The Effects of a Social Participation App on Seniors

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ABSTRACT

Background: Advancements in medical care have increased the average life span in many countries, resulting in a generally longer postretirement life span. However, retirees may find it difficult to adapt to retirement. Therefore, encouraging retirees to engage with society is important.

Purpose: In this study, a senior social participation mobile software application (SSP-App) was developed to stimulate social participation among seniors with the goal of improving their social participation intentions and behaviors.

Methods: After developing the SSP-App based on user experiences, a quasi-experimental study was conducted. Participants were recruited from the Keelung Ren’ai Community Center. Next, Random Allocation Software Version 1.0.0 software was used to randomly allocate the participants into experimental and control groups. The 54 participants in the experimental group took part in an SSP-App program, whereas the 53 participants in the control group did not participate in any experimental treatment program. Measurements were conducted at Week 4 (T1) and Week 12 (T2) to evaluate the effects. Data were collected using a demographic datasheet, Geriatric Depression Scale-Short Form, Emotional and Social Support Scale, Social Participation Intention Scale, and Social Participation Behavior Scale. The generalized estimating equations method was used to determine intervention effectiveness.

Results: The SSP-App has six main functions, including an activity partner message board, an activity search function that provides useful information, transportation information, an activity planning and reminder system, and a “First-Aid Station.” Most participants in the SSP-App precursor test expressed approval. At T1, effects were observed in social participation intention only. However, at T2, effects were observed in both social participation intention and social participation behavior.

Conclusions/Implications for Practice: The SSP-App developed in this study uses information and communication technology and multiple strategies covering information provision, social support, education, and reminders. Social participation obstacles must be overcome to effectively provide seniors with social participation opportunities and improve their social participation.

Key Words: seniors, app, social participation intention, social participation behavior.
because of poor physiological condition. Their mentality also creates obstacles to social participation. For example, social participation is hindered by beliefs regarding poor abilities, the inability to contribute, the inability to adapt, and fear of failure (Tsai & Yeh, 2011) as well as anxiety regarding the safety of the participation environment, the inability to meet required expenses, troublesome procedures, a lack of communication tools, and discrepancies between activity content and personal preferences (Levasseur et al., 2014). In addition, lack of family encouragement and approval, and anxiety about not having a partner for participation inhibit the social participation of seniors (Donnelly & Hinterlong, 2010; Levasseur et al., 2016). Furthermore, the presence of social participation information is an important factor that affects the social participation of seniors. Obstacles to obtaining information relate primarily to insufficient publicity or insufficient information (Baez et al., 2019; Ye, 2012).

A systematic literature review that included databases from 2006 to 2016 found that health status and the friendliness of an environment both influence senior social participation. Nurses should work with interprofessional groups to provide a better environment, education, and support for seniors to engage in social participation (Wanchai & Phrompayak, 2019). In terms of social participation types, community-based activities (e.g., volunteering, religious activities, community events) are the most popular type of social participation engaged by seniors, followed by individual-based activities (e.g., neighborhood relationships, hobbies). Demographic factors, environmental friendliness, and health status are related to social participation in seniors. A friendly environment such as neighbor relationships, family involvement, and capital conditions have been found to significantly correlate with social participation in seniors. Social support from friends has been shown to be the main factor affecting senior participation in social activities. Seniors with chronic diseases, cognitive impairments, depression, or psychological dependence are less likely to attend social activities (Wanchai & Phrompayak, 2019).

Because of the rapid development of information and communication technologies, smartphones and phone apps have become an important part of our lives. They have changed the way we communicate with others and obtain information. The most commonly mentioned advantages of smartphones include the rapid dissemination and acquisition of information. Furthermore, social networks are a medium for communication for not only exchanging information with others but also providing emotional support (Lee, 2006; Quintana et al., 2017; Yli-Uotila et al., 2014). The advantages described above overlap significantly with the common obstacles to social participation. Thus, information technology may help overcome the current obstacles faced by seniors to social participation. Strengthening the accessibility of information on social participation activities, widely disseminating information about activities, and promoting important strategies for social participation are important ways to increase information reception among seniors and increase social participation (WHO, 2007). In Taiwan, 66.9% of people aged years 65 and older have smartphones, and 87.2% of seniors access the internet via wireless networks or mobile devices (National Communications Commission, 2021). Mobile devices and apps are widely recognized as advantageous platforms for disseminating information and delivering emotional support (Yli-Uotila et al., 2014). Seniors often use Line, WeChat, and Facebook. However, despite offering information dissemination and emotional support, these apps do not help overcome the multiaspect obstacles to social participation. Currently, no product is able to comprehensively overcome the diverse obstacles to social participation (e.g., environmental, support, physiological, psychological, and information factors). Considering that smartphones are the main mobile communication devices used by seniors, the design of a smartphone application program (hereinafter referred to as an “app”) as a medium for social participation may comprehensively overcome obstacles to social participation by seniors, thus helping them meet their social needs. Seniors may use the app to obtain information about social participation, which may strengthen the user experience and increase seniors’ social participation intention and behavior. Thus, in this study, a seniors’ social participation app was developed based on user experiences. Interviews were conducted among seniors to explore their needs and obstacles regarding the use of smartphones and apps in everyday life and their social participation. The information was used to develop suitable guidelines for the app design process. An app was then designed to effectively increase social participation among seniors. In addition, this study examined whether the social participation app promoted seniors’ social participation intention and behavior and whether it may be applied to seniors’ social participation in the future. The objectives of this study were to (a) explore the influence of a social participation app intervention on seniors’ social participation intention and (b) explore the influence of a social participation app intervention on seniors’ social participation behavior. The hypotheses of this study were as follows: (a) In Week 4 (first posttest), the experimental group will have higher social participation intention than the control group; (b) in Week 12 (second posttest), the experimental group will have higher social participation intention than the control group; (c) in Week 4 (first posttest), the experimental group will have higher social participation than the control group; and (d) in Week 12 (second posttest), the experimental group will have higher social participation than the control group.

