Physical Medicine and Rehabilitation Research

Research Article ISSN: 2398-3353

The effects of Wii bowling on balance in older adults

Teresa Ingenito*, Melanie Hoffer, Jaclyn Paler and Veronica Southard PT

Department of Physical Therapy, New York Institute of Technology, USA

Abstract

Background: Balance training alone or in combination with other exercise interventions, have been shown to improve gait and balance in the elderly reducing the risk of falls. The therapeutic aspects of Nintendo Wii® are a viable alternative to traditional interventions. The Nintendo Wii® uses a simulated environment in which to deliver fun yet effective and balance training.

Objective: The purpose of this study was to investigate the effects of playing the Wii Bowling game on balance in older adults.

Design: The study consisted of 14 subjects over the age of 65. There were 8 females and 6 males who completed the study; 6 experimental subjects dropped out. The subjects were assigned group membership by convenience. The experimental group participated in Nintendo Wii® bowling in the seated position for 30 minutes twice a week for 8 weeks. The control group followed their usual routine. Pre and post outcome measures included the Berg Balance Test and the Timed Up and Go (TUG) Test. We used a pretest-posttest control group design with a sample of volunteers from an adult home, who were instructed on playing the Nintendo Wii®. An independent t-test was used to assess for differences between the groups at the outset. Dependent t-tests were employed to assess for differences pre and post Nintendo Wii® bowling intervention for each group.

Results: A significant difference of .006 was found in the Berg scores of the experimental group only pre and post intervention. No significant differences were found in the pre and post TUG scores of either group.

Conclusion: Participating in Nintendo Wii® bowling, seated, twice a week for 30 minutes for 8 weeks may be seen as an option to improve balance in older individuals; however further studies need to be performed given the small sample size and sample of convenience.

Introduction

In the United States, greater than one third of adults 65 years and older fall each year [1]. Gait abnormalities, poor strength, and poor balance have been found to be major risk factors for falling in the elderly [1-3]. Balance is required for maintaining static posture, dynamic mobility, stabilizing dynamic movements, and performing daily activities [4]. It has several components including visual, vestibular, and somatosensory systems. With age, all three systems begin to decline resulting in balance deficits and an increased risk for falls [5]. Consequences of falls are serious and are associated with high rates of mortality and morbidity [1].

Balance training alone or in combination with other exercise interventions, such as strengthening, have been shown to improve gait and balance in the elderly reducing the risk of falls [1-3,6,7]. Although conventional physical therapy has been proven to improve balance, more recent studies are beginning to investigate interactive virtual reality gaming systems, such as the Nintendo Wii®, and its physiologic effects, such as balance, on different populations. The advantages of virtual reality gaming systems being integrated into rehabilitation include promotion of motor learning, carry-over to real world tasks, instant visual feedback, enjoyment of therapy, and low cost [8]. In fact, the American Physical therapy Association has published clinical practice guidelines in which virtual reality activities are recommended for vestibular conditions that cause symptoms of dizziness [9].

Several studies using the Nintendo Wii® have shown improvements in balance, strength, and the cardiovascular system in different populations, however, others have been inconclusive [8-15]. Esculier *et al.* studied the effects of a home-based balance training program on patients with PD using Nintendo Wii® and Nintendo Wii® Fit games with a balance board. This study showed significant improvements on balance outcome measures such as the TUG, unipedal stance, 10-meter walk test, and the POMA. Based on these results, Esculier *et al.* concluded that the Nintendo Wii® Fit could lead to better static and dynamic balance in PD-affected persons [16].

The Nintendo Wii® focuses on four main areas including gait, balance, coordination, and functional exercise [3]. Duclos *et al.* mentioned how external perturbations play a major role in maintaining one's balance. Brumels *et al.* also described how the Nintendo Wii® Fit challenges all of the systems that compose balance (visual, vestibular, and somatosensory) unlike other digital games. This facilitates improved ability to focus and use all three systems to maintain their balance on the balance board [18].

The literature generally supports the feasibility of the Nintendo Wii® as an intervention with older populations. However, previous study limitations include small sample sizes, a diverse range of outcomes, and varied protocols of different durations and frequencies. In addition, there are few studies on any one particular population since the Nintendo Wii® and other active gaming systems are relatively new [8]. This leaves a significant gap in knowledge that we hope to fill with

Correspondence to: Teresa Ingenito MS, PT, DPT, Assistant Professor-Department of Physical Therapy, School of Health Professions, New York Institute of Technology, Old Westbury, NY 11568, Tel: 516 686 7696; E-mail: tingenit@nyit.edu

Received: May 12, 2016; **Accepted:** June 11, 2016; **Published:** June 15, 2016

our study using a standard protocol on a homogeneous population.

