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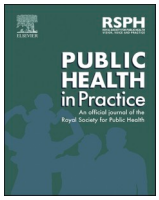

The efficacy of a mobile-based multidomain program on cognitive functioning of residents in assisted living facilities☆

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A B S T R A C T

Objectives: The purpose of this study is to test the efficacy of a mobile-based multidomain application, Silvia Program, on cognitive functioning of residents in assisted living facilities (ALFs).
Study design: Pilot randomized controlled trial using a two-group pretest-posttest design.
Methods: Twenty participants living in ALFs were randomized to a Silvia group or usual care group. Silvia group received mobile-based Multidomain lifestyle intervention for 50–60 min, twice weekly, for 12 weeks. We assessed the cognitive functioning using the Montreal Cognitive Assessment (MoCA).
Results: Results are that the total MoCA scores of the Silvia group showed significant improvement while the total scores of the control group declined.
Conclusion: The present study provides suggestive evidence for an overall positive effect of the use of the Silvia Program on the cognitive functioning among residents in ALFs.

1. Introduction

Clinical trials have demonstrated the effectiveness of multidomain lifestyle interventions designed to prevent or reduce the risk of developing dementia [1]. A systematic review and meta-analysis has provided evidence that multidomain interventions involving two or more non-pharmacological components are more effective than single non-pharmacological interventions in improving cognitive functioning in older adults [2]. While multidomain lifestyle interventions have been evaluated mainly through in-person clinical trials, smartphone based digital health platforms have also played an important role in the efficient delivery of cost-effective cognitive training that is individualized, immersive, and engaging for users [3]. There is growing agreement that mobile-based cognitive programs are effective in delaying and preventing cognitive decline among older adults living in assisted living facilities (ASF) [4]. ASF serves individuals with limitations by providing essential daily livings assistance. Many ASF residents often encounter challenges such as social isolation and limited health care access which can exacerbate cognitive declines. Researchers have implemented a mobile-based cognitive training as a platform for promoting cognitive health [5]. However, little is known about the impact of digital health platforms and the specific benefits of an individualized multidomain approach for older adults. With the current lack of rigorous scientific inquiry and inadequate technology support provided to older adults who are at high risk of dementia, further research is needed into the effects of technology-based multidomain lifestyle programs on cognitive functioning.

Thus, the aim of this study was to pilot test the efficacy of a mobile-based multidomain application, the Silvia Program, on the cognitive functioning of residents in ALF, and to examine whether age or gender might be associated with positive effects. It was hypothesized that participants in the Silvia Program group would exhibit higher levels of cognitive functioning improvement than those in a comparison group.

2. Methods

2.1. Design and sample

This study was a 12-week randomized pilot trial using a two-group pretest-posttest design to assess the effect of the use of the Silvia

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Program on cognitive functioning among residents in ALF. Participants (n = 20) were scheduled for baseline cognitive measurements, and those who scored in the range of mild cognitive impairment (MCI) (18–25) were included in this study. This group randomized into either the intervention group (Silvia users, N = 10) or the control group (usual care, N = 10). The exclusion criteria are having a history of dementia or major depression disorder, or severe sensory problems associated with sight and hearing. Intake procedures took place at the facility in which we obtained informed consent from participants and asked them to complete a baseline questionnaire. Members of the research team helped participants in the intervention group install the mobile app and demonstrated its use. During the trial, the research team monitored participants' activities including cognitive training and exercise programs. Ethical approval was granted by the institution's review board of the institution.

2.2. Measures

Demographic and baseline cognitive data were obtained through a demographic questionnaire and the Montreal Cognitive Assessment (MoCA) [6]. The demographic questionnaire consisted of basic information (e.g., age, sex, race/ethnicity, educational level). Previous studies have identified age, gender, and education as key variables influencing cognitive function. Consequently, this study examined the demographic characteristics of participants, including age, gender, race, and education. We used the MoCA to determine each participant's baseline cognition. The MoCA is used to assess various aspects of cognitive abilities including visuo-spatial abilities, executive function, concentration, orientation, short-term memory, and language. While data on its psychometric properties is limited, preliminary findings suggest that it has good reliability and consistency [7]. The test was administered by a research team member, with a score of 26 points or higher indicating normal cognitive functioning.

2.3. Intervention

Intervention Group vs. Control Group: Our research team implemented the Silvia Program, which consists of five main components: (a) daily smart goal setting routine, (b) cognitive training consisting of 15 validated training programs spanning a range of cognitive domains with provision for the individual to adjust the degree of difficulty for each program (15–30 min per session three times a week for 12 weeks), (c) lifestyle monitoring of nutrition, daily activity patterns/intensity, and sleep patterns/quality, (d) home-based exercise programs consisting of aerobic and resistance exercises with visual step-by-step illustrations (30 min twice a week for 12 weeks), and (e) voice-based AI cognitive assessments including the difficulty of each task, cognitive exercise scores, and time spent by users. The AI system in Silvia Health features allows participants to engage in individualized training based on their real time assessment through conversation. The usual care control group engaged in all data collection activities and was asked to continue their routine daily activities without the use of the app.

2.4. Analysis

Statistical analysis was conducted using SPSS version 29.0 (IBM Corp, Armonk, NY, USA). The normality of outcome variables was assessed by using the Kolmogorov-Smirnov test and the Shapiro-Wilk test, which showed a p-value greater than 0.05. Baseline characteristics were described with frequencies, percentages, means, and standard deviations. Independent chi-square tests and t-tests were conducted to compare categorical and continuous variables between groups, respectively. Paired t-tests ($p < 00.05$) were used to identify significant changes in cognitive scores before and after intervention within each group.