**Methods**

**Research Design**

This was a quasi-experimental research study. The research was conducted from August 23 to December 12, 2016. The research framework is shown in Figure 1. Sample recruitment
began after review and approval by the institutional review board of National Yang-Ming University (YM104138E and YM105077E). After the sample recruitment procedure, Random Allocation Software Version 1.0.0 software was used to randomly allocate the participants into experimental and control groups. The experimental group used the senior social participation app (SSP-App) that was designed for this study. The control group received no experimental treatment.

Participants

The study sample included Taiwanese people aged 60 years and older who lived in Ren’ai District, Keelung, and who regularly used a smartphone or tablet. Posters were placed in the Keelung Ren’ai Community Center to recruit volunteers, who were then randomly allocated into the experimental and control groups. After an explanation of the research objectives was provided by the researchers, those potential participants who met the criteria listed below and were willing to participate in the research were selected as participants. The inclusion criteria were as follows: (a) adults aged 60 years or older who used a smartphone or tablet (reasons for including the 60- to 65-year age range in this study are as follows: the definition of senior in Taiwan is ≥ 60 years old, a significant number of retirees are 60–65 years old, study results may be used as retirement planning and suggestions, and younger seniors use smartphones more often), (b) regular user of a smartphone or tablet app for at least 6 months, (c) able to communicate in Mandarin or Taiwanese, (d) able to walk independently and free of mobility disorders, (e) free of mental disorders and a Short Portable Mental Status Questionnaire score higher than 8 points, and (f) Barthel Index score higher than 91 points. In addition to the above, the control group participants had to conform to the following research requirements: maintenance of their initial lifestyle and nonparticipation in extra courses during the 12-week research period. One hundred eight participants met the inclusion criteria and were randomly allocated into the experimental and control groups, with 54 people in each group. Pretest data were collected from 54 participants in the experimental group and 54 participants in the control group. No participants from either group withdrew from the study at Week 4. At Week 12, no participants in the experimental group withdrew from the study, whereas one participant in the control group withdrew from the study (because of hospitalization). Thus, the attrition rate was 0.92%.

Senior Social Participation App Development

The SSP-App developed in this study was the new tool introduced to and used by experimental group participants. The development of the SSP-App consisted of three phases: qualitative research, app development, and preliminary testing. The qualitative research phases were based on purposive sampling, and subjects were recruited in Ren’ai District, Keelung City, Taiwan. The number of interviews in this study was based on data saturation. Thirty seniors were interviewed. The qualitative research phases involved observing and interviewing seniors to explore their experiences with using smartphones in everyday life and their experiences and difficulties in social participation. To promote the responses of the participants, semistructured interviews were conducted based on pre-prepared interview guidelines. The interview process was recorded, and the interview time depended on the physiology and expressiveness of each participant. Each interview took about 50–60 minutes to complete. After the interview, the interview content was transcribed verbatim, subject analysis was conducted, and the way seniors use smartphones in daily life was observed concurrently from three levels (tools, app experience, and community) to explore the conditions and influences that users encounter during use. On the other hand, the social participation experience of the participants, including participation, continuity, and obstacles encountered, was used as a design reference and development direction for the next stage. On the basis of this, suitable guidelines for the
SSP-App design were determined. In the app development phase, the qualitative research results were used to design a social participation app for seniors with an optimal interaction system and interface. Preliminary testing was done before the study began. The preliminary testing phase involved the evaluation of subjective perceptions regarding the system’s overall use, subjective evaluations of the operational interface, and testers’ feedback. The evaluation of subjective perceptions regarding the system’s overall use was evaluated using a system usability scale score, with the result showing satisfaction with use. Subjective evaluations of the operational interface were evaluated using the NASA Task Load Index, with the result showing a positive evaluation. Most of the feedback suggestions from participants were positive. The testers’ feedback and suggestions were used to assess the effectiveness of the app software and to revise and finalize the SSP-App.

Senior Social Participation App Production
The SSP-App was developed using the Web App web design system. The app could be accessed from smartphones, iPads, and computers with different operating systems. No smartphone limitations were set with regard to mobile operating systems. A cross-platform compatible internet app was developed. This study utilized Weebly as the web development tool. Weebly’s web development model and editing functions were used. Web design was conducted using the online Weebly editor. No self-built servers or programs were applied. Because of Weebly’s ability to construct a mobile website automatically, a high level of effectiveness could be achieved regardless of browser platform. Therefore, the app was compatible with iPhone, iPad, and Android systems, thus allowing users to access it via different platforms and making the app content accessible at any time. The SSP-App has six main functions, including an activity partner message board, an activity search function that provides information about different activities, a “Seniors Learning Kiosk” that provides useful information, transportation information, an activity planning and reminder system, and a “First-Aid Station.”

