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Exergames for Subsyndromal Depression in Older Adults: A Pilot Study of a Novel Intervention

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Abstract

Objectives—Subsyndromal depression (SSD) is several times more common than major depression in older adults, and is associated with significant negative health outcomes. Physical activity can improve depression, yet adherence is often poor. We assessed the feasibility, acceptability, and short-term efficacy and safety of a novel intervention using exergames (entertaining video games that combine game play with exercise) for SSD in older adults.

Methods—Community-dwelling older adults (N = 19, age 63–94) with SSD participated in a 12-week pilot study (with follow-up at 20 to 24 weeks) of Nintendo’s Wii Sports, with three 35-minute sessions a week.

Results—86% of enrolled participants completed the 12-week intervention. There was a significant improvement in depressive symptoms, mental health-related quality of life, and cognitive performance, but not physical health-related quality of life. There were no major adverse events, and improvement in depression was maintained at follow-up.

Conclusions—The findings provide preliminary indication of the benefits of exergames in seniors with SSD. Randomized controlled trials of exergames for late-life SSD are warranted.

Keywords

Physical activity; Aging; Videogames; Depression; Quality of life; Cognition

INTRODUCTION

Among older people, subsyndromal depression (SSD) is several times more common than major depression, and is associated with substantial suffering, functional disability, increased use of costly medical services, and higher mortality (1,2). There is a dearth of safe, evidence-based interventions tailored to older persons with SSD that can be delivered in the home (3).

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In public health, level of physical activity is a key modifiable behavior for improving physical health conditions and functioning, and reducing depressive symptoms in late life (4). Yet, fewer than 5% of older adults meet physical activity recommendations (5). There have been several randomized controlled trials of physical activity interventions to reduce major depression and SSD, with promising results when the exercise program is maintained (6). However, non-adherence is a key barrier to most exercise programs, with a drop-out rate of approximately 50% within 3–6 months. Older adults with depression may be at particular risk for diminished enjoyment of physical activity, and therefore, more likely to stop exercise prematurely. Recently there has been a rapid growth in popularity and use, among the elderly, of “exergames” – entertaining video games that combine game play with significant physical exercise by using physical input devices (7). Exergames such as Nintendo’s Wii are being increasingly used in senior centers and retirement communities. While there is some evidence in children and adolescents that exergames reduce sedentary behavior and improve mood (8), studies of exergames among older adults with depression are lacking.

Exergames can be home-based and intrinsically reinforcing and, therefore, may improve engagement and sustainment in physical activity programs. We report here results of a 12-week open trial evaluating feasibility, acceptability, and short-term effects of exergames (Nintendo’s Wii sports) in older adults with SSD. We hypothesized that there would be significant improvement in depressive symptoms, health-related quality of life (QoL), and cognitive functioning.

METHODS

The protocol was approved by the local IRB, and all participants signed a written informed consent. Approval was also obtained from each participant’s primary physician. Participants were recruited through senior community centers and retirement communities in San Diego County. Inclusion criteria were: aged > 60 years, fluent in English, and meeting screening criteria for SSD. Currently there is no consensus approach to the construct of SSD. Criteria-based definitions for depressive syndromes fail to include a large proportion of those with clinically significant depressive symptoms. We employed a definition based on the Judd et al. (9) criteria for SSD, which require the presence of any depressive symptom beyond a threshold level. This definition did not differ in functional impairment from other definitions of SSD among older primary care patients (10). Participants were excluded if they met criteria on the Mini International Neuropsychiatric Interview for current major depression, primary anxiety disorder, bipolar disorder, schizophrenia, or substance use disorder; had a score < 24 on the Mini-Mental State Examination (MMSE) (11); were taking anti-depressant medication; or failed to complete the Timed Up and Go (TUG) task in < 14 seconds (12). The TUG tests the time it takes to rise from an arm chair, walk 3 meters, turn, walk back, and sit down. A TUG score of ≥ 14 seconds has been shown to correlate with poorer balance, gait speeds, and activities of daily living as well as a higher incidence of falls (12).

Of the 59 persons who responded to recruitment flyers, 22 individuals (aged 63 to 94 years) met the criteria and consented to participate, and 19 of them completed the 12-week study. Two participants dropped out prior to 6-week assessment and one between 6- and 12-week assessments; the reasons included medical problems unrelated to the study, unexpected caregiving duties, and time constraints, respectively.

We employed the Nintendo’s Wii gaming console. It included the Wii Sports game package, consisting of five games (tennis, bowling, baseball, golf, and boxing). These are played using the Wii Remote—a wireless device with motion sensing capabilities. A player uses arm/body motions that simulate actions engaged in playing the actual sport (e.g. swinging the Wii Remote like a tennis racket for Wii Tennis).

