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**Title: Use of an interactive video gaming program compared with conventional physiotherapy for hospitalised older adults: A feasibility trial**

Key words: Video Games, Elderly, Exercise, Physiotherapy, Randomized controlled trial

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## **Abstract**

**Purpose:** To assess the feasibility of a physiotherapy intervention using an interactive gaming program compared with conventional physiotherapy for hospitalised older people.

**Methods:** Randomised controlled pilot study in a geriatric rehabilitation unit within an acute public hospital. Participants were randomly allocated to physiotherapy using an interactive gaming program (N=22) or conventional physiotherapy in a ward based gym (N=22).

Feasibility was assessed by comparing the effects of the intervention on clinical outcome measures (primary outcome: mobility as assessed by the Timed Up and Go Test, secondary outcomes: safety, adherence levels, eligibility and consent rates).

**Results:** Participants (N=44) had a mean age of 85 years (SD 4.5) and the majority (80%) were women. Univariable analyses showed no significant difference between groups following intervention. However, multivariable analyses suggested that participants using the interactive gaming program improved more on the Timed Up and Go Test (P=0.048) than participants receiving conventional physiotherapy. There were no serious adverse events and high levels of adherence to therapy were evident in both groups. Only a small proportion of patients screened were recruited to the study.

**Conclusions:** In this feasibility study the use of a commercially available interactive gaming program by physiotherapists with older people in a hospital setting was safe and adherence levels were comparable with conventional therapy. Preliminary results suggest that further exploration of approaches using games as therapy for older people could include commonly used measures of balance and function.

**Key Words:** Video Games, Elderly, Exercise, Physiotherapy, Randomized controlled trial



## **Introduction**

The benefits of exercise for older people have been clearly demonstrated [1-3] however it is still unclear which approach to exercise is most effective for older people who are hospitalised due to illness [4]. Current approaches include practise of walking, strengthening and balance activities which are provided by a physiotherapist.

The use of interactive video games as an alternative to traditional exercise approaches for older people is increasing and the use of these programs in acute hospitals, rehabilitation centres and residential care facilities is often reported in the media [5-7] and leading medical journals [8,9]. The Nintendo Wii has been marketed as a fitness tool for people of all ages and is one of the most widely used interactive gaming consoles in the health and aged care sector [10-13]. Furthermore the Nintendo Wii Fit Plus is the first interactive video game to be endorsed by the United Kingdom's National Health Service Change4Life Program [14]. The Nintendo Wii Fit program consists of games and exercises claimed by the manufacturer to improve strength, balance and fitness. These activities have been shown to improve balance and lower limb muscle strength in a small study involving 10 healthy women aged 30-60 years [15]. Use of the Nintendo Wii Fit as an exercise tool for older people may have some advantages over traditional approaches in that it provides structured exercises and activities, is designed to be fun and motivating and provides detailed feedback on performance. Furthermore, it can be used within a variety of settings, including the person's own home, which offers increased flexibility in the delivery of therapy services.

Despite media coverage and widespread use in clinical settings, published studies evaluating the Nintendo Wii are limited. A pilot randomised controlled trial involving 22 participants showed that use of the Nintendo Wii in stroke rehabilitation was safe, feasible and resulted in improved arm function when compared to participation in general leisure activities (for

example, playing cards) [16]. Evaluation studies of the Wii Fit program for older people have been limited to case studies [17] and non-randomised feasibility studies in outpatient settings [11,13,18].

The endorsement of the Nintendo Wii Fit as a health and fitness tool, its widespread use in health and aged care settings and the lack of published studies indicates that more research is required on its feasibility and effectiveness as an exercise tool for older people. The objective of this pilot study was to determine the feasibility of a physiotherapist providing activities from the Nintendo Wii Fit compared with physiotherapy using a conventional therapy approach in hospitalised older adults. Feasibility was operationally defined by:

(1) Indication of effect: This was measured primarily using the Timed Up and Go Test [19].

Secondary outcomes included measures of balance, activities of daily living function, self efficacy and quality of life.

(2) Safety: Adverse events associated with using the Nintendo Wii Fit in hospitalised older adults when used as prescribed and supervised by the treating physiotherapist.

(3) Adherence to treatment sessions.

(4) Proportion of patients that were eligible and consented to participate in the trial.

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## **Methods**

This study was a single centre, parallel, randomised controlled trial. Ethical approval was granted by the Flinders Clinical Research Ethics Committee and all included participants provided written consent.

