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An Integrated mHealth Campaign to Reduce the Risk of Falling for Older Adults

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Abstract

The number of falls among older adults is rising due to an aging population worldwide. An integrated communication campaign utilizing mHealth (mobile health) encouraged older adults to perform strength, balance, and flexibility exercises to reduce their risk of falling. Campaign development was guided by a mixed-method approach which incorporated expert interviews (N = 3), qualitative interviews (N = 22), and a quantitative baseline pre-campaign survey (N = 274) with older adults. We evaluated the campaign impact with a pre-post survey analysis (post n = 141). Impact was measured by knowledge, attitudes, self-efficacy, and behaviors as key Social Cognitive Theory factors to exercise adoption. Results showed that respondents with campaign exposure had a significant increase in all factor scores from pre- to post-campaign survey, which was significantly higher in the group with campaign exposure. The impact evaluation illustrated how digital mobile channels effectively provide means to reach older adults to reduce their risk of falling.

Keywords

campaign, exercise, falls, information technology, prevention, mHealth, older adults

Worldwide, fall-induced injuries were recorded as the fifth leading cause of death for older adults (Kannus et al., 2005). Impacts of falls include injuries and can have significant economic and social consequences. Many older adults do not regain prior levels of functional performance, experience reduced quality of life, or suffer from post-fall syndromes (WHO, 2007).

The risk of falls is becoming more prevalent with a rapidly aging population, and with the number of older adults living alone steadily increasing (Linton et al., 2018). Older adults living alone are most at risk of falls (Bongue et al., 2011), as are pre-frail and frail adults (Cheng & Chang, 2017). Fried et al. (2001) explain frailty as a clinical syndrome in which at least three out of five criteria are present, including unintentional weight loss, self-reported exhaustion, weakness in grip strength, slow walking speed, and low physical activity. Pre-frailty is defined as the presence of one or two criteria.

In Singapore, 17% of older adults aged 60 years and above experienced at least one fall annually and one-third of this group experienced recurrent falls (Chan et al., 1997).

Exercise was found to be most effective in reducing fall risks (Guirguis-Blake et al., 2018), especially for pre-frail adults who benefit from designed exercise programs (Faber et al., 2006). Strength, balance, and flexibility (SBF) exercises have the ability to improve postural control and muscle strength (Martínez-López et al., 2014); thus, reducing incidences of falls in community-dwelling older adults (Gillespie et al., 2012).

To promote the adoption and sustained practice of SBF exercise behaviors, the inclusion of mobile health technologies (mHealth), as a component of information and communication technologies (ICTs) for health, can promote exercise in older groups (Changizi & Kaveh, 2017). This is because mHealth has the potential to improve self-efficacy and health behavior adoption (Nacinovich, 2011). mHealth includes health applications or text/instant message services on mobile communication devices. Studies display the feasibility and effectiveness of text messages for increasing exercise behavior among older adults (Müller et al., 2016) and of exercise games for mitigating falls risk (Choi et al., 2021). mHealth can be

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adapted for older adults to adhere to falls prevention exercise (Arkkukangas et al., 2020), or to assess their falls risk (Hsieh et al., 2018). mHealth/ICTs for health allow older adults to manage their health, stay connected, and remain independent (Goldwater & Harris, 2011). These can improve older users' quality of life by addressing loneliness and social connectedness, thereby allowing them to access activities (Fields et al., 2021; Gallo et al., 2021).

Despite proven benefits, barriers against ICT use for older people include usability pitfalls (Tan & Chan, 2018), technology anxiety (Guo et al., 2012), apathetic behaviors towards technology (Kong & Woods, 2018), as well as lack of support to be inclusive towards seniors (Chib et al., 2021). Increasing adoption rates of ICTs among older adults have proven elusive (Niehaves & Plattfaut, 2017), with some research going so far as to claim that older groups do not personally view the need for ICTs (Dogruel et al., 2015). Consequently, campaigns intended for older adults often fail to include mHealth channels, although there is an expanding literature which supports the success of mHealth for older audiences.

