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Effects of a Combined Exercise Program Using an iPad for Older Adults

Juhee Lee, PhD, APRN[1], Dukyoo Jung, PhD, RN[2], Jinyee Byun, MSN, RN[2], Minkyung Lee, MSN, RN[2]

[1]College of Nursing, Yonsei University, Seoul, Korea; [2]College of Nursing, Ewha Womans University, Seoul, Korea

Objectives: The purpose of this study was to examine the function, health status, and efficacy effects of a combined exercise program using an iPad among older women in Korea, a tech-savvy country. **Methods:** The study employed a pretest and posttest experimental design with a control group. The experimental group of subjects comprised 16 female older adults and the control group comprised 10 who were aged 65 years or older. The experimental group participated in a supervised group-based exercise program and an individualized home-based exercise program that involved the use of an iPad. The combined group and home-based exercise program consisted of group exercise, which took place in a senior center for 30 minutes weekly, and a home-based iPad exercise program, which the subjects followed at least 3 times a week. The collected data were analyzed using the Statistical Analysis System (SAS ver. 9.3 TS Level 1M0) program, which utilized a chi-square test, a Fisher exact test, a *t*-test, and a repeated-measures ANOVA. **Results:** The results showed that cognitive status changed significantly over time, and there was an interaction between group and time. Further, self-efficacy for exercise and outcome expectations for exercise changed significantly over time. **Conclusions:** Exercise programs using iPad interventions may be useful for the management of cognitive functioning and the integration of functional physical abilities in older adults.

Keywords: Age, Exercise, Equipment and Supplies, Physiology, Self Efficacy

I. Introduction

As populations age around the world, the importance of regular exercise in old age to help combat chronic disease is becoming more evident. Exercise is promoted globally by the World Health Organization [1]. Evidence from meta-analyses on the impact of exercise on older adults has shown that exercise interventions have various positive effects on functional and physical performance [2]. In particular, exercise programs improve participants' physical fitness by increasing cardiopulmonary endurance, muscle strength, and balance [3]. Moreover, steady exercise enhances both physiological and psychological health [3], improves older adults' quality of life, and influences the management of depressive symptoms [4].

However, despite the positive benefits of exercise, in the United States in 2012, approximately 54% of older adults between 65–75 years and 68% of adults >75 years did not exercise [5]. The situation is similar in Korea, where approximately 80% of adults ≥65 years of age do not regularly take part in medium- or high-intensity exercise [6]. Illnesses are the biggest barrier to regular exercise in older adults [7], especially women, who are more susceptible to diseases

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Corresponding Author
Dukyoo Jung, PhD, RN
College of Nursing, Ewha Womans University, 52, Ewhayeodae-gil, Seodaemun-gu, Seoul 03760, Korea. Tel: +82-2-3277-6693, E-mail: dyjung@ewha.ac.kr

such as degenerative arthritis, osteoporosis, and back pain, which interfere with exercise. Even if older individuals begin exercising, boredom could lead them to stop [8]. Thus, it is imperative to determine the factors influencing exercise adherence to decrease dropout rates and improve participation in exercise programs [9].

To increase exercise engagement, various exercise programs have been developed, which include both group and individual exercise [10]. Although group-based exercise programs are beneficial in enhancing functional performance in older adults, such interventions can be expensive, hard to implement, and difficult to access [11]. Therefore, cost-effective and easily accessible physical activity interventions are needed. Previous research found an increase in interest in home-based exercise regimes which offer physiological health enhancement [12]. However, exercise adherence may be more difficult in individual exercising without continuous motivation [13]. Therefore, combined group and individual exercise may be more effective in improving adherence to exercise in older adults, as this approach is capable of reaching older adults who have difficulty visiting a center for regular exercise.

Findings from a recent study reported that electronic-type exercise interventions were effective among older adults in terms of engaging them in consistent exercise. An example of electronic exercise programs is web-based exercise, which has been introduced in a variety of areas of health behavior change [14]. This method helps people overcome geographic barriers and time limits [15]. Various benefits (e.g., improvement in leg muscle strength and overall functional status) [8] have been associated with the use of electronic exercise programs such as Nintendo Wii. However, the effects of Wii programs are controversial; some previous studies found no significant changes in physical function, self-efficacy for exercise, and outcome expectations for exercise in older adults [16].

