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Original Research

Effects of a Game-Centered Health Promotion Program on Fall Risk, Health Knowledge, and Quality of Life in Community-Dwelling Older Adults

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ABSTRACT

International Journal of Exercise Science 12(4): 1149-1160, 2019. Quality of life (QOL) is an important aspect of overall well-being in older adults and can be improved with increased physical activity. One in four older adults experiences a fall each year, making it necessary to focus public health interventions towards decreasing fall risk and improving QOL in older adults. The purpose of this study was to determine the effects of the health promotion program, Bingocize®, on QOL and fall risk in community-dwelling older adults (n = 36; mean age 73.63 ± 6.97). Participants were clustered and randomly assigned to (a) experimental (n = 19; participating in Bingocize® program, or (b) control (n = 17; only played normal bingo). Each group completed a 12-week intervention that consisted of two 45-60 minute sessions per week. There were no significant interactions for any of the variables, with the exception of positive affect (PA) (F (1,34) = 5.66, p = 0.02, η_p^2 = 0.15, power = 0.64) and handgrip strength (F (1,34) = 8.31, p = 0.007, η_p^2 = 0.196, power = 0.80). There was also a significant main effect for time for health knowledge. Participating in the Bingocize® health promotion program can produce a meaningful and detectable change in handgrip strength and PA in community-dwelling older adults.

KEY WORDS: Older adults, falls, fall risk prevention, Bingocize®, exercise

INTRODUCTION

Psychological well-being and quality of life (QOL) are important aspects of overall well-being in older adults. QOL is an individual's "overall sense of well-being, including aspects of happiness and satisfaction with life as a whole" (19) and is associated with functional, physical, and psychological health (27). Psychological health is a great concern for older adults because it is an important component of overall quality of life and can often affect physical health (15). An effective way to determine an individual's psychological health is to measure positive and negative affect. Due to the fact that increased physical activity can improve all of these factors,

public health professionals are focused on designing and implementing effective and sustainable physical activity interventions (6).

The population of adults age 65 years and over is rapidly increasing because people are living longer, and the baby boomer generation is aging (17). Older adults are such a large part of the world's population, so it is necessary to focus public health interventions towards older adults' health problems. One particular health problem affecting the QOL of many older adults is falls (18). The fact that one out of every four older adults experiences a fall each year shows the magnitude of the problem. (18). Therefore, there is a continued need for effective evidence-based physical activity interventions to reduce or eliminate falls for older adults.

Bingocize® is an example of an evidence-based physical activity intervention for older adults shown to improve gait, decrease fall risk, and increase patient engagement; all of which improve the overall QOL in older adults (10, 7). Bingocize® is an interactive combination of the game of bingo, physical activity, and health education. A recent investigation using Bingocize® showed an adherence rate of over 90% (21), which provides solid evidence that participating older adults are engaged in this program. Currently, there are two versions of Bingocize®. The first version involves strategically inserting physical exercises for participants to perform within the original game of bingo. The second is a mobile application or app which involves a modified game of bingo, physical exercises, and health knowledge information presented throughout the game. Since the mobile app version requires the purchase of computer tablets and internet accessibility, we decided to create a third paper-based version of Bingocize® that includes the same components as the mobile app, but is paper-based, eliminating the need to purchase tablets and internet accessibility. The new version focuses primarily on specific exercises recommended by the CDC to decrease fall risk such as balance, lower body strength, and core exercises (18). Health information is presented throughout the game to improve participants' knowledge of fall risk, ways to decrease fall risk, and QOL. The new paper-based version of Bingocize® targets functional, physical, and psychological health factors necessary for a successful public health intervention. The purpose of this study was to determine the effects of the new version of Bingocize® on fall risk, QOL, and health knowledge in community-dwelling older adults compared to a normal game of bingo. It was hypothesized that all of the variables will improve after participating in the Bingocize® intervention.