3. Results

A total of 20 participants were included in the analysis, with two participants dropping out before randomization due to lack of interest and personal health issues. The mean age of participants was 78 years for the total sample, 80 for the control group, and 76 for the intervention group, with no significant differences in age between groups indicated (p = 0.51). No significant difference was found in the male-to-female participant ratios between groups (p = 0.60), which was 1:3 for the total sample, 1:4 for the control group, and 3:7 for the intervention group. Participant educational level was significantly different between groups as seven participants in the control group (70 %) and three in the intervention group (30 %) reported having either less than a high school education or a high school diploma. Similarly, we found no significant difference between the baseline average MoCA scores collected from participants, which were 22.8 for the total sample, 22.0 for the control group, and 23.6 for the intervention group (p = 0.47).

Table 1 shows the changes in the scores of MoCA's seven subdomains between the pre and post-intervention assessments within each group [6]. The total MoCA scores of the intervention group showed significant improvement (p = 0.04), while the total scores of the control group declined but not significantly (p = 0.49). No significant differences were found between the subdomain scores for each group. Looking at patterns, the intervention group showed some increases in visuospatial/executive function, language, delayed recall, and orientation scores, while attention scores decreased, naming and abstraction scores were unchanged. The control group also showed non-significant increases in visuospatial/executive function, naming, and abstraction scores, while language and delayed recall scores declined. Attention and orientation scores remained unchanged.

4. Discussion

4.1. Summary

The present study provides suggestive evidence for an overall positive effect of the use of a mobile-based multidomain program on the cognitive functioning of residents in ALFs. Recent systematic reviews have indicated the importance of multidomain lifestyle interventions for dementia prevention among older adults [8]. The results of the present study extend this body of knowledge, showing the potential of a mobile platform based multidomain program in promoting overall cognitive functioning, and preventing or delaying cognitive decline among residents in ALFs.

Table 1
Changes in MoCA scores between pre- and post-intervention assessments.

Variables	Intervention group(n = 10)			Control group(n = 10)		
	Pre, mean ± SD	Post, mean ± SD	p	Pre, mean ± SD	Post, mean ± SD	p
MoCA	23.60 ± 3.78	24.30 ± 4.06	0.04	22.00 ± 4.45	21.7 ± 5.38	0.49
Visuospatial/ executive	3.30 ± 1.56	3.50 ± 0.54	0.17	3.40 ± 1.36	3.60 ± 1.18	0.34
Naming	3.00 ± 0.00	3.00 ± 0.00	–	2.70 ± 0.48	2.80 ± 0.42	0.34
Attention	4.60 ± 1.17	4.40 ± 0.31	0.44	3.30 ± 0.95	3.30 ± 1.26	1.00
Language	2.50 ± 0.70	2.60 ± 0.22	0.59	2.70 ± 0.49	2.50 ± 0.52	0.17
Abstraction	2.00 ± 0.00	2.00 ± 0.00	–	1.70 ± 0.48	1.90 ± 0.32	0.17
Delayed recall	3.30 ± 0.30	3.40 ± 0.34	0.34	3.30 ± 1.06	3.20 ± 1.13	0.34
Orientation	4.90 ± 0.41	5.40 ± 0.31	0.05	4.60 ± 1.17	4.60 ± 1.17	1.00

Substantial evidence has established that cognitive training programs and cognitive activities play an essential role in promoting the cognitive function and performance of older adults [9]. For example, Jang et al. [5] found that a mobile-based cognitive training program was associated with improvements in the cognitive functioning of older adults. Adding to current literature, one of the important features of the Silvia Program is individualized cognitive training, and our study contributes new knowledge to the field about how mobile-based cognitive training can facilitate the improvement of cognitive functioning by showing that voice-based, AI-facilitated cognitive assessments can be used to adjust the difficulty of each task, thereby impacting the scores on each cognitive exercise, and time spent by users.

Prior studies have demonstrated how home-based physical activity programs slow cognitive decline and improve cognitive performance among older adults [10]. One notable benefit of home-based physical activity programs for the geriatric population is that they are cost-effective, easily accessible, and easy-to-implement therapeutic interventions [10]. Our mobile-based multidomain program offering exercises and monitoring shows promise in promoting overall cognitive functioning with the additional benefit of being delivered in an easily accessible home-based format.

4.2. Limitations

This pilot study used a small, short-term, randomized clinical trial to test the effects of a multidomain mobile program on the cognitive functioning of ALF residents. As such, findings are more suggestive than definitive. Future long-term clinical trials at multiple sites with larger study populations are needed to fully assess and disseminate the cognitive health benefits of this mobile technology. In addition, as the participants were predominantly White females, this study lacked a diverse representation of ALF residents that is essential to gaining a deeper understanding of the program's full potential for different populations. Lastly, additional variables such as comorbidity, functional abilities, and technology acceptance that can affect cognitive health and technology use. Research team will use a senior technology acceptance model (STAM) to see the acceptance construct of using technology among older adults in future studies.

4.3. Significance and Implications for practice

This study is proof of concept of the benefits of a mobile multidomain program that is customized to meet the needs of individual users. The Silvia Program provides a range of achievable daily activities including diet monitoring, learning activities, home-based exercise, cognitive training, and brain activity information. In addition, voice-based, AI informed cognitive assessments, the results of which are available to users, are conducted with each user on a weekly basis. This mobile multidomain program has the potential to be effective in promoting the overall cognitive functioning of ALF residents. Designing and implementing a variety of mobile-based multi-domain platforms has significant potential to contribute to supporting and improving the cognitive functioning of older adults.

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Conflicts of interest

The authors have no conflict of interest to report.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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