Does Wii Based Intervention Cause Meaningful Improvement in Functional Balance in Idiopathic Parkinson's disease – A Systematic Review.

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ABSTRACT:

Background

People suffering from Parkinson's disease with an unknown reason, have increased functional dependency due to falls and their quality of life is also reduced. Commercial gaming like Wii games are commonly used for rehabilitation of balance inorder to prevent falls.

Objective

Wii, a portable videogame is a cost-effective balance training tool, however, evidence for meaningful improvement is inconclusive. This systematic review is to explore this evidence for the meaningful change in functional balance.

Methods

PubMed, PEDro, Google Scholar search were done with the alternative words for keywords Wii, Parkinson's Disease, and Balance. Inclusion criteria – Wii as a balance training tool for idiopathic Parkinson's disease, functional balance scale as an outcome measure, article in English. A tailored scale was used to examine the quality of studies on its methodology.Minimum detectable changes (MDC) and minimum clinically important differences for balance measures was used for analysing the meaningful change.

Results

The search strategy identified 3435 articles and 15 articles met the inclusion criteria. Five RCTs were identified. Though significant improvement was identified with time interval, no group effect was observed in the functional balance scale and the extent of changes was below the MDC in high-quality studies. It is also observed that baseline score affects the magnitude of the improvement.

Conclusion

Wii games-based therapy was found to be useful in improving functional balance among the IPD population but more research is needed with low baseline scores and games that elicit larger movement production for a meaningful outcome.

Keywords: Parkinson's disease, Physiotherapy, Wii training, Functional balance, Meaningful change.

INTRODUCTION

The ability to maintain body equilibrium while performing daily activities, thereby preventing falls, is referred to as functional balance. Falls are one of the primary reasons for functional dependence and a reduced Quality of Life in the geriatric population, especially among those suffering from idiopathic Parkinson's disease (IPD) [1]. Falls may result from either intrinsic causes like - age, severity of symptoms, duration of the disease, autonomic dysfunctions, medications, postural instability (impaired balance), and other co-morbidities or extrinsic causes like – poor lighting, wet floor, uneven surface, narrow doorway, and obstacles in the walkway. In IPD Postural instability is a common symptom, especially during later stages, independently or resulting from rigidity, bradykinesia, freezing, cognitive impairment or from poor muscle recruitment [2]. Physical therapy interventions that explicitly focuses on strengthening the muscles; improving the trunk flexibility, and reducing rigidity are used by Physiotherapists to address the issue of postural instability and to manage falls [3,4]. Meta-analysis reveals that exercise and motor training may not help falls in people with IPD in spite of improvement in parameters concerning balance[5]. Physiotherapy intervention targeting balance improves anticipatory strategies and reactive strategies thereby decreasing

the danger of falls. Recent meta-analysis discovered that balance training can reduce the incidence of fall in patients with Parkinson's disease [6]. The efficiency of these intervention in Parkinson's disease is also affected by the level of challenge associated with practice and adherence to the interventions [7,8]. Interventions that promote motivation, cognitive functioning and behaviour potentially promote better compliance [9,10]. It is now clear that Commercial video games are associated with increased enjoyability and better motivation for long term compliance and have shown improved practice adherence [11-13].

For playing different kinds of games, movements are required from the different body segments with varying accuracy and speed. From a therapeutic point of view, games can be classified depending upon the amount of perturbation of centre of mass elicited by the games, speed of the movement, accuracy of the movement, repetition & duration of the games. They are used for improving flexibility, endurance, training upper extremity coordination, and for training balance [14-21]. Games that can elicit larger lower body perturbation, especially those that are played in standing which involves the displacement of the centre of gravity are used for training balance. Low-cost Wii consoles are found to be enjoyable and sensitive in tracking centre of mass, provide more tactile input [13]. In Nintendo Wii several game packages are available. For the Wii sports and Resorts games, participants have to stand on the floor and play with their upper extremity and they are used in upper extremity rehabilitation. For playing the Wii fit games the participants, have to stand on a balance board and lean forward, backward, and side-to-side. During this movement, the centre of mass is displaced in various directions and magnitude. Hence these games are considered for balance training in many studies.

