

Effectiveness of Nintendo Wii on Balance in People with Parkinson's Disease: A Systematic Review

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The use of exergaming exercises is increasingly becoming accepted as an alternative to surgical and medical therapies for Parkinson's disease (PD). Although the area has attracted some results, there is still no conclusive evidence on the benefit of exergaming exercises in improving PD patients' body balance. The current study is a systematic review aiming at examining the effectiveness of the Nintendo Wii Fit ("Wii Fit") game on improving the balance in people with Parkinson's disease. A total of 200 articles were selected online after conducting an extensive search on PubMed, Cochrane, PEDro, CAPES Periodic, ResearchGate, Web of Science, and ProQuest. Upon reviewing the identified sources, ten articles were included, of which four were randomized control trials. The results show that at least five weeks of Wii Fit exercises effectively enhance PD patients' body balance and life outcomes. However, better results occur when patients combine Wii Fit with other conventional exercises.

Key Words: Parkinson's disease, Exergaming, Video games, Rehabilitation, Physical therapy, Nintendo Wii Fit

INTRODUCTION

Maintaining body control and balance is crucial to ensuring physical wellbeing and functional independence [1]. According to Negrini et al.'s [2] observation, body balance and control do not just degrade over time as individuals grow old but may occur independently as a result of degenerative nervous and musculoskeletal diseases. One of the most common conditions that cause the problem is Parkinson's disease (PD) [3]. PD refers to a neurological disorder in-

volving motor dysfunctions, stiffness, tremor, rigidity, bradykinesia, and postural and gait instability [4]. Spencer et al. [5] narrate that the disease has serious adverse effects on patients, curtailing their mobility, and limiting their daily life by increasing some risks, such as frequent falls.

While it is challenging to know the exact number of PD patients due to lack of diagnosis, about 1 million Americans live with PD and up to 60,000 PD diagnoses are made each day in the United States of America. Still, statistics show that PD majorly affects 1 percent of individuals over 60 years and just a small percentage of people below 50. In terms of gender and ethnicity, PD mostly affects men and is common in Hispanics. Idiopathic Parkinson's Disease (IPD), a common form of PD, affects 1% of adults above 65 [6]. The disease starts with few symptoms then progresses over time. Individuals with PD report lack of posture control and frequent falls to the extent that it is challenging to manage daily functions.

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Difficulties in postural control and postural instability is a significant problem in individuals suffering from PD. Garcia-Agundez et al. [7] show that IPD manifests cardinal signs, including bradykinesia, asymmetry, rest tremor, and an excellent response to dopamine for pathology confirmation in almost 9% of cases. In many instances, PD patients do not exhibit more oscillations than normal subjects during Stabil metric platform examination [8]. PD patients cannot scale the required oscillations to take a variety of stable postures. Stabilometric evaluations evidence sensory disorders, balance impairments, and increased body sway and velocity, particularly in the sagittal plane [9]. Although there are controversial results, a large body of evidence reports postural sway either at a decreased or increased level compared to normal persons.

The good thing is that PD patients have a similar life expectancy like other normal subjects when treated. Braz et al. [10] explain that many PD patients receive medications as the first treatment forms. Medications, such as levodopa, have depicted positive results in enhancing motor functions in early PD stages. Nevertheless, in the long-term, drugs are ineffective and cannot help in any way. Most PD medications aim at replenishing dopamine in the body to delay the disease progress by inhibiting nerve cell destruction [11]. However, in prolonged usage of the drugs, different problems, including nerve malfunction, cognitive impairment, motor disturbance, and disease acceleration, may occur [12]. Although surgical option as stereotactic brain surgeries including, deep brain stimulation could reduce stiffness and tremor [13], Ribas et al. [14] report that even if PD patients undergo surgery as a correction measure in addition to medication, they would still show progressive physical and functional deterioration. That implies that patients should seek other alternatives to improve their life outcomes.

Physical therapy (PT) interventions are now essential rehabilitation tools for Parkinson's patients. Several studies prove their efficacy, such as optimizing patients' functional ability and alleviating secondary complications associated with the disease, like social withdrawal and inactivity [13,14]. Therapeutic approaches that promote the integration of motor skills, cognitive, and multi-sensory abilities can be better in making PD patients active and enhancing their life functionality [14]. Nonetheless, there is still

no evidence supporting the effectiveness of such therapies that enable the interaction of different elements in enhancing body balance in PD patients.

