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MAIN ARTICLE

Vestibular rehabilitation using video gaming in adults with dizziness: a pilot study

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Abstract

Objective: To determine the effectiveness of vestibular rehabilitation using the Wii Fit balance platform, in adults with dizziness.

Methods: A single-site prospective clinical trial was conducted in a university hospital in the UK. Forty patients with dizziness, who would normally be candidates for vestibular rehabilitation, were identified and considered as potential participants. Participants were randomised into either the treatment group (the Wii Fit group) or the control group (standard customised vestibular rehabilitation protocol). Participants were assessed over a 16-week period using several balance and quality of life questionnaires.

Results: Both exercise regimes resulted in a reduction of dizziness and an improvement in quality of life scores over time, but no statistically significant difference between the two interventions was identified.

Conclusion: This pilot study demonstrated that use of the Wii Fit balance platform resulted in a statistically significant improvement in balance function and quality of life. Furthermore, outcomes were comparable to a similar group of individuals following a standard customised vestibular rehabilitation protocol. The study provides useful information to inform the design and execution of a larger clinical trial.

Key words: Neurotology; Dizziness; Vestibular Diseases; Rehabilitation; Quality Of Life

Introduction

In an economic climate where many health systems are reducing spending for certain services, there has been a drive to develop initiatives where patients can undergo an effective and inexpensive programme of rehabilitation in the community.[1] The use of low-cost, commercially available gaming consoles for rehabilitation purposes is becoming ever more popular.[2,3] To this end, the Wii Fit™ balance platform has been proposed to improve postural control, visual perceptual processing and functional mobility in certain patients.[2]

In this pilot study, we propose that exercises on the Wii Fit balance platform may present as an effective treatment to improve balance. If shown to improve balance, the Wii Fit balance platform may represent an effective and inexpensive tool that could be applicable on a larger scale in the community.

Materials and methods

The ethical issues regarding this study were presented to the UK National Health Service (NHS) National Research Ethics Service for approval. Local approval was then obtained from the Research and Development Department of the Norfolk and Norwich University Hospital NHS Foundation Trust.

Patients

Patients under the care of the Norwich Balance Clinic (Norfolk and Norwich University Hospitals NHS Foundation Trust) were offered the opportunity to participate in this study.

Inclusion criteria were: (1) adults aged 18 years and over, with the capacity to provide consent; (2) patients with a Dizziness Handicap Inventory[4] score of over 20 per cent; and (3) patients with motion and/or visually provoked symptoms.

Exclusion criteria were: (1) complicating balance problems; (2) fluctuating vestibular function; (3) bilateral vestibular loss; (4) use of vestibular sedatives; (5) central vestibular abnormalities; (6) medical contraindications for making the required head, neck, body or limb movements (e.g. severe cervical disorder); (7) severe co-morbid conditions (e.g. life-threatening condition or progressive central disorder); (8) patients who did not own a television; (9) patients who lived alone; (10) patients with epilepsy; and (11) patients with pacemakers.

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Study design

Patients with a significant Dizziness Handicap Inventory score, and motion and/or visually provoked symptoms, who would normally be a candidate for vestibular rehabilitation, were identified and considered as potential participants for this study. Appropriate information about the study was given to the patients and informed consent was obtained.

Patients were randomised into either the treatment group (the Wii Fit group) or the control group (standard customised vestibular rehabilitation protocol). This was achieved using a computer-generated list. The technique of block randomisation was employed, using a random number of blocks.

In the treatment group, participants exercised, using a Wii Fit balance platform, for two 30-minute sessions per day. Participants were initially instructed on how to use the Wii Fit balance platform safely and were excluded from the study if their using the Wii Fit balance platform was considered unsafe. This took place during a 1-hour introductory session with the Wii Fit balance platform so that the various settings for the platform could be set up.

Nine different 'balance games' are available, and each patient in the treatment group followed a standard tailored routine that included the most appropriate balance games for this setting. The balance games utilised were: Heading, Ski Jump, Ski Slalom, Tightrope, Irritating Maze, Penguin Game, Snowboarding and Meditation. The game Zazen was excluded, as it does not require the patient to move.

The participants randomised into the control group were provided with instructions on how to perform specific exercises to aid vestibular rehabilitation, and received a 1-hour introductory session. This is the standard care that patients normally receive. Their exercise time was customised to match that of the intervention group (two 30-minute sessions per day).

Outcome measurements

The primary outcome measure was the Dizziness Handicap Inventory. Secondary outcome measures were the Short Form 36 quality of life questionnaire ('SF36'),[5] and a visual analogue scale (VAS) that assessed the enjoyment experienced whilst performing the exercises.

