**SYSTEMATIC REVIEW**

# Effect of Balance Exercises for Person with Multiple Sclerosis using Wii® Game: A Systematic Review of Randomized and Non-Randomized Control Trials

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### ABSTRACT

**Background:** The recent engagement of Game base console is emerging in rehabilitation practice and its overall effectiveness has not been yetsubstantially manifested.

**Objective:** To evaluate the effectiveness of Wii based balance interventions among Multiple Sclerosis people.

**Data Sources:** A systemic search was conducted in the PubMed and Scopus data bases electronically up to February 2014.

**Study Selection:** Randomized and non-randomized control trials with Wii intervention on balance as an outcome measure among people with Multiple Sclerosis were included in this review.

**Data Synthesis:** After screening 57 studies, 7 were selected for full-text screening and 5 were included in this review. Three out of five were RCTs and rest were quasi experimental and 2-point crossover pilot studies. Total of 205 medically diagnosed mild to moderate MS people were in the selected studies with less than 6 expanded disability status scale (EDSS). Total of 13 different outcome measures were used on assessment of balance in Multiple sclerosis individuals and the most common outcomes were Berg balance scale (BBS), Center of Pressured (COP), Four Square step test (FSST), Time up and Go test (TUG). Three out of five studies report statistical significant improvement in the Four Square step test (FSST), Berg Balance Scale (BBS) and center of Pressure (COP) between intervention and control groups of MS.

**Conclusion:** Review of the selected studies indicates that the inclusion of Wii game in balance exercise on Multiple sclerosis people improve static balance more effectivelyas compare to dynamic balance in mild to moderate level of disability. However evidence on the mode selection in Wii, treatment setting and frequency lacking. Further studies with large sample size and more homogenize outcome measure and control setting is recommended for future.

## INTRODUCTION

Balance related disorder in Multiple Sclerosis (MS) is one of the cardinal predicament among the other disabilities and impairments as in Coordination, Muscle tone, Muscle strength, sensation and cognition.[1] About one quarter of the MS patients experiencedbalance related disorder[2] and according to research conducted by Cattaneo et al, reported 54% MS patients experience at least 1 fall over the last 2 months and 32% of them are recurrent faller and reported more than 2 falls.[3] Fear to fall and the fall related injuries are the limiting factor in functional capabilities of patients with Multiple sclerosis.

To overcome this disablement conventional Physiotherapy and Rehabilitations, balance and

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lower limb muscle strengthenexercises were implicated to MS patients to reduce functional limitation which was considered one of the major and worth considerable draw back accompanied with this disease. Although the relationship between physical activity and incident of relapses in multiple sclerosis was ambiguous paradox even in past medical community which was recently discarded by the latest studywhich report negative correlation between relapses and sport index.[4] Contemporary evidence illustrates considerable benefits if interventions were based on feedback and sensory strategies to improve or maintain motor functions.[5] Despite efficacious biomedical interventions research flow is directed towards the patient exercise adherence and behavior strategies so that efficient and long lasting results could be achieved. Research could declare the prediction on fall, as early as 6 months before with the probability of 82% that patient will fall again, if the patient has a history of fall in previous year.[1] Keeping this point of view to make the exercises more flexible, ecstatic, efficient and reliable gaming interactive technology revolutionize the rehabilitation science in 21st century. Recently growing trend of Interactive active gaming in rehabilitation science is gaining accent which claim supreme efficient intervention and long lasting exercise adherence behavior when compare with conventional physical therapy session. As this novel collaboration of interactive gaming technology and medical science recently emerge therefore there is a great deal to empirically quantify the overall competence, efficacy and reliability in the presence of available evidence. We specify the effectiveness of Wii games in the corporation of balance exercise in the MS patients. Wii games came in to surface in December 2006 in Japan which is a home based video game console developed by Nintendo.[6] Only few researches were conducted to evaluate the efficacy of the Wii game based balance exercised for Multiple sclerosis patients by using different parameters for assessment and interventions. To quantify the overall efficacy of Wii based balanced exercise program for MS patients of all age groups we conducted a systemic review on all these randomized and non-randomized controlled trials and summarize the reliable and valid outcome measures such as Berg Balance Scale (BBS), Postural assessment test, stabilometric Test, and Secondary outcome measures which include time-up and go Test (TUG), Four square step Test, 25 Feet walk test (25TW) and Dynamic gait Index (DGI).which measure the subjective and objective efficacy of Wii game based balanced exercise Plan.

