OPEN ACCESS

RESEARCH ARTICLE

Effects of Exer gaming on upper extremity function and activities of daily living in Sub-Acute Stroke patient (Randomized Controlled Trial)

Yamna Mazher[1], Iram Shafee[2], Hassan Shahid Dar[3]

ABSTRACT

Background: Stroke or cerebrovascular accident (CVA) can be defined as the quick loss of brain function caused by the alteration in circulation of blood to brain which may be ischemic or hemorrhagic.

Objective: To determine the effectiveness of exergaming compared to conventional treatment on upper extremity function and activities of daily life in sub-acute stroke patients.

Methods: Study with ethical approval REC/RCRS/20/2032 was conducted at Services Hospital Lahore. On the basis of diagnoses of left and right sided ischemic or hemorrhagic first strokes, with age from 45 to 65, at least six months and more than one month post-stroke, and cumulative Mini Mental State Examination scores of 19 or higher (MMSE) criteria 32 subjects were recruited and were allocated to Group A and B. Fugal Meyer Assessment (Upper Extremity) (FMA-UE) and Stroke Impact Scale (SIS) Version 3.0 were used to assess upper extremity motor function and activities of daily living (ADLs**)**. Group A received Exer game therapy and Group B received conventional treatment. The patient received sessions five times a week, 30 minutes/ day for one month. Outcomes were evaluated at Pretreatment, four weeks and eight weeks interval.

Results: Results show that patients belonging to both Exer gaming group and conventional group showed improvement. When comparing the two groups' upper extremity motor function and daily living activities, there was a statistically significant difference found (p value < 0.05)**.**

Conclusion: It is concluded that Exer gaming was more effective as compared to the conventional treatment improving level of function in upper limbs and activities of everyday living

Clinical Trial Number: NCT04750746

Keywords: Activity of daily living, Rehabilitation, Stroke, Upper extremity function, Virtual reality.

DOI: http://doi.org/10.33897/fujrs.v5i1.420

Introduction:

Stroke is defined as a disorder of vascular origin in which rapid loss of brain activity occurs.(1) Stroke causes permanent disability among adults. According to the survey conducted by World health organization (WHO), every year 15 million people affected by stroke. In approximately stroke causes permanent disabilities in five million people.(2) Upper limb hemiparesis is most common disability.(3) Normal upper extremity function is necessary for some fine movements needed to complete activities of daily living (ADLs).(4) Among stroke victims, functional upper limb motor disturbances is experienced by 69% patient, Upper extremity (UE) motor disturbances affects 77% patients which has impacted their ability to perform tasks of everyday life.(5) Approximately 30-66 % patient are not able to use their affected arm.(6) According to estimates, Pakistan has a yearly incidence of 250/100,000 stroke cases, or 350 000 new cases annually.(7) Treatment of the upper limb of people with hemiplegia continues to be a challenging and often exasperated experience for clinicians.(8) Stroke has a detrimental effect on a person's quality of life and ability to carry out daily duties on their own, in particular.(9) About 50% survival of stroke have limitation in performing the tasks of daily living which is affecting their quality of life.(5)

Varying level of evidences is available to support the treatment options available to include in treatment

Affiliations: [1]University of Biological and Applied Sciences, Lahore, Pakistan, [2]Allied Institute of Health Sciences, Avicenna Medical and Dental College, Lahore, Pakistan. [3]THQ, Kahna Nau, Lahore, Pakistan.

Correspondence: Yamna Mazher

Email: yamnamazher@gmail.com

Received: May 8th, 2024; **Revision 1:** September 13th, 2024; **Revision 2:** November 29th, 2024.