METHODS

Participants

Community-dwelling older adults (both male and female), over the age of 60, were recruited for this investigation. This age was chosen because all previous Bingocize® research used this as the age criterion. An a priori power analysis revealed a total sample size of 40 participants was needed to detect significant differences (power = .8; beta = .2; alpha = .05; effect (η_p^2) = .40). Participants were recruited from four different community senior centers. The Activities Director at the specific community senior center recruited the participants and lead the Bingocize® program. Participants met the following criteria to participate: a minimum score of 17 on the telephone mini-mental status exam (24), able to perform the specific exercises during

the intervention, participate in less than 150 minutes of moderate intensity exercise per week, and not diagnosed with any neurological disorders. Qualified participants were instructed not to participate in any physical activities outside of the intervention while participating in the experiment.

Protocol

Prior to study initiation, approval was obtained from the Western Kentucky University Institutional Review Board (IRB). This study was a 14-week, cluster randomized control trial (RCT). Random assignment of participants to condition was not feasible due to the locations of the senior centers; instead, groups of participants from each of the four community senior centers were randomly assigned by a coin toss to one of the two conditions. This RCT was an experimental, between-groups, repeated measures (pre/post) design. All groups used the specific Bingocize® bingo cards. Each of the sites were randomly assigned to one of two conditions: experimental or control. Cluster randomization was used to randomly assign groups of participants from each of the four senior centers to one of two conditions. The researchers were blinded to condition.

During the first week of the experiment, participants completed an informed consent, health questionnaire form, and learned the purpose of the experiment, participant expectations, and risks and benefits of participating. A physician's release was required to ensure participants could safely complete the assessments and the Bingocize® intervention. The participants also completed the World Health Organization quality of life assessment (WHOQOL-BREF), Positive and Negative Affect Scale (PANAS), Falls Efficacy Scale (FES), and a health education quiz consisting of 30 multiple-choice questions focused on testing the participants' knowledge of fall risk, fall prevention, and QOL in older adults. Information from the CDC, American Society on Aging (ASA), and the World Health Organization (WHO) was used to construct the quiz (8, 16, 17, 14). The physical assessments were conducted by trained graduate students, blinded to condition, and included blood pressure, weight, height, the timed up and go (TUG), 30-second chair stand, 4-stage balance, and maximal handgrip strength using a JAMAR handgrip dynamometer. The TUG, chair stand, and 4-stage balance assessments were administered according the CDC protocols (17). The questionnaires and physical assessment were assessed during the first week (pre-intervention) and last week (post-intervention). Both experimental and control conditions completed two weekly 45-60 minute sessions of either Bingocize® bingo with added exercise and health knowledge information (experimental group) or just Bingocize® bingo (control group) for 12 weeks. The Bingocize® bingo for the control group was played like a typical game of bingo. The Bingocize® leader for the specific group recorded attendance for each session in order to measure adherence. All outcome measures were reassessed within a week of completing the intervention.

The facilities in the experimental group were provided with all of the Bingocize® materials, including specific Bingocize® cards and chips to place on the card. Those in the experimental group were also provided with exercise equipment, consisting of resistance bands and balance pads, as well as a binder for each participant consisting of health education questions that were addressed throughout the game. The information for these questions was derived from the same

sources as the quiz questions that were answered for the pre and post-intervention assessments (CDC, ASA, and WHO). The Bingocize® leader was provided a binder with step-by-step instructions on how to lead each specific Bingocize® session instructions, as well as the health knowledge questions and the answers to those questions. During the intervention, each experimental group played Bingocize® two times per week, with each session lasting 45-60 minutes.

