Journal of Aging Science
ISSN: 2329-8847

Crandall and Shake, Aging Sci 2016, 4:2
DOI: 10.4172/2329-8847.1000151

Research Article Open Access

A Mobile Application for Improving Functional Performance and Health Education in Older Adults: A Pilot Study

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Received date: March 09, 2016**, Accepted date:** May 19, 2016, **Published date:** May 26, 2016

Abstract

The purpose of this pilot study was to test a mobile app that combines exercise, health education, and bingo (Bingocize®) to improve functional performance, health knowledge, and adherence. Senior volunteers were assigned to use the app on tablets twice a week for 10 weeks or a use the app to play only modified bingo. Pre/post functional performance and health education knowledge were compared using Mixed ANOVA ($p<.05$).

Health knowledge ($\lambda=6.06$, $F(1,10)=6.50$, $p=.029$, $\eta_p^2=.394$), Short Physical Performance Battery ($\lambda=.584$, $F(1, 10)=6.41$, $p=.032$, $\eta_p^2=.416$) , and gait velocity ($\lambda=6.10$, $F(1,10)=6.40$, $p=.030$, $\eta_p^2=.390$) were significantly improved in the experimental group only. Adherence was equivalent in both groups. Bingocize® can be a fun and effective way to teach older adults health information, while improving functional performance.

Keywords: Mobile application; Health education; Bingocize®

Introduction

Quality of life for older adults depends on their ability to remain functionally independent and able to manage their own life for as long as possible. Health promotion programs have the potential to help reduce health care costs as well as maintain, or even improve, quality of life for older adults. Despite the potential improvements in health and well-being, barriers to adherence and retention exist for older adults especially those suffering from chronic diseases [1]. Many older adults believe health promotion programs are time-consuming and perceive exercise as a form of therapy rather than recreation, or as a negative activity that leads to muscle pain and soreness rather than an enjoyable activity [2].

Combining exercise and health education programs in a fun and familiar game may be an effective strategy to reduce older adults' barriers to participation. For example, researchers used an interactive trivia game similar to "Jeopardy" to improve knowledge and awareness of antibiotic use in older adults [3]. Another widely popular and familiar game for all age groups, but especially for older adults, is bingo. The pervasive familiarity and attractiveness of bingo thus serves as an ideal program enhancer to successfully incorporate exercise and health education. In the context of health education, bingo has been effectively used to increase older adults' knowledge about their risks of medication use and possible drug interactions [4].

Unfortunately, most of the evidence-based programs currently available either focus on exercise or health education, and few studies have directly compared them. In one recent study, researchers compared the effects of a long-term exercise program versus health education alone [5]. They compared two groups of older adults: one that participated in a long-term exercise program, and one that participated in a health education only program. The exercise program significantly reduced major mobility disability over 2.6 years when compared to the health education program alone. However, they did not examine the potential additive benefits of a program combining both exercise and health education. Although few studies have combined the two into one program, there is some evidence for positive synergistic effects of the combination. For example, Song [6] combined exercise training and self-management education in community-dwelling diabetic older adults. Triglycerides, body weight, body mass index, and diabetes self-management behavior showed significant differences compared to wait-listed controls. In another study, Park [7] administered an integrated exercise and health education program for older adults with hypertension. Exercise self-efficacy, social functioning, and systolic blood pressure were all significantly improved compared to a wait-listed control group. Still, there is clearly a strong need for scientifically well-designed programs which compare and contrast the benefits of multimodal health promotion programs versus single-domain interventions.

A mobile application (app) called Bingocize® was created for use on any mobile device including tablets, laptop PC's, or mobile phones. Because the mobile app is simple, intuitive, and uses touch-screen technology, it may be an ideal application for use with older adults [8]. Indeed, a tablet-based strength training program was found to improve retention and adherence in a group of older adults [9]. One of the central advantages of the mobile app is that it is concurrently multimodal, incorporating health education and aspects of strength, cardiovascular fitness, flexibility, and mobility. Therefore, the aim of this investigation was to examine the efficacy of a mobile app that

combines exercise, health education, and bingo to improve measures of functional performance and health education in community-dwelling older adults.