Acceptance: January 13th, 2025

How to Cite: Mazher Y, Shafee I, Dar HS. Effects of Exer gaming on upper extremity function and activities of daily living in Sub-Acute Stroke patient (Randomized Controlled Trial). Foundation University Journal of Rehabilitation Sciences. 2025 Jan;5(1):33-40.

strategies for post stroke patient.(10) Several methods are being applied to the rehabilitation of upper limb motor control such as constraint induced movement therapy, task training with intensive repetition, motor imagery and training through mirror. In promoting physical recovery post stroke, no physical therapy approach is higher other treatment options according to a study conducted.(11) To improve the motor functions in stroke patients repeated practice and training of daily living tasks is very effective.(5) Using games such as XBOX games in stroke survivors patient to perform exercise appears to be suitable and fruitful, although there is limited evidence support is available on this. (12)

Patients of all ages can benefit from virtual reality therapy since it is a simple, affordable application that provides feedback to patients and raises their motivation levels.(13) Historically the literature relating to gaming systems has focused on two systems for use in rehabilitation of stroke, one is Play station and the other is Nintendo Wii.(14) In recent studies the use of video based games along with virtual and extended reality is being more and more recognized not only in the framework of occupational therapy but also in physical therapy and rehabilitation for both adults and children having problems related to movement, neurological problems or trauma causes.(15)

Different types of games are available for the purpose of rehabilitation but the game that stand out among the other is exer-game.(9) The use of exer game have a restorative and collaborative nature, definitive institutional purpose and create an atmosphere that supports to learn new motor function through motivation.(10) Playing games provide environment for practicing and enhancing intense repetitive task, bilateral arm training, and provide feedback and also allow self-controlled practice.(16) For improving the motor function and skills of patients with disabilities, playing games has come up as a beneficial method of rehabilitation.(9)

Several researches have disclosed remarkable improvements in functional outcome measures when therapist use exer-games as additional therapy in the rehabilitation of stroke.(17) Several researches on exer-gaming have estimated its effects on the recovery of upper limb motor control, balance, coordination, cognitive and functional capacity independence.(9) The emphasis of the game is not the expected upper limb movement of post stroke patients, so they do not take special note of spasticity that these patients may have.(9)

A multimodal gaming platform is the Microsoft Kinect for the Xbox 360. A low cost digital camera that is used to navigate a full-body skeletal posture evaluation system is its key input tool.(18) User-game interaction takes place through a wireless control platform that allows gestures to be translated into game commands and the user is most often portrayed by an avatar.(19) Since the Kinect is a marker-free motion-controlled gaming system, no wearable accessories are required for the user. The camera enables body position to be evaluated in three dimensions, which enable to monitor complex body poses. The precision and durability of the Kinect sensor has been assessed. However it is important to recognize that using the peripheral can be problematic in some circumstances.(18) In the Virtual reality world, user can see their posture and gestures without a controller, reported in real time.(13)

In this clinical experimental study, there are two explanations for selecting subjects with sub-acute stroke rather than other stages of post stroke. First patients have been shown to have the easiest, quickest and effective functional recovery and hand function sparing in this sub-acute stage of stroke.(20) Changes in body orientation arise in the sub-acute phase, requiring the introduction of interventional technique based on enhancing postural control and weight bearing symmetry. Furthermore, the fulfillment of everyday tasks is affected by common paresis, leading to an impact on the functional role and standard of life of patient.(21) Six month after the beginning of disease, no improvement in the activity of hands suggest a poor prognosis for hand function In order to establish clearly specified interventional protocol with video games as a supplement to traditional care program, only small number of researches have been done in stroke in the subacute stage with a useful strategy.(21,22)

The goal of this research was to assess the effect of exer-gaming on upper limb motor control & capacity to perform activities of everyday in sub-acute stage of stroke by using the Xbox Kinect framework. This type of game can serve as a therapy tool in rehabilitation of patients. This study can also help to incorporate gaming as a treatment for stroke patients. Minimal supervision is required so PT can save their time. Easy to incorporated such technology in clinical practice.

Methods:

The double blinded randomized controlled trial (clinical trial number NCT04750746 and ethical approval number REC/RCRS/20/2032) was conducted in the physical therapy department of Services Hospital, Lahore from March 2020 to March 2021.