Berg balance scale (BBS) and Timed up and Go test (TUG) are valid and reliable functional balance scales to evaluate the efficacy of intervention and predict the risk of falling. Timed up and go test, an objective test which measures postural stability in dynamic activities like sit to stand, walking, and turning. Berg balance scale though subjective, measures balance in a range of activities that are performed in day-to-day life. Though Wii consoles are used in many aspects of Neurological rehabilitation, games with specific characteristics that can potentially help in improving balance are essential for fall prevention. Wii games have been found to be a better adjuvant for giving balance training in IPD [22]. But the evidence to support meaningful improvement in functional balance by Wii games in people with IPD is still inadequate. Several reviews were conducted to explore the available evidence for Wii-based balance therapy [23-28]. Previous systematic reviews and meta-analysis that had analysed the effectiveness of Wii balance training in IPD, included studies that assessed the effectiveness of other forms of interactive games[23,26,27], studies in which laboratory measurement was used for balance outcome and studies done on non-Parkinson's people [25]. The effectiveness of the intervention is appraised statistically by either the significant difference from pre and post test score of same group or in the significant difference between group score. Statistically significant difference may be observed even when the difference is less than reported minimum detectable change of the respective scale. Minimum detectable change is defined as minimum detectable difference which can be observed without error. Hence to observe the effect of intervention the difference in score must be greater than the

reported MDC which can be considered as meaningful change. The studies conducted to find out the effectiveness of Wii games in Parkinson's disease did not analyse for any meaningful change [24,28].

The current study is therefore planned to explore the evidence for a meaningful impact of Wii-based balance training programme on functional balance and the lacunas needed for the improvement of balance and in reducing the falls in patients with idiopathic Parkinson's disease.

METHODOLOGY

Search strategy

Medline, Google Scholar (Search engine) and PEDro databases was searched for articles with focus on improvement of balance in subjects who have Idiopathic Parkinson's disease from Jan 2006 to March 2020. The following keywords were used to search the relevant article. In Pubmed, the search terms (Exergame OR active video game OR Commercial video game OR Computer game OR Wii games OR Virtual reality training) AND (Parkinson OR Movement disorder OR Neurological conditions) AND (Rehabilitation OR Balance Training OR Gait OR Functional balance OR postural stability OR fall) AND exercise were used. In the filter for articles types; clinical study, clinical trial, randomized control trial were activated for searching appropriate articles. In PEDro keys; Parkinson's disease AND along with Wii or alternative terms for Wii used in Pubmed search were used individually. In google scholar, Wii AND Parkinson's diseases AND balance training were used. Further search was done manually in the Institute library. The present study followed the PRISMA statement guidelines.

Inclusion & exclusion criteria

The following criteria were used to select articles for inclusion in the study: 1. The prime objective of the research must be to evaluate Wii games on balance in Parkinson's disease, 2. Studies, which were interventional in nature, 3. The primary outcome must be balance and assessed by at least one functional balance scale, 4. The articles that are excluded a) If the article's full text was not available, or full text was other than English language or b) used only laboratory measurement for balance assessment.

Methodological quality assessment

For the purpose of assessment of the studies' methodological quality, sample size based on power analysis is taken as one of the criterion and the remaining three criterions 1) Comparison with control group or other intervention, 2) adapting randomization or matching for allocation into the groups, 3) baseline similarity tested between the groups for balance outcomes were taken from Pedro scale, used to analyse the the standard of clinical trials in physical therapy. The included studies were assigned 1 point if it meets the above criteria and 0 points if not.

DATA ANALYSIS

Because of the heterogenic nature of the included studies, to find out the meaningful change in the balance outcome, The analysis of the data was carried already by reporting minimum detectable change (MDC) for berg balance scale [29] and timed up and go (TUG) test [30]. Reported MDC for BBS is a change of 5 points and for TUG test is a change of 4.85 secs. Since the minimum clinically important difference (MCID) is not established for those suffering from Parkinson's illness, the value reported for stroke is taken for the analysis. A change of 12.5 points on berg balance scale is considered as the minimum clinically important difference in IPD[31]. Further to identify the effect of Wii training in reducing the risk of fall, a score less than 45 points out of 56 on BBS [32] and more than13.5 sec on TUG is considered as a cut of score for fall risk [33]. The floor / ceiling effect of the therapy was also analysed based on the baseline score of the balance measures.

RESULTS

The results are shown in the flow chart. Totally 3435 articles were identified, 66 in Pubmed, 41 in PEDro, 3320 in Google Scholar, 8 in manual search with the keywords selected for this study. After removing duplicate articles and screening by title, 33 articles were included for further analysis. Abstracts of these studies were reviewed and those articles on Idiopathic Parkinson's disease with Wii used as a training tool and functional balance as one of the outcome measures were identified. For final analysis 15 studies were included.