Methods and Materials

Participants

Flyers, direct contact, and word of mouth were used to recruit a convenience sample of male and female volunteers over the age of 60 from a senior center located in rural south-central Kentucky. During an orientation meeting, fifteen (N=15) participants meeting the initial criteria for participation completed the informed consent Figure 1 for participant flow through the investigation. The 21-item telephone mini-mental State Examination (T-MMSE) was administered by a trained undergraduate student prior to completion of further pre-testing [10]. A cut-off of 17 on the telephone version of the T-MMSE was used to exclude participation, as scores below 17 are indicative of significant cognitive deficits. Criteria for inclusion included: normal or corrected-normal vision; no history of severe neurological impairment; mobility (i.e., not wheel-chair bound); no history of colorblindness; and English as their native language. Qualifying participants were compensated $25.00 for their participation. The investigation protocol was approved by the Institutional Review Board (IRB# 749182-5).

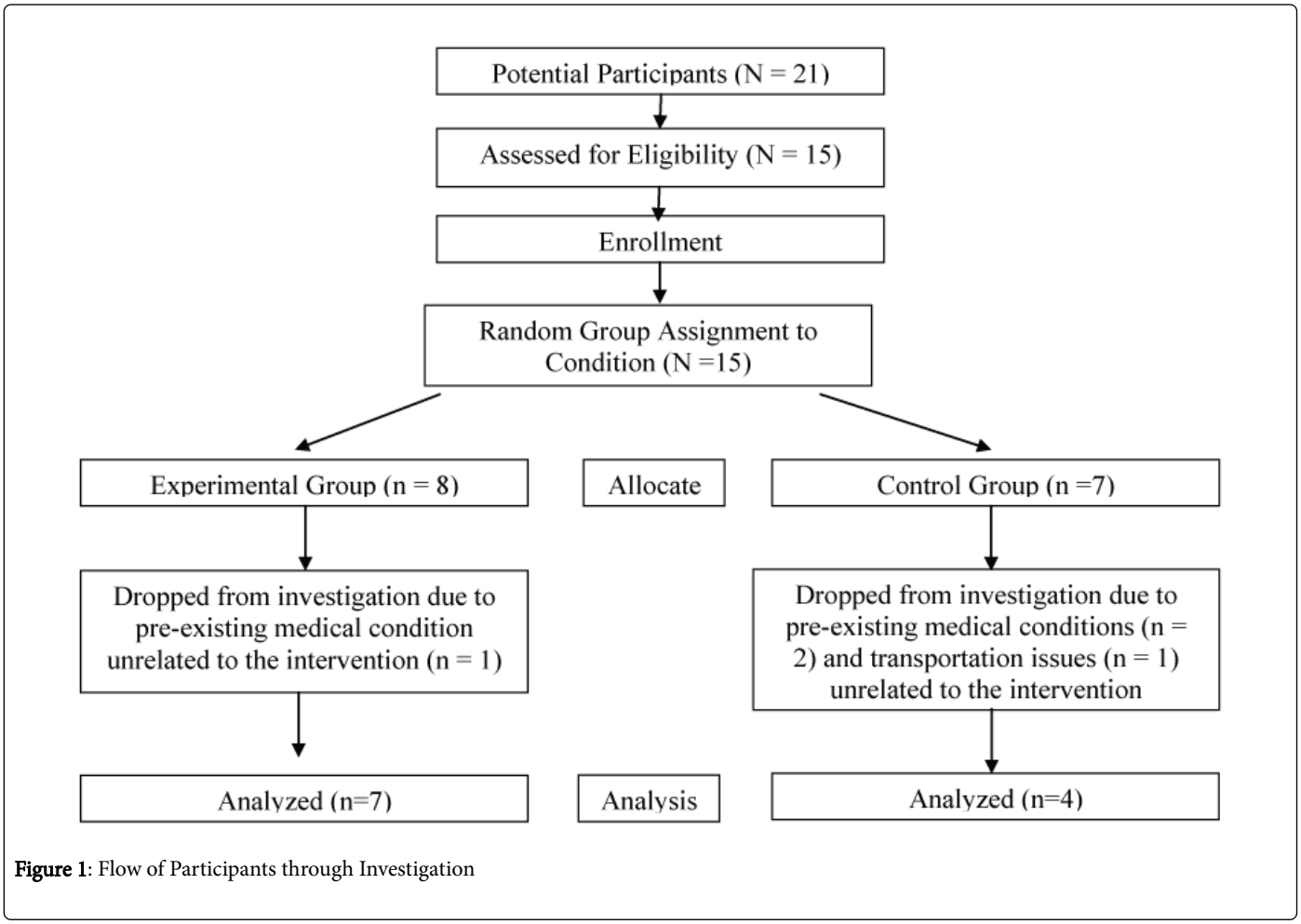

Figure 1: Flow of Participants through Investigation

Procedure

This investigation was a pre/post-test two group experimental design. Participants were randomly assigned using random number generating software (SPSS Version 21) to one of two conditions: (a) an experimental group (n=8) that used the Bingocize® mobile app (bingo, exercise, and health education) twice a week for 10 weeks and (b) a control group (n=7) that used the mobile app to play standard bingo for 10 weeks. Both groups used tablets (Samsung Galaxy Tab 4 Tablet with 10.1" Screen, 16 GB Storage) supplied by the investigators as the mobile app is designed to accommodate the usage of both methods. By having the control group play simple standard bingo, the groups were matched with regard to the social and fun nature of the program. The investigators supplied a router to ensure a stronger Wi-Fi signal after encountering interference issues on site.

The intervention was administered in a recreation room located in the senior community center twice per week for 60 minutes each session. A senior community center employee was trained by the investigators to lead sessions for both groups. The principal investigator or one trained undergraduate student observed 25% of the sessions in order to ensure the mobile app was being used as intended. Participants were trained by the principal investigator to use the tablet and mobile app.

Each session began with the experimental group participants sitting at a large table with the mobile app loaded on the tablet. Bingocize® is a bingo-like game as the participants' virtual bingo cards were modified