During each session, the experimental groups played bingo, using the specific Bingocize® game cards, answered health education questions, and performed exercises that were instructed by the Bingocize® leader. The specific Bingocize® game cards were modified from the original bingo game to ensure every participant had the number for each roll, thus allowing each participant to participate in every bingo call. The numbers on the card were mixed randomly. The leader was provided instructions for each session explaining when to call a number, when to ask a health education question, or when to instruct the participants to perform certain exercises. The researchers also provided the instructors specific exercises for the participants to complete for each session, which focused primarily on balance, lower body strengthening, and core strengthening. A Kinesiology graduate student constructed the Health Knowledge questions to focus on falls, fall risk, and QOL. The health knowledge questions were written to be understand by anyone with a minimum seventh grade reading level. Each participant was provided with a packet of multiple-choice questions posed throughout the 12-week intervention. The instructor informed the participants when to answer each question during each session. The instructor read the question number, the question text, and the answer choices aloud before allowing the participants time to circle an answer choice after which the instructor provided the correct answer to all the participants. A blank space was provided beside each question for the participants to record the correct answer once announced. The questions were randomly assigned to a training session, with each question repeated twice throughout the 12-week intervention. Each week, the exercise repetitions and sets gradually increased. It was instructed that the participants remain at a moderate intensity during the exercises because the CDC recommends older adults exercise at this intensity (17). The Borg Rating of Perceived Exertion Scale (RPE) was used to help the participants perform the exercises at a moderate intensity (16). Participant adherence was determined by an attendance sheet. The Bingocize® leader was in charge of recording when each participant was present or not present for each session.

The control group played a modified version of bingo using the Bingocize® game card provided, without exercise or health knowledge information (similar to a typical bingo game) (5). The specific Bingocize® game cards were modified from the original bingo game to ensure every participant had the number for each roll.

Statistical Analysis

A mixed-design analysis of variance (ANOVA) was used to compare intervention effects and effect size for the experimental and control groups. A one-way ANOVA was used to compare adherence rates, height, weight, BMI, and age. Chi square tests were used to analyze gender, race, yearly income, and highest level of education. All data were analyzed using the Statistical

Package for the Social Sciences (SPSS, version 23.0. Armonk, NY). Statistical significance was set at $p < 0.5$.

RESULTS

Shown in Figure 1, 44 participants met the criteria for the investigation; 43 completed the pre-testing; and 36 participants ($n = 19$, experimental; $n = 17$, control) completed the post-testing, the Bingocize® intervention, and the post-testing. The average age for all participants was 73.63 ± 6.97 years. No significant differences in baseline characteristics were observed between the two groups in relation to the conditions (Table 1). The overall average adherence rate during the intervention was 95.16% (93.86% for experimental group and 96.53% for control group). Based on a one-way ANOVA, no significant differences in adherence rates were observed between both conditions.

Results from the mixed-ANOVA for intervention effects on the variables are presented in Table 2. There were no significant interactions for any of the variables, with the exception of PA and handgrip strength. There was also a significant main effect for time for health knowledge.

There was a significant interaction (group x time) for PA, with a large effect, in the experimental group compared to the control group (F (1,34) = 5.66, $p = 0.02$, $\eta_p^2 = 0.15$, power = 0.64); however, there were no significant main effects for PA. Post hoc analyses using paired sample t-tests were conducted on PA for both conditions, with neither the experimental group (t (17) = -1.36, $p = 0.19$, two-tailed) nor the control group (t (16) = 1.99, $p = 0.64$, two-tailed) showing significant changes over time. Post hoc analysis using independent sample t-test were also conducted on PA for baseline and post-intervention. There was not a significant difference between the control condition and experimental condition at baseline (t (41) = 0.96, $p = 0.35$, two-tailed), however, there was a significant difference in PA between the two conditions for the post-intervention (t (33) = 2.39, $p = 0.02$, two-tailed).

There was a statistically significant interaction (group x time) in handgrip strength, with a large effect, in the experimental group compared to the control group (F (1,34) = 8.31, $p = 0.007$, $\eta_p^2 = 0.196$, power = 0.80); however, there were no statistically significant main effects for handgrip strength. Post hoc analyses using paired sample t-tests were conducted on handgrip strength for both conditions, with the experimental group showing a significant increase in handgrip strength over time (t (18) = -2.86, $p = 0.01$, two-tailed) and the control group not showing any significant changes over time (t (16) = 1.20, $p = 0.25$, two-tailed).

