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ORIGINAL ARTICLE

Effect of Brain Training Game on Mild Cognitive Impairment (MCI) in Older Adults

HAFSAH ARSHAD[1], KINZA ANWAR[2], HAFSAH GUL KHATTAK[3], IMRAN AMJAD[4], YASER MAJEED[5]
[1]*Lecturer, University Of Lahore Department of Physical Therapy, Islamabad*
[2]*Senior Lecturer, Riphah International University, Islamabad*
[3]*Lecturer, University Of Lahore Department of Physical Therapy, Islamabad*
[4]*Associate Professor, Riphah International University, Islamabad & Post-Doctoral fellow in New Zealand College of Chiropractic*
[5]*Physiotherapist Special education school Hamza Camp, Rawalpindi*
Correspondence to Hafsah Arshad, Email: hafsah.arshad@uipt.uol.edu.pk, Tel. 0331-5165234

ABSTRACT

Aim: To determine effects of Kinect- based games on neurocognitive functions in older adults with mild cognitive impairment.

Methodology: A quasi experimental pre-post trail was conducted on 18 mild cognitive impairment (MCI) older adults. The subjects were recruited to access cognitive impairment through purposive sampling technique. The inclusion criteria were elderly aged ≥ 50 years, both genders, able to read and write, whereas older adults with severe cognitive impairments, neurological disorders and un controlled comorbidities were excluded. Brain training was provided for 30 minutes with 5-minute warm-up time and 5-minute cool-down time for 6 weeks. Blind assessor measured readings at baseline and after six weeks. The outcome measures were Mini-Mental State Examination (MMSE), Montreal Cognitive Assessment (MOCA), Trail making test A & B and verbal fluency test (Semantic &Phonemic). The data was analyzed at baseline and after six weeks of intervention

Results: Significant improvements were observed in post-test measurements ($p < 0.05$) in MMSE, MoCA, TMT A & B and verbal fluency (Semantic &Phonemic) tests after 6 weeks of treatment.

Conclusion: Kinect-based virtual reality games are beneficial in improving cognitive abilities of older adults with mild cognitive impairment.

Keywords: Cognitive training, Mild cognitive impairment, Montreal Cognitive Assessment,

INTRODUCTION

Mild cognitive impairment (MCI) was first described by Petersen et al 1997, refers to impairment in cognition above that which is seen with normal age-related cognitive decline, but not sufficient to cause significantly decreased daily life function[1], considered as transitional stage from normal cognitive function to dementia[2]. Clinical symptoms include memory loss, language problems, attention deficits, disorientation, and changed visuospatial skills .MCI prevalence reported in elderly above 65 years is about 3% to 22%[3]. MCI subjects have high risk of developing dementia, previous studies reported rates of transition from MCI to dementia from 20–40% i.e., 10–15% per year, while the incidence of MCI is about 1% to 2% per annum in the general population[2,3]. Diagnostic criteria for MCI, based on cognitive complaint impairment or decline, objective evidence of impairment in cognitive domains i.e. memory, executive function/attention, language, or visuospatial skills, Decrease in routine functions, unchanged basic daily life activities (ADL) and absence of dementia. One method to diagnose MCI based on inquiring questions related to memory, recall, attention span, language and visual-spatial abilities, general health status, medications and comorbidities[4]. Even though no specific treatment for MCI persists but to prevent from further cognitive decline in MCI various pharmacological and non-pharmacological stratagems are used. Non pharmacological approaches for MCI includes diet and life style modification, cognitive rehabilitation, cognitive brain training/gamification, behavioral therapies, physical activities and exercise such as aerobics, resistance training help improve in cognitive decline[5].

From literature three broad categories of cognitive intervention have been identified cognitive training, cognitive stimulation, and cognitive rehabilitation[6,7]. Cognitive or brain training is now broadly being applied in research as well as in clinical settings for prevention of cognitive decline among young healthy individuals, healthy older adults and in MCI patients[8]. Cognitive training defines as intervention, comprising of structured, repetitive and guided practice on standardized exercises or tasks which targets a specific cognitive domains for the purpose of enhancing cognitive function[6]. Main purpose of brain training games intends to rousing creativity to improve learning ability, psychological well-being and cognitive domains such as attention, language and memory, the capability to be self-sufficient and improve daily life activities. Due to technology evolution various brain training software are available in market[9].

Exergaming also known as active gaming or motion-based video gaming is considered as useful options option as it consists of blend of exercise and gaming in which individuals have to do physical actions to play games and complete task in response to visual clues. Commons types are included in this category Nintendo Wii, Play Station Move and Microsoft Xbox Kinect[5,25]. Microsoft Kinect uses motion sensor that without the use of any controllers, captures movements. This gives players the chance to play and interact with the game with gestures and bodily movements. Xbox 360 has advantages due its accessibility, safe, user friendly, low price and entertaining and pleasurable[3,10].

As previous studies explored the effect of games on normal elderly population as well as on MCI adults and

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found beneficial effects on various cognitive domains. To the best of knowledge fewer studies have conducted to the determine the effect of Xbox 360 Kinect games on MCI subjects. Due to of favorable effects gaming on various cognitive domains, it was hypothesized that Xbox 360 Kinect cognitive games would have positive effects on MCI subjects.