The latest trend in electronic exercise programs is one using the iPad, which is a user-friendly device used widely for education or entertainment [17] that has a portable, touch-based platform. Furthermore, the iPad has several applications that provide potential methods for delivering health information [18]. Some examples of such applications include health information in medical dictionaries, drug databases, and methods of physical exercise [19]. Several studies have reported the usability of iPads as an education device, but no study has tested the effects of the iPad on exercise motivation among older adults.

Thus, the purpose of this study was to examine the function, health status, and efficacy effects of a combined exercise program using an iPad among older women in Korea, a tech-savvy country.

II. Methods

1. Study Design

This study employed a quasi-experimental, nonequivalent control group pretest-posttest design to examine the effects of exercise programs on function outcome (cognitive status, activities of daily living [ADL]), health status outcome (perceived health status), and efficacy outcome (self-efficacy, outcome expectations for exercise) among older women.

2. Setting and Samples

Participants were recruited from one senior center in a community of Seoul, Korea. Inclusion criteria for the study participants were that they must be (1) aged 65 years or older; (2) able to communicate with an interviewer without difficulty; (3) able to independently perform ADLs; and (4) able to comprehend and follow instructions. Participants were excluded if they participated in another program affecting cognition or individual beliefs to control for other effects.

For the recruitment, the researcher(s) initially contacted a department chair of the community senior center and explained the purpose and procedure of this study. After obtaining permission, an announcement about the program was made in the senior center. When senior adults wanted to participated in the study, they were asked to sign up. A total of 22 older females were initially contacted for the experimental group. After completion of intervention for the experimental group, 15 female older adults were recruited for the control group.

A power analysis was performed to determine an appropriate sample size. With a Type I error rate (α) set at 0.05, power at 0.80, and a medium effect size (0.5), we used the G*power 3.1 program to calculate the appropriate sample size. The experimental group and the control group each required at least 14 participants.

3. Ethical Considerations

After approval was obtained from the appropriate Institutional Review Board (IRB No. 2011-2-12), the recruitment was conducted. Participants were informed of the purpose and procedures of the study and it was explained that they had the right to withdraw or withhold any piece of information from the study at any time. Informed consent was also obtained from each participant. A total of 18 older females were initially selected for experimental group. After completion of intervention for the experimental group, 15 female older adults were recruited for the control group.

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4. Measurements

The outcome measures focused on the intervention group's participation in the combined group and home-based exercise as well as cognitive and physical function, perceived health status, and efficacy outcomes.

1) Functional outcome

Functional outcome comprised cognitive and physical function.

(1) Cognitive function: The Korean version of Mini-Mental State Examination (K-MMSE) [20] was used to assess participants' cognitive status. The inventory is based on seven cognitive domains. The highest possible score is 30 points. Any score ≥24 points is considered cognitively normal. Scores <24 can indicate severe (>10 points), moderate (10–19 points), or mild (20–23 points) dementia. In this study, Cronbach's α for the K-MMSE was 0.89.

(2) Physical function: The Barthel Index [21] was used to measure participants' performance of ADLs. The index consists of 11 items measured on a Likert-type scale. Scores range from 0–100 points. A higher score indicates a better functional state. In this study, Cronbach's α for the ADLs scale was 0.87.

2) Health status outcome

(1) Perceived health status (PHS): The PHS scale includes three items: "How would you rate your health?", "How is your health status compared to three years ago?", and "How is your health status compared to other people your age?" [22]. Responses ranged from excellent (5 points) to poor (1 point). The highest possible score is 15 points. A higher score signifies a better perceived health status. In this study, Cronbach's α for the PHS was 0.92.

3) Efficacy outcome

Efficacy outcome comprised self-efficacy for exercise and outcome expectations for exercise.

(1) Self-efficacy for exercise (SEE): The SEE is a 9-item measure that asks about participants' confidence related to their ability to continue exercising in the face of barriers to exercise [23]. A higher score indicates a higher state of self-efficacy towards exercise. Evidence of reliability is supported by internal consistency and a Cronbach's α coefficient of 0.92 or higher. In this study, Cronbach's α for the SEE was 0.93.

