Effects of Nintendo Wii Fit® balance exercise program on physical abilities and quality of life in Multiple Sclerosis patients.

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Abstract

Introduction: In the last few years, the use of interactive video games is becoming increasingly popular as a different intervention tool for rehabilitation training. Few studies have investigated the use of a Nintendo Wii Fit Balance Board® in people with Multiple Sclerosis (pwMS), showing that home exercising using the device may improve physical activity and general health. We aimed to evaluate the effectiveness of a Nintendo Wii Fit® balance exercise program in improving the physical abilities and the quality of life in pwMS.

Materials and Methods: We screened 80 pwMS consecutively referring to MS centre at University of Catania in the period between July 2011 and June 2013. Functional Independence Measure (FIM), Barthel Index (BI), Berg Balance Scale (BBS), Timed 25-Foot Walk test (T25-FWT), Rivermead Mobility Index (RMI), 12-item MS walking scale (MSWS-12), and Short Form (36) Health Survey (SF-36) were administered at baseline (T0) and at the end of treatment (T1).

Results and Discussion: We enrolled 46 pwMS: 19 pwMS (41.3%) were assigned to Nintendo Wii Fit Plus® balance (Wii group) and 27 pwMS (58.7%) to a standard rehabilitation programs (SR group). At T1, both groups improved in FIM and BI. BBS, RMI and MSWS-12 were improved in Wii group. SR group improved in some items of SF-36.

Conclusion: Nintendo Wii Fit® could be considered a helpful tool to potentiate standard rehabilitation treatment in pwMS and mild-to moderate disability.

Keywords: Multiple sclerosis, Balance, Rehabilitation, Balance, Quality of life.

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Introduction

Multiple Sclerosis (MS) is a chronic demyelinating disease of the central nervous system (CNS) and the most frequent cause of disability in young adults 1. MS shows a great inter and intraindividual variability in terms of disability increasing along the disease course. About 50% of people with MS (pwMS) will experience a limitation in ambulation and 10% will restrict to wheelchair within 15 years from the onset [1,2]. Functional independence in daily living activity will be compromised in about 90% PwMS whiten 25 years from the onset [3]. PwMS can experience weakness, spasticity, balance problems during the disease course, leading to physical (decrease in mobility, falls, fear of falling, incontinence) and social disabilities (frustrating distress on work, family, society) [4]. All these troubles negatively affect quality of life (QoL) in both pwMS and their care-givers, causing an increased demand for health care services. Although advances in MS care and new disease modifying drugs, no long-term benefit on contrasting disability accumulation and enhancing social life have been reached at today. A multidisciplinary approach oriented on a supportive and symptomatic management provided by a specific task-oriented rehabilitation program, including occupational, psychological and speech therapy, remains the unique approved treatment approach for advanced pwMS [5-8]. Maintaining gains achieved in functional independence remain an important challenge in rehabilitation so far. Implementation of easy and economic training could allow this rehabilitation goal, being able to involve pwMS in performing the rehabilitative program more regularly. This need carried out new ways of promoting exercise and physical involving. Recently, the use of interactive video games is becoming increasingly popular as different intervention tools [9,10]. Improvements in balance have been reported in elderly people [9], in acquired brain injury and with stroke patients, when using the Nintendo Wii Fit® Balance board System [11,12]. In a recent review, balance training was identified as the most notable feature of Wii Fit® interventions [13]. Moreover, Wii Fit® has been successfully used to support rehabilitation training in order to prevent falls and to induce functional improvements in a wide range of healthy or pathologic populations (e.g., elderly, orthopaedic patients, children with developmental delay, and neurological patients, including multiple sclerosis, etc.) [14-16].

Moreover, in pwMS postural sway was able to improve after Wii Fit® training without significant differences with traditional balance training [16]. Indeed, considering that falls in MS seems to be linked with increased postural sway area and associated with a compromised control movement, have shown that exergaming is comparable to traditional balance training for its effects on balance and gait [17].

Few studies have investigated the use of a Nintendo Wii Fit Balance Board® in pwMS, showing that home exercising using the device may improve physical activity and general health [18]. A recent study showed that a 12-week Wii Fit® Balance board System training was able to improve static and dynamic balance and patients' QoL [19-21].

Aim of this study was to investigate whether a different interactive exercise program using the specific balance section of the Nintendo Wii Fit® would improve physical abilities and QoL (balance performance, walking and finally functional independence measure), as compared to a conventional rehabilitation program.

