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Exergaming: A new technology for all domains of elder people

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Abstract

Background and Objectives: Exergaming or exergames appears to be now promising training in this technological era. Exergaming have a various effects on different age group people. Here our focus is to discuss its effect in all domains of elderly. Aging leads to a various body system changes and decline in function of almost all system. Here we have discussed positive and critical aspect of using exergaming in elder people. Articles were searched in various databases such as google scholar, pub med, IEEE Xplore, science direct with Boolean operators and articulating different terms such as exergaming, exergame, active video games, older or elder people. Different RCTs, systematic reviews and other literature reviews are searched which mainly showed exergames effect on balance, fall, postural control, cognitive function, vestibular function in older population.

Major Findings: From different therapies exergaming is giving equally effective results in improving balance, postural control, fear of fall, cognitive function, vestibular function and social wellbeing. More studies showed need for investigating more precise intervention and its long term effect.

Conclusion: Exergames can be used as an adjunct to conventional physiotherapy as a new more acceptable tool even in older people. There is still need to develop more accurate exergames which fits to older aged people of different culture.

Keywords: Balance, cognitive function, elder people, exergaming, fall

1. Introduction

A current era in research suggest that playing video games is a way to increase physical activity and is not always sedentary. By definition exergaming is “an experimental activity in which playing exergames or any video games that require physical exertion or movement that are more than sedentary activities and also include strength, balance and flexibility activities.”

Different literature have used different terms for the word ‘exergame’ and that words are entertainment, dance simulation video game, exergaming, interactive video game, activity promoting video game, active video game, physical activity change game, kinaesthetic video game and physical gaming. Among all ‘exergaming’ is most popularly used in health related research [1].

2. Exergaming – A New Technology

The ‘exer’ from the exergaming word doesn’t have a precise meaning ‘exercise’ but it is used just as a being active [2]. Most of exergames are designed for younger children and young adults but current research also suggest its use for elder people [3]. As the aging occurs it leads to a different system changes and most common include decrement in fine motor skills and changes in posture and balance [4], decrease in learning new motor skills [4, 5], decrease in sensory process [6], cognitive impairment [4, 6], reduced attention span [4, 5], loss of self-confidence, anxiety and increase in depression [7, 8].

There are so many conventional therapies or exercise program to improve all these aging related domains but one commonest drawback from most of the literature is low adherence [9, 10, 11]. Exergaming can overcome this problem and also have an advantage that it motivate the people to practice and dual task performance can train both cognitive and motor skills. In exergaming focus of attention is on outcome of movement instead of on movement itself [11, 12, 13].

Exergaming are not only used as a fun exercise but also used in rehabilitation and training of physical function in elder people [14]. There are so many studies which shows exergaming effect on different domain of elder people life.

In exergaming different algorithms are needed for game control and feedback depending on the source of input. Exergaming devices are controlled using a broad variety of sensory system. The commonly used sensors in input devices are gyroscope, accelerometers, infrared and RGB optical cameras/sensors and pressure sensors [15-20].

Different sensors used in exergame & its function with example of device are

1. Inertial sensor (accelerometers and gyroscopes-positioning sensors)- Measure angular velocity and acceleration, exa. Nintendo wii [21].
2. Pressure sensors- Measure COP, [22] exa. Wii balance board(WBB), Pressure mats
3. Camera system- Play games without holding or wearing input devices [23-27] exa. Sony PlayStation eye toy

3. Exergaming: In View of Elder Person

Different studies showed beneficial and demanding aspects of exergaming.

Beneficial aspect in view of elder person

1. Instant feedback in the form of audio, visual or score forms [28, 29].
2. Provide competitiveness among players [28-30].
3. To get tips of achieving higher scores or better movements it will encourage social interaction [28, 30, 31].
4. Provide challenge in various forms [29].
5. They can play in groups [28].
6. Close to grandchild and can spend time with them [29].
7. Improve body awareness [32].
8. Provide feedback of different body positions [33].

Demanding aspect: in view of elder person

1. Complexity and speed should not be more [28, 29].
2. Personal information or data on screen won't be comfortable for all elders [28].
3. Native language absence is a major issue to follow game commands [28].
4. It require space for setting up and to do exercise [31].
5. Support needed by elders to set up of machine [29, 31].