Function 1: activity search
The activity search function provides information related to activities (including the given activity name, date, time, contact telephone, address, and cost). Activity categories include exercise, leisure, religious, learning, and volunteer.

Function 2: activity partners’ message board
Friends motivated seniors to participate in activities and connected through the community. Seniors participating in activities could encourage each other and exchange activity-related information through the activity partners’ message board function.

Function 3: seniors learning kiosk
Seniors need to have accurate active-aging knowledge to develop a correct understanding about social participation concepts. Furthermore, they need to have the basic health knowledge necessary to help them maintain healthy physical functions and thus ensure they are able to participate in activities. Therefore, the “Seniors Learning Kiosk” function provides an active aging and health knowledge interface.

Function 4: transportation information
The transportation information function provides information about transportation to activity venues, including maps and public transport information, to increase the ability of users to reach social participation venues and reduce obstacles to social participation.

Function 5: activity planning and reminder system
The activity planning and reminder system function sets alarm reminders an hour before activities to remind seniors about activities to help them participate on time.

Function 6: first-aid station
The “First-Aid Station” function provides response measures for emergency situations, including information about nearby hospitals and an emergency call system. The station may be used in cases of sudden discomfort during social participation, thereby reducing seniors’ anxiety regarding obstacles related to their physical health.

Study Intervention
This research was conducted from August 23 to December 12, 2016. The research began with a pretest (T0) questionnaire, after which the researchers helped the participants download the SSP-App and explained and showed its use, which was then followed by a first trial use (for 60 minutes). The SSP-App was made available to the experimental group for a period of 12 weeks. The control group did not receive any experimental treatment or intervention. SSP-App back-end operations were managed and maintained by the researchers of this study, who had professional knowledge and rich experience in nursing for the older adults. Activity-related information in the activity search function was updated weekly and carefully screened by the researchers to provide activities suitable for seniors living in Keelung, Taiwan. The activities in this study were screened carefully by the researchers for suitability in terms of seniors’ physical capacity, cognition, economic means, and interest. This is consistent with the strategy of social participation in WHO with regard to “affordable activity.” In different activity categories (e.g., exercise, leisure, religious, learning, and volunteer), 10–20 new activities were added each week. These included exercise activities (e.g., tai chi, yoga, folk dance), leisure activities (e.g., karaoke, senior’s harmonica club, photography club), religious activities (e.g., Buddhist ceremony in temple or worship activities in church), learning
activities (e.g., senior’s English class, spirit-growing class, senior’s art class), and volunteer activities (e.g., hospital volunteer recruitment, environment protect volunteer, Keelung community cultural protection volunteer). Extensive categories were provided, and activity choices were consistent with the social participation strategy of the WHO, which is focused on extending opportunities for social participation. The activities were all held in Keelung City and designed to provide suitable activities for seniors in the city. To increase accessibility, the SSP-App in this study provides location guidelines to decrease the traffic-related barriers to social participation. This is consistent with the social participation strategy of the WHO regarding increasing senior accessibility to suitable activities. The seniors learning kiosk function provides seniors correct knowledge regarding active aging and social participation as well as advocates for and provides education on the benefits of social participation. Through education and empowerment, seniors can take the initiative to increase their social participation. Therefore, the seniors learning kiosk in the SSP-App is consistent with the social participation strategy of WHO with regard to education.

The researcher was a member of the Activity Partners’ Message Board and interacted and provided consultations to seniors in the experimental group every day. Each day, the researchers browsed the participants’ messages and information on the activity partners’ message board to observe their interactions within the community and respond to the participants’ messages. The researchers published accurate information regarding active aging and social participation knowledge in the seniors learning kiosk every week to promote the benefits of social participation. Researchers published about 5–10 new articles weekly on topics including the need for seniors to participate in activities, indicators of pressure in seniors, preventing falls in daily life, and healthy eating habits, among others. Measurements were conducted during Week 4 (T1) and Week 12 (T2) to evaluate the effects of SSP-App use (Figure 2).

**Measurements**

The research instruments used in this study included a demographics datasheet, Geriatric Depression Scale-Short Form, Emotional and Social Support Scale, Social Participation Intention (SPI) scale, and Social Participation Behavior (SPB) scale. The experts’ content validity of each questionnaire of this study was the content validity index (CVI), which ranged between .81 and .95.

**Demographics**

The demographic data collected in this study included age, gender, partner status, educational level, living condition, app use duration, phone use time, frequency of phone app use, perceived financial health, and perceived health status.

**Geriatric Depression Scale-Short Form**

As depression has been highlighted in the literature as a factor affecting social participation in seniors (Donnelly & Hinterlong, 2010; Kang, 2012), depression was treated as a potentially confounding variable in this study. The Geriatric Depression Scale-Short Form is a 15-item self-report inventory, in which each item, a yes/no question, is used to assess the presence of depression symptoms within the past week. “Yes” and “No” answers on positively scored questions are given 1 and 0 points, respectively. “No” and “Yes” answers on reverse-scored questions are given 1 and 0 points, respectively. The total possible score on this form is 15 points, with 5 points set as the threshold, a score of > 5 indicating the presence of depression symptoms, and higher scores (6–15) indicating increasingly severe levels of depression. The CVI for the scale in this study was .95. The Cronbach’s α for the scale in this study was .83 (> .7), indicating the questionnaire results to be highly reliable.