(2) Outcome expectations for exercise (OEE): The OEE scale-2 [24] is a 13-item measure that identifies an individual's belief that exercise will result in certain outcomes. A higher score on this scale signifies higher expectations. When this measure was developed, the reliability coefficient was 0.93 for positive questions and 0.80 for negative questions. In this study, Cronbach's α for the OEE was 0.73.

Table 1. Description of treatment fidelity plan for the combined group and home-based intervention

Component of treatment fidelity	Plan for evaluation of treatment fidelity component
Design	Developed according to Conn's essential intervention framework and Bandura's self-efficacy theory. Assurance that the experimental group was exposed to the intervention and the control group exposed to the control intervention and there was no carryover between groups.
Training	An Exercise Manual for the iPad (EMP) was developed for the interventions and used for training. Weekly group exercise and meetings were held to determine whether or not the participants were continually exercising using the iPad at home and to discuss the progression of participants.
Delivery	Log books of the combined intervention were maintained by the trained research assistants at each session. Data from the log books were entered and evaluated to determine whether participants correctly exercised both at the senior center (group) and their homes (individual). Continued participation in the exercise program was encouraged through one-on-one phone counseling.
Receipt	Coming to the senior center and participating in the combined group and home-based intervention was evidence of receipt. Data from the log books indicate that an individual had come into the senior center and engaged in the combined group and home based intervention. Participants exercised 8 sessions with trainers and 24 sessions alone in their homes.
Enactment	The combined group and home-based intervention was applicable to the community-based setting.

5. Treatment Fidelity

Treatment fidelity was considered with regard to study design, training of providers, delivery of treatment, receipt of treatment, and enactment of treatment skills [25]. Table 1 describes each component. All intervention participants were provided with weekly group exercise lasting 30.0 ± 5.0 minutes and home-based exercise at least 3 times a week. The 30 minutes included verbal cueing to motivate participants to carry out the exercise and a mastery experience to increase self-efficacy (Table 1).

6. Data Collection

Participants in the experimental group received interventions between May 1, 2011 and September 8, 2011. For the experimental group 22 individual were approached; 18 of them agreed to participate in this study, and 4 of them were not eligible to participate. Finally, there were 18 experimental group members during the pretest, of whom 16 remained in the experimental group and completed the posttest. Two of these individuals dropped out because of busy schedules, and another decided not to take part in the study after being informed about the study. The control group comprised 15 participants during the pretest, 10 of whom remained and completed the posttest. Two of these individuals moved out of the senior center, and three participants did not participate in the posttest.

7. Intervention

A combined group and home-based approach is capable of reaching older adults who have difficulty visiting a center to exercise regularly, so this approach formed the basis of our intervention. First, group exercise took place in a senior center for 30 minutes weekly. We provided participants with a combination of aerobic and resistance exercises that focused on enhancing muscle strength, flexibility, and balance [26]. The exercise trainer had a background in sports and experience in implementing exercise interventions for older people; this trainer trained 5 assistants to conduct the intervention. The components of the exercise program are shown in Table 2.

Next, individuals used the home-based iPad exercise program at least 3 times a week. A video clip of the same exercise movements performed in the group-based program was installed on each iPad. Participants were instructed to exercise at home using the iPad at any time they desired

Table 3. Description of participants' general characteristics and medical history

Characteristic	Experimental group (n = 16)	Control group (n = 10)
Age (yr)	82.19 ± 5.54	79.70 ± 5.64
Education		
Below elementary school	10 (62.5)	9 (90.0)
Middle school	2 (12.5)	1 (10.0)
Over high school	4 (25.0)	0 (0.0)
Marital status		
Single	2 (12.5)	0 (0.0)
Widowed	2 (12.5)	2 (20.0)
Married	11 (68.8)	7 (70.0)
Separated	0 (0.0)	1 (10.0)
Divorced	1 (6.2)	0 (0.0)
Medical history		
Hypertension	12 (75.0)	5 (50.0)
Diabetes mellitus	4 (25.0)	1 (10.0)
Hyperlipidemia	3 (18.8)	1 (10.0)
Osteoporosis	4 (25.0)	1 (10.0)
Anemia	1 (6.2)	1 (10.0)
Osteoarthritis	5 (31.3)	5 (50.0)

Values are presented as mean ± standard deviation or number (%).

