The effect of virtual reality gaming on dynamic balance in older adults

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Abstract

Background: physical therapy interventions that increase functional strength and balance have been shown to reduce falls in older adults.

Aim: this study compared a virtual reality group (VRG) and a control group (CG).

Design: randomised controlled 6-week intervention with pre- and post-test evaluations.

Setting: outpatient geriatric orthopaedic and balance physical therapy clinic.

Population: forty participants were randomised into two groups.

Method: the VRG received three different Nintendo® Wii FIT balance interventions three times per week for 6 weeks and the CG received no intervention.

Results: compared with the CG, post-intervention measurements showed significant improvements for the VRG in the 8-foot Up & Go test [median decrease of 1.0 versus −0.2 s, \( P = 0.038 \)] and the Activities-specific Balance Confidence Scale (6.9 versus 1.3%) \( P = 0.038 \).

Conclusion: virtual reality gaming provides clinicians with a useful tool for improving dynamic balance and balance confidence in older adults.

Keywords: balance, virtual reality gaming, older adult, randomised, elderly

Introduction

In the USA, falls are the leading cause of injury death in adults 65 years of age and older accounting for approximately 10,000 deaths annually [1, 2]. Every year approximately 33–50% of people 65 years and older experience a fall [3–6]. Functional mobility and balance confidence are critical components of the multi-faceted treatment approach for an ageing population with increased fall risk.

Virtual reality gaming is an emerging technology that is being used for that purpose. A variety of health care practitioners are using virtual reality technology to enhance patient treatments as well as provide multiple innovative interventions requiring attention and active patient participation [7, 8]. In 2005, Shigeru Miyamoto designed the Nintendo® Wii with its innovative remote and Wii Balance Board (WBB) control [9]. The WBB is portable, widely available, and inexpensive balance assessment tool suitable
for clinical setting [10, 11]. The WBB has shown positive response in improving balance and reducing risk of falls in patients with balance deficits [11–13]. The purpose of this investigation was to determine the feasibility and outcome using the WBB for improvement of dynamic balance in older adults classified as fall risk individuals.

Methods

Community-dwelling adults between 60 and 95 years of age, able to participate in physical activity for 45–60 min and verbally reported having normal vision were included in the study. Participants with known orthopaedic, neurological or circulatory disorders that would prevent them from participating in the study were excluded. A pre-test/post-test control group design was used to assess the 8-foot Up and Go (8ft UG), Activities-specific Balance Confidence scale (ABC) and Geriatric Depression Scale (GDS) [14–16], before and after 6 weeks of balance training.

Participants

Forty participants were recruited at the Air Force Village West retirement community located in Riverside, CA. Participants read and signed an informed consent regarding their voluntary participation in the investigation. Participants then completed the GDS and ABC followed by a physical therapist conducting an 8ft UG and an assessment of body control using the WBB. The participants were randomly divided into two groups. The control group (CG) received pre-post measurements only. The virtual reality group (VRG) was assigned to use virtual reality gaming using the WBB with the Nintendo® Wii Fit software package. The VRG was under supervision of a physical therapist and was pre-post tested by two additional physical therapists that were blinded to the randomised groupings.

Procedures: intervention

An 8-min cardiovascular warm up on a stationary bicycle and an 8-min cool-down was performed in the VRG intervention. Participants unable to sit on an upright stationary bicycle had the option of using a recumbent stepper for warm-up and cool-down.

In the VRG group, each participant used three different balance games from the Wii Fit software package. Participants were instructed to follow the onscreen visual displays while maintaining their limit of stability during dynamic stance activities. All participants wore a gait belt to aide the physical therapist in the event of a loss of balance. Additionally, each participant had the use of, as needed, a quad cane, a front-wheeled walker or hand held assistance during all the games for added safety. A chair was available for rest periods if participants required a break. During the VRG balance training a physical therapist was present to assist the participant in the operation of the game or in stepping on or off of the WBB. The three Wii FIT exercise games were lunges, single leg extensions and twists.

Participants alternated the exercise game sequence week-to-week during the 18-session intervention (3×/week×6 weeks). Each session lasted approximately 35–45 min.

The pre- and post-test for the CG and the VRG were administered in the same manner. During the interim the CG was instructed not to alter their normal daily activities, whereas the VRG commenced exercise game intervention with the WBB. Twenty participants were randomly assigned to the intervention group of which 16 met the 15-minimum treatment requirement. Four participants did not complete the study due to loss of interest, and/or

![Figure 1. Outcome measure changes over 6-week study period. *Mann–Whitney U P < 0.038.](image-url)
arthritic discomfort; also, 2 of the 20 control participants did not show up to the post-test data collection.