Methods

Subjects

The study was approved by the Institutional Review Board of New York Institute of Technology. Participants were informed of the purpose and possible associated risk factors involved in the study and signed a written consent form for participation.

One week prior to the initiation of the study, baseline measures were collected using the Berg balance test and the TUG. Upon completion of the last bowling session, the Berg balance test and the TUG were performed to determine the effects of the intervention. The study consisted of 14 subjects over the age of 65 all of which were residents at an adult home. Age: 65 and Older, Ambulatory with or without assistive devices, Good Overall Health. Exclusion criteria; No known serious medical conditions or taking medications that interfere with balance or patient's safety, Congestive Heart Failure or significant muscular or neurologic deficiency, Severe Chronic Obstructive Pulmonary disease. Participants did not have any experience with virtual gaming activities. Eight females and 6 males completed the study, as 6 subjects dropped out. The loss of experimental subjects was mostly due to unavailability during scheduled sessions due to MD appointments, adult home outings, deciding they didn't like the activity and one subject was admitted to the hospital. The subjects were placed in either the control group (n=10) or the experimental group (n=4) based on convenience. The experimental group participated in Nintendo Wii® bowling in a seated position, in the lounge for 30 minutes, twice a week for 8 weeks. The control group did not receive any intervention.

Procedures

The subjects were given verbal instructions prior to the start of the study on proper use of the Nintendo Wii® and gaming techniques. A practice session was allowed to assure the subject understood the buttons. Additional instructions on the handling of controllers were reviewed before and during each session as needed. Participants were seated three feet away from the centered television in a row. Four subjects participated in each bowling session at a time for 30 minutes. Seat selection was random.

Results were analyzed using independent and dependent t-tests with the alpha level set at $p<.05$. The independent t-test was used to compare the differences between the experimental and control groups prior to the start of the study to ensure no difference between them with respect to age, pre-Berg scores, and pre-TUG scores. The dependent t-test was used to compare the pre-Berg and pre-TUG scores with the post-Berg and post-TUG scores of both control and experimental groups when the intervention was complete.

Outcome measures

A systematic review of the literature pertaining to functional balance assessments in community based adults, reported the best tests to perform are the Berg Balance test and the TUG test [19]. Both tests had successfully demonstrated properties of reliability and validity pertaining to community dwelling older adults [19].

The Berg Balance Scale appears to be the best single predictor of fall status [20]. One long term study examined balance over time and revealed that declining BBS scores were associated with increasing impairment leading to increasing fall risk. A 1-point change in the BBS score can lead to different predicted probabilities of falling [20]. Since the test detects small changes, the BBS appears highly precise in measuring balance.

Schumway-Cook's study suggests that patients who score high on the BBS have a relatively low fall risk and should probably not be referred for further intervention. On the other hand, patients who score 40 or less have a high probability for falls and are therefore appropriate for referral into a program designed to improve balance, mobility function, and reduce fall risk [21].

Since the TUG test, assessing dynamic performance, yielded a high specificity rating (93%) and the BBS, assessing static performance, yielded a high sensitivity rating (91%), both were used in our study for optimum test results [22].

Results

The independent t-test was used to compare the experimental and control group prior to the start of the intervention to determine if there was a difference that may affect the interpretation of results following the intervention. The experimental group and control group were compared in terms of age and balance ability, as determined by pre-Berg and pre-TUG scores.

Our demographics included an experimental group mean age was 85.6 ± 8.8 and 74.4 ± 12.1 for the control group.

The dependent t-test was used to compare differences between pre and post Berg scores of the experimental group; pre and post Berg scores of the control group; pre and post TUG scores the experimental group; and pre and post TUG scores of the control group (Figures 1 and 2).

Significant differences were only found in the Berg balance test scores of the experimental group pre and post intervention ($p=.006$), which increased from a mean score of 28.6 to 36.3. This mean difference of 7.7 is not only statistically significant, but is also of clinical importance as it surpasses the minimal detectable change (MDC) of 6.3, indicating a true improvement in balance following the Nintendo Wii® bowling intervention. Donoghue and Stokes determined the MDC for different ranges of Berg balance test scores for the elderly. Based on their findings, 6.3 is the MDC if the initial score is between 25 and 34 [23].

