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Physical and Psychosocial Effects of Wii Fit Exergames Use in Assisted Living Residents: A Pilot Study

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Abstract

The purpose of this study was to investigate the physical and psychosocial effects of the Wii Fit exergames incorporating self-efficacy theory on assisted living residents. The study was a quasi-experimental pre/post-test design. Thirty-two participants were recruited from two assisted living facilities. Sixteen participants received the Wii Fit exergames incorporating self-efficacy theory twice a week for 4 weeks. The other participants received a health education program. Physical function, fear of falling, depression, and quality of life were evaluated. *T* tests were used for data analysis. After the 4-week intervention, the Wii Fit group showed significant improvements in balance ($p < .01$), mobility ($p < .01$), and depression ($p < .05$). The education group showed no significant improvement in any of the outcomes. Integrating

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concepts of self-efficacy theory with the exergames show promise as a potential tool to improve and maintain physical and psychosocial health for older adults.

Keywords
exergames, older adults, exercise, self-efficacy theory

Introduction

An aging population is growing rapidly in the United States (U.S. Department of Health and Human Services, 2014). Assisted living facilities (ALFs) have become a popular and less costly option for many older adults. A national survey estimates that the cost of nursing home care is twice that of ALF care. For example, in 2013, the average annual rate for a private room in a nursing home was US$83,950 compared with US$41,400 for an ALF (Genworth Financial, 2013). ALF residents are at risk of mobility decline, cognitive impairment, and depression that can precipitate nursing home placement (National Center for Assisted Living, 2001). For this reason, interventions that prevent function decline and promote independence are important to enable older adults to remain in ALFs, and delay or prevent the need for nursing home placement, thereby decreasing health care cost.

Background

In recent years, the Nintendo Wii exergames (interactive exercise video program) are broadly used in health care facilities. Compared with traditional exercise devices, the Wii exergames provide meaningful, intensive, enjoyable, and purposeful activities. The exergames provide an attractive audio/visual feedback, which may engage and motivate individuals to use the program. In addition, the exergames can respond to changes in direction, speed, and acceleration (Lange et al., 2010). Studies have found that using Wii exergames has improved balance, balance confidence, mobility, cognitive performance, as well as decreased anxiety and depression, and improved health-related quality of life in older adults (Rendon et al., 2012; Rosenberg et al., 2010; Williams, Soiza, Jenkinson, & Stewart, 2010). Studies show that self-worth, motivation, and activity enjoyment are important factors for long-term exercise adherence, and exergames can enhance these factors (Lange et al., 2010; Shubert, 2010). As such, exergames offer a venue to help increase exercise and exercise adherence of older adults.

Self-efficacy theory (Bandura, 1997) has been applied to exercise programs to motivate older adults to exercise, and has demonstrated positive physical and psychosocial effects (Lee, Arthur, & Avis, 2008; Resnick, 2003). According to Bandura's (1997) self-efficacy theory, there are four approaches to increase an individual's self-efficacy, including enactive mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective feedback. These approaches can be applied to the exergames intervention. For example, positive psychological feedback (e.g., enjoyment) makes individuals more likely to continue to exercise. In addition, individuals may increase self-efficacy to exercise if they can successfully perform the tasks.

Hence, the principal investigator (PI) designed the Staying Active, Healthy Aging (SAHA) program, which integrated self-efficacy theory into Wii Fit exergames, to enhance the motivation of ALF residents to engage in exercise. Our previously conducted pilot study suggests that integrating self-efficacy theory into exergames is an effective mechanism for encouraging older adults to engage in exercise. We found that residents had a significant improvement in balance after an 8-week SAHA program (Chao, Scherer, Wu, Lucke, & Montgomery, 2013). For the present study, we shorten the SAHA program from 8 weeks to 4 weeks and expanded it to a larger population because significant improvement on balance was found using the same exercise frequency and a 4-week exercise time frame was found to be effective in promoting exercise in a study by Williams et al. (2010). In addition, we added an education group to serve as the control group for this study.