Based on various literature exergaming show its effectiveness in different domains of elder people life such as fall prevention, postural control, balance, cognitive function, quality of life, motivation, vestibular function.

4. Exergaming and balance, postural control, fall prevention

Due to aging effect there are various system changes in elder people lead to a major problem of fall. Physical dysfunction, loss of independence and significant disability are result of fall injuries in elder people. Among different causes poor postural control is the major risk factor for fall and this factor can be trained in fall prevention program. From last few years to avoid commonest from of conventional therapy i.e low adherence exergame can be used as a balance and postural control training.

A new acceptable, effective and potentially cost effective

way to improve pain, balance and fear of falling is exergaming. Also can be used as an intervention to reduce falls. From various studies it has showed that no gold standard outcome measure is present for quantification of postural control and its discussion is always under continuous dispute. In literature they reported broad variety of outcome measure for exergame effect [34]. From 2 different method one is during game play and second is outside the game environment which is also referred as internal (instrumental tool-cop range of movement measurement) [10] and external (administer after game play-BBS, TUG etc.) [35, 36, 37].

A few RCT and systematic review showed favourable improvement in static balance but that is not statistically significant. More dynamic component improvement in balance seen in elder patients. This improvement is in both functional performance test and balance confidence assessment aspect [38]. Task that require a weight shifting on a movable platform and postural control while maintaining dynamic activity have a positive effect on balance [39].

So, exergaming training are helpful to achieve less fear of falling for elder persons and more confidence in balance control while performing daily activities [38]. An additional good unquantifiable outcome of exergaming is motivation. The exergaming group in most studies is more motivated [11], more appealing to do exercise with fun [10] and showed better improvement [15, 20, 22, 24]. Specially Wii-fit balance training shown significant effectiveness in balance training compare to conventional exercise for reducing falls in elder people [40].

5. Exergaming and cognitive function

Structural and functional deterioration and associated cognitive decline is a part human aging [41]. Among different cognitive function fluid type (i.e. executive function, processing speed, attention and visuospatial skills) are more prone to decline with age compare to crystalline type (i.e. language and vocabulary, general knowledge and arithmetical skills) [42-45]. From that measured of executive function were described as mental flexibility, inhibition, planning, reasoning and working memory [46, 47]. In recent training exergaming is supposed to attenuate aging related brain deterioration and may improve cognitive function in elder people [41].

Players have to mentally simulate scene and virtual object in the game so they can engage cognitively and mentally [48]. Two main mechanism identified that have an effect on cognitive functions by exergaming. One is physical exercise like running, moving and jumping can enlarge player's attentional pool by increasing motor control skills and physiological arousal. Second is mental exercise in which memorizing movement and rule of game involves cognition and higher order cognition of players [49, 50]. Also exergaming can increase effects of physical exercise by guiding neuroplastic changes via cognitive exercise [51-53]. So a game feature with mental simulation can be a unique tool for preventing cognitive decline in elder people [48]. A research shows positive effect of exergaming on multiple cognitive domain like executive functions, processing speed, short and long term memory, verbal fluency and visuospatial skills [41, 54, 55]. So exergaming is slightly more or equally effective compare to other physical interventions on cognitive function in elder person [41].

6. Exergaming and other domains of elder people

A vestibular function decline is observable with aging in elder population. This lead to vestibular disorder and can cause decreased dynamic visual acuity, reduced postural stability during locomotion and oscillopsia during head movements. So in exergaming the movements with active stepping and with moving game projection is feasible and also facilitate gaze stability during head movements in elder people [56].

Elder people can be affected by several negative events like a decline in mobility, a reduction in active participation in social activities, lack of closed family ties and loss of a loved one. This all can lead to inadequate social support and impaired social interaction [57, 58]. To avoid this social intervention should be develop to reduce emotional damage and to improve quality of life. From that exergaming is showing promising result that increase social connection, reduce loneliness, more social wellbeing and positive attitude towards others [59].

Future Recommendation

Different studied recommended to evaluate cost effectiveness of exergames implementation. Also to test its effectiveness in different other settings like care homes, longer term rehabilitation at home under monitoring of clinician and within early hospital discharge scheme. Future study also in need to investigate optimum intensity, progression and long term adherence to exergaming [60].