Results from the mixed-ANOVA for intervention effects showed a significant main effect for time for health knowledge (F (1,34) = 22.70, $p < 0.000$, $\eta_p^2 = 0.40$, power = 0.996); however, there was not a statistically significant main effect of group nor interaction (group x time) for health knowledge. Post hoc analyses using paired sample t-tests were conducted on health knowledge for both conditions, with the experimental group (t (18) = -4.15, $p = 0.001$, two-tailed) and control group (t (16) = -2.57, $p = 0.02$, two-tailed) both showing significant increases in health knowledge over time.

Table 1. Participant Demographics.

Characteristics	Experimental Group *(n = 19)*	Control Group *(n = 17)*	*p* value
Sex [a]			0.56
Male	2	2	
Female	17	15	
Age (years) [b]	70.89 ± 4.92	76.88 ± 7.77	0.18
Race/Ethnicity [a]			0.12
Caucasian	11	14	
African-American	8	2	
American Indian	0	0	
Hispanic	0	1	
Other	0	0	
Highest Level of Education [a]			0.17
Less than high school	2	1	
High School	9	14	
Associate's Degree	5	2	
Bachelor's Degree	1	0	
Graduate Degree	2	0	
Yearly Income [a]			0.20
Less than $10,000	4	7	
$10,000-$15,000	9	8	
$15,000-$20,000	2	1	
$20,000-$25,000	0	1	
$25,000-$35,000	2	0	
$35,000-$50,000	1	0	
$50,000-$75,000	1	0	
Greater than $75,000	0	0	
Anthropometrics			
Height (cm) [b]	163.49 ± 7.69	160.15 ± 7.72	0.30
Mass (kg) [b]	82.87 ± 19.09	87.06 ± 25.14	0.59
BMI [b]	31.17 ± 7.34	33.94 ± 8.33	0.38

Note: Data are represented as mean ± standard deviation, *BMI* Body Mass Index, [a] Chi Square was used to analyze; [b] one-way ANOVA used to analyze, *$p < 0.05$, statistically significant