**Emotional and Social Support Scale**

As emotional and social support have been highlighted in the literature as factors affecting seniors’ social participation (Buffel et al., 2014; Minhat & Amin, 2012; Ponce et al., 2014), these factors were treated as potentially confounding variables in this study. Professor Chang-Ming Lu’s Chinese version of the Emotional and Social Support Scale was used as the social support scale in this study. This scale was designed to assess self-perceived levels of actual emotional and social support and consists of six items scored using a 4-point grading system with minimum and maximum total scores of 6 and 24, respectively, and higher scores associated with higher social support. The Cronbach’s α values for the social support scale in the two reference studies were > .75. The Cronbach’s α for the scale in this study was .72 (> .7), indicating the questionnaire results to be highly reliable. The CVI for the scale in this study was .86.

**Social Participation Intention Scale**

The measuring table of the SPI scale consists of three items, including “I intend to participate in activities in the next 6 months” (Item 1), “I am planning to participate in activities in the next 6 months” (Item 2), and “I am determined to regularly participate in activities in the next 6 months” (Item 3). A 5-point grading system was applied, ranging from “strongly disagree” (1 point) to “strongly agree” (5 points). The total possible score ranged from 3 to 15. The CVI and Cronbach's α for the scale in this study were .90 and .96, respectively, indicating that the questionnaire results are highly reliable.

**Social Participation Behavior Scale**

The measuring table of the SPB scale assessed social participation categories and frequency. The social participation categories included religious activities (e.g., worshippers’ groups, Christian associations, temple fair activities),
volunteer activities (e.g., hospital volunteering, environmental volunteering), exercise activities (e.g., Wai Tan Kung exercises, folk dance, park aerobics groups), learning activities (e.g., community college courses, health lectures), and leisure activities (e.g., community traveling, outdoor excursions, community karaoke). The total SPB score was the sum of the numbers of participations in each category activities in the past 4 weeks. The CVI for the scale in this study was .81.

Data Analysis

Individual interviews were used to collect research data, and IBM SPSS Statistics Version 21 software (IBM Inc., Armonk, NY, USA) was used for all data analyses. The chi-square and Wilcoxon rank sum tests were respectively used to examine the homogeneity of the categorical variables and continuous variables in the experimental and control groups’ pretests. First, pretest data regarding social participation intention and behavior were tested for normal distribution. The Kolmogorov–Smirnov test results indicated that neither social participation intention ($D = .30, p < .001$) nor social participation behavior ($D = .13, p < .001$) exhibited a normal distribution. Moreover, neither SPI nor SPB exhibited a normal distribution, and during Week 12 of the intervention, the issue of missing occurred in one participant. To improve the accuracy of the dependent samples analysis, generalized estimating equations (GEEs) were used to analyze the effectiveness of the intervention.

Results

Background Variable Distributions in the Two Groups Before Intervention

The preintervention participant background variable distributions in the experimental and control groups are presented in Tables 1 and 2, respectively. The chi-square test and

![Figure 2: Flowchart of Study Procedure](image)
Wilcoxon rank sum test were applied to analyze the homogeneity of the background variables in the experimental and control groups before the intervention. The statistical results indicate no significant difference \((p > .05; \text{Tables 1 and 2})\). Thus, the background variables of the two groups are homogeneous.

**Performance Variable Distributions in the Two Groups Before Intervention**

In the performance variables, the social participation intention mean score in the experimental group was 11.02 \((SD = 2.06)\) and the incidence of social participation behavior was 16.67 \((SD = 16.18)\) times a month. In the different types of social participation behavior, exercise was 7.81 \((SD = 11.01)\) times, leisure was 2.38 \((SD = 3.35)\) times, religious activity was 1.15 \((SD = 2.26)\) times, learning was 2.33 \((SD = 2.77)\) times, and volunteer was 2.78 \((SD = 3.83)\) times a month (Table 1). In the control group, the score for social participation intention was 11.74 \((SD = 2.04)\) and the incidence of social participation behavior was 16.09 \((SD = 12.89)\) times. In the different types of social participation behavior, exercise was 9.91 \((SD = 10.66)\) times, leisure was 1.94 \((SD = 3.53)\) times, religious activity was 0.87 \((SD = 1.28)\) times, learning was 1.56 \((SD = 3.16)\) times, and volunteer was 1.81 \((SD = 4.40)\) times a month (Table 1).

The Wilcoxon rank sum test was applied to analyze the homogeneity of the performance variables (SPI, SPB, exercise, leisure, religious, learning, and volunteer) in the experimental and control groups before the intervention. The statistical results indicate no significant difference between the two groups \((p > .05; \text{Table 2})\). Thus, the performance variables of the two groups were homogeneous.