Each participant took part in the study for a maximum of 16 weeks. Outcome measures were recorded pre-intervention (baseline measurement), and further assessments were made at 4, 8, 12 and 16 weeks thereafter. The Dizziness Handicap Inventory and Short Form 36 questionnaire were completed at all measurement time points, but the VAS was only completed at weeks 4 and 16.

Adverse events

Adverse events were reviewed at every study visit. Compliance with the intervention, particularly for the Wii group, was also confirmed at each visit.

Statistical analysis

Descriptive statistics were reported for all variables at baseline for both groups. Descriptive statistics were also reported for the changes from baseline for each outcome variable (the Dizziness Handicap Inventory, Short Form 36 questionnaire (physical and mental health scores) and VAS scores), at each recorded time point. The change from baseline for the Dizziness Handicap Inventory was reported at time points 4, 8, 12 and 16 weeks; for the VAS and Short Form 36 questionnaire, only the change from baseline to week 16 was reported. Within both groups, the changes from baseline were appraised using a paired *t*-test. A two-sample *t*-test was also performed to test for differences in the changes from baseline between the two groups. All analyses were carried out using SAS® statistical software version 9.4.

Results

Forty patients participated in this study; 21 in the treatment group and 19 in the control group. None of the participants recruited into the treatment group were excluded because of concerns regarding the safe use of the Wii Fit balance platform.

In the treatment group, 29 per cent of the participants were male, and the average age was 48 years (standard deviation (SD) = 15). In the control group, 42 per cent of the participants were male, and the average age was 47 years (SD = 16).

The median duration of symptoms for the treatment group was 9.00 months (interquartile range, 7.36–30.34). The median duration of symptoms for the control group was 10.15 months (interquartile range, 5.19–25.23). No significant difference in symptom duration was identified between the two groups after applying the Wilcoxon signed-rank two-sample test ($p = 0.6769$).

Table I reports the questionnaire baseline values for the two groups.

Table II details the numbers of participants who did not complete the trial, and the reasons for failing to complete the trial are provided. The attrition rates for each of the groups were comparable. Of those participants who did not complete the trial for technical reasons in the Wii group, one did not understand how to set the equipment up, one found it difficult to understand how to perform the tasks required, and another discontinued with the exercises as they found them 'boring'.

Table III outlines the overall trial results. Figure 1 illustrates the improvements in Dizziness Handicap Inventory scores for both groups.

Both exercise regimes resulted in a reduction in dizziness scores over time, but there was no statistically significant difference between the two interventions. For the Wii Fit group, all changes from baseline for the Dizziness Handicap Inventory scores were significant ($p < 0.001$). For the customised exercise group, all changes from baseline were significant ($p < 0.0001$

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TABLE I
QUESTIONNAIRE BASELINE VALUES FOR EACH INTERVENTION GROUP

Variable	Wii balance board group				Customised exercises group			
	Patients (*n*)	Mean	SD	95% CI	Patients (*n*)	Mean	SD	95% CI
Dynamic Gait Index score	21	19.81	2.68	18.66, 20.95	19	19.32	5.18	16.99, 21.64
Anxiety score	21	7.43	4.30	5.59, 9.27	18	8.78	4.19	6.84, 10.72
Depression score	21	5.95	3.80	4.33, 7.58	18	7.28	3.74	5.55, 9.00
Nijmegen score	21	22.38	9.29	18.41, 26.36	18	19.94	8.86	15.85, 24.04
Dizziness Handicap Inventory score	21	51.43	17.90	43.77, 59.08	19	49.79	21.53	40.11, 59.47
SF36 physical component summary	19	42.11	9.69	37.75, 46.47	13	40.08	11.92	33.61, 46.56
SF36 mental component summary	19	40.49	10.27	35.88, 45.11	13	45.18	9.01	40.28, 50.08
VAS (visit 4)	12	72.67	21.18	60.68, 84.65	10	46.50	33.25	25.89, 67.11

SD = standard deviation; CI = confidence interval; SF36 = Short Form-36 questionnaire; VAS = visual analogue scale

for weeks 8, 12 and 16, and $p = 0.0019$ for week 4). For the Wii Fit group, the Short Form 36 questionnaire physical health score was significantly different at week 16 compared to baseline ($p = 0.0122$). There were no other significant changes from baseline for either group.