Study design, sample size, selection criteria, and Quality

Table -1 shows the summary of study design, intervention, outcome measure, and the results of included studies. Only five randomized control trials and one quasi-experimental study were done to observe the effectiveness of Wii in people with IPD as control and experimental group [12, 13, 22, 34-36]. In two studies Wii effectiveness was compared with healthy adult [37,38] and in one study the different dosage of Wii was compared [39]. Five studies were conducted with single group [40-44], and one study was conducted with single case [45]. The quality assessment of the studies that are included is shown in Table-2. Size of the sample ranged from 1 to 76. In five studies the sample size was determined by power analysis. Randomisation was adapted for group allocation in five studies. In most of the studies, people are diagnosed as IPD using Brain bank criteria. HoehnYahr stage 3 or less than 3 was eligibility criteria in all the studies except in a single case study [45]. Studies conducted by Gandolfi et al (2017), Pompeu et al (2012), Ribas et al (2017) were considered as high-quality study based on quality assessment criteria used in this study [12,22,35].

Selection of games and intensity of intervention.

Games from Wii fit, Wii sports, and resort were selected for interventions. In thirteen studies; Wii fit training with the Balance Board was used for balance training. Zalecki T et al (2013) and Esculier JF et al (2012) in addition to Wii fit games had used Wii sports games for training [37,43]. The study conducted by Herz et al (2013) used only Wii Sports games [41]. Though balance training was not the objective of the study, they claimed that to play this game balance is essential. According to a study done by Lee et al (2015) K pop dance music

was incorporated in Wii to elicit lower extremity movements [36]. Training intensity of Wii training ranged from weekly 60 minutes to 180 minutes, for a period of 4 to 12 weeks.

Improvement in Balance

Berg Balance scale was employed as primary outcome measure in seven studies [12, 34, 35, 39, 42, 43, 45]and as a secondary outcome measure in one study [22]. Except for the study by Gandolfi et al (2017), all other studies claimed significant improvement [12]. The baseline score and pre-post intervention difference for the berg balance scale and timed up and go test is shown in table-3. In the article by Negrini S et al (2017) and Zettergren et al (2011) the differences between pre-test and post-test for BBS were above MDC [39, 45]. The baseline score in these investigations is lower than the cut-off number for the risk of falling. The minimum clinically important difference for BBS was not noticed in any of the included studies. Five studies used the Timed up Gotest as a measurement for dynamic balance [13, 34,37,43,45]. Among the five studies, only in the single case study, the baseline score for fall risk was above the cut-off value and there was an improvement greater than MDC for TUG[45]. In other balance measures like Sharpen Romberg test, Functional reach test, Performance oriented mobility assessment, Dynamic gait index the improvement was observed at significant level but these are observed either in single group studies or in studies where healthy subjects are controls [37,38,42,43].

Confidence in balance improvement

Activity Specific Balance Confidence scale was used in five studies for examining the effect of the Wii balance training for the improvement of balance confidence [12,37,42-44]. In a study conducted by Tomasz Zalecki (2013) significant difference was observed but this difference (6.5%) was less than the reported MDC (13%) for ABC by [30]Steffenet al (2008) [29,43].

Improvement in Fall, Functional activity and Quality of Life

It is observed from the study of Gandolfi M et al (2017) that there was no significant effect of Wii in reducing the amount of falls [12]. It had also been observed from the study of Liao YY et al (2015) there was no significant improvement in fall efficacy as assessed by FES -I [34]. Part - II of UPDRS, Modified Barthel index, NEADL, WHOQoL_old, and PDQ-39 were used to measure the changes in the functional activity and quality of life with Wii training, and no significant improvement was observed in functional activity, especially in mobility aspect [13,22,34-36,41].

DISCUSSION

Balance impairment is a major factor that leads to falls, fear of falls that affects functional mobility and quality of life among the aged people affected with Neurological conditions. Though balance impairment is caused by diverse neuro-musculoskeletal factors in different neurological conditions, Physiotherapy was found to be the ultimate non-pharmacological intervention. Though Physiotherapy is a possible technique for improving balance and quality of life, adherence to Physiotherapy is a challenging one. Many adjuvants are tried to increases adherence to Physiotherapy. Commercially available videogames are one such adjuvant used

for both children and the elderly to increases exercise adherence. Wii console is widely considered in balance rehabilitation but the evidence is inadequate. The Wii balance board detects the pressure distribution of the foot of the person standing on it by force transducer built within it. This gives feedback about the weight shifting of the body. During the game as the patients shift their body weight in different directions with varying magnitude and speed the balance is challenged. Hence, studies focussing on balance have selected the games from Wii fit.

