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Wii Fit Balance Board Playing Improves Balance and Gait in Parkinson Disease

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Abstract

Objective—To assess the effect of exercise training by using the Nintendo Wii Fit video game and balance board system on balance and gait in adults with Parkinson disease (PD).

Design—A prospective interventional cohort study.

Setting—An outpatient group exercise class.

Participants—Ten subjects with PD, Hoehn and Yahr stages 2.5 or 3, with a mean age of 67.1 years; 4 men, 6 women.

Interventions—The subjects participated in supervised group exercise sessions 3 times per week for 8 weeks by practicing 3 different Wii balance board games (marble tracking, skiing, and bubble rafting) adjusted for their individualized function level. The subjects trained for 10 minutes per game, a total of 30 minutes training per session.

Main Outcome Measurements—Pre-and postexercise training, a physical therapist evaluated subjects' function by using the Berg Balance Scale, Dynamic Gait Index, and Sharpened Romberg with eyes open and closed. Postural sway was assessed at rest and with tracking tasks by using the Wii balance board. The subjects rated their confidence in balance by using the Activities-specific Balance Confidence scale and depression on the Geriatric Depression Scale.

Results—Balance as measured by the Berg Balance Scale improved significantly, with an increase of 3.3 points (P = .016). The Dynamic Gait Index improved as well (mean increase, 2.8; P = .004), as did postural sway measured with the balance board (decreased variance in stance with eyes open by 31%; P = .049). Although the Sharpened Romberg with eyes closed increased by 6.85 points and with eyes opened by 3.3 points, improvements neared significance only for eyes closed (P = .07 versus P = .188). There were no significant changes on patient ratings for the Activities-specific Balance Confidence (mean decrease, −1%; P = .922) or the Geriatric Depression Scale (mean increase, 2.2; P = .188).

Conclusions—An 8-week exercise training class by using the Wii Fit balance board improved selective measures of balance and gait in adults with PD. However, no significant changes were seen in mood or confidence regarding balance.

INTRODUCTION

Parkinson disease (PD) is a progressive neurodegenerative movement disorder caused by a lack of dopamine production in the substantia nigra. The cardinal features of this disorder include bradykinesia, gait disturbance, rigidity, and tremor [1]. Idiopathic PD is one of the most common chronic diseases in the United States and affects up to 1% of the population older than 50 years old. With the population of the United States aging, the prevalence of the disease is only expected to increase [2,3]. Given the trends that indicate an increased prevalence of this disorder, the development of community or home-based exercise programs to reduce PD-related impairments and to improve function is of great interest, both from a resource-utilization and a cost perspective, given that, with balance improvements, one can expect falls to occur less often, which leads to an expected increase in safety and decreased costs associated with injury.

Due to deficits in dopamine production, patients with PD have impaired movement and mobility, and subsequently experience increased morbidity and mortality compared with their peers [3]. Impairments of balance and postural stability likely contribute to the increased risk of falls and fractures found in this patient population [4]. In response to perturbations of balance with backward waist pull, individuals with PD demonstrated differences in weight shift, use a modified ankle joint motion before liftoff, and land with weight shifted posteriorly compared with healthy age-matched controls [5]. These differences in movement patterns suggest that targeted training for balance may be effective in addressing movement deficits.

Selected physical and occupational therapy exercise interventions have been shown to reduce impairments associated with PD [6–10]. Outpatient treatment programs in PD have evaluated exercise programs that are task-specific and involve balance or resistance training programs [7,8]. Data on functional rehabilitation in PD has emphasized the usefulness of specific neurorehabilitation interventions in the global management of PD [11]. In a randomized controlled trial of PD outpatients, Ellis et al [6] compared subjects who received physical therapy with a similar group of subjects who received delayed therapy. Improvements were observed in the Sickness Impact Profile, mobility, and Unified Parkinson’s Disease Rating Scale. A critical review that evaluated the effects of physical therapy on neurologic signs, activities of daily living, and walking ability concluded that persons with PD benefit from physical therapy when added to standard medications [12]. Previous studies that looked at group dance interventions for balance and functional mobility have found improvements in balance and locomotion with as little as a 10-session intervention over 2 weeks [13], with more sustained improvements seen after a 20-session intervention over 10–13 weeks [14,15]. In animal models, prior studies demonstrated that exercise alters dopaminergic neurotransmission [16]. As such, neurorehabilitation interventions, including balance and gait training, may well alter fundamental central pathophysiologic changes of PD.