To determine effects of Kinect- based games on neurocognitive functions in older adults with mild cognitive impairment.

MATERIALS AND METHODS

The quasi- experimental study was conducted after approval from Ethical Committee on 21 MCI subjects at Physical Rehabilitation Department of Pakistan Railways General Hospital, Rawalpindi. The study was ethically approved by ethical review committee of Riphah College of Rehabilitation Sciences (RCRS). Sample size was calculated with 3.5 SD, 0.95 CI with precision level set as 1.5 by using Epi-tool. The sample was raised through purposive sampling. The study was carried out in a single experimental group without randomization and no control group. Subjects were recruited who visit the hospital and were diagnosed as MCI by NIA/AA 201134[11] and Petersen criteria[12]. Participants was aged ≥ 50 years, be able to read and write in their names in Urdu (local language) and English, without prior history of dementia or severe cognitive impairment and had well-controlled comorbidities i.e., hypertension, diabetes and willing to participate were included in study. The subjects were excluded if they were on medications interfering with the cognition, had any disease affecting the central nervous system such as multiple sclerosis, Parkinson, stroke, thyroid disease, hypertension, severe respiratory disease, diabetes and had current significant anxiety or depressive disorder. The procedure was explained in Urdu to the subjects, and written informed consent was taken before conducted the study. Demographic data was collected using a standardized questionnaire. Standardized Assessment tools were used to collect data that includes Mini mental state Examination (MMSE), Montreal Cognitive Assessment (MoCA), Trail Making Test A and B and Verbal Fluency test Semantic and Phonemic.

Subjects in intervention group were explained in detail about the procedure and a detail description about games was given before start of intervention. A commercially available puzzle video game ‘‘Body and Brain Exercises’’ by Dr. Kawashima developed and published by Namco Bandai Games for the virtual reality-based Xbox 360[13]. Before and after the brain training session there was a 5-minute warm-up time and 5-minute cool-down time. The intervention time was 30 minutes, 5 days a week for 6 weeks. The subjects played the games in the hospital on an Xbox 360 with Kinect (China, 2014; 015543340108) under the supervision of a therapist. For brain training, there are five domains logic, physical, memory, reflexes and math were targeted with each game focus on one of the five domains. In these games, subjects were asked to perform different tasks by seeing different visual clues and to respond with different physical movements. All subjects started their training with same beginner level and with the same game. For good follow-up and interest subjects were trained with different games in the same category on each alternate session. Blind assessment was done. Scores on each tool were recorded at baseline and after 6 weeks of intervention.

Statistical analysis was done on 18 MCI patients after 2 dropouts by using SPSS 24.0. Descriptive statistics were used to summarize the demographic data. The test of normality was used to evaluate distribution of data. The p value of Shapiro Wilk test for all outcome measures was >0.05, parametric paired t-test were used to measure the differences. Due to small sample size <30 non-parametric contrast test (Wilcoxon test) was performed to compare the scores with in group before and after the training.

RESULTS

The total number of participants included in this study were 18. The number of male participants was 12 (66%) and number of female participants was 6 (33%). The Mean age was 62.0±8.49. Participants who had diabetes were 3(16.7%), 2(11.1%) were hypertensive, 3(16%) and 10 (55.6%) had reported with other comorbidities. Mostly participants 8 (44.4%) in our study had completed their primary education. The number of participants who smoked were 6(33.3%) and 12 (66.7%) participants were on medications. Regarding occupation of the participants, 6(33.3%) were housewives, 3(16.7%) were working in government sector, 6(33.3%) were retired employee and 3(16.7%) were working in private set-ups. Additionally, majority of study participants 10 (55.6%) came with memory complaint, problem solving difficulty and sleep disturbance (Table 1).

When inferential analysis was done, there was statistically significant post-test score for measures of neuropsychological tests ($p<0.05$) i.e. MMSE (Pre-treatment 22.22±1.83 vs Post-treatment 24.67±1.68, p=0.001), MoCA (Pre-treatment 18.78±2.55 vs Post-treatment 20.61±2.14, p=0.002), TMT-A (Pre-treatment 3.00±0.26 vs Post-treatment 2.30±0.17, p=0.001), TMT-B (Pre-treatment 5.28±0.26 vs Post-treatment 4.09±0.46, p=0.001), semantic fluency test (Pre-treatment 4.56±1.42 vs Post-treatment 5.44±1.33, p=0.003) and Phonemic verbal fluency was (Pre-treatment 3.39±1.37 vs Post-treatment 4.67±1.23, p=0.001) (Table 2).