After approval from the ethics review board of Riphah International University, Lahore, Pakistan, the sample size was determined. Sample size was calculated by WHO sample size calculator and the sample size was 32 (16 patient in each group) with Power of the test = 1- β = 90%.(23) The sample was taken using the convenience sampling technique, and informed consent was obtained from all respondents who fulfilled the eligibility requirements of the 37 participants initially assessed, 32 were enrolled.

Diagnoses of left and right sided ischemic or hemorrhagic first strokes, with ages ranging from 45 to 65, both sexes, at least six months and more than one month post-stroke, and cumulative Mini Mental State Examination scores of 19 or higher were included (MMSE). Patients with global aphasia, visual and cognitive impairments, a history of convulsions, those using drugs that can impair cognitive function, and patients undergoing any other kind of intervention were not included in the study. Patients with any other neurological conditions were also excluded.

Two groups, Group A (the experimental group) and Group B (the control group), each with sixteen people, were established from the sample. While the control group received conventional exercise therapy in addition to training in daily tasks such as feeding, grooming, dressing, using the restroom, and transferring, the experimental group received Xbox kinetic-based rehabilitation training for upper limbs in addition to standardized physical therapy treatment. Each group received five 30 minutes sessions per week for one month.

Experimental group included program such as Boxing and Bowling in Kinect Sports Pack, Rally Ball, 20,000 leaks and Space Pop in the Kinect Adventure Pack were chosen for training all of which involved the use of upper limbs. Control groups included physical therapy exercises and the training of tasks of daily routine, included feeding, grooming, dressing, toileting and transferring were conducted. Each task was completed in 15 minutes, with a 5-minute break in between. Using the Fugl-Meyer Assessment for Upper Extremity (FMA-UE) with intra-rater (ICC 0.99, 95 percent CI 0.99 to 1.00) and the inter rater (ICC 0.96, 95 percent CI 0.92 to 0.98), UE's motor function was evaluated. With a total score of 66, the FMA-UE evaluates the UE's motor function across four domains: wrist, hand, coordination/speed, and UE. Stroke Impact Scale (SIS) verion 3.0 with Cronbach's alpha values ranging between 0.80 and 0.95 was used to assessed disability and the quality of life of the participant after stroke. This 59-item test assesses the self-reported impact of stroke in eight domains: mobility, hand function and participation/role function, memory and thinking, emotion, communication, daily living activities and instrumental activities of daily living (ADL/IADL), strength, and mobility. It is possible to combine four of the domain of scale to form an overall physical component score. Strength, mobility, hand function, and ADL/IALD domains make up the physical domain. Furthermore, a Visual Analog Scale with a range of 0 to 100 assesses the overall perceived level of recovery since the beginning of the stroke.

Both groups were evaluated at the beginning, after four weeks, and after eight weeks. Data was analyzed using SPSS 21. Mean and standard deviation (SD) were used to compute quantitative variables for the descriptive analysis, and frequencies and percentages were used to show the categorical variables. For intra- and inter-group analyses, the parametric independent T test and repeated measure AVONA were used, respectively.

Figure 1: Showing starting position of upper extremity to bounce ball back

Figure 2: Showing ending position of upper extremity to bounce ball back

Results:

Out of 32 enrolled participants, in Group A (experimental group) 13 (72.2%) were males and 3 (27.7%) were females while in Group B (control group) 10 (55.5%) were males and 6 (44.4%) were female. In Group A 11 (61.1%) had ischemic stroke and 7 (38.8%) had hemorrhage stroke while in Group B 14 (77.7%) had ischemic stroke and 2 (22.2%) had hemorrhage stroke. In Group A 10 (55.5%) participant had right side involved 6 (44.4%) had left side involved, while in Group B 12 (66.6%) participants had right side affected and 4 (33.3%) had left side affected

The mean age of participants in group A and Group B was 52.94 ± 5.28 years and 56.17 ± 6.44 years respectively. The mean MMSE of participants in group A was 22.17 ± 2.14 and in group B was 22.00 ± 2.67. The mean BMI of participants in group A was 24.90 ± 2.69 and in group B was 24.80 ± 3.60.The mean time onset of stroke in group A and B was 10.50 ± 2.43 and 11.94 ± 3.24 respectively. It is also apparent that, in terms of demographics variables there was no statistically significant difference between the groups at the baseline. Ensure comparability, therefore.