Materials and Methods

Study cohorts

Participants were identified from a waiting list of MS patients referring to our MS Center at University of Catania, during July 2011 to June 2013.

The study followed the Helsinki Declaration of 1964, subsequently modified by 55th General Assembly on October 2008, and was approved by local hospital Ethics Committee, and patients gave their consent to participate in the study.

The inclusion criteria were: a) diagnosis of MS was reached according to the revised McDonald diagnostic criteria [22] b) no relapse for at least six months; c) a disability level assessed by Expanded Disability Status Scale (EDSS) of 4-0 to 6.5 (that is an ability to walk independently with or without aid up to 100 m [23].

The exclusion criteria were: (a) Inability to understand the protocol instructions or fill the self-administered outcome measures; (b) Exacerbation of MS whiten last six months or ongoing too; c) Other systemic disease interfering with either intervention or evaluation procedures; d) Being under another rehabilitative treatment for six months before entering the study; e) Use of assistive device or foot ankle orthosis; f) Previous use of Wii® or other balance board device; g) Access to Wii at home. A weight limit of 140 kg was used according to the restriction stated by the producer of the Nintendo Wii Fit® balance platform.

Changing or starting any new medication was not allowed during the entire study period, except for steroid treatment required to treat relapse. Before the treatment allocation, all enrolled PwMS underwent the clinical and instrumental evaluations included in the study protocol. Patients were not randomized for this study, giving the opportunity to each of them to choose the treatment group. They were assessed at baseline (T0) and at the end of rehabilitation program (T1) by a clinician (V.C.) who was blind about the treatment allocation.

Intervention

This study was an open, single blind, control group, prospective study. Patients who met all the eligibility criteria underwent study assessments and were assigned to Nintendo Wii Fit Plus® balance programs (Wii group) or a standard rehabilitation program (SR group). As described elsewhere [11], we adopted the same time schedule for intervention consisting of individual physiotherapist-supervised 5 sessions a week of 60 min of balance exercise using Nintendo Wii Fit Plus® for 4 weeks, 20 sessions for Wii group totally. Participants in SR group received 5 sessions a week of 60 minutes for 4 weeks, individually tailored to meet patient needs. SR consisted of physiotherapy including balance and gait training, muscle stretching, occupational therapy comprehensive of fatigue management and specific tasks of daily living. The Nintendo Wii Fit Plus® is a video exercise game containing different interactive games regarding balance, yoga poses, strength and aerobics. A physiotherapist selected games in the Nintendo Wii Fit Plus® targeting balance and classified, in order to standardize the exercises difficulty. The patient stood on a Wii Balance Board detecting the center of balance. The exercises focused on controlling the games using the patient's center of balance. The first session started with the games categorized as easier (Penguin Slide, Ski Slalom, Perfect 10, Heading, Table Tilt). During all sessions, the PTs encouraged the participants to progress to more difficult games (Tightrope Tension, Balance Bubble, Snowboard Slalom, Skateboard Arena, Table Tilt+, Balance Bubble+). Concerning all the games, the patient started at basic level and based on his score, he/she is asked to perform a game with a progressive increasing difficulty. The intervention was personalized differently to participant's ability.

All adverse events (falls and injury during treatment, fatigue, other complications) occurring during rehabilitations session and/or clinical evaluations were recorded.

Outcomes

The following outcome measures were collected at each scheduled visit (at T0 before individual treatment and at T1) by a clinicial (V.C.) blinded to the treatment allocation: EDSS, Functional Independence Measure (FIM), Barthel Index (BI), Berg Balance Scale (BBS), Timed 25-Foot Walk test (25-FWT). All patients completed the following self-reported outcomes: Rivermead Mobility Index (RMI), 12-item MS walking scale (MSWS-12), Short Form (36) Health Survey (SF-36).

FIM is an 18-item instrument measuring a person's level of disability in terms of burden of care. Each item is rated from 1 (requiring total assistance) to 7 (completely independent). Three independent FIM scores were generated by summing item scores: a total score (total FIM: 18 items), a motor score (motor FIM: eating, grooming, bathing, dressing – upper body, dressing – lower body, toileting, bladder management, bowel management, and transfers bed/chair/wheelchair, toilet, tub/shower, walk, stairs), and a cognitive score (cognitive FIM: auditory comprehension, verbal expression, social interaction, problem solving, and memory). The validity of the FIM for its use in inpatient and outpatient rehabilitation settings is well established, and its reliability is good [24,25].