to include only numbers on the spaces. A virtual spinning wheel with the same numbers as the virtual cards was spun by the game leader. The game leader controlled the sequence and number of exercises and health education questions for each session. Once the wheel stopped on one of the numbers, either an exercise or health education question was presented to the participants. When a multiple choice or true/false health education question was presented, the participant chose the correct answer and clicked the question number on their virtual bingo card. Participants had the opportunity to select until the correct answer was chosen to ensure the participants were presented the correct answer before continuing the game. Additional information about the question topic was provided on the tablet screen and also read aloud by the game leader. If the virtual wheel landed on a number that was associated with an exercise, the participants completed the exercise and then clicked the question number on their virtual bingo card. The game continued until a participant won the game. Prizes (valued at less than $2.00) were awarded to the winners of each game. Four games were played each session to ensure coverage of all the health information and completion of the exercise program. After each session, participants from both groups were entered a drawing for $100.00 awarded at the end of the investigation.

The exercise component included 12 different exercises each session. Using the American College of Sports Medicine guidelines for older adults, the selected exercises focused on improving cardiovascular (CV) fitness, muscular strength and endurance, flexibility, and balance [11]. Intensity of exercise was monitored using a modified Borg's perceived exertion scale (1=no exertion, 10= maximum exertion [12]. Participants were encouraged to maintain a moderate intensity (5 to 6 on the scale) when performing the exercises. The CV activities included walking and stepping in place. Each CV bout lasted between 30-120 seconds. Participants completed a minimum of 15 minutes of CV exercise during each session. Using graded exercise bands (Black Mountain, Inc., Lakemoor, IL.), the muscular strength and endurance exercises focused on functional movements and targeted major muscle groups. With direction from the game leader, participants chose between two different (light or extra light resistance) graded exercise bands. Beginning with one set of 8 repetitions for each exercise, participants progressed until able to complete 3 sets of 15 repetitions by the end of the investigation.

The health education component of the mobile app can be modified to include any type of health education information. For this investigation, the focus of the health education component was to teach participants information to help reduce fall risk and manage osteoarthritis. These topics were chosen because they are often a focus of existing self-management programs [13]. Material from the Arthritis Foundation's Put Pain in Its Place program [14], the Centers for Disease Control [15], and the National Institute on Aging [16] were used to construct multiple choice and true/false questions. Below is an example of one of the fall risk reduction questions along with the question answer, and the associated information used to expound upon the answer.

Question: What is the percentage of falls that happen every day in the home due to overlooked hazards?