References

- Oh Y, Yang S. Defining exergames & exergaming. Proceedings of Meaningful Play. 2010Oct;21:1-7.
- Bogost I. Persuasive games: The expressive power of videogames. mit Press, 2010Aug13.
- Gerling KM, Schild J, Masuch M. Exergame design for elderly users: the case study of SilverBalance. In Proceedings of the 7th International Conference on Advances in Computer Entertainment Technology, 2010Nov, pp. 66-69).
- Birren JE, Schaie KW. Handbook of the Psychology of Aging. San Diego, CA, USA: Academic Press, 2001.
- Czaja SJ, Lee CC. Information Technology and Older Adults. In The Human Computer Interaction Handbook, A. Sears and J. A. Jacko, Eds. New York, New York, USA: Lawrence Erlbaum Associates, 2008.
- Gamberini L, Alcaniz M, Barresi G, *et al.* Cognition, technology and games for the elderly: An introduction to ELDERGAMES Project. Psychology Journal. 2006;4(3):285-308.
- Nawaz A, Skjæret N, Ystmark K, *et al.* Assessing seniors' user experience (UX) of exergames for balance training. In: Proceedings of the 8th Nordic conference on human-computer interaction: fun, fast, foundational, Helsinki, New York: ACM. 2014October, pp. 578-587.
- Skjæret N, Nawaz A, Ystmark K, *et al.* Designing for movement quality in exergames: lessons learned from observing senior citizens playing stepping games. Gerontology. 2015;61(2):186-194.
- Sherrington C, Whitney JC, Lord SR, *et al.* Close JCT: Effective exercise for the prevention of falls: a systematic review and meta-analysis. J Am Geriatr Soc. 2008;56:2234-2243.
- Betker A, Szturm T, Moussavi Z: Development of an interactive motivating tool for rehabilitation movements. Conf Proc IEEE Eng Med Biol Soc. 2005;3:2341-2344.
- Fitzgerald D, Trakarnratanakul N, Smyth B *et al.* Effects of a wobble board-based therapeutic exergaming system for balance training on dynamic postural stability and intrinsic motivation levels. J Orthop Sports Phys Ther. 2010;40:11-19.
- Lamoth CJC, Caljouw SR, Postema K. Active video gaming to improve balance in the elderly. Stud Health Technol Inform. 2011;167:159-164.
- Lamoth CJC, Alingh R, Caljouw S. Exergaming for elderly: Effects of different types of Game feedback on performance of a balance task. Stud Health Technol Inform 2012. In press.
- Smith ST, Schoene D. The use of exercise-based videogames for training and rehabilitation of physical function in older adults: current practice and guidelines for future research. Aging Health. 2012;8(3):243-252.
- Gil-Gómez JA, Lloréns R, Alcañiz M, *et al.* Effectiveness of a Wii balance board-based system (eBaViR) for balance rehabilitation: a pilot randomized clinical trial in patients with acquired brain injury. J Neuroeng Rehabil. 2011;8:30.
- Studenski S, Perera S, Hile E, Keller V, *et al.* Interactive video dance games for healthy older adults. J Nutr Health Aging. 2010;14:850-852.
- Smith ST, Sherrington C, Studenski S, *et al.* A novel Dance Dance Revolution (DDR) system for in-home training of stepping ability: basic parameters of system use by older adults. Br J Sport Med. 2011;45:441-445.
- Yavuzer G, Senel A, Atay MB, *et al.* Playstation eyetoy games" improve upper Extremity related motor functioning in subacute stroke: a randomized controlled clinical trial. Eur J Phys Rehabil Med. 2008;44:237-244.
- Kosse N, Caljouw S, Vuijk P, *et al.* Exergaming: interactive balance training in healthy community-dwelling elderly. Journal of Cyber Therapy & Rehabilitation. 2011;4:399-407.
- Saposnik G, Teasell R, Mamdani M, *et al.* Effectiveness of Virtual Reality Using Wii Gaming Technology in Stroke Rehabilitation. A Pilot Randomized Clinical Trial and Proof of Principle. Stroke. 2010;41:1477-1484.
- Analog Devices Inc: Small, Low Power, 3-axis ± 3 g iMEMS \otimes Accelerometer. Norwood: Analog Devices Inc; 2007.
- Williams MA, Soiza RL, Jenkinson AM *et al.* EXercising with Computers in Later Life (EXCELL) - pilot and feasibility study of the acceptability of the Nintendo \otimes WiiFit in community-dwelling fallers. BMC research notes. 2010;3:238.
- Bisson E, Contant B, Sveistrup H, *et al.* Functional balance and dual-task reaction times In older adults are improved by virtual reality and biofeedback training. Cyberpsychol Behav. 2007;10:16-23.
- Lange B, Flynn S, Chang C *et al.* Development of an interactive stepping game to reduce falls in older adults. In 8th Intl Conf. Disability, Virtual Reality and Associated Technologies. International Society for Virtual Rehabilitation. 2010, 223-228.
- Flynn S, Palma P, Bender A: Feasibility of using the Sony PlayStation 2 gaming platform for an individual