So far, Singaporean health campaigns for older adults mostly follow traditional practices, focusing on sit-down exercises (Singapore HPB, 2017), falls prevention (The Online Citizen, 2016), or social engagement to encourage older adults to achieve behavioral objectives (NUH, 2019). mHealth channels, however, are an untested proposition. This approach ignores beneficial pre-conditions for mHealth as an effective tool for SBF promotion in Singapore, which include an increasing interest in using mobile phones and a high smartphone penetration rate, with 73% of adults above 60 years using a mobile smart device in Singapore (IMDA, 2018).

There is thus unexploited potential for the use of mHealth in campaigns to educate older adults about SBF behaviors for falls prevention, especially in settings with favorable conditions. To address this gap, this study aimed *to use case study results to develop an integrated mHealth communication campaign to promote the adoption of SBF exercises in older Singaporean adults to reduce their risk of falling. Effectiveness was evaluated via measurement of the campaign impact on knowledge, attitudes, self-efficacy, and health behaviors as key theoretical factors to exercise adoption.* Results inform the suitability of integrated health communication campaigns using mHealth for older beneficiaries.

Theoretical Background and Research Questions

Social cognitive theory (SCT) (Bandura, 1986) has been established as an effective theoretical perspective for understanding and predicting physical activity behaviors (Young et al., 2014). At the core of SCT are self-efficacy beliefs to attain designated performances and results (Bandura, 1997), for example, the ability to plan and follow an exercise schedule. Self-efficacy was found to be key in sustaining exercise behavior in studies of older adults' long-term maintenance of exercise to alleviate knee osteoarthritis (Focht et al., 2005). Moreover, self-efficacy has been investigated as a major factor impacting associations between fear of falling, active lifestyles, and dependence in older adults (Fuzhong et al., 2002; Schepens et al., 2012). Apart from self-efficacy, SCT studies identified several other factors that correlate with regular exercise behavior of older adults, such as exercise attitude (Rhodes et al., 1999). The KAB (knowledge, attitudes, behavior) as stages of change model focuses on knowledge and attitude, which are relevant as cognitive factors in SCT (Bandura, 1986). The KAB assumes that there is consistency among knowledge, attitudes, and behaviors in individuals with high involvement (Chaffee & Roser, 1986). We focused on the factors of knowledge, attitude, self-efficacy, and behavior as a foundation for designing educational campaign messages for supporting SBF behaviors, and for evaluating the resultant campaign impact. Research questions for the formative campaign development included the following:

RQ1. What are key barriers and motivators related to knowledge, attitude, self-efficacy, and prior SBF behavior?
RQ2. Do knowledge, attitude, and self-efficacy predict SBF behavior?
RQ3. Is self-efficacy a mediator of associations between knowledge/attitude and SBF behavior?

For campaign evaluation we hypothesized (H) that campaign exposure has a significant impact on mean knowledge, attitude, self-efficacy, and behavior scores as compared to no campaign exposure.

Method

Formative Campaign Development Research and Campaign Evaluation Research

Formative research prior to campaign development comprised face-to-face interviews with 22 older adults and three experts on geriatrics (female doctor of physiotherapy, male specialist of a center for aging, and male specialist/program lead of a geriatric research institute) to understand barriers and motivators of SBF exercise adoption in older adults (45 minutes each). A structured interview guide was developed for older adults by the research team based on the literature, while the expert interviews were unstructured to leave as much room for input as possible. Recruitment included convenience sampling for the older adults and purposeful sampling for the experts. Interviews were conducted by four research team members (AYFT, JXJN, YTJW, YSG; three women, one man) with a communications background at selected locations until data saturation was reached for interviews with older adults (repetitive patterns in answers to questions). Interviews were audio recorded and transcribed.

The structured interviews were analyzed in a descriptive way, with thematic analysis employed to open-ended

questions and the unstructured expert interviews (analysis by the same research team). Unclear analysis results were discussed with a fifth researcher (AC). The COREQ checklist for qualitative research, which lists items to be included in qualitative research reports (Tong et al., 2007), was used to ensure research quality when reporting the study results.