Participants played the Wii Sports games in their residential facility or a senior center for three 35-minute sessions per week. Staff members set up the equipment, and trained the participants in the use of Wii during initial sessions. Participants were given a manual with basic technical guidelines and instructions on how to play the Wii Sport. The staff ensured adequate room for movement, with no obstacles that a player might accidentally trip over or hit. Participants' safety was monitored with regular evaluation for adverse effects, having a physical trainer present during the initial session, and practicing warm-up and cool-down activities. Subsequently, staff members were present to assist participants on an as-needed basis, helping them to become independent in Wii play. The subjects could choose any of the Wii Sports games they wished to play.

Between weeks 12 and 24 (the follow-up period), the Wii device was left in place, but staff members were not present and participants were assessed 20 to 24 weeks post-baseline.

Measures

Participants were administered measures of depression and health-related QoL at baseline, 6 weeks, 12 weeks, and 24 weeks (12 weeks post intervention). The measures of anxiety and neurocognitive functioning were administered at baseline and 12 weeks only. At 12 weeks, participants were also informally interviewed about their experiences in the study.

Mood—Depression was measured using the Quick Inventory of Depressive Symptoms (QIDS) – Clinician Rated Version (13) a 16-item self-report scale scored from 0 to 48 with higher scores indicating greater depression. Anxiety symptoms were assessed with the Beck Anxiety Inventory (BAI) (14), a 21-item self-report scale scored from 0 to 63 with higher scores indicating more severe anxiety.

Health-Related QoL—Physical and mental health functioning were assessed using the 36-item MOS SF-36 (15).

Cognitive Functioning—The Repeatable Battery for Assessment of Neurocognitive Status (RBANS), a measure of global cognitive functioning, includes items tapping attention, memory, visuoperceptual skills, and aspects of expressive language (16).

Rating of Individual Wii Sports—The participants were asked to rate their enjoyment with each Wii sport on a Likert scale from 1 (least) to 7 (most). They were also asked to state the level of physical and mental effort required for each sport.

Wii-adherence—Participants were asked to complete a log of their activity following each Wii-playing session, with adherence being computed as the proportion of 36 days (12 weeks \times 3 days per week) reported engaging in the exergame for at least one half hour.

Statistical Analysis

We examined normality of distribution of each continuous variable at each time point. The only variable to violate normality assumption was the baseline BAI score. QIDS-C and SF-36 scores were assessed with pairwise t-tests, comparing changes from baseline to 6-week, 12-week, and 24-week scores. A single pre-post pairwise t-test was performed for the RBANS (baseline versus 12-week scores), and a single pre-post non-parametric Wilcoxon Signed-Rank Test was performed on the BAI due to non-normal distribution of its baseline values. Because of the small sample size we also confirmed our results using permutation paired t-tests. Because there were drop outs, we re-ran the analyses from baseline to week 12 using multiple imputations. Based on the method of chained equations (17), estimates of test statistics were

combined across imputations using the method of Little and Rubin (18). The significance level was set at $p < .05$.

RESULTS

Nineteen participants (ages 63 to 94 years; mean age=78.7 years, $sd=8.7$; 13 women; 14 Caucasians) completed the 12-week study; of these, 17 also completed a follow-up at 20 to 24 weeks. Participants varied in their level of functioning. Based on the SF-36 scores, 18% of the subjects felt that they were “limited a lot” in performing moderate level of physical activity, 35% were “limited a little”, and 47% did not feel limited at all. MMSE scores ranged from 24 to 30 (mean=28.1, $sd=1.9$). The number of self-reported significant medical problems ranged from 0 to 7. The most common conditions were hypertension, arthritis, and diabetes, although several subjects had osteoporosis and heart disease. One participant was in a wheelchair while two used canes regularly.

On the Wii-adherence logs, the mean rate of adherence was 84% of the total possible days. Based on an analysis of data from baseline to 12 weeks among the 19 participants who completed the 12-week study, there was a significant improvement from baseline to week 12 in QIDS score, SF-36 Mental Composite score, and RBANS score (Table 1). 37% of participants had $\geq 50\%$ or greater reduction in depressive symptoms. The SF-36 Physical Composite score and BAI score did not improve significantly. The permutation t-tests resulted in p-values very similar to the asymptotic version, with no changes from significance to non-significance.

Including the three drop-outs, multiple imputation analyses showed significant improvement from baseline to 12 weeks in QIDS score ($t(21)=3.24, p=0.004$), SF-36 Mental Health Composite score ($t(21)=2.57, p=0.014$), and RBANS score ($t(21)= 2.41, p=0.028$). The SF-36 Physical Composite and BAI scores did not change significantly between 0 and 12 weeks.

Among the 17 participants who completed the 20- to 24-week follow-up assessments, improvement on QIDS was sustained (mean=3.7, $sd=1.5$; baseline vs. 24 weeks: $t(16) =3.9, p=0.001$), with 53% of participants reporting $\geq 50\%$ reduction in symptoms, but there were no significant differences between baseline and follow-up ratings on SF-36.

There were no major adverse events (physical or psychiatric) or injuries during the study. Two participants had minor pain that resolved quickly with minimal care.