Costa et al. [15] found that the use of virtual reality and exergaming are increasingly being recognized as crucial neurological rehabilitation tools. Exergames involve activities in the virtual environment that demand cognitive and physical interaction to overcome set limits [15,16]. Players in exergames encounter challenging tasks that require cognitive and physical skills to attain, and they receive immediate feedback on their performance. Each time, the game encourages a player to overcome their ability by incorporating more challenging and engaging tasks. Moreover, exergaming is fun, inexpensive, and operable from a remote setting. Studies have shown the potential of using exergaming as a tool for preventing functional losses and ensuring positive outcomes in PD patients. However, no conclusive evidence is available of the effectiveness of the tools in improving postural balance and control in patients suffering from PD [16]. A systematic review may be essential in synthesizing the findings from past studies presenting conflicting results in the area.

The current systematic review aims at examining the effectiveness of the Nintendo Wii Fit ("Wii Fit") game in improving balance in people with Parkinson's disease. Wii Fit is a gaming software designed to enhance balance and fitness for people and, at the same time, give entertainment [2,17]. The game is widely available, portable, and affordable compared to the costs involved in other PD therapeutic interventions. It uses a novel balance system that coordinates activities and tracks changes in the center of pressure (COP) during gaming. Diverse physiological interventions have proven effective in enhancing balance and ambulation, but they have exceedingly high costs compared to Wii Fit games [17]. Understanding the effectiveness of Wii Fit can enable wide adoption of the gaming tool to help PD patients improve their life outcomes, considering its accessibility, portability, and affordability. The purpose of the systematic review is to examine the effectiveness of Wii Fit exercise training in persons with PD, with an ultimate goal of providing information that can help in designing an exercise program for enhancing balance and control in the identified patient population.

MATERIALS AND METHODS

The review was conducted based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) requirements. The primary databases used for the study were PubMed, Cochrane, PEDro, CAPES Periodic, ResearchGate, Web of Science, and ProQuest. The researcher selected the mentioned databases since they contain empirical studies on health and social care topics. The electronic search was restricted to English language to enable accuracy. The search terms used for searching articles included Parkinson's disease, physical therapy, exergaming, Nintendo Wii Fit, posterior balance, and gaming software. The researchers used the PICO framework to frame research question. The question for consideration was "Does engaging in Nintendo Wii exercise frequently help people with Parkinson's disease improve their balance compared to conventional exercise?". After retrieving numerous studies, the researcher reviewed their titles and abstracts to ensure that only relevant ones were selected.

Once this was done, the researchers considered the eligible articles using pre-established inclusion and exclusion criteria. For inclusion, the articles had to be peer-reviewed with a scope relevant to the field of study. Only journals focused on physical therapy and neurological rehabilitation were considered. Specifically, the studies had to deal with the rehabilitation of patients with Parkinson's disease through physical therapy. In addition, the articles had to be initially published in English, published since 2013, and use qualitative or quantitative research methodologies. The researcher selected sources published from 2013 (within seven years) due to the scarcity of resources in the area. Just a few studies were available dealing with Wii Fit and the rehabilitation of patients with PD. All articles that were published before 2013 and never focused on Parkinson's disease were excluded. The researcher also excluded non-academic articles and all studies that aimed at examining the effectiveness of different modalities on Parkinson's disease. The inclusion and exclusion criterion is summarized in Table 1.

The aim of the data extraction and analysis process was to obtain relevant information included in the selected studies. The selected articles were reviewed and data extracted separately by two reviewers using a pre-developed

table. The reviewers focused on the purpose of the studies, methodologies, data collection, results, discussion, and conclusion. During the extraction, the reviewers anticipated and considered the possibility of reporting data in different ways, risks of subjectivity, inconsistencies, and ambiguity. They compared the extracted data to address any inconsistencies and create a consensus. The use of two reviewers on essential steps during the review ensured low subjectivity and bias throughout the study. The reviewers first took training on article review and data extracti to minimize human error and ensure the extraction of the most appropriate data.