In this review, the studies focussing on the Wii training for improving functional balance and measured by BBS and TUG were analysed. The BBS and TUG are utilised to assess the balance performance in most of the studies. Though included studies observed significant improvement in balance measures like BBS and TUG, it has been observed either in single group studies or in studies where the comparison group was healthy subjects. None of the previous RCTs observed the improvement above MDC for BBS, and TUG. One possible explanation for the slow progress in the BBS & TUG could be due to ceiling effect as observed by Leddy et al (2011), especially when at baseline low risk score and close to 50/56 for BBS and 13.5 sec for TUG [46]. The effect of Wii training for balance confidence, functional change, and quality of life are also inconclusive. Results of Wii based training effect on fall and fall efficacy among IPD is also insignificant.

Most of the studies used games from Wii fit for giving balance training. Wii fit games are more immersive and induce weight shifting during games. In real life, to avert falls many strategies are to be performed including stepping strategies, performed to increase the base of support through lower limb movements [47]. The movements of the lower limb might have been prevented with the use of Wii balance board. Among elderly population with Parkinson's disease standing on the limited space on the balance board may induce fear of fall, divert their attention, and reduce the involvement in the game, but patients could have achieved this goal by trick movements. This affects the fidelity of the training. The moderate level of the evidence from the previous reviews for Wii training in IPD could be associated with this (23-28).

In the previous studies of Wii balance training, the selected subjects had minimal functional balance deficit and the scores are well beyond the risk for fall. This might have caused the ceiling effect and this is associated with the insignificant improvement noted in those studies. Though in some studies significant improvement in balance measure is noted, this improvement is inadequate to reduce the risk of fall. To our knowledge, this is the first review conducted to analyse the effectiveness of Wii game exclusively and focused on meaningful change in the functional balance. We have limited our analysis pertaining to BBS and TUG. The major limitation of this study is we have limited our search to Pub Med indexed journals, PEDro, Google Scholar, and full-text English articles only.

CONCLUSION

Wii based training could help the IPD people improve their balance parameter, but from this review it has been identified that evidence for meaningful improvement on balance and it has a limited impact on fall prevention and life quality. Adequately powered randomised trial is

required to strengthen the evidence for Wii game in balance training for IPD. Future studies have to be conducted with the subjects whose baseline scores are well below the critical level, especially when the balance is measured by the subjective scale, and should include games that allow all the strategies to recover balance during Wii training.

Clinical relevance

- Games that can elicit larger movements and can elicit stepping have to be selected for the training to be effective.
- While using commercial games for training, proper instructions regarding expected movement have to be given.

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CONFLICT OF INTEREST: There are no conflict of interest.

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Flow chart for selection of the studies based on PRISMA statement.