Throughout the course of this disease, as many as 50% of patients with PD also experience depression [17], which is a predictor of poor quality of life (QoL), and is associated with decreased function [18,19]. Exercise has been shown to be effective in reducing depression in older individuals with major depression [20]. In older community-dwelling adults, exercise also reduces falls and improves QoL [21]. In the PD population, however, studies that examined the relationship between exercise and mood have yielded mixed results. A 2008 meta-analysis by Goodwin et al [22] found no significant improvement in depression in patients with PD after participating in exercise. A more recent study, however, demonstrated a trend toward improved mood and decreased fatigue in patients with PD after participation in exercise programs [23]. The high prevalence of mood disorders in PD and the potential for exercise to mitigate symptoms suggests that QoL-related factors may be important to evaluate in an exercise program for individuals with PD.

The Wii Fit video game system (Nintendo of America Inc, Redmond, WA) has the potential to serve as a home-based system for exercise and balance training. The Wii Fit uses a novel balance board system that tracks changes in the center of pressure (COP) during exercise games. It is widely available, portable, and far less expensive than typical costs incurred with therapy interventions, for example, physical therapy. Although a wide range of physical therapy interventions have been found to improve measures of balance and ambulation speed, most interventions occur on the order of months [24], with costs quickly exceeding that of a Nintendo Wii system, Wii Fit games, and a balance board, currently available commercially for approximately $250. A feasibility study found that the Wii balance board appears to be a valid tool for assessing standing balance and thus may be helpful for both balance tracking as well as training [25]. In addition, a pilot study completed by using the Nintendo Wii in patients with PD has demonstrated decreased rigidity and increased movement in participants when using this game system [26]. Because this system has the potential to improve balance and movement, it could also lead to decreased costs associated with fall-related injury in this population. These characteristics indicate that the Wii Fit may be a promising platform for rehabilitation in the context of PD.

The purpose of this study was to assess the effect of exercise training in patients with PD by using the Wii Fit, with the ultimate goal of developing a program to improve balance and gait in this patient population. We hypothesize that, after participation in group-exercise classes when using the Wii Fit, the subjects should have improved balance, decreased postural sway, and improved QoL. The primary outcome measures in this study were balance, as measured by the Dynamic Gait Index (DGI), Sharpened Romberg test (SRT) and Berg Balance Scale (BBS), and postural sway. Secondary outcomes include QoL, measured by the Geriatric Depression Scale (GDS), and balance confidence, measured by the Activities-specific Balance Confidence (ABC) scale.

METHODS

Study Design

The study is a prospective interventional cohort study that took place over the course of 4 months. An initial screening session was performed to assess eligibility and perform baseline testing. Within 2 weeks of initial screening, the subjects then participated in exercise group class 3 times per week for 8 weeks (24 sessions). Each week, the subjects were asked about any changes in medications or falls that they may have experienced at home or in the community. After completion of the exercise classes, the subjects underwent follow-up assessments within 2 weeks of the final training session. This study was approved by the Northwestern University Institutional Review Board. All the subjects gave written informed consent before starting the study. The study was registered at clinicaltrials.gov, with study number NCT01228851.

Participation and Recruitment

Subjects were recruited from the records of the outpatient movement disorders clinic at the Rehabilitation Institute of Chicago. Letters were sent to potential subjects who had been seen in the clinics of the principal investigators, and follow-up calls were made to assess interest. Potential participants were seen for an initial screening visit, where they were assessed for the inclusion and exclusion criteria by physician study investigators (P.V.M., S.M.S., C.M.M., S.T.). The following inclusion criteria were used: a diagnosis of idiopathic PD, age older than 18 years old, no change to PD medications for at least 2 weeks before study enrollment, the ability to ambulate at least 150 feet without an assistive device, and endurance sufficient to stand at least 20 minutes unassisted per subject self-report.

Exclusion criteria were as follows: Mini-mental Status Examination of <24; anticipated change in PD medications during the course of the study; uncontrolled orthostasis; symptomatic coronary artery disease; fracture of a lower limb within 6 months before the study onset; other neurologic diagnoses, including multiple sclerosis or vestibular disease; untreated depression on the Geriatric Depression Scale ≥ 20; acute illness; alcohol abuse; significant visual impairment that would inhibit the ability to participate in the study, with distance vision >20/40; drug induced or inherited PD; physical therapy within the month before study entry or during the course of the study; use of the Wii Fit balance board at home as an exercise program; significant camptocormia; or any medical condition that the physician investigator determined would compromise the safety of the exercise program for the subject.