### Table 1

**Distribution and Homogeneity Test of Categorical Variables at Baseline \((N = 108)\)**

| Variable                  | Experimental Group \((n = 54)\) | Control Group \((n = 54)\) | \(\chi^2\) | \(p\) |
|---------------------------|----------------------------------|-----------------------------|------------|------|
| Gender                    |                                  |                             | 0.04       | .83  |
| Male                      | 17                               | 31.5                        | 18         | 33.3 |
| Female                    | 37                               | 68.5                        | 36         | 66.7 |
| Partner                   |                                  |                             | 1.47       | .22  |
| Yes                       | 41                               | 75.9                        | 46         | 85.2 |
| No                        | 13                               | 24.1                        | 8          | 14.8 |
| Educational level         |                                  |                             | 5.21       | .26  |
| Elementary school         | 21                               | 38.8                        | 16         | 29.6 |
| Junior high school        | 11                               | 20.4                        | 11         | 20.4 |
| Senior high school        | 15                               | 27.8                        | 16         | 29.6 |
| Professional college      | 7                                | 13.0                        | 11         | 20.4 |
| and higher                |                                  |                             |            |      |
| Living together with children |                        |                             | 0.78       | .37  |
| Yes                       | 40                               | 74.1                        | 42         | 77.8 |
| No                        | 14                               | 25.9                        | 12         | 22.2 |
| Perceived financial health|                                  |                             | 0.01       | .96  |
| Insufficient              | 30                               | 55.6                        | 32         | 59.2 |
| Sufficient                | 24                               | 44.4                        | 22         | 40.8 |
| Perceived health status   |                                  |                             | 1.33       | .33  |
| Unhealthy                 | 24                               | 44.4                        | 30         | 55.6 |
| Healthy                   | 30                               | 55.6                        | 24         | 44.4 |
| Frequency of phone app use|                                  |                             | 5.69       | .22  |
| Very seldom               | 12                               | 22.2                        | 8          | 14.8 |
| Seldom                    | 10                               | 18.5                        | 16         | 29.6 |
| Average                   | 17                               | 31.5                        | 21         | 38.9 |
| Often                     | 15                               | 27.8                        | 9          | 16.7 |

Note. Chi-square test was used.

### Table 2

**The Differences in Age, Depression, Emotional Social Support, Social Participation Intention, and Social Participation Behavior Between the Experimental Group and the Control Group \((N = 108)\)**

| Variable                   | Experimental Group \((n = 54)\) | Control Group \((n = 54)\) | \(p\) |
|----------------------------|---------------------------------|-----------------------------|------|
| Age (years)                | 67.20                           | 66.80                       | 5.60 | .92 |
| GDS-SF                     | 2.20                            | 2.90                        | 3.60 | .80 |
| App use duration (months)  | 25.80                           | 19.20                       | 16.40| .12 |
| Phone use time (hours/day) | 1.60                            | 1.50                        | 1.40 | .68 |
| ESS                        | 19.70                           | 20.10                       | 2.20 | .91 |
| SPI                        | 11.02                           | 11.74                       | .25  |
| SPB (times/month)          | 16.67                           | 16.09                       | .25  |
| Exercise                   | 7.81                            | 9.91                        | .53  |
| Leisure                    | 2.38                            | 1.94                        | 3.53 | .76 |
| Religious activity         | 1.15                            | 0.87                        | 1.28 | .91 |
| Learning                   | 2.33                            | 1.56                        | 3.16 | .08 |
| Volunteer                  | 2.78                            | 2.78                        | .40  |

Note. Wilcoxon rank sum test was used.

GDS-SF = Geriatric Depression Scale–Short Form; ESS = Emotional and Social Support Scale; SPI = Social Participation Intention Scale; SPB = Social Participation Behavior Scale.

### Table 3

**The Differences in Social Participation Intention and Social Participation Behavior Between the Experimental Group and the Control Group \((N = 108)\)**

| Variable                  | Experimental Group \((n = 54)\) | Control Group \((n = 54)\) | \(p\) |
|---------------------------|---------------------------------|-----------------------------|------|
| Gender                    |                                  |                             |      |
| Male                      | 17                               | 31.5                        | 36.7 |
| Female                    | 37                               | 68.5                        | 36.7 |
| Partner                   |                                  |                             |      |
| Yes                       | 41                               | 75.9                        | 46.7 |
| No                        | 13                               | 24.1                        | 54.3 |
| Educational level         |                                  |                             |      |
| Elementary school         | 21                               | 38.8                        | 16.7 |
| Junior high school        | 11                               | 20.4                        | 16.7 |
| Senior high school        | 15                               | 27.8                        | 16.7 |
| Professional college      | 7                                | 13.0                        | 16.7 |
| and higher                |                                  |                             |      |
| Living together with children |                        |                             |      |
| Yes                       | 40                               | 74.1                        | 42.3 |
| No                        | 14                               | 25.9                        | 57.7 |
| Perceived financial health|                                  |                             |      |
| Insufficient              | 30                               | 55.6                        | 32.3 |
| Sufficient                | 24                               | 44.4                        | 67.7 |
| Perceived health status   |                                  |                             |      |
| Unhealthy                 | 24                               | 44.4                        | 30.7 |
| Healthy                   | 30                               | 55.6                        | 69.3 |
| Frequency of phone app use|                                  |                             |      |
| Very seldom               | 12                               | 22.2                        | 8.8  |
| Seldom                    | 10                               | 18.5                        | 16.7 |
| Average                   | 17                               | 31.5                        | 21.8 |
| Often                     | 15                               | 27.8                        | 9.0  |

Note. Chi-square test was used.

GDS-SF = Geriatric Depression Scale–Short Form; ESS = Emotional and Social Support Scale; SPI = Social Participation Intention Scale; SPB = Social Participation Behavior Scale.