## METHODS

### Eligibility Criteria
Studies were selected according to the PICOs (Population, Intervention, Comparison and Outcome) as follows:

**Population:** Medically diagnosed Multiple Sclerosis.
**Intervention:** Balance interventions by Wii balanced board.
**Comparison:** Control group with/without conventional Physiotherapy session of balance interventions.
**Outcome:** Outcome measure of Balance parameters like, TUG, 25TW, DGI and related measures as mentioned somewhere else here.

Other Inclusion criteria include population with medically diagnosed Multiple sclerosis with subjectively and objectively perceived balance control impairment.

### Exclusion Criteria
- Studies were not included if they were conducted on the subjects who werefullydependence on external support or ambulatory devices during walking.
- Subjects, who have some Cognitive, linguistic or visual sensory impairment, which may interrupt in the understanding of instructions or become secondary barrier in maintaining balance.
- Only those studies are included which are published in English. Studies of qualitative, single case studies are excluded in review.

### Sources and Search Strategy
Data bases, PubMed and Scopus, were searched from the beginning up to the 15 February 2014. During the search process following keywords and MeSH terms combinations were used for example:

Gaming OR interactive games/active gamesOR Wii, Nintendo Games OR TELE games (TELE rehabilitation Keywords are used) AND Multiple Sclerosis ({MS}, Disseminated Sclerosis, Encephalomyelitis Disseminata) AND Balance Exercises (Equilibrium Exercises).

### Study Selection
Data bases of PubMed and Scopus were searched by using different combinations of keyword and MeSH term, which include Multiple sclerosis, WII, gaming, rehabilitation and balance exercises etc., which gave us total of 57 studies. After title and abstract review, 50 were excluded(TELE-Rehabilitation based on Xbox {n=3}, outcome measure was cognitive and physical active behavior on MS patients {n=4}, Gamingissue {n=8}, other are related to genetic and biological nature {n=35}).

Seven full text articles were screened for eligibility criteria which contains relevant informations and two (n=2) were excluded because one study by Nilsagård, Forsberg, & Koch, 2013[7] was the replied, second study was by Plow & Finlayson, 2011[8] provided inadequate measures to assess Wii interventions in balance exercise on MS people.

### Data Extraction

Fivestudies out of seven were selected for this systemic review after the full text reading and applying the criteria. All of these studies used the Wii Balance board as a major intervention in assessment of primary outcome variable which wasbalance and stability accompanied by secondary outcome measure, Modified fatigue impact score, while some studies also measure behavior outcome such as overall quality of life and physical active behaviors.

Data was extracted by the Author individually by full text reading from each research. Data consists of subject selection allocation, place and location where research was conducted and intervention applied, blinding and grouping into the intervention and control group, Objective of the study, Data collection instruments and data analysis software, limitation and further suggestion from the each paper. Quality assessment was not performed for the selected studies because of the limited number of studies and participants.

## RESULTS

The initial search yield 57 studies with keywords Wii or multiple sclerosis and balance in the PubMed and Scopus data bases. After applying selection criteria and abstract reading, 50 studies out of 57 were excluded because of absence of Wii intervention orunmatched protocol. In the end we studied 7 full text articles and 2 were excluded in second phase because one study by Nilsagård et al., 2013[7] was the reply to other author and second study by Plow & Finlayson, 2011[8] was behavior study of Wii intervention on physical activity among multiple sclerosis people. In the second study although author used balance assessment to check overall physical activity but the tool used to quantify balance outcome was not reliable and valid, because balance assessment was nor the primary outcome of the study neither the main objective.Complete study selection is shown below in the flow diagram of Figure 1.