## **Participants**

Participants were recruited from the 30 bed geriatric rehabilitation unit at the Repatriation General Hospital; a 300 bed public acute care hospital in metropolitan Adelaide, South Australia. All admissions to the unit between May and December 2010 were screened for eligibility. Inclusion criteria were: aged  $\geq 65$  years, Mini Mental State Examination (MMSE) [20] score of  $\geq 21/30$ , sufficient communication skills to participate, deemed as medically fit to participate by the treating medical team, weighing less than 150kg, able to perform sit-to-stand transfers without physical assistance, previously ambulating independently prior to hospitalisation and adequate vision (measured as 6/18 on the Snellen Chart). Patients were excluded if they were unable to be screened for eligibility within 1 working day of admission (for example, if the person responsible for recruitment to the study was on sick leave, or the patient was unavailable for assessment)).

## **Procedure**

The randomisation sequence was generated by a statistician using Stata 11.0 statistical software and consisted of random blocks of 4 and 6. The allocation sequence was concealed from the researchers in sequentially numbered opaque sealed envelopes and randomisation was managed by an external department (pharmacy). Although it was not possible to blind participants and treating staff, the outcome assessor was blinded to allocation. Patients were assessed for eligibility within 1 working day of admission to the unit by the research therapist (KL) and consenting, randomisation and baseline assessment occurred on the same day in order for intervention to commence on day 2 of the participant's stay on the unit. Participants were randomly assigned to receive either physiotherapy using the Nintendo Wii Fit or conventional physiotherapy.

### **Interventions:**

Participants in the Nintendo Wii Fit group participated in Wii Fit activities selected by the treating physiotherapist to match the patient's individual abilities and treatment needs and included tasks that focussed on balance, strength or developing aerobic capacity. Interaction between the user and program occurs via a wireless pointer and balance board. Balance tasks involved weight shift on the balance board (for example, in one activity the participant is represented on screen as a penguin and has to shift their weight laterally to balance on an iceberg and 'catch fish'). Strength tasks involved exercises for the lower limb such as sustained squats or single leg extension and aerobic tasks included stepping on and off the balance board or walking on the spot. Physiotherapists were trained in using the Wii Fit program with older people and intervention was based on a protocol that outlined appropriate activities from the program and modifications of the activities for older people. Intervention was provided for 25 minutes per day, 5 days per week for the duration of the participant's stay on the unit and took place in an activity room on the unit. During the activity participants were closely supervised by the physiotherapist and were able to use their walking frame or prop their arm on a sturdy chair for safety if required and all activities were performed while standing.

Participants in the conventional therapy group also participated in activities designed to match their abilities and treatment needs. The purpose of conventional physiotherapy was to maximise functional mobility (walking and transfers) in order for the person to be discharged from the unit (preferably to their preadmission place of residence). Treatment sessions included walking, practise of transfers, walking up and down steps, balance tasks (such as standing on a foam block, tapping a balloon or reaching for objects) and strengthening, conditioning and flexibility exercises (for example, use of light weights or stretches). As per



the Wii Fit group, intervention was provided for 25 minutes per day, 5 days per week for the duration of the participant's stay. Treatment was provided in a gym located on the unit equipped with parallel bars, a treadmill and small equipment items such as weights. The same physiotherapists provided both interventions.

### **Outcome Measures**

Assessments were completed at baseline and post-intervention (at the time of discharge from the unit). The primary outcome was functional mobility as measured by the TUG [19].

Secondary outcomes were physical function (measured by the Short Physical Performance Battery (SPPB) [21]), balance (measured by the Modified Berg Balance Scale (MBBS) [22]), activities of daily living (measured by the Timed Instrumental Activities of Daily Living (TIADL) test [23]) and the Functional Independence Measure (FIM) [24]), balance self efficacy (measured by the Activity specific Balance Confidence (ABC) Scale [25]) and health related quality of life (measured by the EQ5D [26]). All outcomes were assessed by the outcome assessor, with the exception of the FIM which was scored by the multidisciplinary team who were trained and certified in administering the measure.

Physiotherapists providing the intervention kept records of treatment sessions including the number of sessions completed, adherence, activities prescribed, participant reports of discomfort and adverse events. The participant's case notes were also reviewed by the research therapist at the time of discharge for documentation of adverse events.

### **Power and sample size**

We investigated the sample size required to show a significant difference between groups for our primary outcome, the TUG. Given a mean (SD) of 34.2 (23) seconds [27] a total of 150 participants were required to detect a difference of 9.2 seconds assuming 80% power and a 2-tailed type 1 error of 0.05. This study is designed as a feasibility study to establish whether

the approach was safe with older hospitalised patients (relative to conventional therapy) and whether commonly used measures such as the Timed Up and Go test would be useful.