Answer: 50-75% of falls happen in the home every day due to overlooked hazards.

Associated information: Reducing home hazards is a simple way to prevent falls. You should check your home for: 1) proper lighting, 2) secure handrails, 3) non-skid rugs, 4) clear electrical cords, 5) removable clutter, 6) installation of grab bars, 7) kitchen items that can be moved within reach.

Outcome measures

Functional performance was assessed using the Short Physical Performance Battery (SPPB) [17]. The battery involves three physical performance measures including preferred gait velocity, repeated chair rises, and a standing balance test. Each subscale is scored 0-4 with 0 being "unable to complete the task" and 4 being the "highest level of performance." Subscale scores are added to create a summary score between 0 and 12. The SPPB has been shown to be valid and reliable to assess functional fitness in older adults. Upper body muscular endurance (arm curl test), resting blood pressure, and body weight were also measured [18]. All testing was conducted in a recreation room at the senior facility by the principal investigators and trained graduate and undergraduate students. Exercise adherence was monitored by session attendance.

Participants' knowledge of fall risk and osteoarthritis were assessed at baseline and post intervention using a 30-item multiple choice health education knowledge test constructed using the same health education questions presented during the Bingocize® sessions.

Statistical Analyses

Descriptive and frequency analysis were performed for all variables. Independent t-tests and Pearson chi-square analyses were used to compare baseline demographic, health knowledge, and functional performance between groups. A mixed design ANOVA was used to examine time (pre/post) x group effects. An independent samples t-test was conducted to compare adherence between groups. All analyses were two-tailed and conducted using the Statistical Package for the Social Sciences (SPSS Version 23). Statistical significance was set at the $p<.05$ level.

Results

Although there were no significant between-group differences in baseline characteristics, SPPB scores revealed both groups were physically low functioning as defined by an SPPB score of 9 or lower out of 12. The low SPPB scores may partially explain why four participants did not complete the investigation; 3 females in the control group due to preexisting orthopedic problems and 1 male in the experimental group due to transportation issues (Table 1). There were no significant main effects for measures of functional performance or health education test scores. There were, however, significant time x group interactions for health knowledge scores (λ=0.495, F (1,9)=6.50, p=0.014,$\eta_p^2 = .505$), gait velocity (λ=0.600, F (1,9)=6.40, p=.037,$\eta_p^2 = .400$), and SPPB scores (λ=0.584, F (1,9)= 6.41, p=.032,$\eta_p^2 = .416$) (Table 2). There was no significant time x group interactions for resting systolic blood pressure, diastolic blood pressure, or arm curl repetitions. Adherence was not significantly different between the experimental (88.57% ± 15.47%) and control groups (100% ± 0%); (t=6)=-1.96, p=0.098.

Discussion

One of the central advantages of the mobile app is that it is concurrently multimodal, incorporating exercise and health education

into an enjoyable game. Indeed, the experimental group voluntarily responded verbally by saying they enjoyed using the mobile app, as well as the social interaction with other participants. These responses are consistent with our previous investigations, which found the unique addition of bingo addressed many of the barriers to older adults' participation because the game is fun and done in a group setting (Author). The ability of the mobile app to successfully engage older adults likely led to the significant improvements in functional performance and knowledge of fall risks and osteoarthritis found during our investigation.

	Experimental n=7	Control n=4	p-value
Age, M (sd)	72.29 (7.41)	73.50 (6.35)	0.790
Sex, n			
Male	0	1	0.165
Female	7	3	
Educational Level, n			
Less than high school	3	2	0.730
High school	3	2	
Graduate degree	1	0	
Heart attack or known heart disease, n	1	1	0.658
High blood pressure, n	5	4	0.237
High cholesterol, n	4	1	0.303
Diabetes, n	2	2	0.477
Previous cancer diagnosis, n	1	0	0.428
T-MMSE, M (sd)	20.00 (1.29)	18.75 (2.06)	0.330
Health education test, (%); M (sd)	54.00 (9.47)	51.25 (13.84)	0.702
Body weight, (kgs); M (sd)	84.37 (16.76)	85.78 (10.28)	0.884
Resting systolic BP, (mmHg); M (sd)	126.43 (8.52)	136.50 (9.43)	0.102
Resting diastolic BP, (mmHg); M (sd)	87.14 (6.99)	85.00 (23.80)	0.871
SPPB score, M (sd)	4.85 (1.57)	6.00 (2.16)	0.335
Gait velocity, seconds; M (sd)	12.60 (4.13)	10.88 (1.87)	0.460
Arm curls, repetitions; M (sd)	15.14 (1.77)	16.75 (1.25)	0.148

Table 1: Baseline Participant Characteristics. Note. SPPB = Short Physical Performance Battery; T-MMSE = Telephone Mini-Mental State Examination. *p <0.05.