The information extracted was well documented using PRISMA guidelines to support accurate reporting and analysis. Studies with similar objectives and results were compared for in-depth analysis. Reviewers considered each authors explanation in the discussion and conclusion section to address disparities identified in the studies. What's more, the reviewers conducted an extensive literature review on studies with the same scope to determine consistency with the information obtained from the sources. All the citations were well maintained during the analysis for reference purposes. The reviewers conducted an assessment of the quality of the ten sources following the Critical Appraisal Skill Program (CASP) assessment approach.

RESULTS

A total of 200 articles were identified using the proposed

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
For inclusion, articles must;	The following were excluded during the review;
• Be peer-reviewed journal focused on physical therapy and neurological rehabilitation	• All articles published before 2013
• Be originally published in English	• Articles that do not focus on Wii Fit and Parkinson disease
• Published between 2013 and 2020	• Articles that are not peer-review
• Be focused on Wii Fit and Parkinson disease	• Articles that are not relevant to the study
	• Articles that were originally published in other languages then translated to English

online search method. Seventy articles were excluded for duplication. Later, an additional 70 articles were removed for being irrelevant after the two reviewers examined them. The remaining articles were reviewed using their abstracts based on the exclusion and inclusion criteria, leaving only twenty articles that were relevant to the study. Of the twenty selected articles, only ten studies were relevant and met the inclusion criteria after a comprehensive review by the two independent reviewers. The remaining 10 articles were excluded since they never focused on Wii Fit and Parkinson’s disease.

Fig. 1 shows the flow chart of the search conducted and the adopted selection process.

All the articles selected focused on the management and treatment of Parkinson’s disease using gaming approaches. Five of the selected studies used systematic reviews research design, one meta-analysis, and four relied on randomized

controlled trials. Although the studies had different goals, their main outcome was to examine the effectiveness of Wii Fit exercises on balance rehabilitation and quality of life improvement in PD patients. However, two of the studies compared the effectiveness of Wii Fit exercise with conventional therapies. All the studies, except the one conducted by Ferraz et al. [17], confirmed the effectiveness of Wii Fit exercises in improving PD patients’ body functionality and life outcome [18]. The studies discovered that Wii Fit training causes significant body functionality and posterior balance improvement, but added that combined Wii Fit and conventional training is the most effective way to address PD. Negrini et al. [2] study even showed that PD patients should have between 10 to 15 Wii Fit sessions in a week. Ferraz et al. [17] never found sufficient evidence to confirm the significance of Wii exercises as a PD therapy, although some articles hinted that Wii could be a vital PD intervention. Discovered that Wii Fit is not just effective, but also enjoyable to older adults with neurocognitive disorders, enabling acceptability. The purpose of the studies, research intervention adopted, and the outcomes are summarized in Table 2.

DISCUSSION

This study examined the effectiveness of Wii Fit exercises in improving body functions and life outcomes of individuals suffering from PD. From a total of 200 articles selected online, ten were systematically reviewed to generate the presented result. Generally, the results confirm the positive effect of Wii games to improve the body balance and functionality of individuals with PD. Only Ferraz et al. [17] found no sufficient evidence to support the Wii Fit as a possible PD intervention. Perhaps, the study found no evidence to support Wii Fit since it included twelve studies, but only three were randomized controlled trials. Sharpe et al. [19] found the same result as Ferraz et al. [17] and recommended more comprehensive studies in the area.

The exergaming tool can increase exercise adherence and balance confidence due to its entertaining and safe nature [19-21]. Patients using Wii Fit tend to stick to their programs, considering that they enjoy the exercises [4]. The current study findings reflect existing literature that Wii Fit