On Fugl Meyer Assessment for upper extremity, there was statistically significant difference between groups ($p < 0.05$) on follow up. On Stroke Impact Scale 3.0 (physical domain), results demonstrated that there was statistically significant difference between two groups ($p < 0.05$) on post-treatment and follow up and on Stroke Impact Scale VAS, the results demonstrated that there was statistically significant difference between two groups ($p < 0.05$) on post-treatment. The inter-group comparison revealed significant differences in all parameters of FMA-UE and SIS 3.0 as shown in table 1, graph 1 and 2.

Figure 3: Consort Diagram

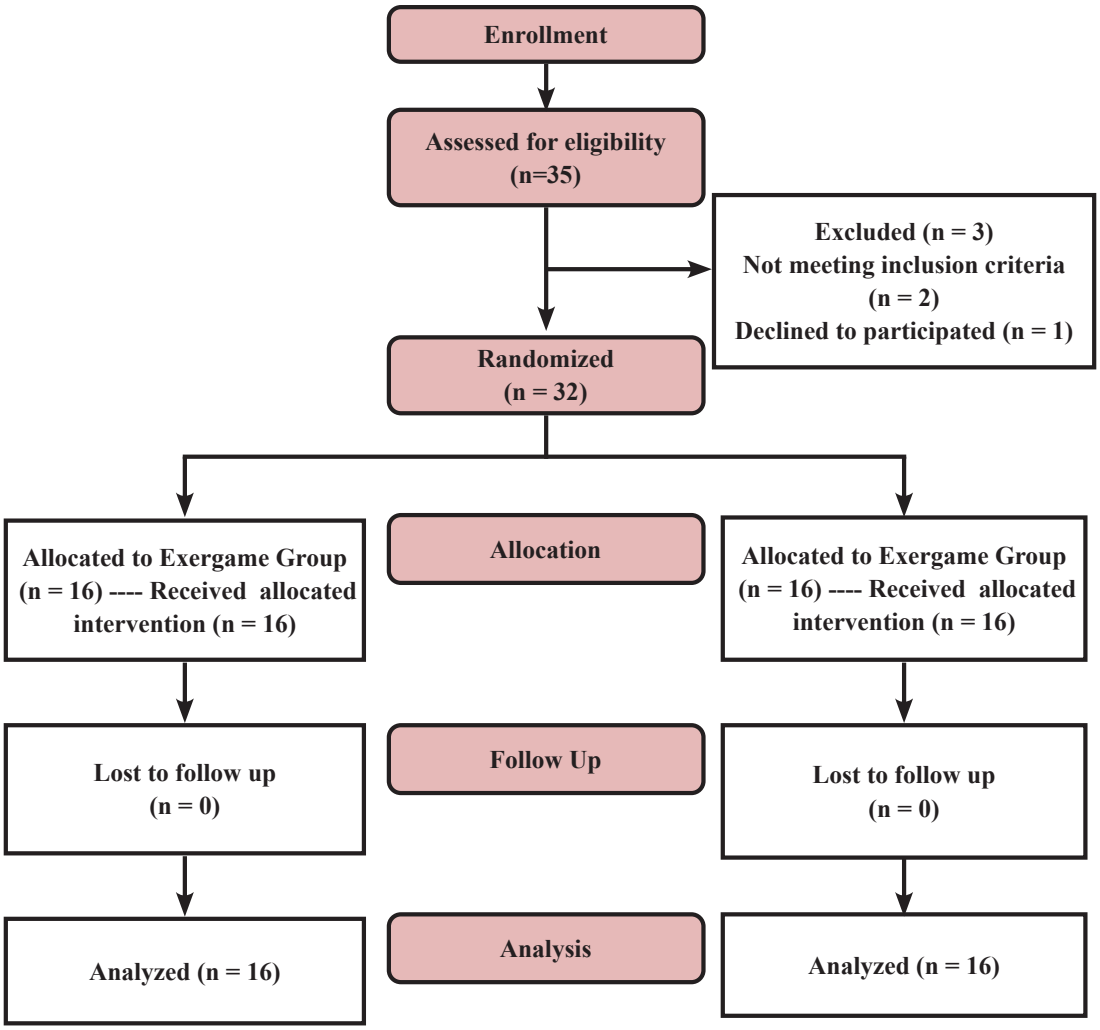
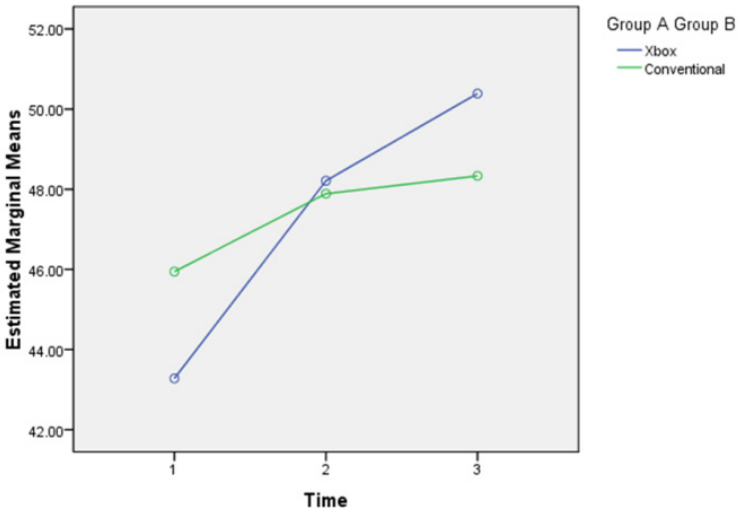