### Table 4

**The Changes in Social Participation Intention After Intervention**

In the experimental group, the GEE results, which consider time effects, indicate that, at T1 and T2, the average SPI score was 1.75 and 2.13 points higher than at pretest, respectively. Both reached a statistically significant difference \((p < .001; \text{Table 3})\). The average SPI score of the experimental group increased significantly \((11.02 \rightarrow 12.93 \rightarrow 13.07; \text{Table 4})\).
In the control group, the GEE results’ consideration of time effects indicated that, at T1 and T2, the average SPI score was .38 and .18 points higher than that at the pretest, respectively, and that these differences did not reach statistical significance \( (p = .09 \text{ and } .48, \text{ respectively}; \text{Table 3}) \). A slight increase was observed in the average SPI score of the control group \((11.74 \rightarrow 11.91 \rightarrow 11.93; \text{Table 4})\).

The potential interaction effect between group and time was examined. The change in the SPI score in the experimental group at Week 4 exceeded that in the control group by 1.38 points. The change in the SPI score at Week 12 exceeded that in the control group by 1.96 points. Both differences were statistically significant \( (p < .001) \). Thus, the group–time interaction effect results indicate that, at both T1 and T2, changes over time significantly increased SPI (Table 5).

### Table 3
**GEE Analysis of Changes in Two Groups at Pretest, Week 4, and Week 12**

| Variable       | SPI                          | SPB                          |
|----------------|------------------------------|------------------------------|
|                | \( \beta \)                  | \( SE \)                      | \( p \)            | \( \beta \)                  | \( SE \)                      | \( p \)            |
| Experimental   |                             |                              |                    |                              |                              |                    |
| T1 vs. T0      | 1.75                         | 0.31                         | < .001            | 2.19                         | 1.19                         | .070              |
| T2 vs. T0      | 2.13                         | 0.28                         | < .001            | 5.50                         | 1.58                         | < .001            |
| Control        |                              |                              |                    |                              |                              |                    |
| T1 vs. T0      | 0.38                         | 0.22                         | .090              | 0.45                         | 1.04                         | .660              |
| T2 vs. T0      | 0.18                         | 0.25                         | .480              | −1.44                        | 1.12                         | .190              |

Note. GEE = generalized estimating equation; SPI = Social Participation Intention Scale; SPB = Social Participation Behavior Scale; T0 = pretest; T1 = Week 4; T2 = Week 12.

In the control group, the GEE results’ consideration of time effects indicated that, at T1 and T2, the average SPI score was .38 and .18 points higher than that at the pretest, respectively, and that these differences did not reach statistical significance \( (p = .09 \text{ and } .48, \text{ respectively}; \text{Table 3}) \).

### Table 4
**Distribution and Changes in SPI and SPB in the Two Groups**

| Variable              | Test | Experimental | Control |
|-----------------------|------|--------------|---------|
|                       |      | n | Mean | SD  | n | Mean | SD  |
| SPI                   | T0   | 54 | 11.02   | 2.06 | 54 | 11.74   | 2.04 |
|                       | T1   | 54 | 12.93   | 2.50 | 54 | 11.91   | 2.34 |
|                       | T2   | 54 | 13.07   | 2.80 | 53 | 11.93   | 2.30 |
| SPB (times/month)     | T0   | 54 | 16.67   | 16.18 | 54 | 16.09   | 12.89 |
|                       | T1   | 54 | 18.78   | 13.68 | 54 | 16.65   | 12.05 |
|                       | T2   | 54 | 21.63   | 16.55 | 53 | 15.02   | 11.31 |
| Exercise (times/month)| T0   | 54 | 7.81    | 11.01 | 54 | 9.91    | 10.66 |
|                       | T1   | 54 | 8.52    | 9.03  | 54 | 9.73    | 10.08 |
|                       | T2   | 54 | 9.15    | 10.50 | 53 | 8.51    | 9.68  |
| Leisure (times/month) | T0   | 54 | 2.38    | 3.35  | 54 | 1.94    | 3.53  |
|                       | T1   | 54 | 2.91    | 4.40  | 54 | 2.26    | 3.92  |
|                       | T2   | 54 | 3.24    | 3.34  | 53 | 1.94    | 3.55  |
| Religious activity (times/month) | T0   | 54 | 1.15    | 2.26  | 54 | 0.87    | 1.28  |
|                       | T1   | 54 | 1.50    | 2.53  | 54 | 0.87    | 1.28  |
|                       | T2   | 54 | 1.48    | 2.59  | 53 | 1.04    | 1.30  |
| Learning (times/month)| T0   | 54 | 2.33    | 2.77  | 54 | 1.56    | 3.16  |
|                       | T1   | 54 | 4.57    | 3.66  | 54 | 1.98    | 0.35  |
|                       | T2   | 54 | 4.90    | 5.88  | 53 | 2.11    | 2.29  |
| Volunteer (times/month)| T0   | 54 | 2.78    | 3.83  | 54 | 1.81    | 4.40  |
|                       | T1   | 54 | 2.85    | 3.80  | 54 | 1.81    | 4.40  |
|                       | T2   | 54 | 2.86    | 2.59  | 53 | 1.42    | 4.14  |

Note. SPI = Social Participation Intention Scale; SPB = Social Participation Behavior Scale; T0 = pretest; T1 = Week 4; T2 = Week 12.
control group, the GEE results' consideration of time effects indicated that the average SPB frequency at T1 was 0.45 times higher than that at pretest and that at T2 was 1.44 times lower than that at pretest. Neither difference reached statistical significance ($p = .06$ and $p = .19$, respectively; Table 3). A slight increase was observed in the average SPB score in the control group ($11.74 \rightarrow 11.91 \rightarrow 11.93$; Table 4).