BI scale is used to assess Activity Daily Living (ADL), with scores ranging from 0 to 100. The top score indicates full functional independence, though not necessarily normal status [26]. Static balance was assessed using 14 items BBS, with a maximum total score of 56 [27]. The BBS has been reported as a valid [28] and reliable [29] tool for the pwMS. The 25-FWT is an individual component of the MS Functional Composite (MSFC) disability assessment [30,31]. It consists of a stop-watch measurement of time (seconds) to walk a 25-foot (7.6 m) distance (mean of 2 consecutive trials) [30].

The RMI is a 15-item questionnaire of perceived mobility and its reliability and validity in MS samples has been demonstrated [32]. The score ranging from 0 to 15; with higher scores indicating better mobility. RMI assessment is carried out by clinician. The 12-item MS Walking Scale (MSWS-12) has proven validity, reliability and responsiveness in a range of MS samples [33]. It a self-reported evaluation of walking abilities that implies several categories (three items have three response categories and nine items have five response categories). The total score ranges from 0 to 100; with lower scores indicating better mobility.

The SF-36 is a health-related quality of life questionnaire that assesses 8 domains, i.e. physical functioning (pf), physical role (pr), bodily pain (bp), vitality (vt), social functioning (sf), role emotional (re), general health perception (gh) and mental health (mh) [34]. Its clinimetric properties have been studied extensively [35].

Statistical analysis

Given the exploratory nature of this study, no sample size analysis was performed. Data are presented as means and standard deviations. Well-balancing of the 2 treatment groups were tested by using the Mann–Whitney U for continuous variables. Descriptive statistics was used to ensure comparability of scores between groups at baseline, to describe performance at each phase and to test whether the assumptions for use of parametric statistics have been met. If the assumptions for F or t-tests are violated, equivalent non-parametric statistics were used. The percentage of patients who improved in the FIM scores of 3 or 5 points [24] were calculated for each group. The $\chi 2$ statistic was used to compare percentages of cases in the Wii group and SR group. We also applied analysis of variance (ANOVA) to test main and interactive effects between groups (Wii group and SR group) and between T0 and T1. ANOVA was adjusted for age, sex and education level. Bonferroni was used to correct for multiple post hoc pairwise comparisons. P values less than 0.05 in either direction was considered as significant. Analyses were carried out by using the STATA software version 11.2 .

Results

A total of 46 pwMS, 19 women (40.4%), mean age 51.2±11.2 years, mean disease duration 15.6±5.8 years and mean EDSS 5.1±0.8 (range 4.0-6.0), matched the required criteria. Nineteen (41.3%) pwMS were assigned to Wii group and 27 (58.7%) to SR group (Table 1). Two pwMS of the Wii group dropped out due to side effect during treatment (low back pain) and were excluded from the analyses. The two treatment groups were not completely comparable in terms of baseline demographic and clinical characteristics (Table 1). A significant difference in term of FIM motor domains and physical health was found in Wii group compared to SR group at baseline (Table 1). All pwMS underwent the second evaluation (T1) after session treatments. At T1, a significant improvement was found in BBS, BI, FIM, FIMmf, RI and MSWS (Table 2). We found not statistically significant differences in terms of percentage of patients improving of 3 and 5 points at the FIM scale in both groups (Table 3). In the SR group, a significant improvement was observed at T1 in SF-36 score for the PR, BP, GH, VT, and SF sub-items; in the Wii group RP, BP and RE sub-items were found improved (Table 4). No accidental falls were registered during Nintendo-Wii training.