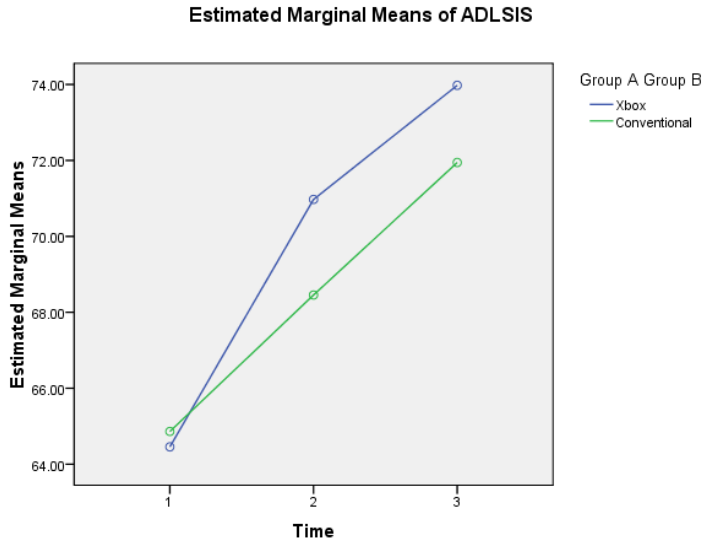
Table 1: Inter-group analysis on FMA-UE and SIS 3.0

Variable	Groups	Pretreatment (Mean ± SD)	Post treatment (Mean ± SD)	Follow up (Mean ± SD)	P value
FMA - UE	Group A	43.2±5.09	48.2±3.29	50.3±3.55	0.021
	Group B	45.94 ± 3.31	47.88 ± 2.67	48.33 ± 2.16	
SIS (ADLs/IADLs)	Group A	64.45 ± 1.16	70.97 ± 2.55	73.97 ± 2.40	0.012
	Group B	64.86 ± 1.72	68.45 ± 2.97	71.94 ± 2.47	
SIS (Physical domain)	Group A	57.98 ± 2.82	61.68 ± 1.91	64.00 ± 1.66	0.003
	Group B	57.15 ± 1.98	59.23 ± 1.65	61.92 ± 1.22	