Baseline Assessments

Participants who met all inclusion and exclusion criteria as assessed by a study physician underwent baseline data collection at the time of screening. The subjects completed questionnaires, including the ABC scale and the GDS. A trained physical therapist (L.P.) or researcher (I.V., M.V.A.) administered the BBS, SRT (with eyes opened and closed), and DGI. In addition, data regarding individuals' COP was obtained by using the balance board, which served as a corollary of overall balance.

Program

Group exercise sessions consisted of subjects who participated in 3 balance board games: a marble game, a skiing game, and a bubble game. At the initial session, the study participants underwent a brief orientation on how to use the Wii game system. The subjects were then told the object of each game (getting the marble in the hole, skiing without hitting the obstacles, and navigating through the maze without popping the bubble). One research assistant demonstrated each game to the subjects. The subjects learned the mechanisms of the gaming system with practice and verbal feedback from the therapist who was leading the session, and visual feedback from the gaming system on their individual television screens. Each subject stood on a balance board and participated in each of the 3 games for 10 minutes per game with 10 minutes rest in between, for a total of 30 minutes of balance training time per session, with sessions 3 times per week for 8 weeks. The subjects wore a gait belt during the exercises and were supervised by a physical therapist and research assistant. A balance bar was next to the subject if needed for balance.

Measurements

Primary Outcomes—One outcome was balance, measured by the BBS, SRT, and DGI. Three measures of balance were chosen to be used in tandem to improve specificity and sensitivity of testing [27]. The BBS is a 14-item test designed to measure dynamic and static balance with a maximum score of 56, with higher scores that indicate improved balance. The SRT is a test of static balance performed with eyes open and eyes closed, with longer length of time maintaining upright balance, which indicated better equilibrium [28]. For purposes of this study, the upper limit of time allowed to perform the test was 30 seconds. The BBS and SRT have been proven to be reliable measures of balance in the adult PD population. The DGI is an 8-item test that assesses the ability to modify gait to different demands, with scores that range from 0 (severe impairment) to 24 (no gait dysfunction) [29]. The DGI has been shown to be a valid tool in assessing balance in the healthy adult population, although susceptible to ceiling effects; it is also commonly used to monitor clinical progression in patients with PD [29,30]. All measures were scored by the same physical therapist at both pre- and postscreening assessments, and the same physical therapist scored all the subjects, for consistency between measurements. Screening assessments and group exercise sessions were performed at the same time of day to mitigate any effect from medications.

Another primary outcome, postural sway, was measured by using the Wii Fit balance board at the pre- and post-screening assessments. This board is a force-sensor plate on which the subjects stand, and it transmits information to the Wii game about the forces that the subjects are producing at any point of time (for example, by leaning), and their COP [25]. We used the capacity to obtain these measures by the Wii and designed a series of additional tests to give us information about the subjects' general balance and ability to control their COP. These tests, although not standard in the clinical community, have the advantage that they are objective, quantitative, and potentially low cost.

The tests used were tests of stability of posture (quiet standing with the eyes open or closed) and of ability to control the COP. In the test "quiet standing with the eyes open" (QSo), the subjects saw a red circle on the screen, which represented their COP, and were instructed to maintain it as stable as possible. In "quiet standing with the eyes closed" (QSc), the subjects were also instructed to maintain their COP as stable as possible but had their eyes closed. For both of these tests, the measure obtained was the sum of the variances of their COP in the x and y directions.

To measure the ability to control the COP, a series of small tasks were designed in which the subject was shown a red dot (their COP), a yellow dot (the "target"), and they were instructed to track the yellow dot with the red dot, which they could control with their COP. The yellow dot would move first horizontally, then vertically, then in a counterclockwise circle, and then in a clockwise circle. For these tracking tests, an error was measured, which consisted of the square root of the mean squared distance between the target and the subject's COP. These errors were then summed and referred to as the tracking error.

Secondary Outcomes—In addition to the primary outcome and/or physical measures, we were also interested in determining if the Wii-training led to differences in psychological measures. Balance confidence was measured via the ABC scale, a validated survey in which subjects rate their confidence in 16 realms, with 0% indicating no confidence and 100% indicating full confidence [31–33]. This survey was administered to participants at pre- and postscreening assessments. QoL was assessed by using the GDS, a questionnaire with yes or no answers for subjects to self-report symptoms of depressed mood. The GDS has been shown to have high specificity and sensitivity in the diagnosis of depression in the elderly; a score of 20 or more indicates severe depression [34]. The subjects self-reported, on a weekly basis, the number of falls and any changes in medications.