Table 1. *Demographic and clinical characteristics of Nintendo Wii Fit Plus® balance programs group and standard rehabilitation group.*

Variables	Wii	SR	p-value
	19 (41.3%)	27 (58.7%)	
M/F (%)	9/8 (53)	17/10 (63)	ns
Age (years)[a]	49.7 ± 10.9	52.2 ± 11.5	ns
Disease duration [a]	202.9 ± 111.7	177.8 ± 103.9	ns
RR (%)	1 (5)	1 (3)	ns
RR plus seq (%)	8 (47)	11 (40)	ns
SP (%)	5 (29)	7 (26)	ns
PP (%)	3 (17)	8 (29)	ns
EDSS [a]	5.1 ± 0.8	5.5 ± 0.8	ns
BBS [a]	38 ± 9.2	32.6 ± 13.4	ns
F25WT [a]	15.8 ± 1.4	22.8 ± 16.9	ns
BI [a]	81.2 ± 13.2	77.8 ± 14.02	ns
FIM [a]	110.0 ± 8.3	104.9 ± 9.6	0.07
FIMmf [a]	77.9 ± 7.4	72.9 ± 7.9	0.04
Self-Care	36.7 ± 3.8	34.7 ± 4.5	ns
Sphincters	11.9 ± 1.9	11.3 ± 2.0	ns
Transfers	18.1 ± 1.5	16.6 ± 1.7	<0.05
Locomotions	11.1 ± 1.4	10.1 ± 1.5	0.03
FIMcf [a]	32.2 ± 3.3	31.9 ± 4.0	ns
Communication	13.3 ± 0.9	13.1 ± 1.3	ns
Cognition	18.9 ± 2.6	19.0 ± 3.3	ns
Rivermead [a]	9.9 ± 3.1	8.2 ± 3.8	ns
MSWS [a]	42 ± 9.06	42.8 ± 11.3	ns
SF-36 [a]			
PF	35.9 ± 19.6	24.3 ± 20.7	<0.05
RP	25 ± 31.9	5.9 ± 12.6	<0.05
BP	55.0 ± 25.6	48.2 ± 20.8	ns
GH	33.9 ± 15.1	38.1 ± 17.7	ns
VT	43.8 ± 18.3	44.4 ± 17.5	ns
SF	62.2 ± 23.0	59.9 ± 23.6	ns
RE	64.6 ± 41.7	53.0 ± 45.5	ns
MH	61.2 ± 17.9	64.3 ± 19.3	ns

[a]Data expressed as mean ± SD.
Wii: Nintendo Wii Fit® Balance program group; SR: Standard Rehabilitation Group; RR: Relapsing Remitting; RR plus seq.: Relapsing Remitting Plus Sequelae; SP: Secondary Progressive; PP: Primary Progressive; EDSS: Expanded Disability Status Scale; BBS: Berg Balance Scale; F25WT: Timed 25-Foot Walk test; BI: Barthel Index; FIM: Functional Independence Measure; FIMmf: Functional Independence Measure Motor Function; FIMcf: Functional Independence Measure Cognitive Function; MSWS: MS Walking Scale; PF: Physical Functioning; RP: Role Limitations due to Physical Health Problems; BP: Bodily Pain; GH: General Health; VT: Vitality; SF: Social Functioning; RE: Role Limitations due to Emotional Health Problems; MH: Mental Health; ns: Not Significant.

Table 2. *Multiple comparisons between T0 and T1 for the objective and self-reported measures in Nintendo Wii Fit® Balance program (Wii) and standard rehabilitation (SR) groups.*

Variables	Wii			SR		
	T0	T1	p-value	T0	T1	p-value
BBS	38 ± 9.2	43.8 ± 7.6	<0.001	32.4 ± 13.4	37.8 ± 13.2	<0.05
F25WT	15.8 ± 5.8	13.9 ± 4.9	ns	22.8 ± 16.9	19.7 ± 12.7	ns
BI	81.2 ± 13.2	86.2 ± 12.4	<0.001	77.8 ± 14	80.9 ± 12.4	<0.005
FIM	110 ± 8.3	113.5 ± 8.2	<0.001	104.9 ± 9.6	110.4 ± 9.4	<0.001
FIMmf	77.9 ± 7.4	81.2 ± 7.1	<0.001	72.9 ± 7.9	78.0 ± 7.6	<0.001
Self-Care	36.7 ± 3.8	37.9 ± 4.1	ns	34.7 ± 4.5	36.8 ± 4.9	0.06
Sphincters	11.9 ± 1.9	12 ± 1.9	ns	11.3 ± 2	11.5 ± 1.7	ns
Transfers	18.2 ± 1.6	19.1 ± 1.3	<0.01	16.6 ± 1.7	18.1 ± 1.9	<0.01
Locomotions	11.1 ± 1.4	12.2 ± 1.4	<0.01	10.1 ± 1.5	11.4 ± 1.3	<0.001
FIMcf	32.2 ± 3.3	32.2 ± 3.2	ns	32 ± 4.0	32.3 ± 3.7	ns
Communication	13.3 ± 0.9	13.3 ± 0.9	ns	13.1 ± 1.3	13.2 ± 1.2	ns
Cognition	18.8 ± 2.6	18.8 ± 2.6	ns	19.0 ± 3.3	19.3 ± 3.1	ns
Rivermead	9.9 ± 3.1	11.8 ± 2.5	<0.001	8.2 ± 3.8	9.3 ± 3.7	<0.05
MSWS	42 ± 9.1	35.3 ± 13.4	<0.05	43.5 ± 11.3	39.2 ± 12.2	<0.05