Collectively, selected studies include 205 MS diagnose people by neurologists using the McDonald criteria and the expanded disability status scale (EDSS) range from minimum 1 to maximum 6 with mild to moderate multiple sclerosis. Only one study use the MS Impact Score 29(MSIS-29) for measuring the disability.[7] (Summary of all information is listed in the Table.1). One study reported Chronic MS course[9] and three reported relapsing and secondary progressive course.[2,7,10] In all studies, persons with MS were reported ambulatory. In our review, three were RCTs and one was two period crossover pilot study[10] and other one was pilot quasi experimental study design.[9] (Second Colum in Table 1 present this information). All the five studies applied Wii intervention in balance
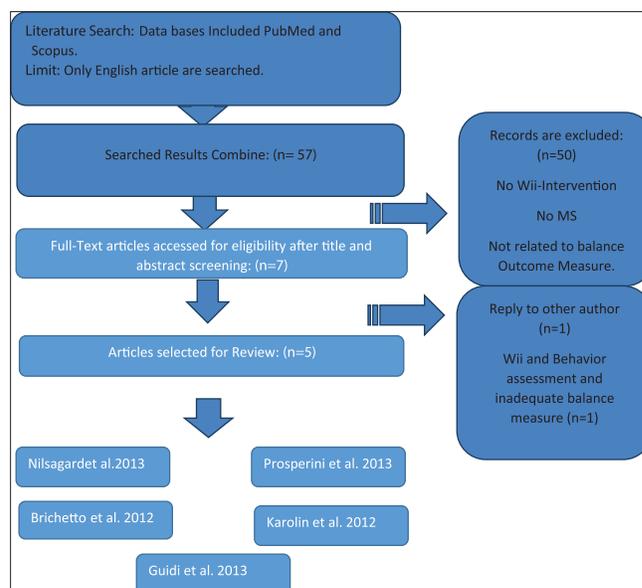


**Figure 1:** Flow diagram of the studies selection (n=number of studies)

exercise among people with MS. Only one study applied Wii intervention in Home based setting[10] while rest were outpatient and in clinical setting. Out of five, One study did not used control group intervention[9] and one used cross over design[10] in which one intervention group (IGa) used Wii console for first session of 12 months and after 12 month no intervention. And in second intervention group (IGb),they did not used any intervention at all in first session of 12 weeks and then used Wii intervention for next 12 week until the end of study period(Fourth Colum in Table 1 present this information). All studies record measures at the baseline (T0) and after the completion of program (T1), only one study recorded measures just after the exercise program, which was lasted 30 min per session.[9]

A total of 13 different outcome measures were identified from the five selected studies (Sixth Colum in Table 1 present the details). Two studies[7,10] used more than two different outcome measures to assess balance among MS people. Most common outcome measures were Berg balance scale (BBS), Center of Pressured (COP),Four Square step test (FSST), Time up and Go test (TUG). Other outcome measures are mentioned in the sixth Colum of Table 1 and also in Table 2. BBS is a five point scale 0-4 where 0 indicates lower level of functioning and 4 is the highest level of functioning, maximum score 56. COP is distance from the center of pressure and it is used from the Wii platform which give reliable and valid measurement of displacement in balance and reported here in millimeter.[11,12] FSST and TUG is also excellent and former have high validity and reliability in measuring balance problem in multiple sclerosis patients and it is measured in seconds and minutes respectively.[13,14] Two studies out of five report no statistical significant improvement in BBS and TUG