To measure effectiveness with a pre–post analysis, a standardized survey with 274 older adults was conducted in person at cooperating senior activity centers in the central area of Singapore prior to campaign development (30 minutes each, by AYFT, JXJN, YTJW, YSG). For recruitment, the center employees informed older adults about the study and introduced the research team. Next, the research team approached the respondents directly for the pre-campaign survey. Survey questions and answer options were read to respondents and the answers were noted down accordingly. After completion of the survey, answers were repeated to confirm responses. This survey served a two-fold purpose: first, it was part of the formative campaign development phase and second, it served as baseline data for the campaign evaluation.

Survey questions were adapted from existing items in the Intrinsic Motivation Inventory (IMI) and the Self-efficacy about Leisure Time Physical Activity (SELPA) questionnaire for measuring attitude and self-efficacy (Abasi et al., 2016; McAuley et al., 1989; Ryan, 1982). Behavior was assessed by frequency of exercise in general and of SBF exercise in particular (in the 2 months prior to the study), using the two questions "in the last two months, how often did you exercise?" and "in the last two months, how often did you do SBF exercises?" For measuring knowledge, eight short knowledge items about falls prevention and SBF exercise were developed based on the literature, for example, "falls can be prevented". Five-point Likert scales (e.g., from "strongly disagree" to "strongly agree"), as well as multiple choice scales were employed. The results were recoded into correct and incorrect answers for knowledge. Composite campaign survey measures had a high internal reliability with Cronbach's alpha scores of $\alpha = .718$ (knowledge), $\alpha = .709$ (attitude), $\alpha = .827$ (self-efficacy), with no excluded cases.

A post-campaign survey was administered to 141 participants from the pre-campaign study, with original questions used alongside additional questions regarding campaign exposure and engagement (campaign awareness, campaign channels, tutorial videos, brochure, etc.). Due to senior activity centers being ordered to close during the response-gathering period (COVID-19), the survey was conducted over the phone with respondents ($n = 191$) who had provided their contact number in the pre-campaign survey. One hundred and forty one completed the telephonic post-campaign survey successfully. Respondents without campaign exposure or engagement were assigned to the comparison group while respondents with campaign interaction were assigned to the experimental group.

Mean knowledge, attitude, self-efficacy, and behavior scores were calculated for the pre- and post-campaign survey data. Descriptive statistical analysis was used to gain insight into knowledge, attitude, self-efficacy, and SBF behaviors in the pre-campaign survey sample. Multiple regression analysis and mediation analysis were conducted to examine the factors of knowledge, attitude and self-efficacy as predictors of SBF exercise (frequency in the past 2 months). These analyses served to understand the relevance of the three factors for SBF exercise adoption and informed the development of the key campaign messages. Independent and paired samples t-tests were used to compare pre- and post-campaign survey results, as well as results between individuals with and without campaign exposure.

Overall, no incentives were given for study participation. Ethical review and approval was provided by the Nanyang Technological University Review Board (FYP201920S1-010). Informed consent for participation was signed by all study participants.

Campaign Description

Based on the formative study results, the campaign *Ready, Steady, Go* was developed for older adults in central areas of Singapore (Ang Mo Kio, Toa Payoh, and Bishan). The awareness and education campaign aimed to prevent falls by increasing older adults' SBF exercise performance to at least "20 minutes a day, two times a week". The campaign lasted for ten weeks (January to March 2020) and addressed knowledge, attitude, self-efficacy, and behaviors as factors identified by SCT theory (Table 1). mHealth channels included a website (information on falls prevention, SBF exercise tutorials, and sign-up for community exercise programs), a Facebook page and Facebook Ads, WhatsApp communication (exercise challenge), YouTube (exercise videos, testimonial broadcast, advertisements), and Google Display Ads. We used Facebook Pixel, Google Ads Tracking Tag, and WhatsApp API to attribute sign-ups for community exercise programs across platforms. Additional offline measures included roadshows with exercise posters and pull-up banners, out-of-home advertising with QR code scans, exercise sessions, and media coverage.

Results

Samples

The age in the pre-campaign interviews sample ($N = 22$) and the standardized pre-campaign ($N = 274$) and post-campaign survey samples ($n = 141$ of previously participating individuals) ranged from 54 to 97 years (Table 2). There were more women than men in all three samples, with the majority of participants comprising Chinese ethnicity, plus Indian and Malay participants (and participants of other ethnicities) (Table 2). All participants resided in Central Singapore.

mHealth use. Half of the pre-campaign survey sample ($N = 274$) reported owning a smartphone (50%, $n = 137$). One third

Table 1. Key Messages of Ready, Steady, Go.