FMA – UE: Fugl Meyer Assessment - Upper Extremity
SIS : Stroke Impact Scale
ADLs: Activity of Daily Livings
IADLs: Instrumental Activity Of Daily Livings
SD: Standard Deviation



Graph 1: Estimated Marginal mean of FMA-UE



Graph 2: Estimated Marginal mean of SIS – ADLs / IADLs.

Discussion:

The purpose of this study was to investigate how upper limb function and daily activities of subacute stroke survivors are affected by exercise gaming, such as Xbox Kinect. In all assessed variables, the assessment of this study outcome on both the exer gaming community and conventional group showed progress The FMA-UE score and the SIS score improved substantially from baseline in both groups. Some patients reported mild symptoms of stimulator disease after treatment; problems were relatively mild, did not require intervention and did not prevent the study protocol from being completed. A recent meta-analysis of stroke VR therapies reported a pattern indicating that higher dose could be more effective Finally, therapies in the chronic phase of stroke recovery often yield only small motor function gains, but testing earlier after stroke therapy can produce bigger benefits.(24)

It seems to be feasible and useful to use single Virtual Reality (VR) games in post stroke patients to perform exercise, but only minimal support for evidence is available on this.(12) In sub-acute stroke individual with an effective methodological design, few studies have been developed in order to improve specified intervention strategies with VR in addition to conventional care programs. Exer gaming offers the unique advantage of concealing the atmosphere of the hospital or clinic, reducing auditory and visual disturbances while highlighting desired stimuli (in this particular case the involved limb). A study showed that VR gaming has immediate impact on motor rehabilitation and offers incentives for stroke patients to comply care.(25) Other studies have reported improvement in performance for FMA post VR but for chronic stroke.(26) Our findings concluded that there was a statistically sufficient change in upper limb performance preferring exer gaming over conventional therapy. Since the exer game chosen in our research did not provide manual dexterity training explicitly, other games specifically designed for manual dexterity can be applied for this purpose to the exer gaming rehabilitation program. Likewise a study conducted found that 12 sessions of augmented upper extremity exercises over a 3 week span by Wii gaming or conventional treatment were not successful in improving upper extremity motor recovery relative to controls.(27) In contrast to this report, their Wii games are distinct from those games used in this study. Their Wii Game needs an autonomous hand-held controller. The participants, with the exception of the hand usually moved their upper extremity. The Xbox did not require an independent control device, however since all games on exer game could be under the control of physical actions performed by the person or patient playing the game.(15) We believe that these conflicting findings may have been caused by variations in the nature of the experiments, sample size of population and gaming system.

A new research has speculated that mobile-based games have a therapeutic efficacy comparable or greater than traditional treatment. Immediate feedback from their movement, satisfaction, high motivation and participation can be the probable reasons for this effectiveness. Games of participation will promote motor learning while growing interest in recovery and encouragement promotion. In addition, the need for interaction can be facilitated by providing auditory and visual feedback to the patients involving in games.

When analyzing the evolution of each object in our study, the most of the results were positive; nevertheless, in the hand portion, there was no statistically significant difference between the two groups. In a study that indicated that eight percent of stroke victors have acute upper extremity weakness and only a third of them regain complete function, difficulties in rehabilitating the hand of the hemi-paretic patients were also identified. In order to clarify and better understand the processes underlying why exer game training can be a potent therapy for patients there is also a need for more basic science research.