Wilcoxon signed-rank test was carried out on outcome measures to determine the median score and exact significant value of neurocognitive parameters. Pre-median value of MMSE was 23.0 (2.25) vs post-median 25.0 (3.00), significantly higher than pre-test scores z= -3.338, p=0.001. Pre-median value of MoCA was 19.0(3.50) vs post-median 21.0 (3.20), significant improvement reported in post-test scores z= -3.005, p =0.003. Pre-median value of TMT-A was 2.95(0.22) vs post-median score was 2.17(0.36), significant improvement reported in post-test scores z= -3.724, p =0.001. Pre-median value of TMT-B was 5.22(0.25) vs post-median score 4.16 (0.62) was significant improvement in post-test scores z= -3.724, p =0.001 after 6 weeks of treatment. VMT-semantic pre-median score was 5.00 (3.00) vs post median scores 6.00(2.25), z=-3.087 p=0.002 and VMT- Phonemic pre-median score was 4.00 (2.00) vs post median scores

4.00(2.00), z=-3.337 p=0.001. Both Verbal fluency test showed significantly higher scores after six weeks of intervention (Table 3).

Table 1: Characteristics of study participants

Variables	Categories	n (%)
Gender	Male	12 (66.7%)
	Female	6 (33.3%)
Co-morbidity	Diabetes	3 (16.7%)
	Hypertension	2 (11.1%)
	Diabetes and Hypertension	3 (16.7%)
	Others	10 (55.6%)
Social Drugs	Smoking	6(33.3%)
	Other Medications	12(66.7%)
Occupation	Housewives	6 (33.3%)
	Government Servants	3 (16.7%)
	Retired	6 (33.3%)
	Private sector	3 (16.7%)
Education status	Primary education	8 (44.4%)
	Intermediate	5 (27.8%)
	Secondary education	5 (27.8%)
Risk Factors	Depression	5(27.8%)
	Lack of physical activity	4 (22.2%)
	Mood and personality changes	2 (11.1%)
	High Cholesterol	2(11.1%)
	Diabetes	2(11.1%)
	Hypertension	3 (16.7%)
Sign & Symptoms	Memory complaint & misplacing things	8 (44.4%)
	Memory complaint, problem solving difficulty and sleep disturbance	10 (55.6%)

Table 2: Data presented as mean± standard deviation after 6 weeks of intervention. Significance is shown after comparison with the pre-treatment value *** P ≤ 0.001 (p < 0.05)

Variables	Pre-Intervention Mean ±SD	Post-intervention Mean ±SD	P-value
MMSE	22.22±1.83	24.67±1.68	0.001***
MoCA	18.78±2.55	20.61±2.14	0.002***
TMT-A	3.00±0.26	2.30±0.17	0.001***
TMT-B	5.28±0.26	4.09±0.46	0.001***
VMT-semantic	4.56±1.42	5.44±1.33	0.003***
VMT-phonemic	3.39±1.37	4.67±1.23	0.001***

Table 3: Data presented as median score pre- post intervention after 6-weeks of training. Significance is shown after comparison with the pre-treatment value *** P ≤ 0.001 (p < 0.05)

Variables	Pre-Intervention Median (IQ)	Post-Intervention Median (IQ)	Z-value	P-value
MMSE	23.0(2.25)	25.0(3.00)	-3.338	0.001***
MoCA	19.0(3.50)	21.0(3.20)	-3.005	0.003***
TMT-A	2.95(0.22)	2.17(0.36)	-3.724	0.001***
TMT-B	5.22(0.25)	4.16 (0.62)	-3.724	0.001***
VFT-semantic	5.00(3.00)	6.00(2.25)	-3.087	0.002***
VFT-phonemic	4.00(2.00)	5.00(2.00)	-3.337	0.001***

DISCUSSION

Kinect based brain training game for six weeks in MCI patients showed improvement in neuropsychological test scores with p-value <0.05. Deborah E. Barnes et al in their clinical trial conducted on MCI subjects found significant improvement in their computerized based cognitive training group after 6 weeks of training for 5 days/week[14]. Rui Nouchi et al suggested that brain games performed among older adults increase processing speed and executive function, which also supports our study results[15]. Park Eunchee et al in their work proposed that a newly developed MR -based cognitive training for 6 weeks showed significant improvement in individuals with MCI[16]. Lee Hyeret in their study found that, a computerized design program, “Cogmed” also improved working memory of older adults with MCI after 25 sessions for 5 to 7 weeks[17]. Abdulrahman Al-Thaqib et al in their work with cognitive brain training game “Lumosity” exhibits improvements in cognitive domains including attention and motor speed[18]. Hui-Ling Yang et al in their study on MCI adults observed better results in cognitive measures of memory, orientation and attention, while training with CogniPlus after six weeks in intervention group[19]. Ji-Su Park and colleagues also found significantly greater improvement in the MoCA, TMT-A, TMT-B , and DST-forward scores in their virtual reality-based cognitive–motor rehabilitation (VRCMR) group after six weeks of training for 30 min per day and 5 days/week[20].

CONCLUSION

The study concludes that brain training with Kinect based games showed significant improvement in neurocognitive domains in elderly subjects with MCI.

Limitations & Recommendations of study: The sample size of this study was small, future studies should be conducted with large sample size. Physiological markers were not encompassed to evaluate the physiological markers and related beneficial effects related to plasticity of brain that occurred at different levels. Further games should be modified for uneducated elderly population.

Conflict of interest: Nil

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