Discussion

Management options for patients with vestibular dysfunction include vestibular rehabilitation, pharmacological interventions and even surgery; however, the latter two options seem to offer only limited improvement.[6] Vestibular rehabilitation is not one simple exercise or protocol; instead, it involves a range of graded exercises consisting of eye, head and body movements designed to systematically stimulate the vestibular system and promote central compensation.

Central compensation is the neurological adaption to altered input from the damaged labyrinth.[7–9] Corroboratory evidence exists for such compensation in animal studies where monkeys and cats with unilateral peripheral vestibular lesions have undergone vestibular exercises.[10,11] Normal compensation relies on three central mechanisms: habituation, adaption and substitution.

TABLE II
EXPLANATION FOR STUDY WITHDRAWAL FOR EACH INTERVENTION GROUP

Parameter	Wii balance board group	Customised exercises group
Total number of participants	21	19
Number of drop-outs	11	8
Explanation for dropping out		
– Better	1	0
– No improvement	0	1
– Unable to get on with technology	3	0
– Other medical problems	2	1
– Personal problems	1	0
– Incomplete follow up or questionnaires	0	4
– Unable to contact	4	2

Data represent numbers of patients

The role of vestibular rehabilitation is to aid compensation for vestibular function loss. It also aims to return patients to their pre-morbid lifestyle, improve confidence, reduce falls, improve balance, reduce fear of falling and improve mobility. Vestibular rehabilitation has been demonstrated to result in a significant reduction in fall risk.[13]

The Cochrane Collaboration assessed the evidence for vestibular rehabilitation[12] and concluded that 'there is moderate to strong evidence that vestibular rehabilitation is a safe, effective management for unilateral peripheral vestibular dysfunction, based on a number of high quality randomised controlled trials'.[12] However, evidence to support one specific form of rehabilitation over another was lacking.

Vestibular rehabilitation programmes are an effective means of treating vestibular dysfunction; they are customised by experienced physiotherapists and/or audiologists, and monitored, often over a 12-week long treatment period.

This pilot study found that dizziness symptoms and general quality of life improved as a consequence of using the Wii Fit balance platform. This finding was replicated in the control group, which followed a standard customised vestibular rehabilitation protocol, and there was no discernible difference in outcomes between the groups.

Video gaming using the Wii Fit balance platform has been used for balance rehabilitation in a number of settings. Sparrer *et al.* used the Wii Fit balance platform in patients with acute vestibular neuronitis, and found the Wii to represent a good, cost-effective and user-friendly alternative to customised exercises.[14] For chronic unilateral vestibular hypofunction patients, similar to the patients identified for our study, Verdecchia *et al.* demonstrated statistically significant improvements in Dizziness Handicap Inventory and Dynamic Gait Index scores and dynamic visual acuity.[15] However, no control group was used for comparison in that study. Meldrum *et al.* have recently published the results of a randomised controlled trial, in which the Wii Fit balance platform was compared with conventional vestibular rehabilitation.[16] Their findings are supportive of our findings, in as much as

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TABLE III
OUTCOME MEASUREMENTS FOR EACH INTERVENTION GROUP

Variable	Wii balance board group (A)				Customised exercises group (B)				Estimated difference between groups (A−B)		
	Patients (*n*)	Mean	SD	95% CI	Patients (*n*)	Mean	SD	95% CI	Mean	95% CI	*p*-value
Difference from baseline											
– DHI – week 4	14	−25.52	23.64	−35.63, −15.41	12	−22.74	27.25	−34.99, −10.49	−2.79	−19.07, 13.5	0.731
– DHI – week 8	9	−36.20	21.87	−45.78, −26.62	8	−31.37	26.47	−43.27, −19.46	−4.83	−20.55, 10.89	0.5373
– DHI – week 12	4	−44.00	19.64	−52.61, −35.39	6	−36.42	22.05	−46.33, −26.51	−7.58	−21.11, 5.95	0.2637
– DHI – week 16	10	−44.60	16.87	−51.99, −37.21	11	−42.32	22.73	−52.54, −32.10	−2.28	−15.23, 10.66	0.7227
– SF36 PCS – week 16	10	8.85	8.96	3.30, 14.40	8	4.84	9.03	−1.42, 11.10	4.01	−5.03, 13.05	0.3607
– SF36 MCS – week 16	10	5.51	12.01	−1.93,12.95	8	3.16	6.78	−1.53, 7.86	2.35	−7.77, 12.46	0.6295
Difference from visit 4											
– VAS – week 16	11	4.09	12.4776	−3.28, 11.46	9	2.78	28.7349	−16.00, 21.55	1.3131	−21.48, 24.11	0.9009

Negative values represent a decrease from baseline. SD = standard deviation; CI = confidence interval; DHI = Dizziness Handicap Inventory; SF36 MCS = Short Form-36 questionnaire mental health score; SF36 PCS = Short Form-36 questionnaire physical health score; VAS = visual analogue scale

they also demonstrated a statistically significant improvement in parameters that reflect an improvement in balance. In addition, Meldrum *et al.* did not identify a statistically significant difference in outcome measures to support the use of the Wii over the use of customised exercises, or vice versa.