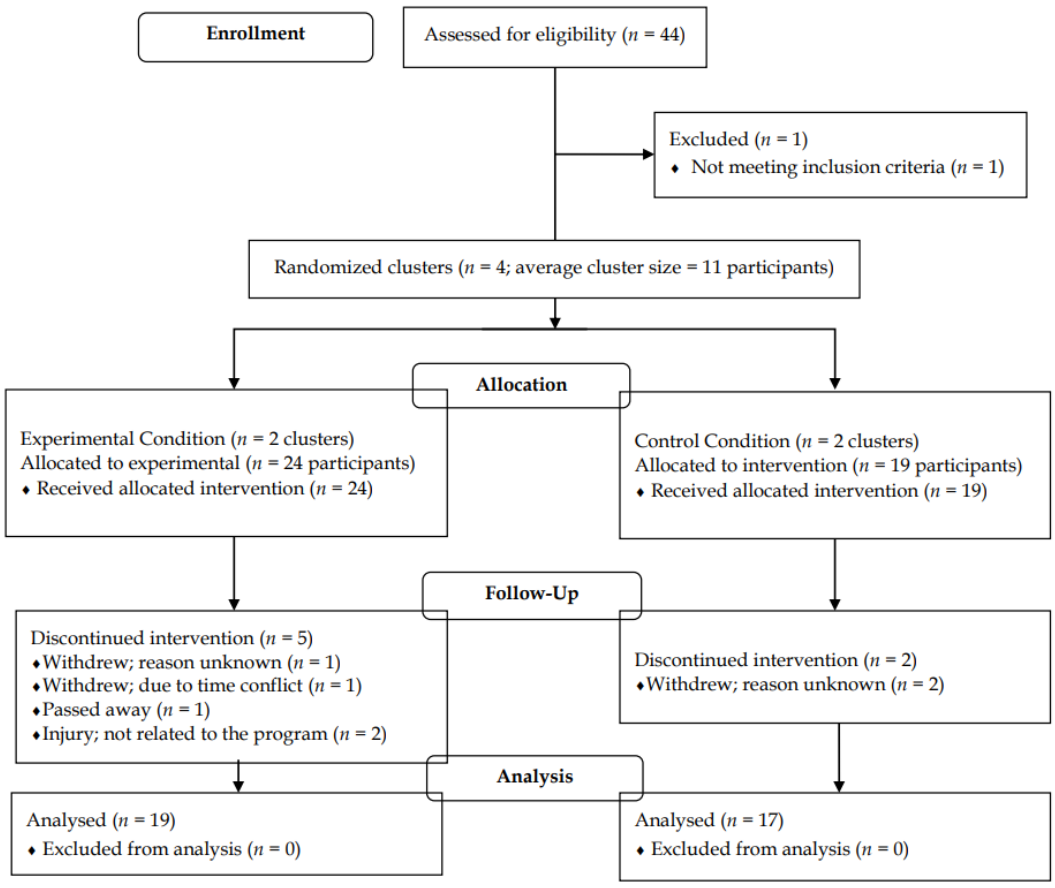

Figure 1. Participant flow diagram.

Table 2. Intervention Effects.

Variables	Control (*n = 17*)		Experimental (*n = 19*)		Group x Time		
	Baseline	Post-Intervention	Baseline	Post-Intervention	$F(1,34)$	p	η_p^2
QOL 1	28.90 ± 9.89	23.86 ± 6.01	30.21 ± 9.24	25.59 ± 7.71	0.02	0.89	0.001
QOL 2	43.14 ± 9.63	38.24 ± 7.70	42.26 ± 6.71	37.87 ± 10.81	0.04	0.85	0.001
QOL 3	109.64 ± 26.32	103.76 ± 18.03	105.41 ± 24.52	109.50 ± 23.97	1.61	0.21	0.05
Positive Affect	34.71 ± 7.29	31.35 ± 9.91	36.83 ± 7.40	39.00 ± 9.00	5.66	0.02*	0.15
Negative Affect	13.35 ± 3.72	14.29 ± 4.96	15.17 ± 7.01	17.83 ± 11.50	0.50	0.49	0.02
FES	20.06 ± 17.10	22.94 ± 25.23	18.39 ± 12.74	26.83 ± 25.10	0.44	0.51	0.01
Average TUG	14.06 ± 6.76	14.32 ± 10.57	10.48 ± 4.13	10.41 ± 5.11	0.068	0.80	0.002
Chair Stand	9.94 ± 4.93	9.59 ± 4.37	8.79 ± 5.00	9.42 ± 5.19	0.66	0.42	0.02
4 Stage Balance	2.71 ± 0.85	2.65 ± 1.06	3.05 ± 1.03	3.37 ± 1.01	2.03	0.16	0.06
Handgrip	21.00 ± 3.82	20.06 ± 5.75	23.71 ± 6.92	26.05 ± 6.75	8.31	0.007*	0.196
Health Knowledge [a]	19.41 ± 4.11	20.82 ± 3.11	18.68 ± 5.08	21.84 ± 4.73	0.011	0.92	0.00

Note: QOL 1 Quality of Life Score (Domain 1: Physical Health), *QOL 2* Quality of Life Score (Domain 2: Psychological), *QOL 3* Quality of Life Score (Domain 3: Social Relationships), *FES* Falls Efficacy Scale, *Average TUG* Average score of all 3 Timed Up and Go trials, [a] Number correct out of 30 questions, *$p < 0.05$, statistically significant interaction

DISCUSSION

The purpose of this investigation was to determine the effects of Bingocize® on QOL, fall risk, and health knowledge in community-dwelling older adults. It was hypothesized that all of the variables would improve after participating in the Bingocize® intervention. The experimental group experienced statistically significant improvements in positive affect and handgrip strength compared to controls. In addition, both experimental and control groups significantly improved their knowledge of fall risk over the course of the investigation.