Statistical Analysis

Power analysis was performed by using PASS Software 2008 (Power Analysis & Sample Size Software, NCSS Statistical Software, LLC, Kaysville, UT) when assuming an α of .05 to detect a mean difference of 5 points between pre- and posttest measurement on the BBS [28]. By using this, it was determined that a sample size of 10 would give more than 80% power when assuming a standard deviation of 5 with an effect size of 0.996 and significance level of .05 [35,36]. To compare the results of the tests before and after the 8-week game training, paired *t*-tests were used. If, however, the standard statistical assumptions for a paired *t*-test were not met, then the equivalent nonparametric test was used (in this case, the Wilcoxon signed rank test). For all tests, unless explicitly noted, n = 10.

RESULTS

The initial pool of potential subjects for this study consisted of 205 individuals with PD seen in the clinics of the principal investigators. After letters were sent for initial contact, interest was assessed via telephone. A large proportion of potential subjects were excluded because they were receiving physical or occupational therapy at the time of study enrollment or were scheduled to start therapies during the time frame of the study intervention. Several were excluded due to inability to ambulate for at least 150 feet without an assistive device due to PD-associated balance impairment. A total of 15 individuals with definitive idiopathic PD were screened for inclusion in the study. Four individuals did not meet inclusion criteria: one had a Mini-mental Status Examination score below 24, 2 self-reported an inability to ambulate more than 150 feet, and one used an assistive device for all mobility. Eleven subjects were recruited; of those, 10 subjects participated in the intervention and completed follow-up screening assessments. One subject dropped out of the study after completing baseline assessments due to an inability to participate in the full 8-week training intervention.

The 10 participating subjects completed the full 8 weeks of training, with 3 group exercise sessions per week. There were no adverse events related to the study; the subjects generally tolerated the treatment regimen very well. There were no falls sustained during the group exercise sessions. One participant did sustain a fall between the initial screening session and the first group exercise session; however, this did not appear to be related to the intervention. One subject reported minor adjustment in Sinemet (Merck Sharpe and Dohme Corp, White House Station, NJ) dosing made before the first group session (increase in dose from 11–12 tablets per day) and change from regular-release to controlled-release Sinemet at week 6 of the study. No other subjects reported changes in any medications, specifically in regard to dopamine agonists or antagonists, or antidepressant medications, during the study period.

The mean age of the study participants was 67.1 years, with a range in age from 44–91 years old. Four men and 6 women participated in and completed the study. The mean time between diagnosis of PD and participation in the study was 6.7 years, with a range of 1–14 years. As noted in the Methods section, untreated depression was an exclusion criterion for participation in the study. Individuals with treated depression, however, were not excluded from the study as long as the GDS at the time of baseline assessment was <20. Of the 10 subjects, 8 had a known history of depression, 6 of whom were being treated with antidepressant medications at the time of the study.

Primary Outcomes

BBS Test—The 8-week Wii Fit training significantly improved balance, according to the BBS test, in our study patients. Dynamic and static balance, as measured by the BBS test, improved after training (Figure 1A). Mean (± standard error of the mean [SEM]) BBS scores increased from 48.8 ± 3.2 points before training to 52.1 ± 2.3 points after training. This improvement of 3.3 points was statistically significant (*P* =.016, Wilcoxon signed rank test) and clinically significant (minimum threshold is 2.8 points, as measured in a population of patients with idiopathic PD [37]), which corresponded to an estimated 16.2% decrease in the risk of falling [38]. The potential improvement may be even higher, given that 3 of the recruited subjects were already at the maximum BBS score from the beginning of the study and thus could not improve further. Analyzing the results without the 3 subjects who had attained the maximum score at both the beginning and end of the study gave an average improvement of 4.7 points (*P* = .016, Wilcoxon signed rank test), which corresponded to an estimated 27.6% decrease in fall risk [38].

DGI Test—A second measure of balance, DGI, also improved after training (Figure 1B). mean (SEM) DGI scores increased from 17.6 ± 0.8 points before the training to mean (SEM) 20.4 ± 1.0 points after training. This improvement (in 2.8 points or a 17% change) was statistically significant (*P* = .004, Wilcoxon signed rank test) and also met the criteria for clinical significance (percentage-wise because the minimum detectable change is 2.9 points or a 13.3% change [30]).

