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EDITORIAL

Advances in Neurorehabilitation; Application of Virtual Reality in Geriatric Rehabilitation

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Introduction

Virtual reality is the practice of interactive computer simulations presenting operators with the opportunity to be involved in atmospheres that seem to be analogous to real world situations.[1, 2] Virtual reality has recently become very popular in the field of rehabilitation and it is now used for physical therapy, cognitive rehabilitation and occupational therapy. As compared to conventional therapy, patients show greater compliance and engagement with virtual reality training because of its fun nature as it provides an immersive and illusionary environment to the patient, and the patient can interact with his or her virtual environment in the form of a game. With the use of virtual reality, telerehabilitation has also become easier and more feasible, and patients can receive similar training in the comfort of their home and in the absence of a physical therapist. Literature has shown that existing amount of physical therapy is inadequate to result in significant plasticity and reorganization of the brain, following stroke.[3] With the use of virtual reality training, additional amount of therapy can be offered to the patient in the absence of a physical therapist, in the form of home exercise program and telerehabilitation.[2] Another benefit, of telerehabilitation, is that objective measurements can be included in the computer system and real time objective measurements can be recorded and analyzed for patient's treatment progression and prognosis. [1]

Advancement in Virtual Reality Systems

With the advancement in technology, the virtual reality equipment and hardware are becoming more and more improved than before. In terms of visual feedback, visual display units (VDU) were used in systems like Wii fit by Nintendo and Kinect by Xbox etc, however, recently head mounted display (HMD) have been used in systems like Oculus, Vive and smartphones etc.[2] In terms of sensor technology, both bodies tracking systems as well walking platforms (e.g. Virtuix) are now being used in virtual reality systems.[3] Moreover, in terms of human computer interaction, advances in virtual reality technology provide more realistic atmosphere to the users, resulting in very realistic spatial-temporal stimuli to facilitate learning.[4] In fact, literature has also shown that visual stimuli in a virtual environment can possibly activate the mirror neuron system, and large scale cortical regions via several feedback mechanisms, following brain reorganization and neuroplasticity.[4, 5]

Neuro-Rehabilitation using virtual reality training

Literature has shown virtual reality training to be effective in the management of different neurological conditions, including stroke[6,7] Parkinson's disease[8], multiple sclerosis[9, 10] and traumatic brain injury and also in geriatric rehabilitation[11] In terms of outcomes, virtual reality training is found to be effective in terms of upper and lower extremity function, gait, balance, activity training and cognition.[2] Moreover, in addition to neurological conditions, virtual reality training is also becoming increasingly popular in geriatric rehabilitation. [11]

Effects of virtual reality training in geriatric rehabilitation

The most common equipment used for geriatric rehabilitation in literature has been shown to be Nintendo Wii, followed by computer games.[11] Literature shows that virtual reality training exerts a positive motivation in the elderly to exercise, and participants report high level of enjoyment.[11] Virtual reality training is found to be effective in the geriatric population in terms of improving physical functioning[12], mobility[13, 14], balance[12, 15-17], reaction time, muscular strength[18], fall risk[19, 20], cognition, and executive functioning.[21] However, it is imperative to point out that even though virtual reality training results in improvements in physical functioning, a review of the literature shows that there is not sufficient and compelling evidence that virtual reality training is significantly more effective than conventional exercise training.[11] Moreover, it is also imperative to point out that fall risk is a major problem in the aging population, and physical therapy interventions including virtual reality training have been focused on improving static and dynamic balance in the elderly. However, according to a recent study published in 2019, no significant correlation of Fall Risk Score (FRS) was observed with Berg Balance Scale (BBS), Timed Up and Go (TUG) and Forward reach Test (FRT), suggesting that balance is not the sole predictor of fall risk in the elderly, and attention should be paid to other factors including muscle performance, gait, and anthropometric parameters to reduce fall risk in the elderly.[22]

The medal table of the Rio Olympics 2016 shows the United States at the top[1] by securing 121 medals. The United States was represented by 558 athletes. The majority of the top nations on the Olympic table are well developed countries which have optimum facilities for the exercises and physical activities. These countries have legislation in place which aims to promote and facilitate sports and exercises. Despite of the fact that Pakistan is the 5th populous country in the word, it did not qualify for any medal in the last two decades and has poor image since 1947 in this arena. Unfortunately, Olympics games in Pakistan are considered as sporting events and sources of entertainment, while health benefits as a pretext of national fitness are poorly understood.