- poststroke: a case report. *J Neurol Phys Ther.* 2007;31:180–189.
26. Lange B, Flynn S, Rizzo A: Initial usability assessment of off-the-shelf video game Console for clinical game-based motor rehabilitation. *Phys Ther Rev.* 2009;14:355–363.
 27. Rand D, Kizony R, Weiss PTL: The Sony PlayStation II EyeToy: low-cost virtual reality for use in rehabilitation. *J Neurol Phys Ther.* 2008;32:155–163.
 28. Aarhus R, Grönvall E, Larsen SB *et al.* Turning training into play: embodied gaming, seniors, physical training and motivation. *Gerontechnology.* 2011;10(2):110–120.
 29. Chiang IT. Old dogs can learn new tricks: exploring effective strategies to facilitate Somatosensory video games for institutionalized older veterans. In: Chang M, Hwang W-Y, Chen M-P, *et al.* (eds) *Edutainment technologies. Educational games and virtual reality/augmented reality applications.* Berlin: Springer, p. 190.
 30. Graves LE, Ridgers ND, Williams K, *et al.* The physiological cost and enjoyment of Wii Fit in adolescents, young adults, and older adults. *J Phys Act Health.* 2010;7(3):393–401.
 31. Nawaz A, Skjøret N, Ystmark K, *et al.* Assessing seniors' user experience (UX) of Exergames for balance training. In: *Proceedings of the 8th Nordic conference on human-computer interaction: fun, fast, foundational, Helsinki, 26–30 October 2014*, pp. 578–587. New York: ACM.
 32. Graf H, Tamanini C, Geissler L, Muntermacher—“think and move” interface and interaction design of a motion-based serious game for the generation plus. In: Stephanidis C (ed.) *Universal access in human-computer interaction. Users diversity.* Berlin: Springer, 2011, pp. 149–158.
 33. Silva PA, Nunes F, Vasconcelos A, *et al.* Using the smartphone accelerometer to monitor fall risk while playing a game: the design and usability evaluation of dance! Don't fall. In: Schmorow DD (ed.) *Foundations of augmented cognition.* Berlin: Springer, 2013, pp. 754–763.
 34. Van Diest M, Lamoth CJ, Stegenga J, *et al.* Exergaming for balance training of elderly: state of the art and future developments. *Journal of neuroengineering and rehabilitation.* 2013Dec;10(1):101.
 35. Berg KO, Wood-Dauphinee SL, Williams JI *et al.* Measuring balance in the elderly: 13 validation of an instrument. *Can J Public Health.* 1992;83:S7–S11.
 36. Podsiadlo D, Richardson S. The timed “Up & Go”: a test of basic functional mobility for Frail elderly persons. *J Am Geriatr Soc.* 1991;39:142–148.
 37. Steffen TM, Hacker TA, Mollinger L: Age- and gender-related test performance in community-dwelling elderly people: Six-Minute Walk Test, Berg Balance Scale, Timed Up & Go Test, and gait speeds. *Physical therapy.* 2002;82:128–137.
 38. Fang Q, Ghanouni P, Anderson SE, *et al.* Effects of exergaming on balance of healthy Older adults: a systematic review and meta-analysis of randomized controlled trials. *Games for health journal.* 2020 Feb1;9(1):11-23.
 39. Kosse NM, Caljouw SR, Vuijk PJ *et al.* Exergaming: Interactive balance training in Healthy community-dwelling older adults. *Journal of Cyber Therapy and Rehabilitation.* 2011 Aug;4(3):399-407.
 40. Fu AS, Gao KL, Tung AK, *et al.* Effectiveness of exergaming training in reducing risk and incidence of falls in frail older adults with a history of falls. *Archives of physical medicine and rehabilitation.* 2015 Dec 1;96(12):2096-102.
 41. Stojan R, Voelcker-Rehage C. A systematic review on the cognitive benefits and neurophysiological correlates of exergaming in healthy older adults. *Journal of clinical medicine.* 2019 May;8(5):734.