**Table 1: Summary of extracted variables from all the included researches related to Wii intervention on Balance exercise on MS patients**

| Study/author and year | Methodology/ randomization | Population | Intervention/subjects characteristic in the study | Setting, follow-up, frequency and/or Intensity | Balance related functional outcome measures | Summary: Main finding based on paper |
|---|---|---|---|---|---|---|
| Balance exercise on MS with Wii game by Nilsagard et al./ 2013 | Multicenter randomized study/ computerize Randomize allocation sequence by sealed envelope | Sample: 84 MS course: RP, PP, SP. MSIS-29 (0-100): IG 72.1±19.7 & CG 73.8±21.2. Dropout rate: 4 | Wii games of balance, yoga, strength & aerobics. IG: n=42 (♂:10, ♀; 32), Age: 50.0±11.5, DD: 12.5±8.0 CG: n=42 (♂:10, ♀; 32), Age: 49.4±11.1, DD: 12.2±9.2 | Outpatient-multi centered, 12 session total. Each session is 30 min, twice a week for 6-7 weeks | Primary: TUGtest (min) Secondary: TUG cognitive (min) 25TW (sec) FSST (sec) DGI (0-3) ABC (0-100) TCS MSWS: (0-100) Measurements: T0 &T1 | There is no statistical significant difference between the groups regarding primary and secondary outcome. There is significant statistical improvement in IG in secondary outcome of TUG cognitive, FSST, DGI, TCS (all p≤0.01). And in CG there is improvement in DGI & FSST (both p≤0.01) |
| Home based balance training using Wii by Prosperini et al./ 2013 | 2 period crossover pilot study/Computer generated Randomization numbers | Sample: 36 MS course: RP, SP Disability: EDSS≤5.5 Romberg test: Positive Dropout rate: 2 | Wii games of Zazen, Table tilt and Ski slalom. IGª: n=18 (♂:5, ♀; 13), Age: 35.3±8.6, DD: 12.2±6.0 IGᵇ: n=18 (♂:6, ♀; 12), Age: 37.1±8.8, DD: 9.3±5.3 | Home based, 48 Sessions total. Each session is 30 min. 4 days/week, for 12 week. (Study period 24 week) Intervention period: 12 week No intervention period: 12 week | Primary: COP (mm) Secondary: 25TW (sec) FSST (sec) MSIS-29 (0-100) Measurement were taken at T0, T1, T2 | WBBS improves the static and dynamic balance after 12 week session and reduces the overall impact of MS on QoL |
| Effect of Wii on balance in MS by Brichetto et al./ 2012 | Pilot randomized control study/ Adaptive based randomization procedure | Sample=36 MS course: SP Disability: EDSS≤6, AI≤4, Dropout rate: NR | IG: Wii based exercises, n=18 (♂:8, ♀; 10) Age (SD)=40.7 (11.5) years.EDSS; 3.9±1.6. DD=11.2±6.4 CG: PT exercise n=18 (♂:6, ♀; 12) Age (SD)=43.2±10.6 years. EDSS; 4.3±1.6. DD=12.3±7.2 | Outpatients, 12 session spread over three 60 Min session/week, IG: Wii one hour supervised session CG: static and dynamic single and double leg stance with/ without balance board | BBS (0-56) MFIS (0-84) Stabilometric Platform (open eye stabilometry & closed eye stabilometry) (30 sec trial with 30 sec rest) All measurement were taken before (T0) and after (T1) rehabilitation program | No significant difference is found between the IG and CG in BBS, MFIS, EDSS and DD. Time factor produced a significant differences in T0 and T1 especially in BBG and stabilometric test in IG vs CG with p<0.05 |
| Wii improves short term balance capability in MS, Kalron et al./ 2012 | Pilot quasi experimental study/ randomization: NR. No control group | Sample=32 (♂:13, ♀;19) Age: (43.6±1.9 years) MS course: CP, Duration: 6.9±0.8 year Disability: EDSS<5 Mean 3.1±0.2 Romberg test: Positive Dropout rate: NR | IG: Wii tennis mode, patients were instructed to play games with in the 30×30 cm area while maintain body balance | Outpatients, Single centered, 3 sub-session of 10 min with 5 min rest between each sub-session Only one session of 30 min with Wii intervention was applied | FRT (cm) FSST (sec) Measurements were taken at T0 and T1 was taken after 30 min of exercise session | Significant improvement were observed in both tests FRT increases from 30.3±0.8 to 32.9±0.9 with p<0.03 indicate 9.1% improvement. FSST decreases from 10.3±0.6 to 8.7±0.5 with p<0.04 representing 17.5% improvement |
| Effect of Wii exercise on balance in MS By Guidi et al./ 2013 | A pilot single blind randomized control trial/ NR | Sample=17 MS course: Mild DD: >3 years Disability: EDSS 1-3.5, Age: 25-65 years Dropout rate: NR | IG: Wii base physio-Mode, (n=9) static and dynamic wii exercises under PT supervision CG: (n=8), received recommendation strategies about behavior and preventing risk of falling | Outpatients, 10 sessions total with each session 45 min, twice a week and for five weeks | BBS (0-56) COP (mm) Measurements were taken at T0 and T1 | Considerable statistically significant improvement were observed in IG vs CG in both outcomes BBS (mean change) 1.89±1.05 vs 0.13±0.64; With p=0.002 & COP area (mean change scores 5.32±4.71 vs −0.83±8.97; with p=0.027 |