SRT Tests—Static balance, as measured by the SRT tests, also showed signs of improvement, although below the threshold of statistical significance. After the training, the subjects were able to maintain an upright balance for 3.3 seconds longer on average with the eyes open (SRTo test) (from 19.5 ± 4.2 to 22.8 ± 3.1, mean [SEM]; *P* = .188, Wilcoxon signed rank test) (Figure 1C) and 6.85 seconds longer with the eyes closed (SRTc test) (from 10.7 ± 3.7 to 17.6 ± 4.0, mean [SEM]; *P* = .07, Wilcoxon signed rank test) (Figure 1D).

Wii Fit Tests—In addition to the clinical tests, we also checked for differences in objective, quantifiable Wii Fit tests related to COP. Most of these tests indicated improvement (Figure 2). We observed an improvement in the quiet standing tasks, with subjects showing a significant decrease, of 31% on average, in the variance of their COP while standing with the eyes open (QSo) (*P* = .049, Wilcoxon signed rank test) (Figure 2A). For the same task but with the eyes closed (QSc), there was an improvement as well, although not significant, with subjects showing an average decrease of 5% in their COP

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variance (*P* = .0695, Wilcoxon signed rank test) (Figure 2B). We also analyzed the subjects' ability to follow a target on the screen with their COP; there was a significant improvement after the Wii-training period, with subjects showing an average decrease of 7% on the summed tracking error (*P* = .035, paired *t*-test) (Figure 2C). Thus, after the Wii-training period, the subjects showed an improved ability to stabilize and control their COP.

Secondary Outcomes

Mood-related effects from the intervention are demonstrated in Figure 3. In the ABC test, to assess confidence in balance, there were essentially no changes observed (from 83.5 ± 4.3% before to 82.5 ± 3.6%, mean [SEM]; *P* = .922, Wilcoxon signed rank test) (Figure 3A). In the GDS test, to evaluate depression, there was an increase in the average score of approximately 2.2 points, but it was nonsignificant due in part to the high variation observed in this measure (from 5.4 ± 1.7 to 7.6 ± 2.2, mean [SEM]; *P* = .188, Wilcoxon signed rank test) (Figure 3B). The raw data for the GDS test demonstrate that, for almost half of the subjects (n = 4), there were no changes at all in the GDS test and that the difference between the before and after conditions was mainly driven by a single outlier. Removing that subject lowered the average increase in GDS score to 1 point (*P* = .375, Wilcoxon signed rank test; n = 9). Overall, there were no significant alterations in subjects' mood or confidence.

DISCUSSION

In a prospective interventional cohort study, we found that Wii Fit balance board game training over a relatively short period of time (8 weeks) improved balance and the ability to modify gait to difference demands, as measured by significant improvements in BBS, DGI, and postural sway. The SRT tests also showed signs of improvement, albeit nonsignificant. The lack of significance in the SRT tests may be due to a ceiling effect, given that many of the subjects (6 for the SRTo test, 3 for the SRTc test) reached the upper limit that was set for the test (30 seconds) and could potentially have stayed an even longer time while maintaining the upright posture. No significant change was found in QoL measures, through self-reported ABC and GDS scores. Over this 8-week study, we also found that this intervention was not only a safe and feasible activity for individuals with PD but also required minimal supervision and could be an enjoyable and motivating activity for participants. Motivation is a key factor for long-term success in rehabilitation, and games promise to uniquely provide this motivation [39]. Because the Wii Fit is available commercially, it is relatively inexpensive, and because its development is driven by large numbers of users, it is engaging and enjoyable. It may be argued that commercial games may be able to fill a central need for the rehabilitation community: self-administered home-based training.