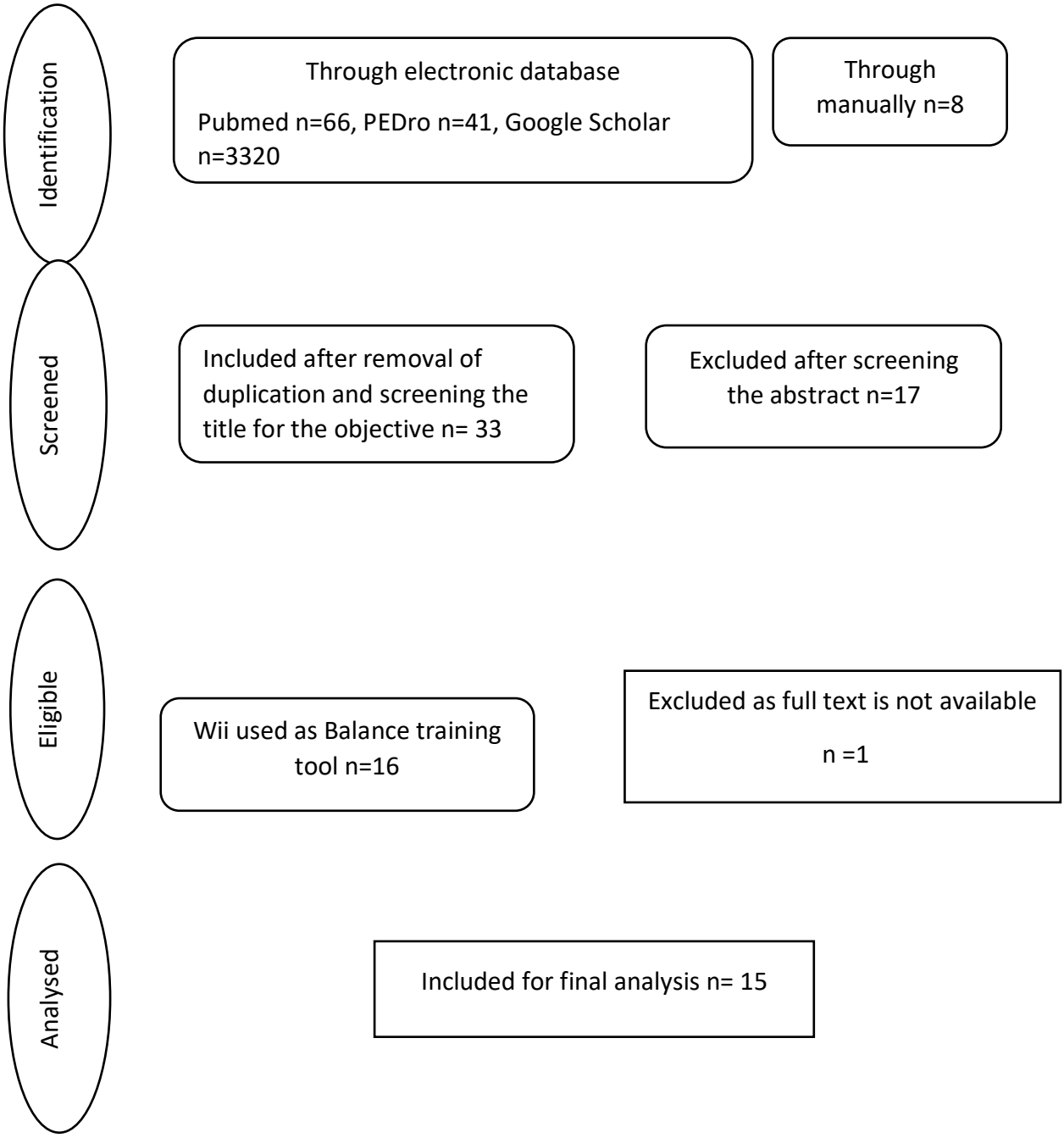

Table – 1 Summary of study design, intervention, outcome measure and result of the studies included

Authors , year	Study design/ Sample size	Treatment in Experimental group	III -group	Treatment in Control group	Primary outcome measure(s)	Results

Alves, (2018) et al	Quasi-experimental comparative – 3 group 27	Wii fit 40 to 60 minutes twice a week , 5 weeks	n/a	X box kinetic 40 to 60 minutes twice a week, 5 weeks	Gait speed, TUG, 30 secs walk test, WHOQoL_old	Significant improvement in all measurement but less than MDC for TUG, gait speed
Gandolfi, (2017) et al	Multisite, single-blind Randomized controlled trial 76 / 2 groups	Tele-Wii fit 50 minutes, thrice a week, 7 weeks	n/a	SIBT 50 minutes,thrice a week, 7 week	BBS, Gait speed, DGI, ABC, Fall & PDQ-8	Significant in non-Wii (SBIT)- BBS, Gait speed No significant improvement b/w group for - DGI, ABC, PDQ-8 No significant improvement -Fall
Ribas, (2017) et al	Pilot RCT 20 10 -EG 10-CG	WBB- 7 seven game 30 minutes, twice a week , 12 weeks	n/a	Conventional 30 minutes, twice a week, 12 weeks	Berg balance Scale, Fatigue Severity Scale, Six-Minute Walk Test PDQ- 39.	Significant (less than MDC) improvement seen in BBS No significant improvement in functional exercise capacity & QoL
Pompeu, (2012) et al	Random control trial 32	30 minutes of global exercise 30	n/a	30 minutes of Global exercise 30 minutes of balance	Section -II of UPDRS BBS	No significant difference between the group

		minutes WBB 1 hour/week, 14 session over 7 weeks		exercise		
Liao, (2015) et al	RCT 36 / 3 groups	Virtual reality based - Wii + tread mill training 45+15 minutes, 12 session over 6 weeks	Traditional exercise + tread mill training 45+15 minutes, 12 session over 6 weeks	No structured exercise	Obstacle crossing performance Posturo-graphy measurement, SOT, TUG, FES-I, PDQ-39	Significant improvement in VRWii training for movement excursion and directional control, for TUG significant improvement in both Wii & TE over control No significant improvement in FES-I & PDQ39