### **Statistical analysis**

The associations between outcomes and treatment groups in table 3 were examined using generalized estimating equations with robust standard errors, to account for correlated readings within individuals and provide valid standard errors. Multiple imputation was used for missing data to conduct intention-to-treat analyses. The difference between treatment groups was evaluated through a group-by-session interaction term, where session was the number of Wii Fit or physiotherapy sessions each patient participated in. All random effects multivariable analyses were adjusted for the potential confounders' length of stay, age, gender and disability. We also conducted two other sensitivity analysis; a between groups analysis, adjusting for baseline, length of stay, age, gender and disability; and a within subjects analysis between date of entry and discharge, adjusting for length of stay, age, gender and disability. As an Australian population specific scoring algorithm for the EQ-5D is currently in development and has not yet been made publicly available, the EQ-5D was scored using the existing United Kingdom general population scoring algorithm [28]. A p-value of 0.05 (two sided) was considered to be statistically significant and all analyses were performed on Stata 11.0 (StataCorp LP).

### **Results**

The characteristics of the treatment groups are displayed in table 1. Of the 235 patients admitted to the unit during the study period, 80 patients were eligible for inclusion in the study and 44 of those eligible (55%) were recruited and randomised. Patients that were ineligible for the study were still often appropriate for, and participated in ward based

physiotherapy. Ten patients stated that their reason for not consenting to involvement in the study was that they weren't interested in trying the Wii Fit program and would only want to participate in the conventional therapy. Figure 1 presents the flow of participants through the trial.

*Insert figure 1 about here*

The majority of participants were female (80%) and the average age of participants was 84.9 years (SD 4.5).

*Insert table 1 about here*

All participants received their allocated intervention and adherence levels (participation in the scheduled therapy sessions) of both groups were high, averaging 90% adherence in the Wii Fit group and 91% adherence in the conventional therapy group. A slight difference in the mean length of stay between groups resulted in a difference in the mean number of intervention sessions, with participants in the Wii Fit group receiving an average of 6 (SD 2) allocated intervention sessions and participants in the conventional therapy group receiving an average of 8 (SD 5) allocated intervention sessions.

No serious adverse events occurred during the Wii Fit intervention sessions however several participants reported discomfort (3 participants 'felt giddy', 1 participant reported neck strain from looking at the wall mounted television, 5 participants reported musculoskeletal pain and 1 participant reported mild chest pain during a session). Within the conventional therapy group, 1 serious adverse event was reported with a participant experiencing a conscious collapse during the intervention session (assessed by the medical team as a vasovagal episode). Other complaints included 2 participants 'feeling giddy', 1 participant 'feeling sick' and 5 participants reporting musculoskeletal pain. Three participants from the Wii Fit group fell while on the unit in comparison to 1 fall reported from the conventional therapy group however none of the falls occurred during the intervention sessions.

Two participants allocated to the Wii Fit group discontinued intervention; one participant was forced to withdraw following a fall which resulted in a pelvic fracture and inability to weight bear, and another participant chose to withdraw due to disappointment with her progress after 8 sessions using the Wii Fit and a perception that conventional therapy would have been more beneficial. None of the participants allocated to the conventional physiotherapy group withdrew.

The results of the assessments prior to, and post intervention, are presented in table 2.

*Insert table 2 about here*

Analyses were performed to determine the efficacy of Wii Fit versus conventional physiotherapy. Univariable analyses showed no difference between groups for the primary or secondary outcome measures. The results from the random effects multivariable analyses using number of interventions as the time variable and adjusting for length of stay, age, gender and baseline function (FIM score), are presented in table 3. The change in outcome was based on the number of intervention sessions the participants completed during their stay in hospital. Therefore the results from the multivariable analyses indicate that participants in the Wii Fit group improved on average 1.26 seconds per session on the TUG (P=0.048) and performed better per session on the MBBS (P=0.042) compared to those on conventional physiotherapy. No statistically significant differences were found between groups in the adjusted multivariable analyses for the SPPB, Timed IADL Test, ABC Scale or EQ5D.

A between groups analysis revealed as expected no significant differences between TUG 0.11 (-0.11, 0.32) and MBBS 2.22 (-1.84, 6.28). Similarly, a within subject analysis using the categorical time points of entry and discharge showed non-significant changes in TUG -3.54 (-14.61, 7.52) and MBBS 2.87 (-1.67, 7.42).

*Insert table 3 about here*

## **Discussion**

In this pilot study we found that the Nintendo Wii Fit, when used by physiotherapists was feasible however only a small proportion of hospitalised older adults were capable of, and willing to participate in this type of therapy. Feasibility in this select group of patients was demonstrated by the functional gains experienced, the lack of serious adverse events and high levels of adherence to therapy.

Univariable analyses showed no significant difference between groups post intervention, suggesting that outcomes from use of the Nintendo Wii Fit in physiotherapy are comparable with those achieved from participation in conventional physiotherapy. Furthermore, whilst the numbers were small, our results raised the possibility that this approach may be more useful in retraining functional mobility (as measured by the TUG) and balance (as measured by the MBBS). The finding of significant results in our small pilot study indicates that larger adequately powered studies are warranted and suggests that the Wii Fit has the possibility to be a useful therapeutic tool. Sensitivity analyses were not significant which may be due to the limited sample size. If larger studies confirm these findings it will provide therapists and patients with more choice in regards to therapy approaches used.