The results of this study are consistent with other recent studies performed that evaluated the effects of the Wii Fit in community-dwelling older adults, including those with PD. In a pilot study by Esculier et al [40] that compared home use of the Wii Fit over 6 weeks in 10 subjects with PD and 8 healthy elderly subjects, the subjects with PD were noted to have significant improvements in static and dynamic standing balance and mobility, with no significant change in the ABC scale score. This study used PD subjects with similar age range and disease duration compared with our study, but they used the Unified Parkinson's Disease Rating Scale (UPDRS) motor score to determine severity of disease rather than the Hoehn and Yahr Scale. The mean UPDRS motor score for study participants was 18.4; given that the maximum UPDRS motor score is 108 [41], this may indicate that the subjects may have had less advanced disease than subjects in our study, although full comparison with UPDRS scores would be necessary to confirm this theory. Our study also used a group setting for use of the Wii Fit with supervision, rather than self-supervised use of the device at home. In addition, our study evaluated use of fewer and different Wii Fit games (Marble Balance, Ski Slalom, and Balance Bubble versus Table Tilt, Ski Slalom, Balance Bubble, Ski Jump, and Penguin Slide), which indicates that similar balance and gait results can be seen with participation in only 3 versus 5 Wii Fit games and that a variety of Wii Fit games may be appropriate for the PD population. Another study that evaluated the effect of Wii Fit use in 7 healthy older adults also found improvements in balance and walking speed after 3 months of participation; this study did show greater improvements in objective measures than our study, which may be in part due their recruitment process, given that they only recruited people with a BBS of less than 52 points [42]. If we only consider subjects with a BBS of less than 52 points, then we find greater improvement. A third study that evaluated the effect of Wii Fit compared with walking exercise in 22 individuals with mild Alzheimer dementia found comparable, significant improvements in BBS and Timed Up and Go after 40 sessions of both types of exercise [43], which indicated that the Wii Fit intervention can be a useful home exercise intervention for individuals with neurologic impairments.

Conventional alternatives for balance training in the PD population frequently use exercises under the supervision of a therapist. In the 2010 study by Smania et al [44] that evaluated effects of balance training compared with general physical exercise on postural instability in subjects with PD, individuals participated in 21 group treatment sessions for 50 minutes each under the supervision of a therapist [44]. The subjects in the balance training arm showed significant improvements in BBS, ABC, and postural transfer scores, with a decrease in overall number of falls, and with results maintained at 1-month follow-up. However, balance training interventions required continuous feedback and postural adjustments by the therapist, which cannot be easily replicated in the home setting without supervision. Exercise interventions with the Wii Fit, in comparison, can be taught to subjects and eventually used without supervision in the home setting, as shown by the study by Esculier et al [40] noted above, which ultimately may be more convenient and less costly for individuals to use consistently. Thus, the Wii Fit may be considered a more convenient alternative to other more conventional forms of balance training in the PD population because it can be performed in the home setting.

Although no effect was seen on QoL measures, this is also consistent with prior studies that evaluated the effect of exercise on mood in patients with PD [22]. Also, given the high proportion of subjects in this study with pre-existing depression, many of them on medications, it is possible that factors extrinsic to the study may have affected the results of secondary outcomes. A recent study that examined the effects of physical activity on neuropsychiatric symptoms in patients with PD found a relationship between intensity of exercise and mood [23]. The subjects who participated in higher intensity exercise demonstrated decreased fatigue and a trend toward decreased depression. It is possible that the intensity and duration of exercise through the Wii Fit in our study was not high enough to affect mood or confidence regarding balance in our sample population.

Although our study found positive effects with respect to our primary outcomes, there are several limitations that must be addressed. The first limitation was in recruitment of research subjects. Of the 205 individuals seen in the movement disorders clinics at this rehabilitation institution, only 15 were able to participate in the screening process based on inclusion and exclusion criteria, and, of those, 11 qualified for the actual intervention. A significant number of potential subjects were unable to participate due to planned therapy interventions, as noted previously. Given that the subjects were recruited from rehabilitation clinics, this may have led to an element of selection bias because individuals with PD who are already followed up by a rehabilitation specialist have likely already been identified as requiring and qualifying for therapy interventions. In addition, the selection process placed heavy emphasis on patients' willingness to participate. Perhaps only those patients who are self-motivated and most likely to benefit from the intervention want to participate. The Wii Fit training, therefore, may be most effective for patients with high motivation. Due to the small sample size, there was significant range in subject age. As such, it is possible that the balance impairments in younger subjects may be attributed to PD alone, whereas, in the older subjects, balance impairments may be secondary to PD, with concomitant age-related changes. Another limitation was the lack of a control group. A control group would have allowed us to correct for any effects of the natural progression of the disease as well as attention provided to study subjects, but limited recruitment did not allow this kind of a design. The balance of patients with PD becomes worse over time [45]. Given that we found improvements instead of the expected decline, this may indicate the beneficial effects of the intervention. A further limitation was that we only chose one group, which was trained simultaneously. This led to 2 potential confounds. One, because the group was training together, the behavior and mood of one subject could influence other subjects. This group influence may particularly affect general mood or motivation. For example, our subjects were enthusiastic about the games but another group could collectively reject the games. Also, the fact that subjects could see the performance in games of all other subjects could affect how they felt about their own results. Second, because all the subjects were training in the same 8 weeks, issues related to the seasons or the weather could have affected our results [46–48]. The estimated prevalence for seasonal affective disorder is 5% in the United States, most occurring in the autumn and winter, and this study was conducted in a northern city during the transition from autumn to winter. It is possible that the change in the season could have had an additional negative effect on mood results [49]. Finally, premorbid depression was not an exclusion criteria for this study, and, as noted previously, 8 of the 10 study participants experienced depressed mood. The high prevalence of depression in this study group may have affected the potential change seen in QoL measures.

