

Effect of exergaming for balance and gait training in geriatric population: An experimental study

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Abstract

Objective: To study the effect of Exergaming on geriatric population for balance and gait training. **Methods and Material:** This is an experimental study, in which 20 volunteers geriatric participants was participated and received a computer game, known as Arkanoid, for 12 sessions (15 minutes) for 2weeks. Assessment of balance and gait was measured by the Berg balance scale, Activities of Balance confidence scale, Dynamic Gait index and timed up go test was assessed in pre and post session. **Results:** Improvement was observed in Berg Balance Scale (BBS) (P= 0.01), Activities of specific Balance Confident scale ABC (P= 0.01), Time "Up and Go" Test (TUG) (P= 0.01), and Dynamic Gait Index (DGI) (P= 0.01). At the 12 session in the 2 weeks and were statically significant. **Conclusion:** The study proved that Exergaming system is feasible, safe and potentially efficacious in enhancing balance and gait training and best rehabilitation tool for geriatric population.


Keywords: Balance, Gait, Exergaming, Geriatric.

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Received Date: 04/09/2016 Revised Date: 21/10/2016 Accepted Date: 10/11/2016

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	DOI: 14 November 2016

INTRODUCTION

In the geriatric community, More than one third of the community-dwelling individuals aged 60 and older falls at least once per year^{1,2}. Approximately 5-20% of the falls have serious consequences including major head trauma, major lacerations, or fracture and may lead to immobility or death.^{1,3} The severity of the consequences of falls increases with ageing and the number of injuries and injurious falls strongly predict placement in a nursing home.^{4,5} Falls are the most common reason for medical intervention amongst the elderly,⁶ and prevention is important. Physical exercise is both important in prevention and in rehabilitation. Also the mental health is of importance. Rosenberg *et al* have found that

exergames also can be used as intervention for subsyndromal depression,⁷ A condition often seen in elderly. The balance, postural control and gait due to impaired cognitive function, decline in sensory, visual, vestibular, somatosensory input, motor responses and musculoskeletal systems that are resulting in a decrease in muscle strength of lower limb, reduced sensation, impaired knee or plantar reflexes, slow reaction time, and decreased efficacy of protective movement contribute to postural instability and results into fall.² There are many interventions has been done to improve balance and gait in the geriatric population. There are muscles strengthening exercises, mirror feedback exercise, co-ordination, balance exercises and gait training.^{3,4} Balance training using visual feedback has been used in treating the geriatric for improving balance.^{5,6} An Exergaming (exercise + gaming) device has a several advantages compared to conventional exercises; Exergaming can motivate people to practice and by performing dual tasks users can train both cognitive and motor skills. Exergames (exercise + gaming) appear promising for home-based balance and strength training for apparently healthy elders.⁷ This also provides objective assessment and retraining of the sensory and voluntary motor control of balance with visual biofeedback. Van Diest *et al*.

Therapeutic Exergaming systems or virtual rehabilitation systems are recently technology using with combination of computers, special interfaces of games, and simulation exercises used to train patients in an engaging and motivating way.⁸ In contrast, exergaming can engage and motivate this group by making the physically demanding exercises more enjoyable and challenging.^{9,10} Exergaming system is the Electronic oscillating table with adjustable radius for proprioceptive prevention, rehabilitation and training. This light device has a large non-slip surface and provides three different oscillating radiuses, along with programmable feedback and testing modes and video games to motivate the patient. It's useful both to improve to recover and control more effectively daily gestures as it requires patients to apply specific forces and co-ordinate movements. Its control the movements that we perform daily, an adequate strength, co-ordination and consciousness of the movement are indispensable.¹¹ As our knowledge, there is a paucity of studies on exergaming system on the geriatric population with the balance and gait training. The aim of this studies the effect of exergaming and evaluates the efficacy of the Computer gaming system as a rehabilitation tool for balance and gait training for geriatric population. We hypothesize that Computer gaming is feasible, safe and potentially efficacious in enhancing balance and gait training in the Geriatric population.