Purpose of the Study

The purpose of this study was to examine the difference in physical function, fear of falling, depression, and quality of life for ALF residents who received the SAHA intervention and those who only received the health education program.

Method

Study Design

The study was a quasi-experimental pre/post-test design. The study was conducted in two 110-bed affiliated ALFs in a suburb of Buffalo in Western New York after obtaining approval from the Health Science Institutional Review Board (HSIRB) of the University at Buffalo, the State University of New York. Two ALFs were randomly assigned to either the Wii Fit group or the education group. The Wii Fit group received the SAHA intervention twice a week for 4 weeks. The education group received health education material once a week. Four research assistants (RAs) were trained to implement the study protocol prior to initiation of the program, including implementing self-efficacy concepts, administering the Wii exergames, and recognizing signs and symptoms requiring termination of the exercise. All the RAs were cardiopulmonary resuscitation (CPR) certified. Evaluations were conducted at pre-intervention (Week 0) and post-intervention (Week 5).

Recruitment Procedure

After having HSIRB approval, the PI met with the administrators and obtained their approval to conduct the study in their facilities. Then, recruitment flyers were sent to all residents and the study was announced in the resident council. In addition, activity leaders and nurses helped to identify potential participants. Next, medical clearance forms were obtained by the PI from primary physicians or nurse practitioners for those residents who were interested in study. Afterward, the two facilities were randomized by drawing sealed envelope. Then, informed consents were obtained from residents who were eligible and willing to participate in the study.

Sample

Eighteen residents from the Wii Fit site showed interest in joining the study; however, two were not able to obtain medical clearance from their primary physician for study participation. Seventeen residents from the education site expressed an interest in participating in the study; however, one became hospitalized at the start of the study and was unable to participate. A total of 32 residents (16 from each ALF) were recruited to participate in the study. Inclusion criteria for the potential participants were (a) age 65 or greater, (b) able to ambulate independently or with the use of assistive devices, (c) able to read and speak English, and (d) able to follow instructions. Excluded from participation were those for whom exercise was contraindicated according to the American College of Sports Medicine (2010), such as uncontrolled blood pressure, cerebral hemorrhage within the past 3 months, or fracture in healing stage.

Intervention

Wii Fit Group. Sixteen participants in the Wii Fit group received the SAHA program. Seven of them had experienced using Wii Bowling in the sitting position, which was held monthly at the facility. However, no study was implemented to investigate the effects of the Wii exergames in these residents. In this study, participants were offered regular standing exercise by using Wii Fit exergames. The SAHA program consisted of a motivational intervention and Wii Fit exergames (Chao et al., 2013). Four strategies used in the motivational intervention to enhance residents' exercise self-efficacy were based on Bandura's (1997) self-efficacy theory, including enactive mastery experiences (e.g., goals setting, discuss performance, and progress), vicarious experiences (e.g., role modeling, storytelling), verbal persuasion (e.g., education, support, and encouragement), and physiological and affective feedback (e.g., monitoring emotional and physical burden, and managing any discomfort). In addition, an exercise-related poster and health education booklet were given to each resident. Topics of health education consisted of the benefits of exercise, how to get started with exercising, safety issues, and how to stay active (National Institute on Aging, 2011). PI discussed each topic with participants at the beginning of each section.

Wii Fit consists of four types of exercise that were used as an exercise device. The program was conducted twice a week for a total of 4 weeks with each session lasting approximately 60 minutes. Sixteen participants were grouped in teams of two. During each session, the participants on each team took turns participating in the gaming activities. Each participant exercised about 30 minutes and spent the other 30 minutes observing and providing encouragement to their partner. Six games from four types of exercise were performed in combination, including aerobic exercise (basic run), a strength exercise (lunge), two balance exercises (penguin slide and table tilt), and two yoga exercises (chair and deep breathing). By the third week, participants were encouraged to perform the "lunge" activity twice during each session, because this strength exercise has been shown to offer the greatest benefit for physical function (Gu & Conn, 2008). Thus, time spent on other gaming activities was decreased to accommodate 30 min of exercise for each team member during each session (Tables 1 and 2). Participants were allowed to perform gaming activities at their own pace and at their own level of tolerance. In addition, game levels and time spent on each game were adjusted depending on the participants' performance. All exercise sessions were supervised by two RAs. A 4-point walker was placed around the Wii balance board for any participant who needed it for stability.