*: Wii T0 versus Wii T1; °: SR T0 versus SR T1; §: Wii T0 vs SR T0.
Wii: Nintendo Wii Fit® Balance program group; SR: standard rehabilitation group; BBS: Berg Balance Scale; F25WT: Timed 25-Foot Walk test; BI: Barthel Index; FIM: Functional Independence Measure; FIMmf: Functional Independence Measure motor function; FIMcf: Functional Independence Measure cognitive function; MSWS: MS Walking Scale; ns: Not Significant.

Table 3. *Effects of Nintendo Wii Fit® Balance and standard rehabilitation programs on Functional Independence Measure (FIM).*

Variables	Wii	SR	p-value
≥ 5 points FIM	4/17 (23.5%)	13/27 (48.1%)	0.1
≥ 3 points FIM	10/17 (58.8%)	18/27 (66.6%)	0.6

Data are expressed as number and percentage of patients improving of 5- and 3-points in Functional Independence Measure (FIM) score after Nintendo Wii Fit® Balance (Wii) or standard rehabilitation (SR) programs.
Wii: Nintendo Wii Fit® Balance program group; SR: Standard Rehabilitation Group; FIM: Functional Independence Measure.

Table 4. *Comparison between T0 and T1 for the SF-36 health dimensions in Nintendo Wii Fit® Balance program and standard rehabilitation groups.*

Variables	Wii			SR		
SF-36	T0	T1	p-value	T0	T1	p-value
PF	35.9 ± 19.6	40.9 ± 22.7	ns	24.3 ± 20.7	24.3 ± 20.4	ns
RP	25 ± 31.9	30.8 ± 38	<0.05	25.6 ± 12.6	24.1 ± 32.9	<0.05
BP	55.0 ± 25.6	58.3 ± 26.5	<0.05	48.2 ± 20.8	59.6 ± 23.3	<0.05
GH	33.9 ± 15.1	35.3 ± 12.8	ns	38.1 ± 17.7	44.1 ± 18.8	<0.05
VT	43.8 ± 18.3	46.5 ± 21	ns	44.4 ± 17.5	52.9 ± 21.4	<0.05
SF	62.2 ± 23	65.2 ± 21.5	ns	59.6 ± 23.6	69.8 ± 23.9	<0.05
RE	64.5 ± 41.7	70.3 ± 33.1	<0.05	53 ± 45.5	48.1 ± 43.6	<0.05
MH	61.2 ± 17.9	62.8 ± 18.7	ns	64.3 ± 19.3	68 ± 20.9	ns

°: SR T0 versus SR T1; §: Wii T0 vs SR T0; #: Wii T1 versus SR T1.
Wii: Nintendo Wii Fit® Balance program group; SR: Standard Rehabilitation Group; PF: Physical Functioning; RP: Role Limitations due to Physical Health Problems; BP: Bodily Pain; GH: General Health; VT: Vitality; SF: Social Functioning; RE: Role Limitations due to Emotional Health Problems; MH: Mental Health; ns: Not Significant.

Discussion

In this study, we investigated the effects of a visual-feedback physical training with a Nintendo Wii Balance Board® on physical abilities and quality of life in pwMS with mild to moderate physical disability (EDSS score<6.5). After the treatment, the Wii group showed better performances in balance, measured by BBS and in patient's perception of mobility, as showed by self-reported questionnaires' (12-MSWS and Rivermead). Both the groups increased significantly the indipendance activities of daily living, as detected by BI score and in mobility as marked by FIM (FIMtot and FIMmf). Moreover, in SR group we found a significant improvement in the majority of SF-36 domains (physical role, bodily pain, general health, vitality, social functioning).