In terms of life's quality our findings show that the combination of conventional therapy with and exer game training strategy has a beneficial impact on everyday living activities. Few studies have shown that Virtual Reality games focusing exclusively on upper extremity exercises are helpful for functions of upper extremity in order to facilitate daily living activities.(12) In comparison to our research, a recent study hypothesized that in enhancing daily living tasks VR care was not superior to the control group.(9) No significant effects on functional mobility and everyday living activities between groups were identified in the study after invention given for six weeks.(9) A potential explanation for these findings is that, as we demonstrated in our research the dosage and the probability of achieving a high intensity of repeated and precise practice receiving multisensory input in the form of feedback are important for obtaining ADL modification in patient with sub-acute stroke. A study reported substantial improvements in everyday living tasks efficiency and motor control of the upper limb before and after the therapy.

Camera monitoring was used by the kinetic method

used in this study analysis, which has the benefits of avoiding compensatory movement. It was difficult for patients to know when another person or entity entered the camera range. Patients must keep their own balance in the sitting position while using kinetic methods. When adapting these games to the recovery of stroke victims, we face difficulties. In particular, when the therapist's presence disrupted the sensor picture signals, repeated calibrations were necessary. The participants have been cautioned to take a seat to sit down and relax in such interruptions, at the same time the therapist amend the game. The length of the intervention was compensated for this extra time.

Conclusion:

It was concluded that Exer gaming was more effective as compared to the conventional treatment improving level of function in upper limbs and activities of everyday living.

Disclaimer: This study is the part of thesis of MS-NMPT of Riphah International University, Lahore.

Conflict of interest: None to declare.

Source of funding: None to declare.

References:

1. Party ISW. National clinical guideline for stroke: Citeseer; 2012.
2. Mokhtar MM, El Semary MM, Hamoda IM, El A, El Sherbini HI, Atteya M. Unilatereal versus Bilateral Virtual Reality XBOX 360 Training on Rehabilitation of Stroke Patients.
3. Ersoy C, Iyigun G. Boxing training in patients with stroke causes improvement of upper extremity, balance, and cognitive functions but should it be applied as virtual or real? Topics in stroke rehabilitation. 2020:1-15.
4. Song G-b, Park E-c. Comparison of the Effects of Task-oriented training and Virtual reality training on upper extremity function, balance ability, and depression in stroke patients. Journal of Korean Society of Physical Medicine. 2016;11(1):115-25.
5. Kim J-H. Effects of a virtual reality video game exercise program on upper extremity function and daily living activities in stroke patients. Journal of physical therapy science. 2018;30(12):1408-11.
6. Crosbie JH, Lennon S, McNeill MD, McDonough SM. Virtual reality in the rehabilitation of the upper limb after stroke: the user's perspective. CyberPsychology & Behavior. 2006;9(2):137-41.
7. Khealani BA, Wasay M. The burden of stroke in Pakistan. International Journal of Stroke. 2008;3(4):293-6.
8. Blanton S, Wolf SL. An Application of Upper-Extremity Constraint-Induced Movement Therapy in a Patient With Subacute Stroke. Phys Ther. 1999;79(9):847-53.
9. Henrique PPB, Colussi EL, De Marchi ACB. Effects of Exergame on Patients' Balance and Upper Limb Motor Function after Stroke: A Randomized Controlled Trial. Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association. 2019 Aug;28(8):2351-7. PubMed PMID: 31204204. Epub 2019/06/18. eng.
10. Trombetta M, Henrique PPB, Brum MR, Colussi EL, De Marchi ACB, Rieder R. Motion Rehab AVE 3D: A VR-based exergame for post-stroke rehabilitation. Comput Methods Programs Biomed. 2017;151:15-20.
11. Kaur A, Balaji GK, Sahana A, Karthikbabu S. Impact of virtual reality game therapy and task-specific neurodevelopmental treatment on motor recovery in survivors of stroke. International Journal of Therapy And Rehabilitation. 2020;27(8):1-11.
12. Singh DKA, Nordin NAM, Abd Aziz NA, Lim BK, Soh LC. Effects of substituting a portion of standard physiotherapy time with virtual reality games among community-dwelling stroke survivors. BMC neurology. 2013;13(1):1-7.
13. Lee G. Effects of training using video games on the muscle strength, muscle tone, and activities of daily living of chronic stroke patients. Journal of physical therapy science. 2013;25(5):595-7.
14. Shobhana NG, Rakholiya S. The Effect of X Box 360 Kinect-Virtual Reality Intervention on Balance and Gait Training In Stroke Patient": An Interventional Study. Indian Journal of Public Health Research & Development. 2020;11(7):532-7.
15. Calin A, Cantea A, Dascalu A, Mihaiu C, Suciu D. Mira–upper limb rehabilitation system using microsoft kinect. Informatica. 2011;4:63-74.
16. Malik AN. Exer-Gaming: A Novel Tool in Stroke Rehabilitation. Journal of Riphah College of Rehabilitaion Sciences. 2015;3(2):48-9.
17. Nguyen A-V, Ong Y-LA, Luo CX, Thuraisingam T, Rubino M, Levin MF, et al. Virtual reality exergaming as adjunctive therapy in a sub-acute stroke rehabilitation setting: facilitators and barriers. Disability and Rehabilitation: Assistive Technology. 2019 2019/05/19;14(4):317-24.