TUG times in the experimental group decreased from a mean of 49.39 seconds pre intervention to a mean of 34.11 seconds post intervention. Although a decrease in time indicates an improvement, the mean difference of 15.28 seconds was not found to be statistically significant ($p=0.272$). This may be due to the fact our protocol required the participants to performed Nintendo Wii® bowling in a seated position. Therefore, it would be expected for Berg balance scores to significantly improve versus the TUG scores. The Berg balance test has several static balance components, while the TUG is a measure of functional mobility with a more dynamic component.

Conclusion

The results from our study are consistent with previous studies using exer-games as an option to improve balance. Participating in Nintendo Wii® bowling for 30 minutes twice a week in a seated position for 8 weeks may be seen as an option to improve balance in older individuals. However, limitations to this study include a small sample size, lack of randomization, length of the Nintendo Wii® bowling program, and long-term follow-up data collection. In addition, the use of Nintendo Wii® bowling may not be appropriate for those with certain

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE-BERG EXPERIMENTAL	28.60	10	11.25	3.56
	POST-BERG EXPERIMENTAL	36.30	10	7.04	2.23
Pair 2	PRE-BERG CONTROL	27.75	4	13.57	6.79
	POST-BERG CONTROL	28.50	4	15.07	7.53
Pair 3	PRE-TUG EXPERIMENTAL	49.39	10	41.92	13.26
	POST-TUG EXPERIMENTAL	34.11	10	27.03	8.55
Pair 4	PRE-TUG CONTROL	75.17	4	64.71	32.35
	POST-TUG CONTROL	63.67	4	36.64	18.32

Figure 1. Mean, standard deviation, and standard error of the mean for Berg and TUG scores, before and after intervention, for control and experimental groups.

	VARIABLE	t	df	Sig. (2-tailed)
Pair 1	EXPERIMENTAL: PRE-BERG POST-BERG	-3.54	3	.006
Pair 2	CONTROL: PRE-BERG– POST-BERG	0.50	9	.650
Pair 3	EXPERIMENTAL PRE-TUG – POST-TUG	1.17	3	.272
Pair 4	CONTROL: PRE-TUG – POST-TUG	0.75	9	.506

Figure 2. Dependent t-test between Berg and TUG scores before and after participation in Nintendo Wii® bowling.

upper extremity conditions and impaired fine motor skills secondary to the nature of the remote controllers. Due to these limitations, these results may not be generalized to other older adult populations.

Future studies that assess the use and clinical application of the Nintendo Wii® using larger sample sizes, different populations, and randomized control trials need to be performed in order to determine the optimal duration and frequency of programs. In addition, these studies should explore protocols requiring Nintendo Wii® bowling to be performed in a standing position. Our goal is for future implementation of Nintendo Wii® bowling leagues in other facilities as a fun, interactive, and an alternative method to traditional balance training in older adults.

Acknowledgements

The authors would like to thank the Nintendo Wii® bowling participants, and the employees at the adult home, for their extraordinary cooperation and involvement, which contributed to the success of this study.

References

1. Agmon M, Perry CK, Phelan E, Demiris G, Nguyen HQ (2011) A Pilot Study of Wii Fit Exergames to Improve Balance in Older Adults. *J Geriatr Phys Ther* 34: 161-67. [Crossref]

2. Hermes D, Hitch S, Honea A, Stephenson J, Bauer J, et al. (2010) Benefits of the Wii Fit as an Exercise Program for Older Adults. Accessed at http://soar.wichita.edu/dspace/bitstream/handle/10057/3201/GRASP_2010_119-120.pdf

3. Padala KP, Padala PR, Malloy TR, Geske JA, Dubbert PM, et al. (2012) Wii-Fit for Improving Gait and Balance in an Assisted Living Facility: A Pilot Study. *J Aging Res*: 597573. [Crossref]

4. Lin MR, Hwang HF, Hu MH, Wu HD, Wang YW, et al. (2004) Psychometric Comparisons of the Timed Up and Go, One-Leg Stand, Functional Reach, and Tinetti Balance Measures in Community-Dwelling Older People. *J Am Geriatr Soc* 52: 1343-1348. [Crossref]