Dizziness does not solely represent a physical condition for those with chronic symptoms. Patients with chronic vestibular symptoms develop psychological consequences of their dizziness, including anxiety and depression.[17] As such, it has been suggested that the use of video gaming technology, including the Wii platform, represents an opportunity to improve depressive symptoms in the elderly (via 'exergames' – video games that are also a form of exercise).[18]

Study limitations

There was a significant degree of attrition during the course of this study, with about half of the participants failing to complete the full study protocol. Although this is disappointing, the number of participants dropping out of this study was similar for both interventions, with a comparable proportion of participants citing similar reasons for failing to complete their assigned course of treatment.

Despite the clinically significant findings within the study protocol criteria, further work is required to confirm the suitability of the Wii Fit balance platform in patient populations that require vestibular rehabilitation for more complex causes of vestibular impairment, such as those with bilateral vestibular failure. It is in these situations that the authors would consider customised exercises to be of greater benefit than the generic type of rehabilitation that is provided by the Wii Fit balance platform.

There are a whole range of subjective and objective outcome measures that can be employed to assess the relative success of a particular rehabilitative therapy. Whilst we considered a particular group of measures, there remain many other domains that could be appraised in future trials when considering the suitability of the Wii Fit balance platform for patients with balance problems.

There have been mixed reports regarding the acceptability of using modern technology such as the Wii Fit balance platform in an older population. Laver *et al.* showed that patients preferred conventional physiotherapy to use of the Wii,[19] whereas a study by Sparrer *et al.* found that the Wii was well received by older, computer-inexperienced patients.[14] By virtue of the requirements set out in the patient information for this study, elderly patients or those patients who would consider themselves to be unable to grasp the essentials of video gaming technology would have excluded themselves at the outset.

Implications for future

The NHS in its current form is facing ever-increasing demands, with ever-increasing financial and

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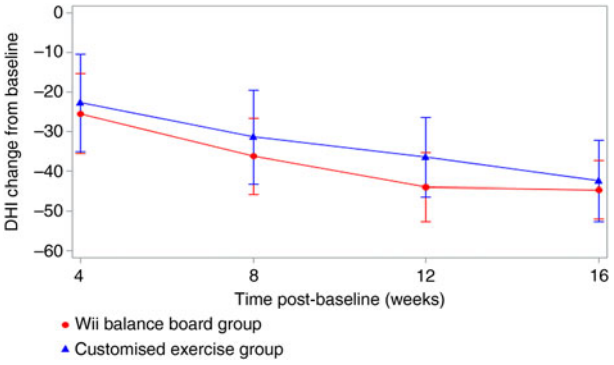

FIG. 1

Plot of change in the mean Dizziness Handicap Inventory (DHI) score over the course of the study for each intervention group.

operational challenges. The use of technology, particularly when implemented outside the hospital setting, provides many advantages to individual patients and the NHS as a whole. The findings of this pilot study add to mounting evidence regarding the role of video gaming technology to improve the health and quality of life of individuals with dizziness and balance impairment. The implementation of video gaming across the board for all types of patient, with all forms of vestibular disorder, would not be appropriate; but when provided to carefully selected patients requiring general vestibular rehabilitation for a defined vestibular loss, with the enthusiasm to engage in such a process, this would be considered a beneficial modality of treatment. The findings of this pilot study, and particularly its limitations, will provide great insight for the planning of a future larger scale study investigating the use of video gaming to improve the rehabilitation of balance disorder patients.

- **Use of low-cost, commercially available gaming consoles for rehabilitation is becoming popular in all areas of medicine**
- **The Wii Fit balance platform has been used in different scenarios to improve outcomes in dizziness and balance disorder patients**
- **This pilot study supports ongoing work in this area, and provides key information to inform further work using the Wii Fit balance platform**

Conclusion

Use of the Wii Fit balance platform resulted in a statistically significant improvement in balance function and quality of life in this pilot study. Furthermore, outcomes were comparable to a similar group of individuals following a standard customised vestibular rehabilitation protocol. This provides useful information to inform the design and execution of a larger clinical trial.

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