Impact of virtual reality games on psychological well-being and upper limb performance in adults with physical disabilities: A pilot study

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ABSTRACT

Introduction: There is limited information regarding the effects of interactive virtual reality (VR) games on psychological and physical well-being among adults with physical disabilities. We aimed to examine the impact of VR games on psychological well-being, upper limb motor function and reaction time in adults with physical disabilities.

Methods: Fifteen participants completed the intervention using Wii VR games in this pilot study. Depressive, Anxiety and Stress Scales (DASS) and Capabilities of Upper Extremity (CUE) questionnaires were used to measure psychological well-being and upper limb motor function respectively. Upper limb reaction time was measured using reaction time test.

Results: Results showed that there was a significant difference ($p<0.05$) in DASS questionnaire and average reaction time score after intervention.

Conclusion: There is a potential for using interactive VR games as an exercise tool to improve psychological well-being and upper limb reaction time among adults with disabilities.

KEY WORDS:
Virtual reality games, psychological well-being, upper limb motor function, reaction time

INTRODUCTION

Adults with disabilities around the world have been estimated to be around one billion, which consist of 15% of the world's population.[1] In Malaysia, there are approximately 300,000 adults with disabilities.[2] Impairments in cardiovascular fitness, balance, motor control, sensation, proprioception and coordination are common in adults with physical disabilities.[3] These impairments can lead to functional dependence, poor quality of life, limited mobility and decreased participation in leisure activities.

Opportunities to participate in regular exercise are especially important for groups that are less physically active than the general population. This is because adults with disabilities are more prone to secondary complications such as pain, fatigue and de-conditioning.[4] Virtual reality (VR) games are games played in a stimulated 3-dimensional (3D) environment. VR games have been developed for leisure activities but we found VR to be beneficial for rehabilitation in our local studies.[5-7]

Involvement in physical activity among people with disabilities is limited. Utilisation of technology may promote adherence, motivation and participation in physical activity and exercise programmes. However, as opposed to conventional rehabilitation and physiotherapy for adults with disabilities, evidence of VR games in improving function is limited. Therefore, the aim of this study was to examine the impact of VR games on psychological well-being, upper limb motor function and reaction time in adults with physical disabilities.

MATERIALS AND METHODS

In this pre-post pilot study involved participants with physical disabilities from Pusat Latihan Perindustrian dan Pemulihan (PLPP) in Bangi, Selangor. Participants were recruited based on classification of physical disabilities, inclusion and exclusion criteria. Participants who were not able to hold a remote, had muscle strength using Oxford Grading that was below three, bilateral amputation of upper limb, limited range of motion in the upper limb joints either due to pain or contractures and have had any upper limb surgery were excluded from the study. Visually impaired participants were also excluded. Ethical approval was obtained from the research and ethics committee of Universiti Kebangsaan Malaysia and written informed consent was obtained from participants.

Baseline measurements of 18 participants who met the criteria were taken. Participants filled up the Malay version of the Depressive, Anxiety and Stress Scales Questionnaire (DASS) and the Capabilities of Upper Extremity Instrument (CUE) that measures functional limitation. Reaction time test was performed to measure upper limb reaction time. Two participants were excluded after baseline measurements as they could not understand the questionnaire. Sixteen

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Table I : Participants' demographic characteristics

		N	%	Mean	SD
Age (years)		15	-	22.7	4.2
Gender	Males	12	80.0		
	Females	3	20.0		
Race	Malay	14	93.3		
	Chinese	1	6.7		
Dominant Hand	Right-handed	12	80.0		
	Left-handed	3	20.0		

Table II: Comparison between pre and post intervention for DASS subscales, CUE scores and reaction time

	Pre Mean + SD	Post Mean + SD	Pre Median (IqR)	Post Median (IqR)	t	Z	p
Stress (score)	7.67 ± 3.09	6.73 ± 2.71			1.32		0.21 [a]
Anxiety (score)	7.27 ± 3.49	5.00 ± 2.62			2.77		0.02* [a]
Depression (score)	4.67 ± 3.16	3.27 ± 3.01			1.44		0.17 [a]
Left Arm CUE (score)	76.8 ± 26.6	85.1 ± 24.0			-2.13		0.05 [a]
Right Arm CUE (score)	83.5 ± 24.1	89.7 ± 20.9	94 (44)	103 (30)		-1.17	0.24 [b]
Total CUE (score)	172.1 ± 41.1	186.5 ± 33.4	175 (80)	195 (56)		-1.70	0.09 [b]
CUE (% score)	73.0 ± 21.4	80.5 ± 17.4	74.5 (41.7)	84.9 (29.2)		-1.66	0.10 [b]
Average Reaction Time (seconds)	0.360 ± 0.072	0.317 ± 0.064			2.74		0.02* [a]

[a] Analysis using paired t-test (normally distributed data);
[b] Analysis using Wilcoxon signed rank test (not normally distributed data).
* Significant difference, p<0.05

participants underwent training sessions using interactive VR games for 30 minutes, twice a week for four weeks, using the Nintendo® Wii Fit. One participant dropped out from this research during intervention due to personal reasons. Games used in the intervention were selected from Wii Sports software that included tennis, bowling and boxing. Each game was carried out for 10 minutes. On the completion of four weeks of the intervention, measurements of DASS, CUE and hand reaction time were performed again.

RESULTS

Participants' demographic data is listed in Table I. The difference between psychological well-being, upper limb motor function and reaction time pre and post intervention is depicted in Table II.

DISCUSSION

The results of this study demonstrated that there was a significant difference (p<0.05) in psychological well-being and reaction time after intervention using interactive VR games. This suggests that interactive VR games can be used as an exercise tool to improve psychological well-being and reaction time among adults with physical disabilities.

Decrease in anxiety subscale was probably due to the enjoyment during the intervention. Exercises that incorporate games are deduced to assist in lowering depression, anxiety, and stress.[3] The authors believe that self-reported psychological effects were probably related to positive changes in self-perception.

There were no significant differences in stress and depression after intervention using interactive VR games. In contrast, previous studies showed significant improvement in psychological well-being, namely lowering stress, anxiety and depression levels and increasing participant's self-esteem and motivation.[8] This may be due to insufficient intensity and frequency of the intervention in our present study. Although not significantly decreased, both stress and depression subscales showed a 12 and 30% decrement of mean scores respectively after intervention.

Upper limb motor function measured using CUE showed no significant improvements among adults with disabilities after intervention in the present study. This result may be due to the small sample size. Significant improvements in upper limb motor function (p<0.05) after intervention with VR games in addition to conventional rehabilitation in stroke survivors were found in a similar study.[9] The inconsistent results in these studies could also be due to the difference in the duration and severity of upper limb disability, outcome measures and methodology employed.

Significant (p<0.05) improvements were demonstrated in the hand reaction time test with about 12% reduction in the average reaction time after intervention. Quick, fast and repetitive hand and arm movements are required when participating in interactive VR games. This could have led to improvements in the reaction time. Likewise, participants playing computer games showed faster response, suggesting increased reaction time and improved hand-eye co-ordination.[10]

One of the limitations of our study was that there were limited participants in the study, mainly because adults with physical disabilities in the centre did not meet the inclusion criteria. The intervention was also limited to four weeks as the participants were residing at the centre for a short period of time to attend a course. Further studies on VR games, using a larger sample size, in randomised control trials and longer duration of intervention are needed among this population.

In conclusion, the results of this study showed that there is a potential for using interactive VR games as an exercise tool to improve psychological well-being and upper limb reaction time among adults with disabilities.

DISCLOSURE

The authors declare that there is no conflict of interest.

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