10MWT- 10 meter walk test, ABC – Activities specific balance confidence , BBS- Berg balance scale, CG-control group, DGI- Dynamic gait index, EG- experimental group, FES- Functional electrical stimulation, FES -I- Fall Efficacy Scale (International), GDS- Geriatric depression scale, , HAM-D- Hamilton depression scale, HS- Healthy subjects, IPD – Idiopathic Parkinson's disease , MDC – Minimum detectable change, n/a- not applicable , NEADL- Nottingham Extended Activities of Daily Living, NDT-Neurodevelopment treatment, PD- Parkinson's disease, PDQ-8- Parkinson's disease questionnaire -8, PDQ-39- Parkinson's disease questionnaire -39, POMA- Performance Oriented Mobility Assessment, QoL – Quality of life, RCT- Random control trial, SOT – SIBT- Sensory integration and balance training, Sensory organization test, STST- Sit to Stand test, TE – Traditional exercise, TUG-Timed and go test, WBB-Wii Balance Board, UPDRS – Unified Parkinson's Disease rating scale, WHOQoL_old – WHO-Quality of life old module,

Table – 1 Continuation

Authors(year)	Study lesign/ Sample size	Treatment in Experimental group	III - group	Treatment in Control group	Primary outcome measure(s)	Results
Lee, (2015) et al	Experimental 20 / 2 group	Wii based dance-30 minutes +30 minutes NDT+ 15 minutes FES 5 session/week, 6 weeks	n/a	30 minutes NDT+ 15 minutes FES 5 session/week, 6 weeks	Berg balance Scale, Modified Barthel Index, Beck depression Inventory	Significant improvement observed for BBS, but it is less than MDC
Negrini, (2017) et al	Consecutive assignment (27) 11 / 15session group 16 / 10 ion group	WBB – 30 mints / 3 session / week for 5 weeks.	n/a	WBB- 30 mints /2 session /week for 5 weeks.	Falls risk test, Postural Stability index, Berg balance scale and Tinetti scale.	No significant group effect
Zalecki, (2013) et al	Single group 24	WBB (20mints)- Ski Slalom & Balance bubble Wii sports - (20mints) /2 session per day 84 session over a period of 6 weeks.	n/a	n/a	Berg Balance scale Tinnet's POMA, TUG, STST,10MWT, ABC	Significant improvement in all measures
Mhatre, (2013) et al	Single group 10	WBB- marble tracking, skiing, and bubble rafting -10 minutes per game,30	n/a	n/a	Berg Balance Scale Dynamic Gait Index Sharpened Romberg test	Significant difference from pre-test to post-test except for Activity Specific Balance

		minutes per week for 8 weeks			Postural sway by Wii BB Activity Specific Balance confidence scale Geriatric Depression scale	Confidence & Geriatric Depression Scale
Gonçalves, (2014) et al	Single group 15	Wii fit plus 40 minutes / twice a week / totally 14 sessions	n/a	n/a	UPDRS-III Schwab and England daily living activity scale Functional Independence Measure	Significant improvement
Holmes, (2013) et al	Single group 15 For final analysis 11 only included	Wii fit 30 minutes / thrice a week / 12 weeks	n/a	n/a	ABC & quantitative analysis of Postural stability	No significant improvement in Postural stability analysis & in ABC

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Table – 1 Continuation

Authors(year)	Study/ Sample size	Treatment Experimental group	III - group	Treatment in Control group	Primary outcome measure(s)	Results
Herz, (2013) et al	Single group 20	Wii sports Tennis, Boxing, Bowling 1 hour /3 session For 4	n/a	n/a	NEADL PDQ-39 HAM-D	Significant improvement except mobility section of PDQ-39
Zettergren, (2011) et al	Single tudy	Wii fit	n/a	n/a	Gait speed Balance-BBS, TUG Functional mobility Depression-GDS	More than MDC for BBS, TUG
Esculier, (2012) et al	Pilot study 11 PD and 9 HS For analysis 10 PD and 8 HS	WBB – (4 games) 30 mints Wii sports -10mints Totally 40-minutes / 6 weeks, 3 days per week.	n/a	Same as the PD group	Sit-to-Stand test, Timed-Up-and-Go, Tinetti Performance Oriented Mobility Assessment , 10-m walk test, Community Balance and Mobility assessment , Activities-specific Balance and	Significant improvement in both PD group and the HS group