 42. Park DC, Reuter-Lorenz PA. The adaptive brain: Aging and neurocognitive scaffolding. *Annu. Rev. Psychol.* 2009;60:173–196.
 43. Murman DL. The impact of age on cognition. *Semin. Hear.* 2015;36:111–121.
 44. Harada CN, Natelson Love MC, Triebel K. Normal cognitive aging. *Clin. Geriatr. Med.* 2013;29:737–752.
 45. Salthouse TA. When does age-related cognitive decline begin? *Neurobiol. Aging.* 2009;30:507–514.
 46. Diamond A. Executive functions. *Annu. Rev. Psychol.* 2013;64:135–168.
 47. Miyake A, Friedman NP, Emerson MJ, *et al.* The unity and diversity of executive Functions and their contributions to complex “frontal lobe” tasks: A latent variable analysis. *Cogn. Psychol.* 2000;41:49–100.
 48. Huang KT. Exergaming executive functions: An immersive virtual reality-based cognitive training for adults aged 50 and older. *Cyberpsychology, Behavior, and Social Networking.* 2020 Mar 1;23(3):143.
 49. Anderson-Hanley C, Maloney M, Barcelos N, *et al.* Neuropsychological benefits of Neuro exergaming for older adults: a pilot study of an Interactive Physical and Cognitive Exercises System (iPACES). *Journal of Aging and Physical Activity.* 2017;25:73–83.
 50. Barcelos N, Shah N, Cohen K, *et al.* Aerobic and cognitive exercise (ACE) pilot study For older adults: executive function improves with cognitive challenge while exergaming. *Journal of the International Neuropsychological Society.* 2015;21:768–779.
 51. Bamidis PD, Vivas AB, Styliadis C, *et al.* A review of physical and cognitive interventions in Aging. *Neurosci. Biobehav. Rev.* 2014;44:206–220.
 52. Monteiro-Junior RS, Vagheti CA, Nascimento OJ, *et al.* Exergames: Neuroplastic hypothesis about cognitive improvement and biological effects on physical function of institutionalized older persons. *Neural Regen Res.* 2016;11:201–204.
 53. Fissler P, Kuster O, Schlee W, *et al.* Novelty interventions to enhance broad cognitive abilities and prevent dementia: Synergistic approaches for the facilitation of positive plastic change. *Prog. Brain Res.* 2013;207:403–434.
 54. Ogawa EF, You TJ, Leveille SG. Potential benefits of exergaming for cognition and dual-task function in older adults: a systematic review. *Journal of Aging and Physical Activity* 2016;24:332- 336.
 55. Stanmore E, Stubbs B, Vancampfort D, *et al.* The effect of active video games on Cognitive functioning in clinical and non-clinical populations: a meta-analysis of randomized controlled trials. *Neuroscience and Biobehavioral Review.* 2017;78:34–43.
 56. Swanenburg J, Wild K, Straumann D *et al.* Exergaming in a moving virtual world to train vestibular functions

- and gait; a proof-of-concept-study with older adults. *Frontiers in physiology*. 2018 Jul 31;9:988.
57. Bøen H, Dalgard OS, Bjertness E. The importance of social support in the associations between psychological distress and somatic health problems and socio-economic factors among older adults living at home: a cross sectional study. *BMC Geriatr*. 2012 Jun08;12:27.
58. Alexandrino-Silva C, Alves TF, Tófoli LF, *et al*. Psychiatry: life events and social support in late life depression. *Clinics*. 2011;66(2):233–238.
59. Li J, Erdt M, Chen L, *et al*. The social effects of exergames on older adults. Systematic review and metric analysis. *Journal of medical Internet research*. 2018;20(6):e10486.
60. Stanmore EK, Mavroeydi A, de Jong LD, *et al*. The effectiveness and cost-effectiveness of strength and balance Exergames to reduce falls risk for people aged 55 years and older in UK assisted living facilities: a multi-centre, cluster randomised controlled trial. *BMC medicine*. 2019 Dec1;17(1):49.