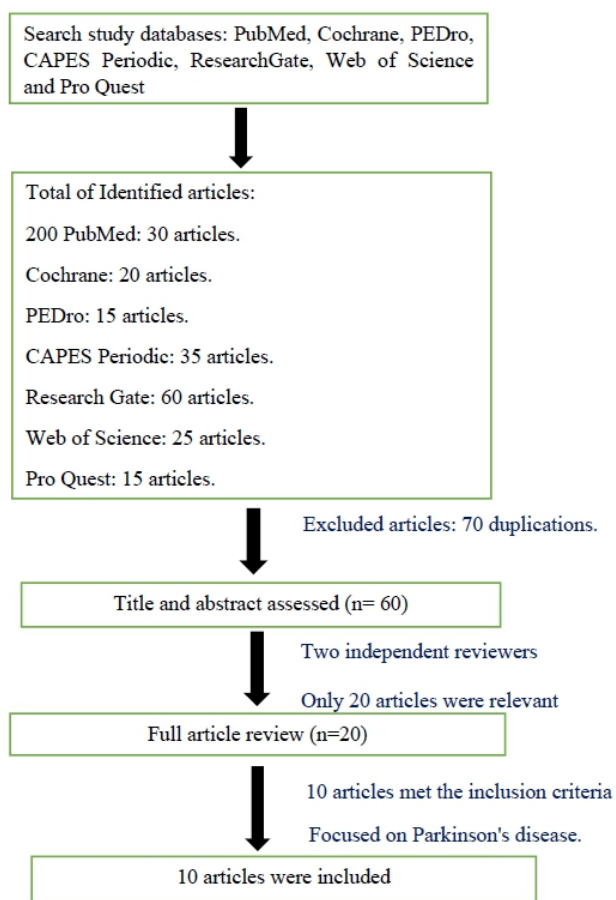


Fig. 1. Search process.

Table 2. Research intervention & outcomes

Authors	Purpose of the study	Study design	Interventions	Findings
Braz et al. (2018)	Effectiveness of Wii Fit gaming in enhancing life outcomes and functionality of PD patients	Systematic review	Review of seven studies	Wii was effective in improving functional and life outcomes
Ferraz et al. (2017)	Effectiveness of Wii Fit on postural balance and mobility treatment of PD in Hoehn and Yahr stages I to III	A systematic review	A systematic analysis of 12 studies	The study discovered that no sufficient evidence to support Wii as an alternative PD therapy. However, some reviewed studies showed that Wii might help improve the body balance of PD patients
Garcia-Agundez et al. (2019)	Effectiveness of Exgamers-Wii in rehabilitating PD patients	A systematic review	Conducted review on the conclusions of systematic reviews published in 2014	Analysis of 64 reviews showed putative improvement in motor skills and postural balance
Harris et al. (2015)	Effectiveness of Exgamers in improving static and dynamic balance in older IPD patients	A systematic review and meta-analysis	Conducted a meta-analysis of data obtained from 11 studies using MedCalc Statistical Software v14.12.0	Wii Fit might be an effective therapeutic
Lee et al. (2015)	Effects of virtual reality dance on the balance, activities of daily living, and depressive disorder status of Parkinson's disease patients	Randomized controlled trial	20 participants were assigned either Wii virtual dance or conventional exercises	Wii virtual reality dance was effective in improving body balance and functionality of PD patients
Negrini et al. (2016)	Comparison of the effectiveness of 10 vs. 15 sessions of Nintendo Wii Fit in improving PD patients posture balance	A comparative randomized controlled trial	27 PD patients were consecutively assigned to either a group receiving 10 or 15 sessions of exercises with Nintendo Wii Fit in recovering balancing ability	All the two groups improved body balance the same way
Ribas et al. (2017)	Effectiveness of Wii Fit gaming in improving functional balance, fatigue, functional exercise capacity, and quality of life in PD	Randomized controlled trial	20 PD patients were assigned either Wii virtual game or conventional exercises	Wii game was effective in improving balance and reducing fatigue after 12 weeks
Santos et al. (2019a)	The effectiveness of Wii Fit combined with conventional exercises on balance rehabilitation and quality of life improvement in PD patients	A randomized control trial	Forty-five PD patients were assigned into three groups, Wii Fit exercise alone, conventional training alone, and Wii Fit plus conventional exercise	Combined Wii exercise and conventional exercises were more effective in improving body functionality and the posterior balance of PD patients
Santos et al. (2019b)	Effects of Wii Fit training vs. traditional therapies on balance rehabilitation and quality of life improvement in PD patients	A systematic review and meta-analysis	Analysis of five randomized controlled studies	Combined Wii exercise and traditional therapies were more effective
Sultana et al. (2020)	Effects of Wii Fit exercise training on the balance of adults (60 years and above) with neurocognitive disorders	A meta-analysis	Systematic review and meta-analysis of five randomized control trials in the research area	Wii game is enjoyable and effective in improving body functionality and the posterior balance of PD patients

can increase body balance by stimulating pressure balance zone in the brain [22]. Wii Fit enables the integration of physical and cognitive elements, interactively, and engagingly.

