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Critically Appraised Paper for “The effects of a home-based virtual reality rehabilitation program on balance among individuals with Parkinson’s disease”

Amanda Lee

Dominican University of California

Sophie E. Miller

Dominican University of California

Holly Snyder

Dominican University of California

Phoebe Taasan

Dominican University of California

Kitsum Li

Department of Occupational Therapy, Dominican University of California

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AOTA Critically Appraised Papers Series

Evidence Exchange

**A product of the American Occupational Therapy Association's Evidence-Based Literature Review Project*

CRITICALLY APPRAISED PAPER (CAP)

Holmes, J. D., Gu, M. L., Johnson, A. M., & Jenkins, M. E. (2013). The effects of a home-based virtual reality rehabilitation program on balance among individuals with Parkinson's disease. *Physical & Occupational Therapy in Geriatrics*, 31(3), 241–253.
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CLINICAL BOTTOM LINE

Parkinson's disease (PD) is a progressive neurodegenerative disorder that affects approximately 7 million people globally. Pharmaceutical interventions have been shown to improve symptoms of PD, including tremors, muscular rigidity, and bradykinesia, but do not have a significant impact on balance deficits. Recent research evaluating the effectiveness of nonpharmaceutical, exercise-based interventions found these to be generally effective in improving all symptoms of PD, including balance challenges. With modern technological developments, the use of virtual reality-based rehabilitation programs is an emerging area of occupational therapy practice. Emphasis is placed on determining the effectiveness of readily available and affordable software, such as the commercially produced Nintendo Wii system, as a therapeutic tool.

This study evaluated the effectiveness of a 12-week home-based exercise program using the Nintendo Wii system in its capacity to improve balance and balance confidence and maintain exercise compliance. Balance and balance confidence were measured with the Center of Pressure Length (COPL) and Activities-Specific Balance Confidence Scale (ABC), which were administered before the start of the intervention, 6 weeks into the intervention, and within 1 week postintervention. Although changes in balance and balance confidence scores were found to be nonsignificant, a pattern emerged in which scores for both measures rose between pre- and postintervention assessments, then fell to nearly baseline levels at postintervention. Changes in adherence to the intervention program over the course of 12 weeks were also found to be nonsignificant, which indicated that user interest in the program was maintained. Despite the nonsignificant changes in balance scores, the study prompts further research into the use of

virtual reality modalities in rehabilitation.

This study establishes a basis for further research on the effectiveness of virtual reality modalities. Although it does not provide statistical support for the use of balance-focused virtual realities for patients with PD, the results of the adherence analysis indicate that the Wii-based program successfully maintained participants' interest over the 12-week period. Further study into the use of virtual reality modalities in rehabilitation programs is necessary to confirm the effectiveness of the intervention. Caution is recommended in using this study as the only source of evidence for a home-based exercise program, given the small sample size, length of the study, and statistically insignificant results.

RESEARCH OBJECTIVE(S)

Evaluate the effect of a 12-week home-based exercise program using the Nintendo Wii gaming console to improve balance and balance confidence and maintain exercise adherence for people diagnosed with PD

DESIGN TYPE AND LEVEL OF EVIDENCE

Level III: Single-group, pretest–posttest design

PARTICIPANT SELECTION

How were participants recruited and selected to participate?

Participants were purposively recruited from a preselected group of patients with PD from a neurological practice in southwestern Ontario, Canada.

Inclusion criteria:

The participants included in this study were individuals who were diagnosed with mild to moderate PD (severity was determined with the Unified Parkinson Disease Rating Scale), were cleared by their doctor as healthy to participate in an exercise program, and had a mild balance impairment.

Exclusion criteria:

Individuals experiencing lower limb and back conditions that might affect their standing balance were excluded from this study. Participants who scored higher than Stage 3 on the Modified Hoehn and Yahr Staging Scale were excluded, because these individuals had difficulty standing without assistance and presented an unacceptable risk of falling.