Qualitative feedback revealed that some participants started out somewhat nervous about how they would perform in these games and understand the technical aspects of game play. However, by the study’s end, most participants reported that learning and playing the Wii was “satisfying”, they enjoyed the fact that the games were “fun and varied” and “challenged me to do better,” and they “saw progress.” Qualitative comments from the subjects as well as the facility staff and our research staff suggested high satisfaction. Of the individual Wii sports, tennis (mean score of 6.0 on a 1-to-7 scale) and bowling (mean score of 5.6) were rated as the most enjoyable games, with golf (mean 4.9) and baseball (mean 3.7) being less so. Boxing appeared to require the most physical effort (66% reported physical effort similar to running or playing basketball) and tennis the most mental effort (85% reported mental effort similar to games/puzzles or balancing a checkbook).

DISCUSSION

Our 12-week pilot trial of exergames in older adults with SSD suggested a high rate of retention (86%) and adherence (84%), significant improvement in depressive symptoms, mental health-related QoL, and cognitive functioning, and no major adverse events. There was no significant

change in physical health-related QoL or anxiety. Overall, the study suggests that exergames are feasible and acceptable to older adults with SSD, and may represent a novel route to improving depressive symptoms in seniors.

The primary limitation of our study is that it was a small, uncontrolled, and unblinded trial, and therefore, possible effects of social contact and expectancy bias cannot be excluded. Additionally, we did not measure treatment adherence with an objective measure nor did we assess the energy expenditure associated with exergames, and thus, cannot conclude that improvement in depression was mediated by increases in physical activity. There is also a possibility of type I error due to multiple comparisons. The observed change in RBANS score is consistent with practice effects on that instrument. There was no significant effect on anxiety, although mean levels of anxiety at baseline were in the normal range for the population (14), indicating a probable floor effect.

Nonetheless, it is encouraging that older adults with SSD, at a mean age of 78, with varied levels of physical functioning, engaged in the exergame intervention three times a week for 12 weeks, given that depression predicts worse adherence to physical activity. With initial instruction and manual, participants were able to independently engage in exergames and sustain game play throughout the study period while reporting high satisfaction. Several attributes of exergames may contribute to adherence. First, exergames are widely available and can be home-based, mitigating against environmental barriers to exercise. Second, exergames are designed to be reinforcing, and maintenance of exercise is reportedly most related to satisfaction with the activity (19); exergames may counteract diminished enjoyment of exercise, which may be particularly relevant for those with depression. Third, exergames allow for choice among activities (different sports), which could lead to sustained play and foster autonomy, and thus result in a personalized intervention for people with diverse physical abilities.

Exergames may increase physical activity, cognitive stimulation, and positive affect (enjoyment). Thus, they may impact all the three elements of the "thinking-moving-feeling" triad commonly implicated in the mechanisms underlying poor health-related QoL in older adults (20). Therefore, the potential therapeutic value of exergames may not be restricted to alleviating SSD, but may extend to improving overall health-related QoL in seniors.

Future studies should be randomized controlled trials of home-based exergames including an attention control group, rater-blind assessments, and a systematic investigation of possible biological (e.g., reduction in inflammatory biomarkers) and psychological (e.g., enhanced intrinsic motivation) mechanisms of action. Treatment adherence should be measured using diary logs of time spent playing and objective accelerometry. Game play proficiency may be assessed by improvement in performance on the exergame. Participants' safety should be monitored and ensured. Using mediator-moderator analyses, physical and cognitive functioning may be evaluated as moderators, and intrinsic motivation and physical activity adherence as mediators of the exergames' effectiveness. Additional research may include determination of optimal "dosages" (frequency and duration) of exergames for different subgroups of seniors.

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Table 1

Mean Scores on Outcome Measures at Baseline, Week 6, and Week 12 (n=19)

	Baseline Week 0	Mid-Point Week 6	End of Treatment Week 12	Significance of Change from 0 to 6 weeks*	Significance of Change from 0 to 12 weeks*
	Mean (SD)	Mean (SD)	Mean (SD)	p-value	p-value
Quick Inventory of Depressive Symptoms- 16	7.8 (3.7)	4.8 (2.3)	5.1 (3.0)	0.002	0.004
SF 36 Mental Composite	52.0 (9.5)	53.7 (7.9)	55.2 (9.6)	0.333	0.043
SF 36 Physical Composite	44.4 (11.3)	48.0 (8.2)	44.2 (9.9)	0.025	0.731
Beck Anxiety Inventory	6.4 (5.1)	-----	4.7 (5.5)	-----	0.228
RBANS Total Score	90.7 (18.0)	-----	95.3 (16.9)	-----	0.032

Note: Analyses presented in this Table pertain to the 19 participants who completed the 12-week study. Please see the text for results of additional analyses on all the 22 participants (including the three dropouts).

SD = standard deviation.

RBANS = Repeatable Battery for Assessment of Neurocognitive Status.

* Pairwise t-tests (df=18) were used to compare change in scores between time points, with the exception of the Beck Anxiety Inventory. Because of the non-normal distribution of the baseline scores on the latter variable, Wilcoxon-Signed Rank Test was performed.