Our results are in line with the current literature demonstrating the effectiveness of Nintendo Wii® exercise program in PwMS [16,19,36]. The constant visual information feedback could be considered as a key to understanding the benefits on balance and mobility obtained with the Wii® exercise training in our study. During the Wii® exercises, pwMS shifted the weight on balance board using the visual display and, thanks to the visual feedback, tried to improve their performances. Thus, the better scores obtained by the Wii group patients in MSWS12 and RMI, could be partially explained by the improvement of proprioceptive system through the empowerment of the visual-sensory pathways [15-17,37-39]. Moreover, the specific training of sensory strategies, in order to perform sensory-motor integration, has been considered an essential component of rehabilitative programs aimed at improving balance in MS

[20,37]. Based on mirror neurons theory, watching one's own movements, while executing an action, could facilitate motor relearning in neurorehabilitation [40]. Indeed, during the Wii training, subjects are asked to follow an avatar mimicking their movements while they are playing. It is conceivable that task-oriented training and rehabilitation can empower both functions and structures of neural adaptation mechanisms [41]. Furthermore, improvement in balance might be even related to the enhancement of lower limb strength [18]. Consequently, it has been demonstrated that increased postural sway with a reduced ability to control movement towards the boundaries of stability and slowed responses to postural disturbances were associated to risk of falls in MS [42].

In another study, it was found a marked improvement in BBS score, in open-eye and closed-eye stabilometry in the Wii group and not in the SR group [36]. Moreover, Wii Fit® was included in rehabilitation training in order to prevent falls and to induce functional improvements in seniors or in subjects presenting neurodegenerative diseases. Concerning balance training, Wii Fit® interventions had a positive impact on BBS and Time Up and Go test (TUG). In line with our study, Wii Fit® interventions appear very safe, with very low levels of injuries being reported [14].

In our study a significant improvement in mobility measures as revealed by the motor score of FIM (transfers/locomotions) was observed in both groups. Indeed, it is known that the improvement in mobility, promoted by practicing high-intensity, repetitive weight shifting exercises, could be a result of a set of muscle strength reinforcement [18,43], restoration of axial control and improvement postural anticipatory strategies [44], and enhancement of fitness level [18].

Although it has been found that Wii Fit® Balance board training reduced the impact of MS on patients' QoL [37], we found a significant improvement on SF-36 after treatment in Wii group in only few items. On the other hand, in the SR group we found a statistically significant improvement on most of SF-36 items after treatment, confirming what previously reported in the literature [7,8]. This contrasting finding could be explained by the different treatment setting, as the home-based treatment has shown in several studies a better effectiveness on QoL [19]. Furthermore, it has been widely demonstrated that a tailored individualized treatment, as standard rehabilitation, including occupational therapy, education, health promotion and mobilization, could improve different domains of quality of life and patient's total care feelings [7,8].

Limitations

Our study had several limitations. Firstly, the relatively small sample size, due to the pragmatic nature of our trial may affect the statistical power of our results. Secondly, as the lack of a placebo group, we cannot completely rule out that the attention from the therapist and support from clinicians during the rehabilitation may have impacted the self-reported outcomes. Third, the lack of randomization may affect the selection of groups; indeed giving each subject the opportunity to choose their own treatment condition could lead someone to choose more frequently standard physiotherapy programs, rather than a new therapeutic strategy. We had higher percentage of males than females not reflecting the MS epidemiological findings. Finally, we did not perform follow-up evaluations in order to estimate the maintenance of the visual-feedback exercises' effects over time.

Despite these limitations, our results showed that rehabilitation exercises based on an interactive visual-feedback platform by Nintendo Wii Balance Board® could be effective in improving balance and mobility functions in MS patients with mild to moderate physical disabilities. Quality of life is not influenced by interactive games program; probably do to the lack of human contact granted by standard approach. There is not a consensus about time schedule of treatment, depending above all on methodological difference of intervention [36]. In our experience likely to previous study pwMS with mild symptoms can safely use Wii Fit® and can thereby improve their fitness levels [10].

Conclusion

This work has relevance for the development and evaluation of other interventions that incorporate technology and personalized rehabilitation training to enhance physical activity levels in chronic degenerative neurological disorder such as MS. Future studies should also explore the effect of Wii Fit® when used alone and in association to standard rehabilitation programs on balance and mobility functions of pwMS.

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