Factor	Message
Knowledge	Walking is not enough; doing SBF exercises is more effective to prevent falls
Attitude	Fun SBF exercises can blend into your lifestyle easily
Self-efficacy	You are capable of doing SBF exercises to lead a confident, falls-free life
Behavior	Do simple SBF exercises regularly (at least 20 minutes, two times a week)

Abbreviations; mHealth = mobile Health; ICTs = information and communication technologies; SCT = Social Cognitive Theory; SBF = strength, balance, and flexibility exercises; KAB = knowledge, attitude, behavior model; Declarations.

Table 2. Description of Study Samples.

Variable	Interviews (N = 22)					Pre-campaign survey (N = 274)					Post-campaign survey (n = 141)				
	% of N	M	SD	Min	Max	% of N	M	SD	Min	Max	% of N	M	SD	Min	Max
Age		69.14	5.71	60	81		72.36	7.40	54	97		71.28	7.13	54	91
Ethnicity															
Chinese	68					89					84				
Indian	5					5					6				
Malay	14					4					7				
Other	14					2					3				
Gender															
Men	41					22					23				
Women	59					78					77				

of the smartphone owners used their phone during exercises (37% of n = 134). Of those with a smartphone, 86% used WhatsApp, around half used YouTube (58%) and Facebook (50%), and one third used health apps (27%; Instagram 4%). In line with the interview results, smartphone users used WhatsApp (81%) and Facebook (47%) to connect with their family and friends, and to share health information and news (65% WhatsApp, 44% Facebook, n = 133/134). Pre-campaign interview participants reported a need to trust the sender of health information such as family, friends, and official sources.

These data show that there is potential for mHealth use benefiting older adults. While this study focused on smartphone use, smart device use was likely higher in the sample with additional devices used (tablets, etc.).

Formative Campaign Development—Pre-Campaign Interview and Survey Results

The qualitative interviews provided insights into key barriers and motivators to help develop the campaign messages based on the SCT factors of knowledge, attitude, self-efficacy, and behavior. The pre-campaign survey (1) validated the significance of the interview findings and confirmed the key messages, and (2) quantified the pre-campaign baseline levels on knowledge, attitudes, self-efficacy, and behaviors.

RQ1. Key barriers and motivators related to knowledge, attitude, self-efficacy, and SBF behavior

Knowledge. There were misconceptions reported in the interviews (N = 22, N = 3 expert interviews) that (1) falls could not be prevented and (2) walking could reduce the risk of falling. Some of the respondents thought that falls were accidents and could not be prevented ("I don't think anyone my age can do anything to prevent falls. Falls are always accidental", participant 8)—one expert mentioned that her patients who felt that falls were just a part of aging tended to take falls prevention advice less seriously (doctor of physiotherapy). Moreover, most of the interviewees expressed the misconception that walking was sufficient for exercising ("Taking long walks is considered exercising for me", participant 3). However, the three experts were concerned about this misconception as the physiological benefits of walking were reported to be insufficient to improve muscle strength and sense of balance in order to prevent falls. The identification of these misconceptions informed the selection of knowledge items for the quantitative pre-campaign survey.

The survey confirmed the misconception that "any type of physical activity can reduce the risk of falling", with only 23% of participants disagreeing with that statement in the survey (5-point scales from "strongly disagree" to "strongly agree", N = 274). 22% of participants agreed with the statement that "physical activities should be avoided as it increases the risk of falling". Furthermore, only 53% knew falls could be prevented. Overall, it was crucial to tackle these misconceptions by developing the key *knowledge* campaign message (falls can be prevented with SBF exercises, Table 1).

Attitudes. The interview participants did not perform SBF exercises, considering these not worth their time. They reported that SBF exercises were time-consuming ("I don't really have the time to exercise", participant 2) and difficult to incorporate into their daily routine of hobbies and responsibilities. The experts stated in the interviews that many older adults perceive exercising as a chore instead of a casual activity. They suggested that exercising in a social setting could make it more fun. Hence, it was important to help older adults perceive SBF exercises being worth their time by communicating the ease of incorporating it into daily life (*attitude* message, Table 1).