It appears the intensity and duration of the exercise component of the mobile app was sufficient for improving functional performance (SPPB); the experimental group increased 53% compared to a 4% decrease for the controls. In addition, gait velocity increased 15.2% in the experimental group while controls decreased 22%. Fahlman, McNevin, Boardley, Morgan, and Topp [19] found similar improvements in gait velocity using a resistance band exercise program, however, their intervention was longer; lasting 16 weeks in duration and the frequency was three times per week. The mobile app used in this investigation required fewer sessions to produce similar results. These results are encouraging since the participants were considered physically low functioning at baseline. The participants were not followed after the intervention to determine the number of actual falls, but improvements in gait velocity and SPPB scores have been associated with fall reduction [5]. Follow-up studies are needed to determine if the mobile app can successfully reduce or eliminate future falls.

Surprisingly, nonsignificant increases in arm curl strength were found in both groups although the increases were greater in the experimental (19.8%) compared to the control group (2.9%). Because the experimental group participants were allowed to select the level of graded resistance band, it is possible the resistance chosen was not sufficient to produce significant results. The small increase in the control group's arm strength requires further investigation.

	Experimental M, SD	95% CI	Control M, SD	95% CI	p-value	Ƞ2p
Health education knowledge; (%)	68.29 (11.90)	[58.33, 78.24]	35.50 (11.12)	[22.39, 48.67]	*.014	.505
Body weight, (kgs)	84.22 (16.77)	[71.17, 97.28]	85.20 (11.68)	[67.93, 102.47]	.522	.047
Resting systolic BP; (mmHg)	131.43 (10.69)	[118.41, 144.45]	140 (21.60)	[122.78, 157.22]	.854	.004
Resting diastolic BP; (mmHg)	88.57 (14.35)	[71.23, 105.92]	93.75 (28.69)	[70.80, 116.70]	.470	.060
SPPB score	7.43 (2.44)	[5.33, 9.53]	5.75 (2.50)	[2.97, 8.53]	*.032	.416
Gait velocity, seconds	10.93 (3.52)	[7.64, 14.21]	13.20 (4.43)	[8.86, 17.55]	*.037	.400
Arm curls, repetitions	18.14 (3.34)	[15.60, 20.69]	17.25 (2.06)	[13.89, 20.61]	.211	.168

Table 2: Post Test Results. Note. CI = Confidence Interval; BP=Blood Pressure; SPPB=Short Physical Performance Battery, *p<0.05.

Despite the positive results of this pilot investigation, there were several limitations that must be discussed. First, although the effect sizes were large, the generalizability of the significant results may be limited due to the small sample size. Second, because the health knowledge test was created by the investigators and the reliability not established prior to the investigation, the results must be interpreted with caution.

Implications and Conclusions

To our knowledge this is the first investigation to examine the use of mobile technology for implementing a multi-modal health promotion program for older adults. Using a mobile app to combine exercise and health education programs in a fun and familiar game (bingo) appears to be an effective strategy for improving measures of functional performance and health education. Although the financial costs of the

Bingocize® program are minimal compared to other evidence-based health promotion programs, purchasing tablet PCs, licensing fees for the mobile app, and internet service may be prohibitive for some older adult facilities. These facilities may be able to use the mobile app as the cost of technology is reduced over time.

Larger randomized clinical trials are needed to determine if the mobile app is effective for older adults residing in other types of long-term care facilities e.g. nursing homes and assisted living facilities. In addition, exploring the efficacy of using the mobile app remotely from an individual older adult's home is needed. Finally, because the health education component is easily modifiable, future investigations may explore using the mobile app to teach additional health education topics such as stress management, medication usage, communicating with physicians.

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