Future Research

There are a very limited number of prior randomized research studies that form the basis of rehabilitation in the context of PD. Topics on using the video game as a clinical instrument are reported in other patient populations with impairments from stroke and spinal cord injury, whereas problems that relate the use of video games into movement disorders such as

PD are not yet clearly defined. Future research should evaluate the use of the Wii Fit by also incorporating a control group to better understand the day-to-day performance variability that is particularly relevant in individuals with PD. In addition, further studies are needed to examine the specificity, intensity, and duration of effect of the Wii Fit intervention. The intensity of training (ie, the number of sessions per week) and the specificity, through the choice of the game, could be optimized to lead to more effective interventions in the PD population. Assessing the duration of effect of the Wii Fit intervention would also give clinicians further guidance in regard to how often this form of therapy should be practiced by patients. Further studies should also be performed to evaluate particular social effects of exercise with the Wii Fit, through individual sessions versus group sessions, to better understand factors that may alter the efficiency of training protocols.

CONCLUSION

Wii Fit games are inexpensive, readily available, and well tolerated by an aging population of patients with PD. They show promise as a tool for the rehabilitation of lower limb function, especially for balance. Future research that assesses training variables are necessary to optimize exercise recommendations.

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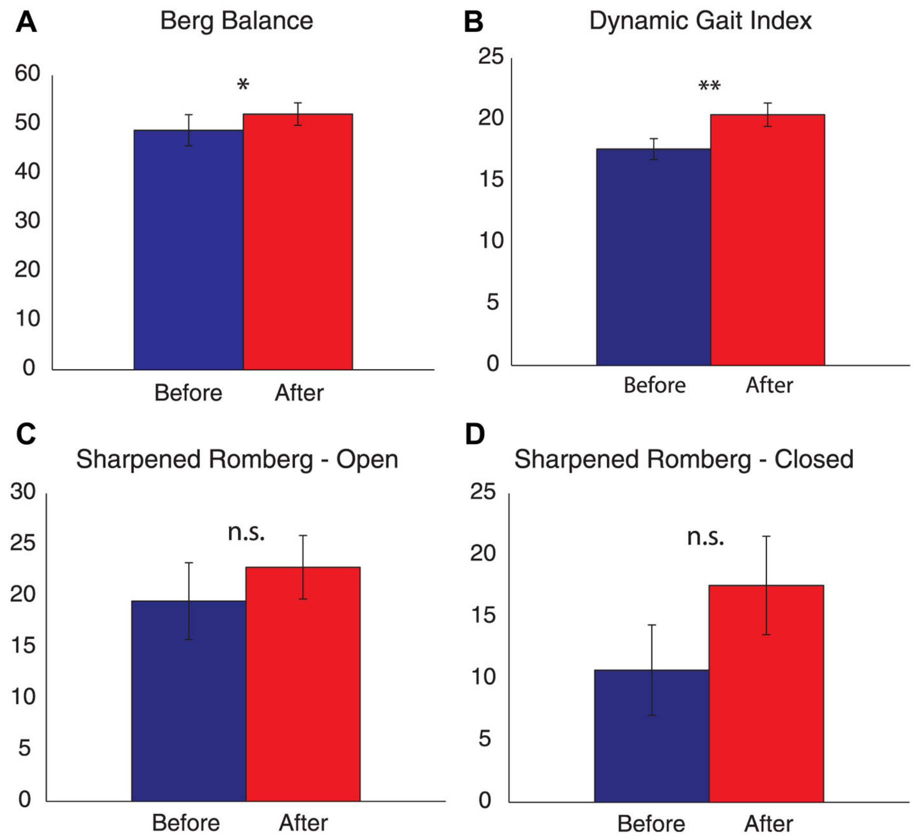

Figure 1.