Education Group. The other 16 participants received a 30-min health educational session once a week for a total of 4 weeks. Participants received an exercise-related poster and a health education booklet, the same as the Wii exergame group. RAs met with participants on a one-to-one basis. Different health education topics were discussed with participants (Table 1). Participants were encouraged to join the routine exercise activity held in the facility. No record or amount of physical activity was calculated for this group.

Table 1. Program Schedule.

Week	Education group	Wii Fit group
1	1. How exercise can help you? 2. How to get started exercising? 3. Stay safe.	**Exergames:** Warm-up (5 min) → basic run (5 min) → table tilt (4 min) → lunge (4 min) → chair (4 min) → penguin slide (6 min) → deep breathing (2 min).
2	1. Preventing injury. 2. Getting the right shoes. 3. How to stay active.	**Health education**: Same as education group.
3	1. Four types of exercise. 2. Flexibility exercise. 3. Balance exercise.	**Exergames**: Warm-up (5 min) → basic run (5 min) → table tilt (4 min) → lunge (4 min) → chair (2 min) → penguin slide (4 min) → lunge (4 min) → deep breathing (2 min).
4	1. Strength exercise. 2. Endurance exercise. 3. Keep going.	**Health education**: Same as education group.

Table 2. Exergame Descriptions.

Games	Description
Basic run	The user walks or runs along the paths and routes.
Table tilt	The user is required to shift his or her weight in all directions on the balance board to direct balls into holes on the shifting platform.
Lunge	The user performs lunge exercise (10 times) on each leg.
Chair	The user performs the squat pose.
Penguin slide	The user is represented as a penguin. He or she is required to lean left and right on balance board to make a penguin catch as many fish as possible.
Deep breathing	The user takes several deep breaths in sync with the blue circle on the interface.

Measures

Participant characteristics including medical conditions and current physical limitations were collected from the medical record. Physical function tests and interview-styled surveys were administered by RAs at pre-test (Week 0) and at post-test (Week 5) to assess the physical and psychosocial impact on all participants in the study. Physical function tests included Berg Balance Scale (BBS-14; Berg, Wood-Dauphinee, Williams, & Maki, 1992), Time Up and Go Test

(TUG; Podsiadlo & Richardson, 1991), and Six-Minute Walk Test (SMWT; Steffen, Hacker, & Mollinger, 2002). Interview-styled surveys included a 15-item Geriatric Depression Scale (GDS-15; Sheikh & Yesavage, 1986), SF-8™ Health Survey (SF-8; Ware, Kosinski, Dewey, & Gandek, 2001), Falls Efficacy Scale (FES; Tinetti, Richman, & Powell, 1990), and Self-Efficacy for Exercise Scale (SEE; Resnick & Jenkins, 2000). Details about the score scheme, validity, and reliability of each measure are located in Table 3.

Data Analysis

Data were analyzed using SPSS 19.0 (SPSS Inc., Chicago, IL, USA). Sample characteristics were reported in descriptive statistics. A paired *t* test was used to examine intragroup change between pre-test (Week 0) and post-test (Week 5). An independent *t* test was used to examine any intergroup differences between the two groups. Significant results were considered if $p < .05$.

Results

Participant characteristics are depicted in Table 4. Eight were male (25%) and 24 were female (75%). All participants were Caucasian. The age of the participants ranged from 68 to 98 years ($M \pm SD$ = 85.19 ± 6.47). At pre-test, there were no significant differences between the Wii Fit group and education group for age, gender, education, the number of comorbidities, and the use of assistive devices (walker or cane). One participant dropped out of each group due to medical reasons. Hence, a total of 30 participants (15 in each group) were used in the data analysis of each outcome variable.