In the survey, almost all participants expressed their desire to reduce the risk of falling (92%, 5-point scales, $N = 274$), with most agreeing that SBF exercises were important (71%) and useful (66%) to reduce falls risk. While half of the survey participants said SBF exercises were fun (56%) and easy to do (53%), approximately half expressed that exercises were tiring (46%) and one fourth said these were inconvenient to do (25%). These statistics confirmed the interview data and signaled the possibility of exercise adoption for participants who felt that SBF were not worth their time by highlighting positive aspects of exercise such as the fun and ease to be incorporated in daily routines (*attitude* message, Table 1).

Self-efficacy. Most interview participants reported their confidence to engage in simple physical activities, but some harbored doubts or wished for instructions and support. Simultaneously, these respondents did not want to depend on others and aspired to take charge of their lives. They aimed to not become a burden to their loved ones ("I want to keep myself healthy and don't want to be a burden to my children", participant 21). Based on these interview results, the key campaign message on self-efficacy focused on confidence to perform SBF exercises for a falls-free life (*self-efficacy* message, Table 1).

In the survey, 80% of participants agreed that they could engage in 20 minutes of SBF exercises in one session ($N = 274$). Yet, around half said that they avoided challenging exercises (54%). Approximately a quarter claimed to be able to plan a SBF session themselves (27%), with a third stating that they could follow their SBF exercise plan (31%), despite being busy (37%). However, one third could not accomplish SBF without emotional support from others (35%) or felt being insufficiently self-motivated (29%). A substantial percentage reported that they could not do SBF exercises if tired (41%), or without a trainer (44%). 18% reported that they would not continue SBF exercises after missing some sessions. The survey results confirmed that the self-efficacy campaign message was important to improve the participants' confidence in, and perceived ability of, performing SBF exercises.

Behavior. The survey results showed that only 22% of respondents had performed SBF exercises "3 to 4 times per week" or more during the past 2 months, while 26% exercised merely "1 to 2 times a week", with almost a third of the sample not performing SBF exercises at all (30%), or only one to two times per month (22%, $N = 274$). A frequency of at least two times per week for strength activities is recommended (Singapore HPB, 2011). Thus, there was a need to increase SBF practice for those with performance (52%) below the recommended frequency.

RQ2. Knowledge, attitude, and self-efficacy predicting SBF behavior

All four variables knowledge, attitude, self-efficacy, and SBF behavior (in the past 2 months) indicated significant yet moderate positive correlation ($p < .001$, $r > .44$ to .61, $n = 272$).

A multiple regression to predict the frequency of SBF exercise performance with $F(3, 270) = 52.111$, $p < .001$ and $R^2 = .367$ found attitude ($p < .01$) and self-efficacy ($p < .001$) to be significant predictors of SBF exercise, but not knowledge ($p > .05$, $N = 274$). Participants' predicted SBF performance was equal to $-1.790 + .027$ (knowledge) $+ .054$ (attitude) $+ .072$ (self-efficacy) with each composite variable measured and coded using a 5-point Likert scale.

RQ3. Self-efficacy as a mediator of associations between knowledge/attitude and SBF behavior

A simple mediation analysis was performed to analyze whether attitude predicted SBF behavior (in the past two months) and whether the direct path would be mediated by self-efficacy. The relationship of the variables attitude, self-efficacy, and SBF behavior included in the mediation analysis was approximately linear, as assessed by the scatterplots using Loess smoothing. An effect of attitude on SBF behavior was observed with B = .1488, $p < .001$ ($n = 272$, Figure 1). After entering self-efficacy into the model, attitude predicted the mediator self-efficacy significantly with B = 1.0269, $p < .001$, which in turn predicted SBF behavior significantly with B = .0748, $p < .001$. We found that the relationship between attitude and SBF behavior was partially mediated by self-efficacy.