Table 2. Details of the combined group and home-based intervention

Exercise program	Frequency	Details of intervention
Group-based exercise part	Once a week × 8 weeks	Warm-up exercise (5–7 minutes) Main exercise (15–20 minutes) Cool-down exercise (5 minutes) The exercise intensity is steadily increased. Weeks 1–3: Lying down-sitting down Weeks 4–5: Lying down-sitting down-standing up Weeks 6–8: Lying down-sitting down-standing up
Home-based individualized iPad exercise part	At least 3 times a week during group exercise period	Customized exercise for each individual (exercise lying down, sitting down, or standing up according to individual physical fitness).

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and to keep their exercise environment safe (e.g., on nonslip flooring). To enhance familiarity, the same exercise trainer appeared in the iPad video clip and instructed the activities in the same manner as in the group exercise sessions.

Before commencing the 8-week home-based exercise program, detailed explanations on how to use the iPad were presented. In addition, participants were provided with a booklet that explained how to use the device. Participants were also given a phone number to call if they had questions regarding how to use the iPad. The adherence to exercise was monitored via one-on-one phone calls in an effort to improve self-efficacy (verbal persuasion). Subsequently, participants kept a record of how often they exercised, and trained research assistants phoned participants once or twice a week to determine whether or not the participants were continuing to exercise using the iPad. All control group participants continued to take part in their usual once-a-week group-based yoga program at the senior center.

8. Data Analysis

Data were analyzed using the Statistical Analysis System (SAS ver. 9.3 TS Level 1M0) program. To test statistical significance, two-tailed tests were conducted using a significance level of 0.05. A homogeneity analysis of the general characteristics of the participants and disease characteristics was conducted using a chi-square test, a Fisher exact test, and a *t*-test. To examine differences in cognitive status, ADL, PHS, SEE, and OEE effects, we conducted a 2 (group level: control vs. experimental) × 2 (time level: pretest vs. posttest) repeated-measures analysis of variance (ANOVA; PROC MIXED procedure in SAS).

III. Results

1. Baseline Participant Characteristics

Demographic data for the 16 participants in the experimental group and 10 participants in the control group are displayed in Table 3. The mean age of the experimental group was 82.19 years (±5.54), and that of the control group was 79.70 years (±5.64). Participants' educational background, marital status, and medical history are reported in Table 3.

Table 4. Effects of the intervention on outcomes

Characteristic	Baseline	Week 8	Sources	*F*	*p*-value
Cognitive status					
Experimental (n = 16)	24.25 ± 3.55	24.56 ± 4.53	Group	0.27	0.61
Control (n = 10)	26.90 ± 4.51	22.67 ± 3.87	Time	4.48	0.04
			Group × Time	5.43	0.02
ADL					
Experimental (n = 16)	87.81 ± 14.82	88.88 ± 7.60	Group	1.06	0.31
Control (n = 10)	81.70 ± 13.34	88.22 ± 6.06	Time	1.33	0.26
			Group × Time	0.69	0.41
PHS					
Experimental (n = 16)	7.80 ± 2.31	8.13 ± 2.94	Group	0.20	0.66
Control (n = 10)	7.40 ± 2.46	7.89 ± 1.54	Time	0.32	0.57
			Group × Time	0.01	0.91
SEE					
Experimental (n = 16)	50.06 ± 25.17	65.69 ± 7.49	Group	0.05	0.83
Control (n = 10)	56.00 ± 16.60	57.56 ± 10.70	Time	3.00	0.09
			Group × Time	2.01	0.16
OEE					
Experimental (n = 16)	49.25 ± 9.28	47.69 ± 6.54	Group	2.75	0.11
Control (n = 10)	55.50 ± 5.68	48.33 ± 4.97	Time	4.40	0.04
			Group × Time	1.81	0.18

Values are presented as mean ± standard deviation.

ADL: activities of daily living, PHS: perceived health status, SEE: self-efficacy for exercise, OEE: outcome expectations for exercise.

2. Outcome of the Intervention

Based on the results of the repeated-measures ANOVA, it was determined that our intervention had significant effects on cognitive status, SEE, and OEE.