METHOD AND MATERIALS

In this experimental study the geriatric subject living in community dwellings was called by posting flyers. The purpose of the study explained to the volunteer. 20 volunteers (17 male and 3 female) were participated in this study, which was reviewed and approved by the ethics committee. Before experimentation and after being informed of the entire protocol, each patient signed a written consent form. Inclusion Criteria - Individuals above 60 years, Berg Balance Scale score more than 21 and above, lower limb, Back and Abdomen strength 3 and above on MRC Grading Scale, Balance problem, walking with minimal support, able to understand simple commands, walk and perform their ADL's. Exclusion Criteria - Berg Balance Scale score less than 20, Lower limb, Back and Abdomen strength less than 3 on MRC Grading, lower limb fracture or surgery, the use of a walking aid or foot orthosis, auditory, ocular and vestibular problems, head trauma with or without loss of consciousness and stroke. The subject was measured by using berg balance scale¹², Activities of Balance

confidence scale, Dynamic Gait index, teamed up go test and Star excursion scale was done in pre and post experiments treatment. Sessions for the Exergaming system for 15 minutes and were timed by using a stop watch. Participants were encouraged to complete the 12 sessions with 6 sessions in each week for 2 weeks in over a 4-week period.

Instrumentation Hardware¹⁸

The hardware components of the Libra computer gaming system consist of a CPU of HP PRO 3330 MT PC. Configuration: Processor: Intel (R) Core (TM) i3-2120 CPU @3.30GHz RAM : 4.00 GB, Operating System: Window 7 Professional, 15 INCH HP LV1911 LCD screen. The communication between Libra high tech wobble board device and the computer is established via the USB wire. The exercises run on a PC and the system uses the Esay tech software as interface. The Exergaming system consists of

- Wide anti-slip area: 42x42 cm
- Three various balancing radiuses: 5-12-20 cm
- Programmable visual feedback
- Stereophonic acoustic feedback
- Video games



Figure 1: Participation performing Exergaming Exercise Software¹⁸

The exercises have been programmed using an authoring system for interactive 2D Esay Tech application. The games have been designed to optimize the visual and audio feedback and to simplify other stimuli to allow patients with cognitive impairments to follow the exercises and to focus on the motor task. The workflow for the game is first, game begins with an initial setup screen¹. This initial screen allows the the rapistto parameterize the game. Screen 2nd is the interface between participants and the Exergaming system, here participants will guide the ball to hit the object and scored the game. Screen 3rd is score list of the participants.



Figure 2



Figure 3

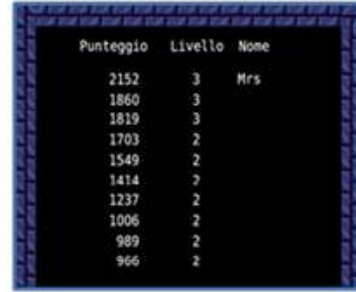


Figure 4

Legend

Figure 2: Screen 1st of the Exergaming system; **Figure 3:** The game section were participants will guide the ball to the hit the object; **Figure 4:** score list of the participants

The Exergaming system allows the patient to play in standing position to improve balance control. In standing position the patients are required to maintain their soles on the high tech wobble board (Libra). During this session, the system gives the participants' auditory feedback with a positive reinforcement when the participants accomplish his/her goal throughout the sessions and a negative reinforcement when the participants perform an incorrect action. The participant's score is continuously displayed on the up right side and points are accumulated to calculate the final score. At the end of the rehabilitation session, the system shows the participants score made during the game (screen3). Game results and sounds serve as motivational elements. (Figure 1)

Intervention

The study was carried out in Research lab of KLE's Institute of Physiotherapy, Belgaum. Each patient participated in for 15 minutes, 12 sessions of 12 days in 2 weeks rehabilitation. All the patients were assessed before and after the rehabilitation. The clinical assessment was assessed by the Berg Balance Scale (BBS), ABC, Time "Up and Go" Test (TUG), Dynamic Gait Index (DGI) and Star excursion scale.