18. Shires L, Brown D, Sherkat N, Lewis J, Standen P, editors. Evaluating the Microsoft Kinect for use in upper extremity rehabilitation following stroke as a commercial off the shelf gaming system. Proc 10th Intl Conf Disability, Virtual Reality & Associated Technologies; 2014.
19. Xavier-Rocha Tb, Carneiro L, Martins Gc, Vilela-Júnior Gdb, Passos Rp, Pupe Ccb, et al. The Xbox/Kinect use in poststroke rehabilitation settings: a systematic review. Arq Neuropsiquiatr. 2020 (AHEAD).
20. Huang Q, Wu W, Chen X, Wu B, Wu L, Huang X, et al. Evaluating the effect and mechanism of upper limb motor function recovery induced by immersive virtual-reality-based rehabilitation for subacute stroke subjects: study protocol for a randomized controlled trial. Trials. 2019;20(1):1-9.
21. Cano-Mañas MJ, Collado-Vazquez S, Rodríguez Hernández J, Muñoz Villena AJ, Cano-de-la-Cuerda R. Effects of video-game based therapy on balance, postural control, functionality, and quality of life of patients with subacute stroke: a randomized controlled trial. Journal of healthcare engineering. 2020;2020.
22. Wang ZR, Wang P, Xing L, Mei LP, Zhao J, Zhang T. Leap Motion-based virtual reality training for improving motor functional recovery of upper limbs and neural reorganization in subacute stroke patients. Neural Regen Res. 2017 Nov;12(11):1823-31. PubMed PMID: 29239328. Pubmed Central PMCID: PMC5745836. Epub 2017/12/15. eng.
23. Jeon M-J, Moon J-H. Effects of virtual reality training on upper extremity function and activities of daily living in patients with sub-acute stroke. Journal of Digital Convergence. 2019;17(9).
24. Song G-b, Park E-c. Comparison of the Effects of Task-oriented training and Virtual reality training on upper extremity function, balance ability, and depression in stroke patients. Journal of the Korean Society of Physical Medicine. 2016;11(1):115-25.
25. Raffin E, Hummel FC. Restoring motor functions after stroke: multiple approaches and opportunities. The Neuroscientist. 2018;24(4):400-16.
26. Holden MK, Dyar T. Virtual Environment Training-A New Tool for Neurorehabilitation? Neurology Report. 2002;26(2):62-71.
27. Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. The Lancet Neurology. 2009;8(8):741-54.

Authors Contribution:

Mazher Y: Conception and design of the work, data acquisition, analysis, interpretation of data of the work and drafting.

Shafee I: Reviewing work critically for important intellectual content.

Dar HS: Final approval of the version, manuscript writing, and analysis of data.