Table 4 shows that the mean score for cognitive status changed significantly in relation to time ($F = 4.48$, $p = 0.04$), and there was a significant correlation between group and time ($F = 5.43$, $p = 0.02$). For SEE, there was no significant correlation between group and time. As seen in Table 4, however, the results reveal that SEE differed significantly for the two groups in relation to time when a significance level of 0.10 ($F = 3.00$, $p = 0.09$) was used. For OEE, the repeated-measures ANOVA shows that there was no correlation between group and time. However, the mean OEE score changed significantly in relation to time ($F = 4.40$, $p = 0.04$) (Table 4).

IV. Discussion

The majority of our results were not significant when the experimental and control groups were compared in terms of group and time levels. However, we observed that the combined exercise program with an iPad might be effective in maintaining the cognitive functioning of the experimental group. Specifically, there was no significant change in cognitive status of the experimental group, while that of the control group significantly declined. From this result, we can infer that intervention is necessary to maintain cognitive status, and that cognitive status will regress without the provision of proper treatment. Several studies have shown that there is a relationship between exercise and cognitive functioning among older adults, including a meta-analysis and systematic review [27] that analyzed the effects of aerobic exercise; it was reported that fitness training improves older adults' cognitive functioning. Another meta-analysis suggested that exercising for more than 60 minutes at least 3 times a week, for an average of 6 weeks, is effective in promoting older adults' cognitive functioning [28]. Like previous studies, the study provided some suggestive evidence that women in the exercise group may have the benefits of a combined exercise program with an iPad that allowed older adults to exercise whenever and wherever it was convenient, with a significant effect on maintaining cognitive functioning. The individualized iPad-based home exercise program utilized in our study also may have positively influenced cognitive function because it required users to learn something new. In particular, it involved the abilities to understand, follow, and repeat the directions provided by the iPad.

In the study, older adults' SEE and OEE were not significantly different between the experimental group and control group, nor was there a correlation between group and time. However, SEE and OEE changed significantly in relation to time. The experimental group's SEE increased during the intervention. This finding suggests that continuous combined group and home-based intervention can lead to increased SEE.

This finding is consistent with those of previous studies that demonstrated correlations between older adults' exercise participation and SEE and OEE scores [29]. Moreover, older adults who participated in a 12-week exercise program reported significant improvement in positive OEE [29]. The results of the intervention were that participants in the experimental group increased their exercise self-efficacy and exercise ability compared to their non-participating counterparts. The results of our study show that a weekly group-based exercise program (as a means to provide social support) in combination with the individualized iPad exercise program was associated with a significant improvement in self-efficacy. During our study, older adults were also instructed and encouraged to continue the exercise program through one-on-one phone calls.

In several studies, exercise in old age has been reported to improve functional abilities [3]. Our study did not find any significant group differences in the ADL and PHS measures. Most of participants were already able to engage in independent ADL. However, the ADL scales contained general questions and were restricted to identifying any changes that may have occurred after the test. It has been previously reported that structured exercise programs enhance physical fitness, including muscle strength and aerobic endurance [30].

Our study provided a significant customized exercise program catered to the specific needs of older adults and a contribution to understanding how iPads could be used to promote exercise programs for older adult females. This research highlights the need to develop mobile applications for older adults that enable them to exercise using a smart device (i.e., smart TV, smartphone).

A limitation of this pilot study was that a nonequivalent control group, pretest-posttest design was adopted instead of a randomized controlled design. Participants were categorized into the control and experimental groups based on convenience and there were only 26 study participants. Furthermore, this study targeted an older population within a single area. Thus, the generalizability of our findings is limited. Additionally, the control group participants failed to meet the expected sample size. There was a high attrition rate (33%) due to moving out and absence from post-testing. This might weaken the generalization of this study,

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but it could be overcome with further study. Due to the small sample size, data should have been analyzed with the nonparametric statistic. According to a previous study [31], the author(s) checked the distribution of each group's data, and we found that they showed same distribution. Thus, despite the lack of normal distribution, the data was analyzed with repeated-measured ANOVA. Taking into account these limitations, the following implications can be identified. To ensure the generalizability of the study, an extension of the study should be conducted targeting community-dwelling older adults in a number of areas with a larger sample. Moreover, to increase internal validity, it is necessary to conduct a replication of the study in this area using a randomized controlled design.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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