Note: MS: Multiple Sclerosis, WBBS: Wii balance board system, QoL: Quality of life, BBG: Berg balance scale, MSIS-29: MS impact scale, MFIP: Modified fatigue impact scale, FRT: Functional reach test, 25TW: 25 feet walk test, FSST: Four square step test, TUG: Time up and go test, MSWTS-12: 12 items of MS walk, DGI: Dynamic gait index, ABC: Activates specific balance confidence scale, TCS: Times chair stand test, SP: Stable phase MS, PP: Primary progressive MS, SP: secondary progressive MS, RP: Remitting Phase of MS, CP: Chronic Phase, NP: Not reported, EDSS: Expanded disability status scale, AI: Ambulation index, IG: Intervention group, CG: Control group, DD: Disease duration, SD(±): Standard deviation, ♀: Female, ♂: Male, Min: Minutes, Sec: Seconds,T0: Measurement taken at baseline, T1: Measurement taken after first session, T2: Measurement taken after second session, IGª: Intervention group A, which received intervention at the starting of program, IGᵇ: Intervention group B, which received intervention after 12 weeks of program, PT: Physiotherapist, N: Patients number, n: Studies number

### Table 2: Summary of the selected studies

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|---|---|
| Total studies | n=5 |
| Total RCTs | 3 |
| Two point cross-over pilot | 1 |
| Quasi experimental study | 1 |
| Total persons with MS in all selected studies | N=205 |
| Total dropout rate | 6 (3 studies did not report dropout rate) |
| MS course | n=1 reported Chronic n=3 reported relapsing and secondary progressive |
| EDSS criteria (min-max) | 1-6 |
| Total outcome measure | 13 |
| Primary outcome measure | BBS, COP, FSST, FRT, TUG |
| Secondary outcome measure | 12TW, MFIS, stabilometry, ABC, TCS, MSWS, DGI & MSIS-29 |

in intervention and control groups[2,7] however Nilsagard et al., 2013[7] reported a significant improvement of $p \leq 0.01$ in Four square step test. Studies by Kalron & Frid, 2012; Prosperini et al., 2013[9,10] reported significant improvement in FSST and in static and dynamic stability in intervention group. Considerable statistical improvement was reported in Intervention group (IG) vs control group (CG) by Guidi, Giovannelli, & Paci, 2013[15] in BBS mean change 1.89±1.05 (IG) vs 0.13±0.64 (CG) With p =.002 while in COP mean change was 5.32±4.71 (IG) vs −0.83±8.97 (CG) with p =.027.

