sessions. In this group some improvement from moderate to minor impairment were observed, but still < 23 points – generally indicates for cognitive impairments. The positive effect may be due to attention's necessity during performance. The recent studies

showed that the elderly people maintained cognitive function after goal-oriented physical therapy (Weuve et al. 2004). The memory function, learning process and concentration affect cognitive ability through many treatments, including virtual reality, is an important moment to increase the independence and to improve the quality of life in this group.

Despite the positive results we need to underline the small number of participants due to including and excluding criteria. Monitoring for a longer period of time it would be beneficial. Further investigations to determine the impact of interactive video games (including home game console) on balance reactions, everyday life motor activity and cognitive function are needed.

Conclusions

The application of virtual reality, including suitable selection of computer games, is feasible in institutionalized elderly people to achieve a positive effect on dynamic postural control and functional ability avoiding cognitive decline.

References

- Andrew, M. K. and Rockwood, K. (2008). "A five-point change in Modified Mini-Mental State Examination was clinically meaningful in community-dwelling elderly people." *Journal of Clinical Epidemiology* 61(8): 827-831.
- Bisson E, Contant B, Sveistrup H, Lajoie Y.. (2007) Functional Balance and Dual-Task Reaction Times in Older Adults Are Improved by Virtual Reality and Biofeedback Training *Cyber Psychology & Behavior*., 10(1): 16-23.
- Boulgarides LK, McGinty SM, et al. (2003) Use of clinical and impairment □ based tests to predict falls by community □ dwelling older adults. *Phys Ther.*;83:328 □ 339.
- Bravo, G. and Hebert, R. (1997) Age- and education-specific reference values for the Mini-Mental and modified Mini-Mental State Examinations derived from a non-demented elderly population. *Int J of Ger Psych* 12(10): 1008-1018
- Brooks, D., Davis, A. M., et al. (2006). "Validity of 3 physical performance measures in inpatient geriatric rehabilitation." *Arch Phys Med Rehabil* 87(1): 105-110
- Burke J W, McNeill M D, Charles D K, Morrow P J, Crosbie J H, McDonoughS M (2009), Optimising engagement for stroke rehabilitation using serious games, *The Visual Computer*, 25(12), 1085-1099
- Darekar A, McFadyen B J, Lamontagne A, Fung J (2015), Efficacy of virtual reality-based intervention on balance and mobility disorders post-stroke: a scoping review, *Journal of NeuroEngineering and Rehabilitation* 12:46
- Donoghue D; Physiotherapy Research and Older People (PROP) group, Stokes EK. (2009). How much change is true change? The minimum detectable change of the Berg Balance Scale in elderly people. *J Rehabil Med*. 41(5):343-6
- Donoghue, D., Stokes, E. K. (2009). "How much change is true change? The minimum detectable change of the Berg Balance Scale in elderly people." *J Rehabil Med* 41(5): 343-346
- Lancu, I., Olmer, A. (2006), The minimal state examination--an up-to-date review]. *Harefuah* 145(9): 687-690, 701
- Lohse KR, Hilderman CGE, Cheung KL, Tatla S, Van der Loos HFM (2014) Virtual Reality Therapy for Adults Post-Stroke: A Systematic Review and Meta-Analysis Exploring Virtual Environments and Commercial Games in Therapy. *PLoS ONE* 9(3): e93318
- Nelson M, Rejeski WJ, Blair, SN, Duncan PW, Judge JO, King AC, Macera CA, Castaneda-Sceppa C. (2007) Physical Activity and Public Health in older Adults: Recommendations from the American college of Sports Medicine and the American Heart Association. *Medicine Science in Sports and Exercise*; 39(8): 1435-1445
- Shimada H, Obuchi S, Furuna T, Suzuki T (2004). New intervention program for preventing falls among frail elderly people:the effects of perturbed walking exercise using a bilateral separated treadmill. *Am J Phys Med Rehabil*, 83(7):493-9
- Shumway - Cook A, Brauer S, Woollacott M. (2000) Predicting the probability for falls in community - dwelling older adults using the timed up & go test. *Phys Ther.*;80:896-903
- Silsupadol P, Siu KC, Shumway-Cook A, Woollacott MH (2006). Training of balance under single-and dual-task conditions on older adults with balance impairment. *Phys Ther*; 86(2):269-81
- Szturm T, Betker A L, Moussavi Z, Desai A, Goodman V, (2011) Effects of an Interactive Computer Game Exercise Regimen on Balance Impairment in Frail Community-Dwelling Older Adults: A Randomized Controlled Trial, *Phys Ther*; 91:1449-1462
- Tsimaras V, Papaioannou M, Proios M, Fotiadou E, Kokaridas D, Kotzamanidou M, (2014) The effect of a digital interactive game in distractibility, hyperactivity and impulsivity in individuals with attention deficit hyperactivity disorder and intellectual disability, *JPES*, 14(4), 77, 500 – 506
- Weuve J., Kang J. H., Manson J. E., Breteler M. B., Ware J. H., Grodstein F., (2004) Physical Activity, Including Walking, and Cognitive Function in Older Women, *JAMA*. ;292(12):1454-1461.