Wii Fit exercise motivates persons with neurocognitive challenges to engage in physiotherapy. Motivation is a crucial factor for the sustainability of neurocognitive rehabilitation, and exergaming uniquely creates the required motivation [22-24]. Since Wii Fit is relatively cheap and driven by many users, it is enjoyable and engaging [22]. Ribas et al. [14] showed that Wii Fit exercise significantly enhances balance and minimizes fatigue within 12 weeks, although the results are not sustainable in the long run. However, the scholars observed that physical handicap is a psychological burden on persons with PD, creating demotivation for performing daily activities and developing a tendency for social withdrawal. Notable, the improvements observed were as a result of Wii Fit motivation. Wii Fit effectively lowers fatigue in patients with Parkinson's disease, enabling active participation in psychotherapy and daily activities. Fatigue is the most dilapidating symptom in PD, affecting roughly 58% of patients [4].

Santos et al. [23,24] discovered that Wii Fit exercises effectively improve body functionality and life outcome of PD patients compared to conventional approaches. However, the scholars found that combining the two techniques can create the best result than any single intervention. Different studies also report the effectiveness of combining conventional approaches and gamification in managing PD [11,14]. The positive effect of combining the two interventions may be explained by the fact that individuals who focus on Wii Fit exercises stagnate in other important social and emotional life aspects necessary for wellbeing [12].

The most important findings in the current study are the required Wii Fit exercise sessions and duration necessary to yield an optimum life improvement. Based on Negrini et al. [2] PD patients require about 10 to 15 training sessions running for at least five weeks with two days training each week. The scholars discovered that in low dose groups, PD patients register strong treatment effects in 10 sessions, and for high dose groups, the required number of sessions was 14. Meanwhile, in one study, the scholars found that patient balance and fatigue differed significantly in different training periods [14]. Nevertheless, in week 12, patients showed

significant motor and body balance improvement, although there was no significant difference among patients. The study findings confirm the ongoing suggestion that Wii Fit exercises should be viewed as cost-effective alternative PD therapies [25-27]. The exergaming tool requires few sessions to yield a positive result and can enable patients to sustain treatment.

The current study provided essential results, although it has some limitations that can make it less credible. First, the study only included four randomized control trials, with the remaining studies being systematic reviews. In as much as systematic reviews provide a broader view on a topic, they create room for subjectivity due to their qualitative methodology [28-30]. Besides, the four randomized controlled trials used small sample groups, which can cause generalization difficulties. With a study population of more than 1 million people, researchers should include a large sample group to address the generalization problem [31,32]. Another problem is that the reviewed studies considered different symptoms of PD that made it difficult to compare the specific body functionality and life outcomes. Using 10 studies in the systematic review may also adversely affect the result [33].

CONCLUSION

In conclusion, the current study has found sufficient evidence that confirms the effectiveness of Wii Fit exercises in improving PD patients' body functionality and balance. The study systematically reviewed ten articles out of which nine verified the effectiveness of Wii Fit in helping PD patients to regain body balance. Most PD patients use medication, but prolonged medicines can cause severe health problems and increased body degeneration. Wii Fit exercises effectively improve PD patients' life outcomes and body balance due to their ability to integrate physical and cognitive processes interactively and entertainingly.

The review provides important contribution to the literature. It shows that Wii Fit is not just effective in ensuring balance and performance in people with Parkinson's disease. The exergaming tool is engaging and enjoyable, enabling the sustainability of rehabilitation. Besides, Wii Fit effectively lowers fatigue and anxiety, which acts as a delimitation in neurocognitive physiotherapy. The review also provides an

important contribution to the required duration for Wii Fit exercises to yield optimal results. According to the findings, at least five weeks of Wii Fit exercises could be an alternative to medical therapies in PD treatment and management. Integrating Wii Fit and traditional exercises can yield better results than single approaches by helping patients address all their life aspects. Despite the important findings, the study outcome may be weak since it relies on systematic reviews. Future studies should include more articles, particularly randomized control trials that used a large sample group. Researchers should examine how Wii Fit enhances postural control and instability in people with Parkinson's disease. The study demonstrates the effectiveness of Wii Fit in improving balance in people with Parkinson's disease, but it is still not clear how this happens.

CONFLICTS OF INTERESTS

None to declare.

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