An interaction effect between group and time was examined. The change in the average SPB score in the experimental group at Week 4 (T1) exceeded that in the control group by a factor of 1.74, although statistical significance was not reached ($p = .27$). However, at Week 12 (T2), the average SPB score in the experimental group exceeded that in the control group by 6.9, which was statistically significant ($p < .001$; Table 5). Thus, the group–time interaction effect results indicate that, after the SSP-App intervention and although the short-term effect is minimal, SPB increases significantly over time. In the different types of SBP, no significant differences were observed in exercise, leisure, religious activity, or volunteer at either T1 or T2 in either the control or experimental group. The change in the learning score in the experimental group at T1 exceeded that in the control group by a factor of 0.96, although statistical significance was not reached ($p = .079$). However, at T2, the experimental group exceeded the control group by 4.38 times, which reached statistical significance ($p < .001$; Table 6).

### Discussion

The information and communication technology (ICT) product used in this study (SSP-App) is a user-based software application designed for use on mobile phones. The SSP-App has six main functions, including an activity partner message board, an activity search function that provides information about different activities, a “Seniors Learning Kiosk” that provides useful information, transportation information, an activity planning and reminder system, and a “First-Aid Station.” During the 4 week of the SSP-App intervention, effects had only been observed in social participation intention. During the final (12th) week of the intervention, effects were seen in social participation intention and social participation behavior. This research is a pioneering examination of social participation

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### Table 5

| Variable | SPI | | | SPB | | | Exercise | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | $\beta$ | SE | $p$ | $\beta$ | SE | $p$ | $\beta$ | SE | $p$ |
| Group | Experimental vs. control | $-0.72$ | $0.39$ | $0.160$ | $0.58$ | $2.82$ | $0.910$ | $-0.74$ | $1.76$ | $0.670$ |
| Time | T1 vs. T0 | $0.17$ | $0.25$ | $0.090$ | $0.56$ | $1.04$ | $0.660$ | $-0.48$ | $1.01$ | $0.632$ |
| | T2 vs. T0 | $0.19$ | $0.22$ | $0.480$ | $-1.07$ | $1.12$ | $0.190$ | $-0.87$ | $1.04$ | $0.403$ |
| Group $\times$ Time | Group $(T1$ vs. T0) | $1.38$ | $0.38$ | $<.001$ | $1.74$ | $1.58$ | $0.270$ | $0.18$ | $1.30$ | $0.887$ |
| | Group $(T2$ vs. T0) | $1.96$ | $0.38$ | $<.001$ | $6.90$ | $1.94$ | $<.001$ | $2.20$ | $1.58$ | $0.163$ |

Note. GEE = generalized estimating equation; SPI = Social Participation Intention Scale; SPB = Social Participation Behavior Scale; T0 = pretest; T1 = Week 4; T2 = Week 12.

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### Table 6

| Variable | Leisure | | | Religious Activity | | | Learning | | | Volunteer | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | $\beta$ | SE | $p$ | $\beta$ | SE | $p$ | $\beta$ | SE | $p$ | $\beta$ | SE | $p$ |
| Group | Experimental vs. control | $-0.72$ | $.39$ | $0.160$ | $0.72$ | $.32$ | $0.025$ | $0.30$ | $.65$ | $0.644$ | $1.83$ | $.61$ | $0.003$ |
| Time | T1 vs. T0 | $0.35$ | $.27$ | $0.203$ | $-0.07$ | $.12$ | $.545$ | $0.35$ | $.33$ | $0.300$ | $0.63$ | $.51$ | $0.222$ |
| | T2 vs. T0 | $0.01$ | $.01$ | $.720$ | $0.17$ | $.18$ | $.345$ | $0.34$ | $.24$ | $.166$ | $0.09$ | $.51$ | $.859$ |
| Group $\times$ Time | Group $(T1$ vs. T0) | $.44$ | $.52$ | $.395$ | $.42$ | $.23$ | $.067$ | $.96$ | $.54$ | $.079$ | $-0.55$ | $.52$ | $.285$ |
| | Group $(T2$ vs. T0) | $.12$ | $.09$ | $.195$ | $.17$ | $.27$ | $.516$ | $4.38$ | $.89$ | $<.001$ | $0.16$ | $.54$ | $.757$ |

Note. GEE = generalized estimating equation; T0 = pretest; T1 = Week 4; T2 = Week 12.
among seniors using an app-based intervention. As no comparable study is available in the literature, ICT was used to discuss the social participation of the seniors in this study.

The SSP-App intervention in this study was shown to have an effect on social participation behaviors. This result echoes that of Müller et al. (2016), which found that a 12-week exercise program intervention that included an SMS reminder given 5 times weekly to 43 seniors was effective in improving exercise behavior.

However, the results of this study differ from those of Slegers et al. (2008), in which participants used a computer network at home according to their personal needs for 48 weeks and no effect on participation was found. It may be because the intervention used computer networks at home or that the intervention was not specifically designed to affect social participation. The SSP-App in this study was designed based on a summary and analysis of qualitative interviews with seniors, followed by a careful screening of the social activities appropriate for seniors using researchers’ professional knowledge and experience in long-term senior care.