PARTICIPANT CHARACTERISTICS

N= 11

#/ % Male: 7/(63.6%) #/ % Female: 4/(36.4%)

Ethnicity: NR

Disease/disability diagnosis: PD

INTERVENTION AND CONTROL GROUPS

Group 1: Intervention group

Brief description of the intervention	The intervention consisted of activities involving the Wii’s balance board accessory. Participants were allowed to select their own balance activity for each session from the list of games in the balance domain of the Wii and were encouraged to vary their selection between sessions to ensure that they practiced a variety of balance components. Each balance game addressed a slightly different area of balance, including rapid weight shifting side to side, forward, and back to control the game; weight shifting from one foot to another while walking in place; and rapidly flexing and extending the knees to simulate jumping. Participants were discouraged from attempting the Ski Jump game because of the positions and movements required, which might increase fall risk.
How many participants in the group?	11 participants completed the study.
Where did the intervention take place?	Participants’ homes
Who delivered?	After an initial home visit from the occupational therapist to set up and train with the Wii, participants self-administered the intervention.
How often?	Participants engaged in a 30-minute session of Wii-based balance activity three times per week.
For how long?	12 weeks

INTERVENTION BIASES

Contamination:

YES <input type="checkbox"/>	<i>Explanation:</i> No contamination bias was present because there was no
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NO <input checked="" type="checkbox"/>	control group.
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Co-intervention:

YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>	<i>Explanation:</i> Cointervention bias was found but not reported in the study. It is possible that participants engaged in exercises and activities outside of the intervention that had an impact on their balance and balance confidence.
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Timing of intervention:

YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>	<i>Explanation:</i> The intervention took place over the course of 12 weeks, which is adequate to determine the treatment effect and is the longest intervention program used for a study of this kind. However, because the greatest neuromuscular adaptations occur in the first 6 weeks, there is the possibility of a new bias. The intervention was not changed at the 6-week mark, and it is possible that participants adapted to the demands of the program; balance gains might seem to regress from midintervention to postintervention as a result.
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Site of intervention:

YES <input checked="" type="checkbox"/> NO <input type="checkbox"/>	<i>Explanation:</i> All participants performed the intervention at their home. Home environment, although consistent for the individual participant, might have varied among participants. There was no mention or assessment of the home environment at all, including amount of available space and environmental modifications to improve safety. In addition, the fact that the intervention took place in the clients' homes might have contributed to participants' sustained and consistent adherence to the intervention, because they were comfortable and familiar with their environment.
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Use of different therapists to provide intervention:

YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>	<i>Explanation:</i> The principal investigator and occupational therapist performed the home visits and trainings for all participants.
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Baseline equality:

YES <input type="checkbox"/> NO <input checked="" type="checkbox"/>	<i>Explanation:</i> Because there was only one group involved in the study, baseline equality is irrelevant and was not established.
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MEASURES AND OUTCOMES

Measure 1: COPL

Name/type of measure used:	COPL
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What outcome is measured?	Balance and postural stability, under four different conditions: eyes open and feet apart, eyes open and feet together, eyes closed and feet apart, eyes closed and feet together
Is the measure reliable (as reported in the article)?	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/> Not Reported <input type="checkbox"/>
Is the measure valid (as reported in the article)?	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/> Not Reported <input type="checkbox"/>
When is the measure used?	At baseline, at Week 6, and at Week 12 of the intervention period

Measure 2: ABC—Short Version

Name/type of measure used:	ABC
What outcome is measured?	Balance confidence
Is the measure reliable (as reported in the article)?	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/> Not Reported <input type="checkbox"/>
Is the measure valid (as reported in the article)?	YES <input checked="" type="checkbox"/> NO <input type="checkbox"/> Not Reported <input type="checkbox"/>
When is the measure used?	At baseline, at Week 6, and at Week 12

Measure 3: Exercise adherence measurement

Name/type of measure used:	Exercise adherence measurement
What outcome is measured?	Measured compliance with intervention program; based on electronic time-of-use data from Wii consoles on intervention completion
Is the measure reliable (as reported in the article)?	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> Not Reported <input checked="" type="checkbox"/>
Is the measure valid (as reported in the article)?	YES <input type="checkbox"/> NO <input checked="" type="checkbox"/> Not Reported <input checked="" type="checkbox"/>
When is the measure used?	On completion of the 12-week intervention, adherence was objectively assessed when time-of-use data were retrieved from Wii consoles and analyzed.

MEASUREMENT BIASES

Were the evaluators blind to treatment status?

YES <input type="checkbox"/>	<i>Explanation:</i> Evaluators were not blind to the treatment status of participants, because they were aware that all participants had engaged in the intervention.
NO <input checked="" type="checkbox"/>	

Was there recall or memory bias?