Outcome Measure

The Berg Balance Scale assesses for static and dynamic balance. It is a 14 item scale with a total score of 56, Individual scores: 41-56 has low fall risk, 21-40 medium fall risk and 0 -20 high fall risk.¹³ Activities-specific balance confidence scale, measures the functional balance, will also predict over confidence or under confidence about falling. Scoring is done on the Ordinal scale has 16 items (score 0-1600 possible).¹⁴ Timed Up and Go test is a tool identify basic mobility skills of frail elderly persons. Scores of ≥ 13.5 seconds predict falls in community-dwelling frail elders, Scores of ≥ 30 seconds correspond with functional dependence in people with pathology.¹⁵ The Dynamic Gait Index (DGI) was used for predicting likelihood of falls and walking ability in older

people. Scoring ranging from 0-3, "0" indicates the lowest level of function and "3" the highest level of function with a total score of 24.¹⁶ The participant played the Arkanoid games. A brief explanation of the purpose of the games was given to the participants, that is game tasks involves guiding a ball on a board and hitting the object. Users must move the High Tech proprioceptive wobble board (LIBRA) in various directions and velocity required to keep the ball on the board according to game's demands. Session: - 1 - 4 days Libra board is given in the Lateral - medial directions. 5 - 8 days Libra board is given in the Anterior - posterior directions for bilateral limbs. 9 - 12 days Libra board is given in the Anterior - posterior for unilateral limbs.

RESULT

Subject Characteristics

Subject characteristics are presented in Table 1. In this experimental study 3 female and 17 male was participated with the means and SD age of 70.1 ± 7.52 and BMI was 30.1 ± 6.95 .

Table 1: Baseline Characteristics of the Participants (N=20)

	Mean \pm SD or no
Age	74.7 \pm 8.91
Gender	3 female/17 male
Body Mass Index (kg/m ²)	30.1 \pm 6.95

Change in balance parameter was noted in the post training session shown in Table 2. The improvement of the balance was observed in Berg Balance Scale pre to post session comparison which shown the 9.8 ± 3.80 difference with statically significant. The improvement in the balance confidence was observed in the Active - specific balance confidence scale (ABC scale) pre to post session comparison which shows the statically significant with a difference of 2.7 ± 9.02 . The improvement of the mobility was observed in the Timed up Go test comparison with pre to post session which shows the statically significant with differences of 3.8 ± 1.95 . The

improvement of the Gait was observed in the Dynamic Gait index pre to post session which shows the statically significant with differences of 5.1 ± 1.65 .

Table 2: Effect of outcome measure of Exergaming on Balance and Gait

Measure	Pre Test	Post Test	Difference	Paired T Test	P
Berg Balance Scale	42.2±5.94	52.1±3.20	9.8±3.80	11.533	<0.001*
Active-specific balance confidence Scale	54.8±11.39	82.6±7.55	27.8±9.02	7.851	<0.001*
Time up and Go Test	12.2±2.91	8.4±1.50	3.8±1.95	8.715	<0.001*
Dynamic Gait Index	17.5±2.06	22.6±1.23	5.1±1.65	13.822	<0.001*

DISCUSSION

The present experimental study shows the effect of exergaming for balance and gait training for geriatric population. In this study 20 individuals participate in a 2 weeks balance and gait training using an exergaming system. Participants enjoyed playing the exergames and found the games were motivating. Moreover, there was preliminary indication that the exergames improved balance and gait as measured by the outcome measure on BBS, TUG, DGI, SET, and ABC. A study suggested that virtual rehabilitation showed significant improvement in the balance compared to traditional treatment.⁴ During this game, balance task was performed that required continuous corrective balance reactions to maintain balance when standing on the unstable wobble board and additional attention to pick up the ball. Noteworthy was that the geriatric otherwise found difficulty in performing these tasks. Outcome of ABC and TUG test showed improvement in exergaming. While performing different balance task, there was improvement due to perceived performance, degree of control and experienced physical and mental effort. This finding provides further support for the notion that exergaming provides a motivational factor for exercising.¹⁹ DGI score also improved in exergaming on geriatric population. The probable explanation for this improvement could be due to variety of movements performed on the wobble board, activated the mechanoreceptors of the joint, that provided information on the motor strategies and muscle activation pattern associated with it.²⁰ The sequence of muscle activation is usually distal to proximal, which in turn helped to improve the gait pattern and gait speed.²¹ However, in the present study, long term flow was not

taken. The study should compare with the other physical therapy exercises.

CONCLUSION

The study proved that Exergaming system is feasible, safe and potentially efficacious in enhancing balance and gait training and best rehabilitation tool for balance and gait training for geriatric population.

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Source of Support: None Declared
Conflict of Interest: None Declared