Quality of life is an important aspect of the overall well-being in older adults and unlike other researchers, we did not find significant improvements in QOL after participating in Bingocize®. Broekhuizen et al. (4) found improvements in older adults' QOL after participating in a 3-month, moderate-to-vigorous exercise program. The intensity of exercise could explain why Broekhuizen et al. (4), and other researchers found significant improvements in QOL. For this study, the participants in the experimental group were instructed to perform the exercises at a moderate intensity per CDC recommendations (17). Intensity was monitored using the Borg RPE scale. Because participants were instructed to refrain from participating in physical activity outside of this investigation, the participants were participating in ~90 minutes of moderate intensity activity per week. One Bingocize® session for the experimental group (each session included playing bingo, answering health knowledge questions, and performing specific exercises) lasts around 45 minutes and occurred twice per week. The American College of Sports Medicine (ACSM) recommends older adults participant in 150 minutes of moderate-intensity activity per week, or 60 minutes of vigorous intensity activity per week (8). More specifically, it is suggested that older adults participate in at least 30 minutes of moderate-intensity aerobic exercise per day, 3-5 days per week. In addition, older adults should add resistance, balance, and flexibility training at least two times per week (26). Because the participants were not reaching the minimum amount of activity recommend by ACSM, the intensity and volume of exercise may not have been sufficient to promote improvements in QOL and other physical outcome measures.

The socioeconomic status (SES) of the participants could also explain the lack of significant improvements in QOL for either group. Bielderman et al. (1) observed the relationship between SES and QOL of 193 community-dwelling older adults and found SES does not directly affect QOL, however, it does affect the social and psychological functioning of the individual, which can ultimately, indirectly affect the QOL in that individual. In addition, older adults with a moderate to low SES reported a lower QOL, regardless of the individual's level of physical function. The majority of the participants in the current study (77.78%) were considered below the 2017 poverty line (see Table 1). which could have negatively impacted improvements in QOL, even if the participants' physical function improved from the intervention (20).
Positive affect has been shown to be an "independent predictor of both mental QOL and physical QOL" (22). Even though there were no statistically significant improvements for QOL, the experimental group showed a significant increase in PA over time compared to the control group. This increase in PA indicates the possibility of increased pleasurable engagement with the environment and increased feelings of happiness, joy, alertness, and excitement for the

experimental group (25). Based on the findings of Stauber et al. (22), this increase could also represent an increase in mental and physical QOL, even though there were no statistically significant results from the WHOQOL-BREF questionnaire. PA is strongly associated with social activity and exercise, which explains the increase in PA in the experimental group (even though there was not a statistically significant increase for the QOL domain), and further supports connection between PA and QOL (22).

The experimental group demonstrated a statistically significant increase in handgrip strength compared to the control group over time. This finding is important because handgrip strength has clinical value and was shown to represent the current overall strength of an individual (2). A meta-analysis on handgrip strength showed low handgrip strength is associated with decreased muscle mass and limited physical function, both of which contribute to increased fall risk (2). Handgrip strength also has a prognostic value. The Bohannon (2) meta-analysis showed handgrip strength as an excellent predictor of 5-year mortality and poor physical function. A study by Kim et al. (11) found that handgrip strength was a better predictor of physical performance and mortality than knee extension strength or muscle mass. This significant increase in handgrip strength for the experimental group may demonstrate an improvement in physical function and muscle mass as a result of participating in the Bingocize® program.

While there were no statistically significant results for the 30-second chair stand test, there were *clinically* significant improvements in the experimental group. The CDC assesses leg strength and endurance as one way to determine if someone is at a higher risk for falling and is assessed by recording the participant's age and the amount of chair stands completed in 30 seconds (28). The CDC provides average scores for this assessment for men and women, based on their age. Any scores below the average indicate a risk for falls for that individual (28). Based on this information and the results from the baseline chair stand test, eight experimental group participants were at risk for falls; however, three of those participants completed enough chair stands after the intervention to no longer be in the fall risk category. The control group began with five participants in the fall risk category at baseline, and only one of those participants completed enough chair stands to no longer be considered a fall risk after the study. Additionally, there were three participants in the control group that were not considered a fall risk for this assessment at baseline but were considered a fall risk after the study.