## DISCUSSION

The primary goal of this review was to evaluate the effectiveness of the balance exercises with multiple sclerosis people using the Wii balance board. Studies included in this review has heterogeneous result and range of outcome measure with vary mode of Wii console but the major objective in all the studies was to evaluate Wii intervention among MS people regarding balance. Out of five selected studies three was randomize control trials and reset was quasi experimental and two point cross over studies design. The quality of overall selected studies was difficult to measure because of impropriate blinding procedure which is not possible in the exercise intervention. The sample size ranges from minimum to 17 MS people to 84 maximum and diagnoses was made in most of the studies by neurologist. Diagnosis was basically based on the radiological & symptomatic findings and also using multiple sclerosis impact score (MSIS-29) or Expanded disability status scale (EDSS) while two studies also utilize Romberg test. We also find out that the course of disease, consent procedure and randomization technique and procedure was poorly reported which also contribute in decline the level of overall quality of study. Most of the studies used different mode for Wii exercise console for intervention, inappropriate information regarding methodology selection and intervention settings make the review difficult to conclude

evidence. As Wii balance board intervention was designed for the MS patients who can stand on board therefor all the MS patients have EDSS less than 6 disability level and were in stable phase while only one study reported MS with chronic phase so the results can be generalize to Mild to moderate course of MS. However it is suggested for future researcher to study separately in relapsing and progressive phase. Still there are insufficient evidence about the effectiveness of mode and intensity of Wii exercises. As most of studies included MS people with expanded disability status scale (EDSS) less than 6 where 1 is for no disability and 6 for constant bilateral disability support and all of them receive same intervention so outcome were considered uncertain regarding this point of view.

According to a study by Nilsagard, Forsberg, & Koch, 2013[7] there were no statistical improvement found in the TUG and 25TW test which were the primary outcome measures however moderate improvement were reported in the self-reported MSWS-12 test between the experimental and no exercise group. Physiotherapists who were supervising the exercise session observer excellent compliance and motivation when WII game incorporated in the exercise regime. Another study[2] supported this evidence that there were no statistical improvement were reported in BBG, MFIS and EDSS however significant improvement in stabilometry and BBG was noted when time factor incorporate in groups. While the time factor was negated by the Prosperini et al., 2013[10] instead they found significant improvement in time x treatment factor after WII intervention in the FSST and COP outcome measures. One of the most important finding was the overall improvement in the quality of life and the increase in the gate speedin the MS people which was due to improve static and dynamic balance strategies.Improvement in speed in FSST test was also evident in the study by Kalron & Frid, 2012[9] where improvement was reported in the experimental group after the WII intervention on balance in MS. It was well known evident that visual and sensory motor feedback with improve vestibular system correlates with the postural stability.[16]

### Implication for Future Studies
Recommendation for future studies are to repot briefly about the course of disease and the previous fall history. Author found recall bias in reporting fall in previous 12 month as impairment in cognitive domain was also found in MS people.[17,18,19] The results would be more useful if studies utilize large sample size and used most evident mood of WII console with comparative group of conventional rehabilitation session because most of the studies employ unsupervised or no exercise control group in their studies. The present review also reveals that there is utmost need for application of WII intervention on the MS people with stratify disability level to conclude reliable results about efficacy in specific group.

## CONCLUSION

Under the light of current studied evidence we can conclude that the Wii implication with balance interventions on Multiple sclerosis people could improve static and dynamic balance. Progressive improvement in gate speed and overall quality of life was reported in studies which might be due to audio-visual or sensorimotor feedback that improve the postural strategies. Most of the studies report excellent compliance and paramount motivation with the Wii regime which could beconsidered a favorableapproach in rehabilitation sciences. There is need for more vigorous and homogenous scientific sound research based on the accurate, validate and standardize methodology which finally improve the MS research.

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