YES <input checked="" type="checkbox"/>	<i>Explanation:</i> The ABC measure was based on self-report postintervention, which required participants to recall past events and outcomes. It is possible that inaccurate recall skewed the results.
NO <input type="checkbox"/>	

Other measurement biases:

Given the lack of real-time tracking, it is possible that family members used the Wii, adding to the participant's overall time and influencing the total time-use data.
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RESULTS

List key findings based on study objectives:

The results of the COPL suggest that the Wii-based exercise program did not lead to statistically significant improvements in balance scores, because the interactions of time and conditions of the intervention were nonsignificant (Wilks's $\lambda = 0.69$), $F(6, 5) = 0.37, p = .87$. The main effect of time was also found to be nonsignificant (Wilks's $\lambda = 0.77$), $F(2, 9) = 1.33, p = .31$. The ABC, similar to the COPL, found that improvements over the span of the intervention were nonsignificant, $F(1.19, 11.9) = 0.45, p = .55$, indicating that the intervention failed to improve levels of balance confidence. However, despite the lack of statistically significant results, the study did yield an interesting pattern: Scores for both measures rose between the pre- and midintervention assessments, after which they nearly returned to baseline levels at the postintervention assessment. The multivariate analysis of participants' exercise adherence was also found to be nonsignificant (Wilks's $\lambda = 0.68$), $F(3, 8) = 1.24, p = .36$, indicating that participants maintained adherence to the intervention program throughout the 12 weeks.

Was this study adequately powered (large enough to show a difference)?

YES <input type="checkbox"/>	<i>Explanation:</i> A total of 11 participants successfully completed the study, which likely is too small a sample size to accurately reflect a statistically significant difference as a result of the intervention.
NO <input checked="" type="checkbox"/>	

Were the analysis methods appropriate?

YES <input checked="" type="checkbox"/>	<i>Explanation:</i> The methods used to analyze the results of the assessments were appropriate for this study. The pre- and posttests of results of the COPL were analyzed with a two-way within-subject analysis of variance (ANOVA). A one-way ANOVA was used to assess the effectiveness of the
NO <input type="checkbox"/>	

	Wii exercise program on balance confidence. Last, the adherence to the Wii exercise program was calculated with a within-subject multivariate ANOVA.
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Were statistics appropriately reported (in written or table format)?

YES <input checked="" type="checkbox"/>	<i>Explanation:</i> Statistics were presented appropriately in table format and were accompanied by written explanation, including numerical findings, as to why the findings were not statistically significant.
NO <input type="checkbox"/>	

Was participant dropout less than 20% in total sample and balanced between groups?

YES <input type="checkbox"/>	<i>Explanation:</i> Eleven of the original 15 participants completed the exercise program (a 26.667% dropout rate).
NO <input checked="" type="checkbox"/>	

What are the overall study limitations?

The specific nature of the purposive sampling method used to recruit individuals for this study resulted in a sample that was not reflective of the wider population. The findings are, as a result, not generalizable to a larger population.

In addition, balance and balance confidence improvements might have regressed because of the body’s ability to adapt to the demands placed on it; the researchers addressed this as possible detraining phenomenon. The researchers posited that neuromuscular adaptations occurred during first 6 weeks of intervention, but the program was not adapted to provide additional balance demands, so the body “detrained” and habituated to the activities. As a result, performance plateaued, and then gains reversed. Ultimately, the decision to maintain the original exercise program was reinforced, because there was no plan in place for determining the potential adjustments. Pragmatic reasoning also hindered the researchers from observing how the participants would apply the hypothetical adjustments.

The authors also hypothesized that the selected games’ focus on slow and controlled lower body movements might have caused the nonsignificant changes in balance outcomes, as compared with similar studies, which incorporated both upper and lower body movements and required rapid balance reactions.

Finally, all participants but 1 were taking levodopa to alleviate PD symptoms. Motor fluctuations are a global limitation among patients with PD and are further affected by medications. Changes in motor abilities may occur throughout the daily medication schedule.

CONCLUSIONS

Despite the lack of significant improvements in balance and balance confidence scores, the pattern that emerged has implications for the design of a future study on the use of virtual reality–based exercise programs. Scores for both measures rose between pre- and postintervention assessments, then fell to nearly baseline levels at postintervention. The researchers inferred that the participants' adherence was related to their maintained interest in the 12-week Wii exercise program. Sustained adherence indicates that virtual reality–based interventions have the potential to produce positive outcomes as a therapeutic modality across diagnoses, which bears further research comparing virtual reality programs with traditional exercises. Finally, because the 12-week program did not produce conclusive results, further study is needed with a longer intervention period to test for possible gains.

This work is based on the evidence-based literature review completed by Amanda Lee, Sophie Miller, Holly Snyder, and Phoebe Taasan, occupational therapy students, and Kitsum Li, OTD, OTR/L, faculty advisor, Dominican University of California.

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