The findings from this study are consistent with other case and feasibility studies that suggest that use of the Nintendo Wii Fit can improve balance and mobility [11,15,17,18]. This pilot study used a randomised controlled design with older people and suggests that this approach to mobility and balance training is feasible and appears comparable to conventional physiotherapy in a hospital setting. It must be noted that both groups made relatively narrow functional gains which may be a reflection of both the participant group and the length of stay on the unit.

It is important to note that of the 235 individuals originally approached for inclusion in the study, only 44 participants (19%) were able to be recruited and randomised. Therefore, regardless of the effectiveness of the Wii Fit intervention, the intervention is only likely to be

applicable to a relatively small proportion of a hospital population and clinicians should consider whether purchase of the program is justified. Several patients that were eligible for inclusion in the study reported an aversion to trying the Wii Fit program and did not consent to participation in case they were allocated to this group. In addition, while there were no withdrawals from the conventional therapy group, one of the participants allocated to the Wii Fit group withdrew as she perceived the intervention to be less effective than conventional therapy. A nested study of participant preferences was conducted using discrete choice experiment methodology [29]. Results revealed that although participants initially expressed no significant preference for mode of therapy, (that is when choosing between participation in conventional therapy and therapy using the Nintendo Wii Fit they did not prefer one type of therapy over another), after experimenting with the Wii Fit, participants stated that they preferred the more conventional approach. These findings suggest reduced acceptability of the Wii Fit program as a therapy approach in this population and approaches to increase the acceptability need to be explored. Clinicians wishing to use the Wii Fit as a therapy tool may find that younger patients are more comfortable with this approach and that patients may be more inclined to try the technology if encouraged or supported by younger relatives such as children or grandchildren who are likely to be more technologically savvy.

With the exception of the costs of the Wii Fit program and therapy equipment, the costs of providing both interventions in this study were approximately equal with both interventions delivered by the same staff for the same amount of time. However, it is possible that in the future, following assessment and training with a physiotherapist, the intervention could be delivered by therapy assistants or as part of a home exercise program which may offer a more cost effective approach to rehabilitation service delivery than conventional hospital based rehabilitation therapy. The safety of older people using the Wii Fit program independently at home was assessed by Agmon et al [18]. The researchers found that seven community-

dwelling older adults (mean age 84 years) were able to safely and independently use the Wii Fit in their home environment following several training sessions with a physiotherapist. Furthermore, participants reported improved balance and high levels of enjoyment in the activity. However, it should be noted that the participants nominated themselves to be involved in the study and that the exclusion criteria was highly restrictive. For example, people were excluded if they had evidence of cognitive impairment or regularly used a walking aid. The authors acknowledged that their findings were not generalisable to all older adults. Given the structured nature of the Wii Fit activities it is possible that once prescribed, intervention could be supervised by therapy assistants however further research is required to determine if this approach is as safe or effective. As both groups only received 25 minutes of therapy, use of the Wii Fit may offer an opportunity to supplement the amount of exercise provided in a hospital environment.

It is likely that with time, further developments in interactive video gaming will occur and the technology will become more advanced, less costly and more appropriate for older people. Furthermore, future generations may be more inclined to embrace this approach to therapy, given their increased familiarity with computers and technology. Based on these factors the future of this approach in therapy appears promising. As the Nintendo Wii Fit was designed as a fitness program for members of the general public, virtual reality programs that are specifically designed for older people may be more effective and acceptable to this population and warrant further development and investigation.

### **Study limitations**

Given that only a small proportion of patients admitted to the unit could be recruited, the findings of this study are not necessarily generalisable to all hospitalised older adults and are a reflection of the study inclusion criteria. It is important that larger randomised controlled studies are conducted to verify these preliminary findings in larger samples of older people.

Further research is also warranted to explore the effectiveness of the program when administered by therapy assistants as opposed to physiotherapists and utilisation of the program as a supplement to rather than a replacement for conventional therapy.

### **Conclusion**

The findings from this study suggest that use of the Nintendo Wii Fit by physiotherapists with hospitalised older people is feasible with a small proportion of patients. Customised virtual reality programs that are specifically designed for the rehabilitation of older people warrant further development and investigation in this population as they may increase the acceptability of the approach.

### **Implications for rehabilitation**

- The use of an interactive gaming program by physiotherapists with hospitalised older people appeared to be safe and resulted in improvements in balance and mobility.
- Use of these programs may be limited to a relatively small proportion of older people; those able to use, and interested in this technological approach to therapy.

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The authors report no declarations of interest.



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