There were no study-related adverse events reported during the intervention. Table 5 summarizes the outcome measures for both the Wii Fit group and the education group. Intragroup analysis demonstrated that the Wii Fit group showed significant improvement in balance ($p < .01$) measured by the 14 tests of BBS. In particular, participants improved significantly in placing alternating feet on the stool while unsupported ($p < .01$), and in standing unsupported with one foot in front of the other ($p < .01$). In addition, the Wii Fit group spent significantly less time completing the TUG ($p < .01$), and experienced significantly fewer signs of depression ($p < .05$) at post-test. Analysis of the self-efficacy outcome measures showed that the FES scores and SEE scores were comparable at pre- and post-test within the groups. Intergroup analysis showed that there was no significant difference in any of the outcomes at pre-test. However, there was a significant difference in SF-8 mental health-related quality of life ($p < .05$) between both groups at post-test.

Table 3. Outcome Measures.

Instrument	Scoring scheme	Validity/reliability
Physical function		
BBS-14 (Berg et al., 1992)	• 14-item scale • 0 (inability to complete the test) to 4 (the highest competence in completing the task) • Score range: 0 to 56 • Higher scores indicate better balance	• Good criterion and construct validity • Internal consistency (Cronbach's α = .92-.98), test–retest reliability (ICC = .98)
TUG (Podsiadlo & Richardson, 1991)	Time to complete the 3-meter walk	• Good concurrent validity • Internal consistency (Cronbach's α = .96)
SMWT (Steffen et al., 2002)	The maximum distance (feet) walked in 6 min	• Good construct validity • Test–retest reliability (ICC = .94-.95)
Depression		
GDS-15 (Sheikh & Yesavage, 1986)	• 15 items • Dichotomously (yes/no) • Higher scores indicate more depressive symptoms	• Good construct validity • Internal consistency (Cronbach's α = .87)
Health-related quality of life		
SF-8 (Ware et al., 2001)	• 8 items • Each item: 5 or 6 point • Higher scores indicate better health status	• Excellent convergent validity • Test–retest reliability (ICC = .8-.88)
Self-efficacy		
FES (Tinetti et al., 1990)	• 10-item Likert-type scale • 1 (extreme confidence) to 10 (no confidence) • Scores range: 10 to 100 • Higher scores indicate lower confidence in performing daily activities without falling	• Good concurrent and construct validity • Good test–retest reliability; high internal consistency
SEE (Resnick & Jenkins, 2000)	• 9-item Likert-type scale • 0 (not confident) to 10 (very confident) • Scores range: 0 to 10 • Higher mean scores indicate higher strength of efficacy expectations	• Good validity • Reliability (Cronbach's α = .89-.94)

Note. BBS = Berg Balance Scale; TUG = Timed Up and Go Test; SMWT = Six-Minute Walk Test; GDS-15 = Geriatric Depression Scale; SF-8 = SF-8™ Healthy Survey; FES = Falls Efficacy Scale; SEE = Self-Efficacy for Exercise Scale; ICC = Intra-class correlation coefficient.

Table 4. Participant Characteristics.

	Wii Fit group (n = 16)	Education group (n = 16)	p value
Age in years ($M \pm SD$)	86.63 ± 4.18	83.75 ± 8.04	.22
Body Mass Index (Kg/m^2) ($M \pm SD$)	26.45 ± 5.52	26.26 ± 4.96	.56
Years of education ($M \pm SD$)	13.06 ± 2.44	12.19 ± 2.46	.32
Number of comorbidities ($M \pm SD$)	4.31 ± 1.50	4.50 ± 1.83	.53
Race (Caucasian)	100%	100%	—
Gender (male/female)	5/11	3/13	.41
Use of assistive device, no. (N/Y)	3/13	6/10	.24

*p < .05. **p < .01.