Similarly, a simple mediation analysis was performed to analyze whether knowledge predicts SBF behavior and whether this direct path would be mediated by self-efficacy as well. The relationship of the variables knowledge, self-efficacy, and SBF behavior was approximately linear again (scatterplots using Loess smoothing). An effect of knowledge on SBF behavior was observed with B = .1079, $p < .001$ ($n = 272$, Figure 2). After entering self-efficacy into the model, knowledge predicted self-efficacy significantly with B = .7488, $p < .001$, which in turn predicted SBF behavior significantly with B = .0834, $p < .001$. We found that the relationship between knowledge and SBF behavior was partially mediated by self-efficacy similar to the analysis with attitude.

Based on the analyses, all key variables of attitude, knowledge, self-efficacy, and behavior were included in the key campaign messages as a tool for education.

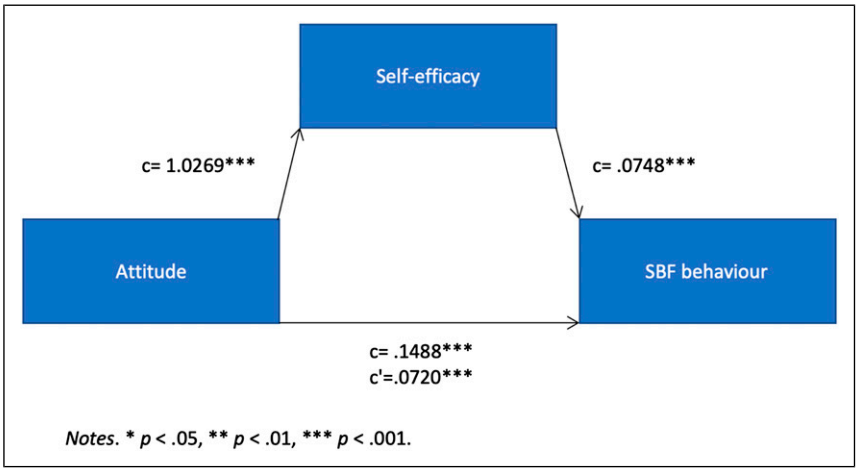

Figure 1. Simple mediation analysis with attitude, self-efficacy, and behavior (n = 272).

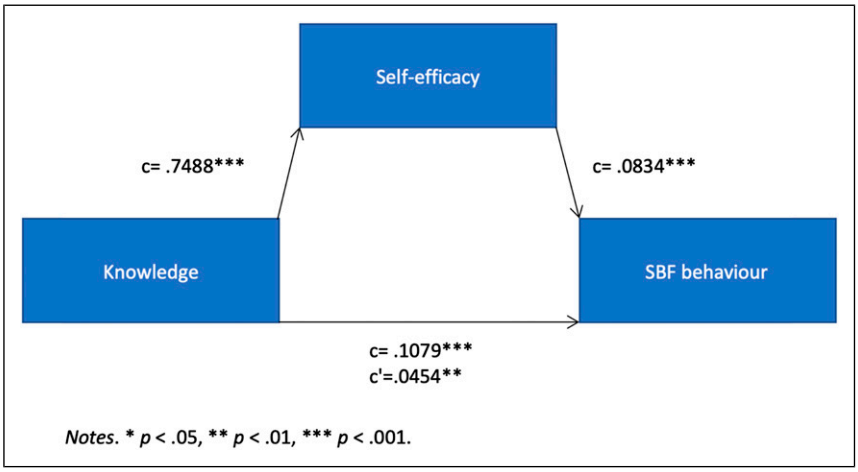

Figure 2. Simple mediation analysis with knowledge, self-efficacy, and behavior (n = 272).

Campaign Evaluation—Pre–Post Survey Results and Campaign Impact

The post-campaign survey determined changes in the participants' knowledge, attitude, self-efficacy and performance of SBF exercises to answer the hypothesis (H) stating that "campaign exposure has a significant impact on mean knowledge, attitude, self-efficacy, and behavior scores as compared to no campaign exposure".

To test preconditions for the pre–post analysis, an independent samples t-test with pre-campaign survey data showed no significant difference ($p > .05$) in the mean pre-campaign scores for the key factors of knowledge, attitude, self-efficacy, and behavior between (1) a comparison group with no engagement with the campaign (n = 40) and (2) an experimental group who engaged with the campaign (n = 101; Table 3). This delivered a necessary foundation to analyze differences in changes of mean scores from pre-campaign to post-campaign survey in the two groups.