The social participation needs of seniors were integrated, and activity-related information was localized to increase activity demand and familiarity with activity content among the participants. This increased the read and activity-participation rates for the app. Thus, the application of ICT in seniors’ social participation should be designed based on seniors’ usage behaviors and habits. The provided activity information must be suitable for seniors, and their social participation needs must be integrated. The practical application of social participation strategies revealed that each senior or the seniors in each area were affected by a combination of multiple obstacles to social participation. Diverse strategies must be used to increase the social participation rate among seniors. The app applied in this study used ICT as the channel and involved different strategies such as provision of information, social support, education, reminder, and so on. Social participation obstacles must be overcome to effectively provide seniors with social participation opportunities and improve their social participation. We suggest that ICT applications to improve individual social participation behavior be designed based on considerations of senior-user behaviors and habits so that the seniors can directly and quickly obtain a variety of suitable activities. The findings of this study suggest that ICT be used in future interventions to improve social participation behavior. The design must be conducted based on senior users’ considerations to promptly provide them with information on multiple, suitable activities. Results showed that the SSP-App intervention had a significant effect on SPI and SPB. Therefore, seniors may use the SSP-App to collect their preferred social participation information. They may use smartphones to search information on web, overcome barriers to social participation and support, and increase their social participation intention and behavior.

Information about community activities is currently largely disseminated via Line groups, WeChat, and Facebook, which only allow for activity-related information to be published. However, because of a lack of a systemized classification of activities (e.g., exercise, learning, volunteer, leisure), seniors find it difficult to find activities they like. Furthermore, the provision of activity-related information does not guarantee seniors’ participation in these activities. In addition to information, accurate knowledge about social participation and coping with obstacles to social participation (e.g., anxiety about one’s physical status, transportation difficulties, forgetting to participate) are necessary. Line groups, WeChat, and Facebook cannot fully meet seniors’ social participation needs or address their obstacles. The developed SSP-App compensates for the deficiencies found in these social media platforms, as it integrates all the social participation needs of seniors in one app. The activity search function provides seniors with clear categories of activities and related information, thus facilitating their search for desired activities. The activity partners’ message board increases the social support given with respect to activity participation. The “Seniors Learning Kiosk” function provides accurate knowledge about social participation, preventing seniors’ misconceptions from affecting their motivation to participate in activities. The transportation information function addresses the transportation issues that hinder social participation. The activity planning and reminder system function sends reminders to seniors so that they will not forget activity-related information. The “Seniors Learning Kiosk” function provides an active aging and health knowledge interface. The First-Aid Station function addresses the obstacles related to seniors’ anxiety about their health status. Thus, the SSP-App integrates seniors’ social participation needs. Therefore, the results of this study support that the SSP-App intervention has a significant effect on SPI and SPB.

This study found that the SSP-App intervention had the greatest effect on SBP learning scores. This result is consistent with the discussion by Liu and Chen (2017) that seniors realize their deficiencies and seek satisfaction through the learning process to achieve their goals. Therefore, the SSP-App provides sufficient information about the learning courses for seniors, and seniors will like to participate in the learning courses.

Furthermore, the results indicate that, during Week 4 of the SSP-App intervention, the experimental group statistically significantly outperformed the control group in terms of behavioral intentions. This effect was maintained through the 12th week of the intervention. No statistically significant effects were observed at Week 4 in terms of behavior. At Week 12 of the intervention, the experimental group statistically significantly outperformed the control group in terms of behavior. These results indicate that the changes in behavioral intention were followed by changes in behavior after a certain period had passed. This corresponds to an argument in Fishbein and Ajzen’s (1977) Theory of Reasoned Action (TRA) that states that an individual’s behavioral intention maintained by willpower control is the main predictor of behavior. Under certain conditions, behavioral intention is the optimal way to predict an individual’s behavior. The behavioral intention in this study was found to have already...
changed by Week 4 of the app intervention. However, no changes were observed in behavior at Week 4. Both behavioral intention and behavior changed at Week 12 after the intervention. Thus, behavioral intention was shown to predict individual behavior. The TRA suggests that an individual’s behavioral motivation and behavioral control abilities may predict and explain an individual’s behavior. The sample inclusion criteria in this study included the ability to use a smartphone or tablet and the regular use of an app for at least a 6-month period. Therefore, the results corresponded to the TRA. However, many factors may affect an individual’s willpower control in future usage of the app. Behavior is unlikely to change in those who cannot operate a smartphone or app. Therefore, it is suggested that seniors first be taught how to use an app to form their SPB via ICT by increasing their SPI.

Because of human resource, material source, and time limitations, the sample in this study included adults aged 60 years and older only from Ren’ai District in Keelung City. Thus, the representativeness of the sample was limited. No follow-up research was conducted, and long-term effects were not observed. The SSP-App’s back-end design did not include statistical data regarding the daily numbers of app users. Thus, the app’s actual use could not be examined and should be considered in future related studies. Because of the small number of studies examining smartphone app use among seniors and intervention measures related to behavioral intention and behavior, this study was only able to compare and examine the ICT effects on seniors’ intention and behavior based on the research results.

Applicability to Nursing

The SSP-App developed in this research may be promoted to seniors who live in the community, thus providing another option for them to obtain information on social participation. The qualitative research conducted during the development of the SSP-App showed that seniors lack correct knowledge regarding active aging and social participation and thus increase their social participation. The SSP-App may be used in the future to provide seniors with information on multiple suitable activities.

Author Contributions

Study conception and design: PTH, IJC
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Data analysis and interpretation: PTH, CSH, YFH
Drafting of the article: PTH, YFH
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The authors declare no conflicts of interest.

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