Group balance scores for clinical tests before and after balance training. Changes in Berg Balance (A) and Dynamic Gait Index (B) were statistically significant (P =.016 and P =.004, respectively). Changes in Sharpened Romberg were not significant, with P = .07 for eyes both open (C) and closed (D).

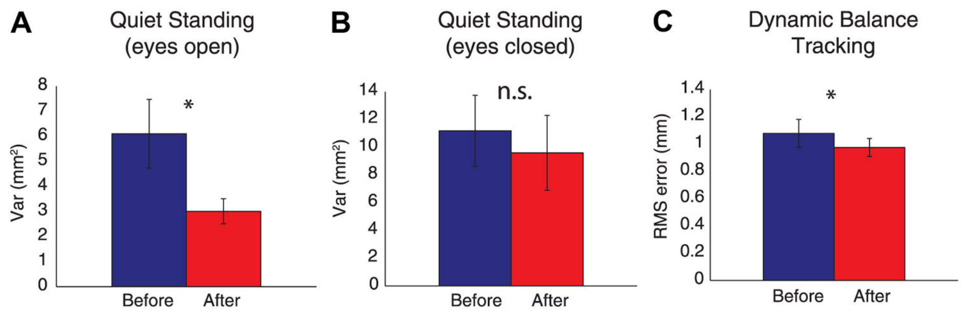

Figure 2.
Tests by using the balance board to measure instability by measuring movement in the center of pressure. Stability was marginally significant for quiet standing with eyes open (A) (P =.049), and insignificant for eyes closed (B) (P =.069). The subjects had significantly less error in manipulating their center of pressure after training (C) (P = .039).

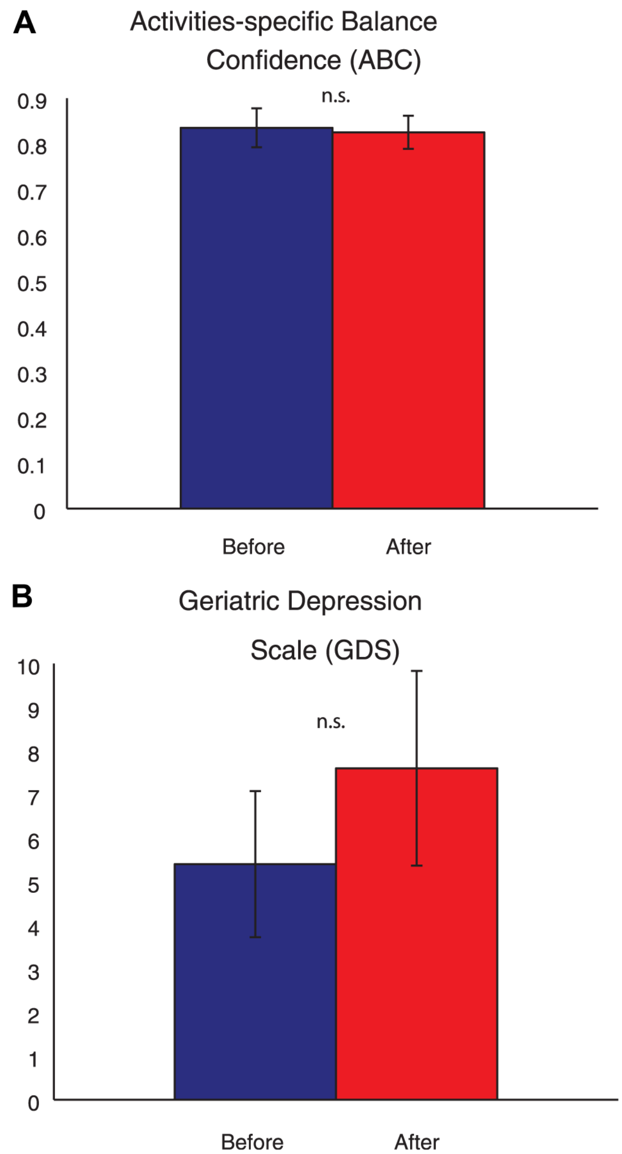

Figure 3.

Changes in confidence and mood due to the intervention. Both the Activities-specific Balance Confidence (A) and Geriatric Depression Scale (B) indicated no significant change (*P* =.922 and *P* =.188, respectively).