The majority of the events in Olympics games are based on the aerobic exercise abilities. The events include, but not limited to, various kinds of sports where endurance, speed, accuracy and general fitness are rewarded in the form of medals. The vast majority of the athletes train for several years before they could qualify for a place in the Olympic squad. Thousands of other disqualifies during the screening for each particular sports through various kinds of national competitions. And many hundreds of thousands of others opt for the amateur role and adapt to the sporting activity -as a pretext to keep themselves fit.

Pakistan squad in Olympic 2016 was composed of 7 athletes- 4 men and 3 women and had more officials than athletes.[1] The desperate situation of Pakistan participated in the Olympics, unfortunately, reflects the poor fitness status of national health.

According to a national survey 1990-1994[2] and the following reports, 33% of the population in Pakistan above the age of 45 and 19% above the age 15 are suffering from high blood pressure. And around 25% of people over the age of 45 suffer from Diabetes. The overall prevalence of diabetes in urban and rural areas is estimated at around 28.3% and 25.3%, respectively.[3] Currently, Pakistan is ranked 6th worldwide in relation to the prevalence of diabetes and the figures are estimated to rise to 13 million patients in 2020, making Pakistan the 4th largest diabetic population worldwide. Around 350,000 people suffer from stroke every year. Heart diseases related deaths are estimated around 200,000 (30-40%) per years. Obesity is estimated 9% and 14% in men and women respectively in rural area of Pakistan. Urban areas have the prevalence of obesity of 22% in men and 37% in women for the obvious reasons. These statistics have reached to an epidemic level and needs emergency measures.

The major risk factor of the high blood pressure, diabetes, cardiac diseases, and obesity are identified as sedentary lifestyle and physical inactivity.[4-6] The World Health Organization's estimates reveals 1.9 million deaths take place per year due to physical inactivity on a global level. In addition, 22% of heart related disease and 10-16% of breast cancers, colon cancer and diabetes are the results of the physical inactivity. WHO further estimates that inadequate physical activity in the developing countries range from 17 to 91% and 4-84% in the developing world.[7]

Conversely, regular exercises play an important role in the reduction of the risk of cardiovascular diseases, diabetes[8], osteoarthritis, respiratory illnesses and hospital stay after admissions.[9-11] Unfortunately, the population in Pakistan with respect to social status and lifestyle is diverse and accurate statistics with respect to exercise social class cannot be estimated.

"Exercise is the best medicine" and is one of the basic needs of health and wellbeing. The health professionals are therefore urged to prescribe more and more exercises and educate their patients regarding the benefits of exercises. The government authorities should optimize facilities for sports and exercises on each level and department. Non-government voluntary organization, electronic media and trusts needs to launch campaigns to promote physical activity in order to educate the general population in relation to the greater health benefits of the exercises.