Table 5. The Effects of a Wii Fit (n = 15) and Health Education (n = 15) Interventions on Measured Outcomes.

Outcome	Group	Pre-test ($M \pm SD$)	Post-test ($M \pm SD$)	Intragroup change p value	Pre-test intergroup p value	Post-test intergroup p value
Physical function						
BBS-14	Wii Fit	40.53 ± 6.59	43.93 ± 6.34	.00**	.83	.59
	Education	41.20 ± 10.30	42.13 ± 11.20	.26		
TUG (sec)	Wii Fit	18.52 ± 5.60	15.27 ± 4.68	.01**	.80	.51
	Education	19.41 ± 12.63	18.11 ± 15.81	.29		
SMWT (m)	Wii Fit	240.24 ± 103.69	262.86 ± 103.07	.12	.24	.23
	Education	195.12 ± 103.40	216.22 ± 104.05	.12		
Depression						
GDS-15	Wii Fit	2.67 ± 2.44	2.00 ± 2.04	.02*	.40	.12
	Education	3.53 ± 3.07	3.47 ± 2.92	.92		
Health-related quality of life						
SF-8: PCS	Wii Fit	44.94 ± 7.51	45.75 ± 7.95	.60	.39	.75
	Education	47.53 ± 8.68	46.76 ± 9.05	.73		
SF-8: MCS	Wii Fit	50.75 ± 5.41	52.98 ± 5.94	.10	.95	.04*
	Education	50.95 ± 9.91	48.69 ± 5.23	.46		
Self-efficacy						
FES	Wii Fit	23.6 ± 12.48	24.13 ± 9.91	.85	.73	.78
	Education	21.93 ± 13.28	22.80 ± 15.42	.56		
SEE	Wii Fit	6.37 ± 1.54	7.02 ± 1.91	.11	.07	.05
	Education	4.53 ± 3.03	5.05 ± 3.50	.59		

Note. BBS = Berg Balance Scale; TUG = Timed Up and Go Test; SMWT = Six-Minute Walk Test; GDS-15 = Geriatric Depression Scale; SF-8 = SF-8™ Healthy Survey; PCS = physical component summary; MCS = mental component summary; FES = Falls Efficacy Scale; SEE = Self-Efficacy for Exercise Scale.
*p < .05. **p < .01.

Discussion

The findings from this study demonstrated that regular exercise using Wii Fit exergames is a potentially effective approach to improve physical function for ALF residents. First, participants in the Wii Fit group had significant improvements in balance. The results of significant improvement in balance after Wii Fit intervention were supported by previous studies (Chao et al., 2013; Williams, Doherty, Bender, Mattox, & Tibbs, 2011; Williams et al., 2010). At the pre-test of this study, many participants had refused to place their foot on the stool and/or stand with one foot in front of the other without support while testing balance measured by the BBS-14. However, participants were more confident in performing these tasks by the end of the study. One reason may be that participants had been required to step on the Wii balance board to perform Wii Fit gaming activities. In additional, the trusting relationships that developed between participants and the RAs made participants more willing to perform each test of the BBS-14 because they believed that RAs would help to ensure that they would not fall. Second, participants in this study showed significant improvements in their mobility measured by TUG. Similar results were also found in the previous studies using Wii Fit as an exercise device (Esculier, Vaudrin, Bériault, Gagnon, & Tremblay, 2012; Jorgensen, Laessoe, Hendriksen, Nielsen, & Aagaard, 2013; Laver et al., 2012). Our study did not show significant improvements in walking distance measured by the SMWT; however, a significant improvement in walking distance was reported by Esculier et al. (2012). But, the exercise prescriptions varied from 2 to 3 days a week, for 4 to 6 weeks, with 30 to 40 min of exercise per session across studies evaluating balance, mobility, and walking distance. Hence, the effects of the exercise program on physical function in older adults could be related to differences in the exercise prescription (e.g., frequency and duration) and sample characteristics (e.g., age and comorbidities).