					Confidence	
dos Santos Mendes, (2012) et al	Longitudinal, controlled clinical study – 16 IPD – Experimental group 11- healthy older – in control group	WBB training - 10 games By both the group 14 -twice weekly session	n/a	Same as the experimental group	Scores on the 10 Wii fit games Functional reach test	Learning ability, retention and transfer is improved but depends on the demand of the games

10MWT- 10 meter walk test, ABC – Activities specific balance confidence , BBS- Berg balance scale, CG-control group, DGI- Dynamic gait index, EG- experimental group, FES- Functional electrical stimulation, FES -I- Fall Efficacy Scale (International), GDS- Geriatric depression scale, , HAM-D- Hamilton depression scale, HS- Healthy subjects, IPD – Idiopathic Parkinson's disease , MDC – Minimum detectable change, n/a- not applicable , NEADL- Nottingham Extended Activities of Daily Living, NDT-Neurodevelopment treatment, PD- Parkinson's disease, PDQ-8- Parkinson's disease questionnaire -8, PDQ-39- Parkinson's disease questionnaire -39, POMA- Performance Oriented Mobility Assessment, QoL – Quality of life, RCT- Random control trial, SOT – SIBT- Sensory integration and balance training, Sensory organization test, STST- Sit to Stand test, TE – Traditional exercise, TUG-Timed and go test, WBB-Wii Balance Board, UPDRS – Unified Parkinson's Disease rating scale, WHOQoL_old – WHO-Quality of life old module.

Table - 2 Methodological quality of the studies

Sl.No	Author / year	Comparison group	Randomization / Matching	Baseline Homogeneity	Sample size based on Power analysis	Total score
1	Alves, 2018 et al	1	0	1	0	2
2	Gandolfi, 2017et al	1	1	1	1	4
3	Ribas, 2017 et al	1	1	1	1	4
4	Pompeu, 2012 et al	1	1	1	1	4
5	Liao, 2015 et al	1	1	1	0	3
6	Lee, 2015et al	1	1	0	0	2
7	Negrini, 2017et al	0*	0	0	0	0
8	Zalecki, 2013 et al	0	0	0	0	0
9	Mhatre, 2013et al	0	0	0	1	1
10	Gonçalves, 2014 et al	0	0	0	0	0
11	Holmes, 2013 et al	0	0	0	0	0
12	Herz, 2013et al	0	0	0	0	0
13	Zettergren, 2011et al	0	0	0	0	0
14	Esculier, 2012 et al	0**	0	0	0	0
15	dos Santos Mendes, 2012et al	0**	0	1	1	2

*Compared different dosages of Wii, ** Compared with healthy adults

Table – 3 Baseline measurement and observed mean difference for BBS and TUG

Authors, year	Baseline BBS score (mean±sd)	Difference of Pre – Post Mean / mean difference BBS (points / mean ± sd)	Baseline TUG score (mean±sd)	Difference of Pre – Post Mean TUG in sec (mean±sd)
Alves, 2018 et al	-	-	10.44±2.16	0.66± 0.70
Gandolfi, 2017et al	48.63± 6.31	3.74 points	-	-
Ribas, 2017 et al	50.40 ± 2.79	1.9 points	-	-
Pompeu, 2012 et al	52.9 ± 4.1	1.4 ± 2.6	-	-
Liao, 2015 et al	-	-	12.6 ± 4.1	–2.9 ± 2.2
Lee, 2015et al	46.0±1.3	2.1±2.3	-	-
Negrini, 2017et al	G1- 46.6 ± 5.8 G2 - 40.1± 7.6	3.8 points 5 points	-	-
Zalecki, 2013 et al	46	4.5 points	8.14 ± 0.37	0.97
Mhatre, 2013et al	48.8 ± 3.2	3.3points	-	-
Zettergren, 2011et al	31	11	36.4	12.3
Esculier, 2012 et al	-	-	Not reported	2.11

G 1- 10 sessions, G 2- 15 sessions of Wii therapy.