**Data analysis**

Non-parametric statistics were used for all inferential analyses. The Mann–Whitney test was used to determine significant differences (*P* < 0.05) between groups at baseline and change in outcome measures over time. The data were analysed using PASW Statistics 17.0 for Windows (SPSS, Inc., Chicago, IL, USA).

To investigate possible effects of dropouts, comparisons of baseline values for age and all three-outcome measures were made between subjects who did and did not complete the study. An intention-to-treat analysis was also conducted with each outcome variable; where the last known value for each outcome variable was entered as the final value for each subject that did not complete the study.

**Results**

The mean ages (SD) of the VRG and CG were 85.7 (4.3) and 83.3 (6.2) years, respectively. The majority of participants were female (65%) and 6 out of 40 participants (15%) used an assistive device with regularity (a single point cane or a four-wheeled walker).

The VRG median change score for the 8ft UG revealed a 1.0 s decrease when compared with a 0.2 s increase for CG (*P* = 0.038) (Table 1 and Figure 1). The VRG also showed a 6.9% median increase for the ABC when compared with a 1.3% increase for CG (*P* = 0.038). These changes reflect a significant increase in confidence with activity and functional movement for the VRG relative to controls, which showed no appreciable changes in the outcome scores. Both groups scored in the ‘normal’ classification of depression scoring by the GDS (0–9 = normal). The median improvement for the VRG was 1.0 and for the CG was 0.0 (*P* = 0.112). A post hoc analysis revealed an effect size of 0.35 and the power to detect this effect was 50%.

Comparisons of baseline values for age and all outcome measures between those who did and did not complete the study showed no significant differences between the two groups (*P* > 0.05). Intention-to-treat analysis did not materially change the results for any outcome (Table 2).

**Discussion**

Participants in the VRG showed positive changes towards clinical assessment outcome measures versus the CG that showed minimal to no change.

Similarly, as reported in a study by Williams et al. [17], this investigation demonstrated the willingness and compliance of older adults in balance training using the Wii Fit. During the 6-week intervention, a minimum requirement of 15 training session was set in order to allow for schedule changes and unexpected emergencies and 80% of the participants completed this. Individuals who regularly exercise make gains in strength, functional capacity and confidence [18]. One of the main objectives of this study was to determine the feasibility of increasing dynamic balance and static stability in older adults when using VRG as an exercise intervention. Since significant improvement in dynamic balance and confidence was made on healthy community-dwelling older adults, we speculate similar benefits could be realised in fall risk groups of older adults. Further research is needed in this area.

There were several limitations in this investigation.

No participant was able to complete the entire series of exercises without the use of the assistive device at least one time. This fact is cause for concern for potential injury in regard to independent practice devoid of supervision.

Also, the sample pool from which the participants were selected from is a limiting factor in terms of generalising the outcome measures. All participants were veterans or spouses of veterans from the US military, which created a specific mindset of accountability of appointment keeping, and exercise rigour, which is possibly higher than the average population. Another potential limitation is that this intervention was not compared with any other form of traditional physical therapy balance training programmes. Additionally, we did not have the control group perform

**Table 2. Comparison between groups of outcome measures over 6-week study period (intention to treat analysis)**

<table>
<thead>
<tr>
<th>Measures</th>
<th>VRG (n = 20)</th>
<th>CG (n = 20)</th>
<th><em>p</em>-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eight-foot up and go median change</td>
<td>10.6 (5.6–23.4)</td>
<td>8.6 (5.1–17.3)</td>
<td>0.045</td>
</tr>
<tr>
<td>ABC median % change</td>
<td>71.7 (47.5–96.9)</td>
<td>78.8 (55.0–96.9)</td>
<td>0.04</td>
</tr>
<tr>
<td>GDS median change</td>
<td>6.0 (0.0–16.0)</td>
<td>4.5 (0.0–14.0)</td>
<td>0.09</td>
</tr>
</tbody>
</table>

*Statistical Significance *p* < 0.05.
the warm-up and cool-down exercises and therefore cannot say with certainty that the intervention group benefits were not due to the warm-up/cool-down routine.

Finally, it would be of interest to conduct a weekly VRG group class to determine the benefit of a less robust exercise programme. Perhaps there would be fewer arthritic complaints and increased attendance.

**Conclusion**

The results of this study suggest that the Wii Fit virtual reality gaming system improves balance and postural stability. Improved confidence with functional activities was also reported. Although no significant change was revealed from the depression scale in either group, both groups median scores were in the normal range of 0–9. With appropriate supervision, a gaming device such as that used in this investigation can improve the dynamic balance and postural stability of older adults and reduce fall risk.

**Key points**

- Increased functional movement.
- Increased activity confidence.
- Randomised clinical trial.

**Conflicts of interest**

None declared.

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**References**


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