It was hypothesized that fear of falling would improve in the experimental group, however, both the experimental and control group showed an increase in fear of falling. The participants' demographics could explain these results. Factors that contribute to a higher fear of falling include being female, having a low income, and having gait or balance problems (which is associated with obesity) (12). The majority of the participants were female (88.89%) were classified in the "obese" category (52.78%) and were below the 2017 Federal Poverty Level based on their income (77.78%) (20). This information and the fact that the participants' gender, BMI, and income remained the same, may have negatively affected participants' fear of falling scores.

Interventions combining physical activity and educational components are more effective at decreasing fear of falling than interventions involving physical activity alone (9). While this

intervention did combine both exercise and educational components, the education could have been presented differently in order for the participants to retain more information. For example, instead of the leader only reading the questions and answers, a summary could be provided to the leader for each question in order to promote a discussion with the participants to further enhance participants' understanding of the information. However, this change could cause an increase in the duration of the sessions, which may negatively affect participant adherence and retention. Another consideration is fear of falling is multi-dimensional and strongly correlated to "the perceived threat of falling, perceived risk of falling, concern about the consequences of falls, and fall-related self-efficacy" (12). While the FES is considered to be a reliable and valid assessment to measure fear of falling, it only captures the perceived self-efficacy dimension of fear of falling in an individual (3). Also, the FES assesses fear of falling based on how confident the individual is completing certain tasks without falling (3). These activities may not have been relevant to each of our participants resulting in unchanged FES scores.

One limitation of our investigation was the study sample may not represent the overall population of community-dwelling older adults. Based on the Population Reference Bureau (PRB), 10% of the American older adult population is under the poverty line and 40% is considered obese (13). For this study, 77.78% were under the poverty line and 52.78% were considered obese. See Table 1. Both categories negatively impact fall risk and QOL and both are over-represented in our sample. Additionally, based on effect sizes from our previous work and the existing research literature, a power analysis determined a total of approximately 40 participants (across both groups) in order to detect at least medium-sized effects (power = .8; beta = .2; alpha = .05; effect (η_p^2) = .40); however, only 36 participants completed this study. Another limitation may be the participant sampling procedure. The activities director (the person also in charge of leading the Bingocize® sessions) was in charge of recruiting participants based on the criteria detailed in the methods section. It is possible that the recruiting was biased based on the fact that the activities director was in charge of recruitment at the center.

To increase the external validity of the Bingocize® program, senior center staff were trained to lead the participants during each session of the intervention. Establishing external validity of the program is important since facility staff will most likely lead the sessions if the program is disseminated in "real world" or community settings. Unfortunately, travel to the community centers to check fidelity was not an option for this study due to budget constraints, therefore, it was difficult to establish sufficient internal validity of the program. For future studies, it would be best to have a trained and qualified member of the research team lead the sessions or plan visits to the facility to ensure fidelity of the program.

For future research examining the Bingocize® program, we suggest participants perform the exercises at a higher intensity in order to reach the minimum duration and intensity of exercise per week as recommended by the ACSM. ACSM recommends a higher intensity of exercise if the duration is decreased, and vice versa. That being said, another way to reach the minimal amount exercise needed for older adults is to increase the frequency of sessions to three times per week. In addition, the Bingocize® leaders not only need to be trained on how to monitor the participants' intensity properly but should also be observed to ensure intensity is being

monitored the correct way. In addition, it would be beneficial to have studies that compare the other versions of the Bingocize® intervention with this current one.

In conclusion, participating in the Bingocize® health promotion program can produce a meaningful and detectable change in handgrip strength and PA in community-dwelling older adults. In addition, this program can also produce clinically significant improvements in lower body strength. However, larger samples, improved fidelity, and higher intensity and/or duration of exercise is recommended for future investigations to determine if this program can be an effective fall risk prevention program.

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