Another interesting finding was that the Wii Fit group showed significantly fewer depressive symptoms at post-test. Increased peer support, social interaction, enjoyment, and a sense of accomplishment had been reported by the participants and could have contributed to improved depression scores. Hence, the SAHA program could lead to greater social interaction and less loneliness. Also, results showed that there was a trend in improved mental health-related quality of life at the post-test. Similar results were also reported in previous studies (Rosenberg et al., 2010; Wollersheim et al., 2010). Although the intragroup results of FES and SEE in Wii Fit group were comparable at pre-test and at post-test, participants did improve the balance confidence and the level of confidence to exercise. Participants reported that they felt more comfortable stepping on to the balance board because they now knew how to control their balance while playing the games. Participants also stated that they enjoyed the program and would like to continue to exercise after the program. A couple of residents suggested to the ALF administrator that Wii exergames should be continued in the facility.

Conversely, the education group had no significant improvements on any of the outcome measures. However, there was an improved trend in balance, mobility, and walking distance which indicated that health education may also be beneficial to this population. In this study, we failed to keep an exercise dairy of each individual in the control group. Using an objective instrument (e.g., ActiGraph) in a future study to record the activity of individuals could provide this missing information. When comparing the Wii Fit group and education group, a significant difference was found in mental health-related quality of life measured by the SF-8. The differences may be due to two reasons. First, the RAs spent 1 hr a week with each participant in the Wii Fit group, but 30 minutes a week for each participant in the education group. Second, the design of the intervention for the Wii Fit group was group based, but the intervention for the education group was a one-to-one format, which may have resulted in the psychosocial differences between two groups. Hence, a more extensive interaction with the RAs and group participation could influence the affective state which may potentially explain the differences in the mental component of the SF-8 between two groups.

There were some limitations of the study. First, sample size was small and all participants were Caucasian. In addition, the study was only conducted at two ALFs in Western New York which limits the generalizability of the findings. Second, although these two facilities were under the same organizations, the participants in the education group had a wider range of health conditions than those in the Wii Fit group which may impact the results of outcome measures. Third, a higher percentage of females live in the ALFs which resulted in more female participants in the study. The unequal enrollment number of males and females may have affected the results. Other limitations included non-blinded assessors, Hawthorne effect, and failure to document participants' additional exercise outside of the programs.

Application

Our findings showed that a self-efficacy theoretical-based intervention that combined with Wii exergames had positive benefits on balance, mobility, and psychosocial effects among ALF residents. After the 4-week SAHA program, participants showed significant improvements in balance, mobility, and decreased depressive symptoms. In addition, this study showed that integrating self-efficacy theory with exergames can be an effective method for motivating older adults to perform physical activity. However, there are limited nursing staff resources in the ALF. Having exergames led by activity leaders, trained nurse aides, or volunteers such as family/friends might make this form of exercise more translatable to the ALF setting. In particular, nurse aids play a critical role in encouraging older adults to engage in physical activity in the long-term care settings. Studies showed that nurse aides could successfully implement and disseminate restorative care activities in nursing homes and ALFs (Resnick, Galik, Gruber-Baldini, & Zimmerman, 2009; Resnick, Gruber-Baldini, et al., 2009). Further research is needed to test the feasibility and effectiveness of an exergaming intervention led by trained nurse aides. In addition, measuring nurse aides' job satisfaction and self-efficacy to implement exergaming activities are suggested in the future studies. Moreover, measuring outcomes at 6 months and 1 year following the intervention would better determine long-term effects of the intervention as well as the most effective length for the program. However, age- or health-related cognitive and sensomotor impairments might affect participants' performance. Therefore, selecting appropriate gaming activities and providing encouragement are important for the senior players. In addition, specifically designed interface (simple menu structures) and games (e.g., large font and slow moving images), simple controllers, and reconfigured support frames are needed to provide a positive gaming experience for senior players. Overall, the study can champion the importance of the application of exergames in older adults and does provide guidance for future research.

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