References

1. Lam YS, Man DW, Tam SF, Weiss PL. Virtual reality training for stroke rehabilitation. NeuroRehabilitation. 2006;21(3):245-53.
2. Ku J, Kang YJ. Novel Virtual Reality Application in Field of Neurorehabilitation. Brain & Neurorehabilitation. 2018;11(1).
3. Lang CE, MacDonald JR, Reisman DS, Boyd L, Kimberley TJ, Schindler-Ivens SM, et al. Observation of amounts of movement practice provided during stroke rehabilitation. Archives of physical medicine and rehabilitation. 2009;90(10):1692-8.
4. Prochnow D, Bermúdez i Badia S, Schmidt J, Duff A, Brunheim S, Kleiser R, et al. A functional magnetic resonance imaging study of visuomotor processing in a virtual reality-based paradigm: Rehabilitation Gaming System. European Journal of Neuroscience. 2013;37(9):1441-7.
5. Oujamaa L, Relave I, Froger J, Mottet D, Pelissier J-Y. Rehabilitation of arm function after stroke. Literature review. Annals of physical and rehabilitation medicine. 2009;52(3):269-93.
6. Lee HS, Park YJ, Park SW. The Effects of Virtual Reality Training on Function in Chronic Stroke Patients: A Systematic Review and Meta-Analysis. BioMed Research International. 2019;2019.
7. Henderson A, Korner-Bitensky N, Levin M. Virtual reality in stroke rehabilitation: a systematic review of its effectiveness for upper limb motor recovery. Topics in stroke rehabilitation. 2007;14(2):52-61.
8. Liao Y-Y, Yang Y-R, Cheng S-J, Wu Y-R, Fuh J-L, Wang R-Y. Virtual reality–based training to improve obstacle-crossing performance and dynamic balance in patients with Parkinson's disease. Neurorehabilitation and neural repair. 2015;29(7):658-67.
9. Eftekharsadat B, Babaei-Ghazani A, Mohammadzadeh M, Talebi M, Eslamian F, Azari E. Effect of virtual reality-based balance training in multiple sclerosis. Neurological research. 2015;37(6):539-44.
10. Massetti T, Trevizan IL, Arab C, Favero FM, Ribeiro-Papa DC, de Mello Monteiro CB. Virtual reality in multiple sclerosis–a systematic review. Multiple sclerosis and related disorders. 2016;8:107-12.
11. Molina KI, Ricci NA, de Moraes SA, Perracini MR. Virtual reality using games for improving physical functioning in older adults: a systematic review. Journal of neuroengineering and rehabilitation. 2014;11(1):156.
12. Laufer Y, Dar G, Kodesh E. Does a Wii-based exercise program enhance balance control of independently functioning older adults? A systematic review. Clinical interventions in aging. 2014;9:1803.
13. Bisson E, Contant B, Sveistrup H, Lajoie Y. Functional balance and dual-task reaction times in older adults are improved by virtual reality and biofeedback training. Cyberpsychology & behavior. 2007;10(1):16-23.
14. Maillot P, Perrot A, Hartley A. Effects of interactive physical-activity video-game training on physical and cognitive function in older adults. Psychology and aging. 2012;27(3):589.
15. Rendon AA, Lohman EB, Thorpe D, Johnson EG, Medina E, Bradley B. The effect of virtual reality gaming on dynamic balance in older adults. Age and ageing. 2012;41(4):549-52.
16. Bieryla KA, Dold NM. Feasibility of Wii Fit training to improve clinical measures of balance in older adults. Clinical interventions in aging. 2013;8:775.
17. Pluchino A, Lee SY, Asfour S, Roos BA, Signorile JF. Pilot study comparing changes in postural control after training using a video game balance board program and 2 standard activity-based balance intervention programs. Archives of physical medicine and rehabilitation. 2012;93(7):1138-46.
18. Jorgensen MG, Laessoe U, Hendriksen C, Nielsen OBF, Aagaard P. Efficacy of Nintendo Wii training on mechanical leg muscle function and postural balance in community-dwelling older adults: a randomized controlled trial. Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences. 2012;68(7):845-52.
19. De Bruin E, Schoene D, Pichierri G, Smith ST. Use of virtual reality technique for the training of motor control in the elderly. Zeitschrift für Gerontologie und Geriatrie. 2010;43(4):229-34.
20. Schoene D, Lord SR, Delbaere K, Severino C, Davies TA, Smith ST. A randomized controlled pilot study of home-based step training in older people using videogame technology. PloS one. 2013;8(3):e57734.
21. Kayama H, Okamoto K, Nishiguchi S, Yamada M, Kuroda T, Aoyama T. Effect of a Kinect-based exercise game on improving executive cognitive performance in community-dwelling elderly: case control study. Journal of medical Internet research. 2014;16(2):e61.
22. Siddiqi FA, Masood T, Osama M, Azim ME, Babur MN. Common balance measures and fall risk scores among older adults in Pakistan: Normative values and correlation. JPMA. 2019.