5. Abrahamova D, Hlavacka F (2008) Age-Related Changes of Human Balance during Quiet Stance. *Physiol Res* 57: 957-964. [Crossref]

6. Gill TM, Baker DI, Gottschalk M, Peduzzi PN, Allore H, et al. (2002) A Program to Prevent Functional Decline in Physically Frail, Elderly Persons Who Live at Home. *N Engl J Med* 347: 1068-1074. [Crossref]

7. Campbell AJ, Robertson MC, Gardner MM, Norton RN (1997) Randomised controlled trial of a general practice programme of home based exercise to prevent falls in elderly women. *BMJ* 7115: 1065-9. [Crossref]

8. Cyarto, EV, Kuys SS, Henwood TR (2011) Blackberry, I. Can Wii work it out? *Telecommun J of Aust* 61: 37.1-12.

9. Hall CD1, Herdman SJ, Whitney SL, Cass SP, Clendaniel RA, et al. (2016) Vestibular rehabilitation for peripheral vestibular hypofunction: An evidence-based clinical practice guideline. *J Neurol Phys Ther* 40: 124-55. [Crossref]

10. Sohnsmeyer J, Gilbrich H, Weisser B (2010) Effect of a six-week-intervention with an activity-promoting video game on isometric muscle strength in elderly subjects. *International Journal of Computer Science in Sport* 9: 75-79.

11. Weybright EH, Dattilo J, Rusch FR (2010) Effects of an interactive video game (Nintendo Wii) on older women with mild cognitive impairment. *Therapeutic Recreation Journal* 44: 271-287.

12. Rosenberg D, Depp CA, Vahia IV, Reichstadt J, Palmer BW, et al. (2010) Exergames for subsyndromal depression in older adults: A pilot study of a novel intervention. *Am J Geriatr Psychiatry* 18: 221-226. [Crossref]

13. Higgins HC, Horton JK, Hodgkinson BC, Muggleton SB (2010) Lessons learned: Staff perceptions of the Nintendo Wii as a health promotion tool within an aged-care and disability service. *Health Promot J Austr* 21: 189-195. [Crossref]

14. Lange BS, Flynn SM, Chang CY, Ahmed A, Geng Y, et al. (2010) Development of an interactive rehabilitation game using the Nintendo® WiiFit™ Balance Board for people with neurological injury. *Inst for Creat Tech* 249-254.

15. Gil-Gómez JA, Lloréns R, Alcañiz M, Colomer C (2011) Effectiveness of a Wii balance board-based system for balance rehabilitation: a pilot randomized clinical trial in patients with acquired brain injury. *J Neuroeng Rehabil* 8: 30. [Crossref]

16. Esculier JF, Vaudrin J, Bériault P, Gagnon K, Tremblay LE (2012) Home-based balance training programme using wii-fit with balance board for Parkinson's disease: a pilot study. *J Rehabil Med* 44: 144-150. [Crossref]

17. Brumels KA, Blasius T, Cortright T, Oumedian D, Solberg B (2008) Comparison of Efficacy Between Traditional and Video Game Based Balance Programs. *Clinical Kinesiology* 62.

18. Kim SG, Goo M, Park JH (2015) Comparison of the effectiveness of balance training using a reaching task between a sitting position and a standing position in the elderly. *J Phys Ther Sci* 27: 2337-2339. [Crossref]

19. Langley FA, Mackintosh SF (2007) Functional Balance Assessment of Older Community Dwelling Adults: A Systematic Review of the Literature. *The Internet Journal of Allied Health Sciences and Practice* 5: 1-11.

20. Muir S, Berg K, Chesworth B, Speechley M (2008) Use of the Berg Balance Scale for Predicting Multiple Falls in Community-Dwelling Elderly People: A Prospective Study. *Phys Ther* 88: 449-459. [Crossref]

21. Shumway-Cook A, Baldwin M, Polissar N, Gruber W (1997) Predicting the Probability for Falls in Community-Dwelling Older Adults. *Phys Ther* 77: 812-819. [Crossref]

22. Shumway-Cook A, Brauer S, Woollacott M (2000) Predicting the probability for falls in community-dwelling older adults using the Timed Up & Go Test. *Phys Ther* 80: 896-903. [Crossref]

23. Donoghue D, Stokes EK (2009) How much change is true change? The minimum detectable change of the Berg Balance Scale in elderly people. *J Rehabil Med* 41: 343-346. [Crossref]