

Using Nintendo Wii Fit U to Enhance Balance Control of Community-dwelling Seniors

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Abstract—Balance control is a key component of seniors' mobility and functional independence. A randomized controlled trial including 40 older adults employed a 6-week exergaming balance training program using the Nintendo Wii Fit U platform in order to verify its effectiveness in improving senior's balance control. The findings will guide future researchers and health professionals who wish to use exergames in balance rehabilitation programs.

Keywords — Active video game, active aging, virtual rehabilitation, postural balance

I. INTRODUCTION

The global senior-citizen population is the fastest growing age group. According to the World Health Organization [1], by 2050 the world's population aged 60 years and older is expected to nearly double from 12% to 22%, summing up to 2 billion.

Research on physical activity suggests that most older adults are sedentary [1]. A sedentary lifestyle leads to an increased load of chronic diseases and severely challenges seniors' balance control [1].

Balance disorders in older age may be caused by one or more factors related to decreasing functional levels in vision, proprioception, and vestibular systems [2]. Such disorders affect seniors' autonomy and their activities of daily living. Moreover, balance impairments increase the risk of falling and consequent injuries [2]. Falls in older age can also result in fear of falling which stimulates further avoidance of physical activity. Thus, falls in the elderly must be prevented by addressing risk factors and providing a well-designed exercise program [2].

The literature shows that seniors who regularly engage in physical activity programs present fewer chances of falling and sustaining fractures as compared to individuals who are physically inactive [2]. Therefore, physical exercise is encouraged as a main component of older adults' daily routine in order to maintain general health, including their balance control. The American College of Sports Medicine has established guidelines for the senior population, which recommends at least 150 minutes of moderate to vigorous intensity aerobic activity per week [3].

Therapeutic exercises such as aerobics, strength training, flexibility, and balance training are the most effective interventions for seniors with balance disorders [4]. These exercises can encourage overall mobility and target muscle strength, endurance and, in some cases, vestibular rehabilitation. However, traditional methods of exercise therapy pose challenges, especially in terms of motivation, engagement, and adherence to exercise programs.

In the last decades, researchers have investigated the effects of virtual-reality-based exercises on physical rehabilitation. The active video games (AVGs) or exergames are video games that demand physical interaction from the player immersed in a virtual environment. The activities target the movement of a specific body segment or the whole body in order to control the game. AVGs allow seniors to improve their physical performance and their attitudes towards preventing and recovering from balance disorders and risk of falls [5].

AVG-based exercises have raised interest for its use in balance training by healthcare professionals due to its relatively low cost, independence, and ease of use. These systems can represent an alternative to expensive and monotonous treatments [5]. However, there is no comparative evidence of the effects of a therapeutic exercise program matching the exact components offered by an AVG-based exercise program for older adults. Therefore, this study aimed to compare the effects of an AVG-based versus a therapeutic exercise program on seniors' balance control.

II. STUDY PROCEDURES

This study was part of a larger randomized controlled trial looking at physical literacy promotion to older adults. The participants fulfilling the inclusion criteria were randomly allocated to one of the three study groups: Exergames Balance Training (EBT); Conventional Balance Training (CBT); and Control - No Training (NT).

A licensed physiotherapist led the EBT and CBT groups. The 50-minute sessions were conducted three times a week for six weeks. The participants in the NT group did not engage in any training and were told not to change their lifestyle during the trial.

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The video game console used for the EBT was the Nintendo Wii U. The major components of the EBT were six sub-games from the Wii Fit U (walk in place, lunge, tilt and tilt city, sun salutation and chair position). Participants in the CBT group went through a conventional balance training program including exercises that addressed the same physical ability components as the EBT group: aerobics, strength, flexibility, balance, and motor coordination exercises.

The difficulty level of each component was increased every two weeks for both groups in order to promote a progressive effect on functional performance. However, the actual amount of progression adjusted on each exercise or sub-games depended on each individual's physical tolerance.

III. OUTCOME MEASURES

A. Centre of Pressure excursion on Wii® Balance Board

Centre of Pressure (COP) excursion or postural sway was measured on the Wii® Balance Board. The Posturography software application developed by Neurorehabilitation & Brain Research Group, Spain, and validated in geriatric individuals was used as a tool to measure the functional standing balance [6]. The COP's maximum excursion was assessed in both anterior-posterior and medio-lateral directions with eyes open and in standing posture. Participants were asked to place their hands on the hips, focus on a point on the wall right across, and to stand still during each of three 20-second repeated measurements. The test was performed at pre and post-intervention.

B. Direct Observation

In the direct observations, the observer could interact and ask questions to the participants. This approach was chosen to understand how the participants were interacting with each other. The observations were conducted over six weeks of exercise program. During the observations, field notes were taken on what the participants did and said. The notes were transcribed to the computer for further content analysis.

IV. DATA ANALYSIS

Statistical and content analysis of the data were coded using IBM® Statistical Package for the Social Sciences (SPSS) version 25.00 and NVivo 12 (QSR International Pty Ltd, Doncaster, Australia), respectively. Descriptive statistics including estimated marginal means and standard errors are reported for participants' demographics. For multivariable analysis, the generalized estimating equation was employed to determine the effects of interventions.

V. RESULTS

A total of 40 older adults took part in the study. The characteristics of study participants are provided in Table 1 below.

TABLE 1. PARTICIPANTS' DEMOGRAPHICS (MEAN ± SD)

N = 40		Age	Height (m)	Weight (kg)	BMI
Male	Female				
13	27	72,4 ± 6,5	1,66 ± 4,3	81,6 ± 14,9	30,6 ± 4,9

Abbreviation: BMI = Body Mass Index (kg/m^2)

Significant declines in COP sway were observed in EBT group from Pre to Post stage in AP direction ($p = 0.02$), and in CBT group from Pre to Post stage in ML direction ($p = 0.03$) (Table 2).

TABLE 2. CENTRE OF PRESSURE SWAY IN AP AND ML DIRECTIONS (MEAN ± SD)

Group	PRE		POST	
	AP	ML	AP	ML
EBT	1.99 ± 0.3	1.31 ± 0.3	1.32 ± 0.2	0.73 ± 0.1
CBT	1.78 ± 0.2	1.26 ± 0.2	1.46 ± 0.2	0.86 ± 0.1
NT	1.90 ± 1.4	1.24 ± 0.1	1.49 ± 0.2	0.97 ± 0.1

Abbreviation: AP = Anterior-Posterior (cm); ML = Medio-Lateral (cm)

During the observations, it was noticed that the participants in the EBT group presented greater interaction with one another, compared to CBT. Through observation, we noted that participants in the EBT group helped each other to become familiar with the game controllers as well as the specificity of each game. Moreover, participants in the EBT group engaged in motivational strategies to encourage each other's improvement, to help reach their optimum game performance.

VI. CONCLUSION

Technology is advancing such that VR-based exercise programs are now clinically feasible interventions available to healthcare providers working with older adults with balance impairment. AVG-based and therapeutic exercises applied as described in the procedures were capable of improving balance control in our senior's sample. Furthermore, during the observations, the participants in the EBT group expressed and showed signs of accepting the virtual activities and felt the competitive side of the games. These findings have important implications for using AVGs as an additional tool in promoting physical activity, treating balance disorders, and preventing falls in the elderly.

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