Table 3. Differences in Pre-campaign Survey Scores Between Experimental and Comparison Groups.

		N	*M*	*SD*	*df*	*t*
Knowledge	Experimental	101	3.31	.59	139	1.97
	Comparison	40	3.09	.67		
Attitude	Experimental	101	3.61	.54	139	−.73
	Comparison	40	3.68	.57		
Self-efficacy	Experimental	101	3.01	.66	139	−1.23
	Comparison	40	3.17	.63		
Behavior	Experimental	101	2.40	1.20	139	−1.24
	Comparison	40	2.68	1.23		

Notes. $p > .05$; independent samples t-tests.

A paired samples t-test (pre- to post-campaign results of experimental group) showed that those exposed to the campaign (experimental group, n = 101) had a significant increase in knowledge, attitude, self-efficacy, and SBF behavior scores from pre- to post-campaign survey ($p < .05$). Most notably,

Table 4. Changes in Scores from Pre- to Post-Campaign Survey in Experimental Group.

		N	*M*	*SD*	*df*	*t*
Knowledge	Pre	101	3.31	.59	100	13.35***
	Post	101	4.05	.44		
Attitude	Pre	101	3.61	.54	100	10.36***
	Post	101	4.09	.44		
Self-efficacy	Pre	101	3.01	.66	100	14.50***
	Post	101	3.77	.59		
Behavior	Pre	101	2.40	1.20	100	9.33***
	Post	101	3.35	1.16		

Notes. Paired samples t-tests; experimental group with campaign exposure. ***$p < .001$.

behavior significantly increased by 39% from $M = 2.40$ (pre) to $M = 3.35$ (post). Self-efficacy increased by 25% ($M = 3.01$ to $M = 3.77$), while knowledge increased by 22% ($M = 3.31$ to $M = 4.05$) and attitude by 13% ($M = 3.61$ to $M = 4.09$) (Table 4, Figure 3).

Moreover, an independent samples t-test of the mean knowledge, attitude, self-efficacy, and behavior score changes (pre- to post-campaign score differences of experimental group versus comparison group) showed that the change in mean scores from pre- to post-campaign survey was significantly higher in the experimental group with campaign exposure ($n = 101$) as opposed to the comparison group ($n = 40$, $p < .05$, Figure 4). The change from pre- to post-campaign survey results was calculated for both the experimental and comparison groups before comparing changes in both groups using independent samples t-tests. Mean changes and t-test results are displayed in Table 5.

Based on these results, the hypothesis that "campaign exposure has a significant impact on mean knowledge, attitude, self-efficacy, and behavior scores as compared to no campaign exposure" could not be rejected. Respondents with campaign exposure had a significant increase in all factor scores from pre- to post-campaign survey, which was significantly higher in the group with campaign exposure.

One potential explanation for the campaign impact might be found in mHealth being integrated in all digital channels and the timely reminders that provided the final push for behavioral conversion. For example, more than 300 people subscribed to WhatsApp messages which delivered video tutorials that showed the ease of performing and incorporating SBF exercises into daily routines. Videos which encouraged vicarious learning were also sent as an exercise reminder. Google Display advertisements were highly effective in increasing campaign awareness, while Facebook advertisements were highly efficient in encouraging (more than 500) community exercise sign-ups among older adults. Motivational messages which increased confidence in recipient's ability to self-care through positive verbal persuasion were disseminated. The benefit statement of confidence in all messages consistently created emotional arousal towards SBF exercises. Moreover, the campaign helped connect 533 target audience members to nine community partners in Central Singapore, where they found a community that practices SBF exercises regularly. Sustainability was addressed with online campaign materials being made available beyond the duration of the campaign, and were adopted by partner organizations.

Discussion

The comparison of the pre–post surveys showed that campaign exposure, incorporating ICTs in the form of mHealth technologies, significantly increased the key SCT factors, and was related to behavioral change. The effectiveness of digital channels to reach older adults had previously been uncertain due to the belief that older adults have insufficient technology literacy (Roupa et al., 2010). Our study delivered some evidence about mHealth effectiveness for reaching older adults, contributing to previous studies on the effectiveness of digital channels for persuading them to engage in the desired behavior, and adding to campaign results in a Singaporean context focusing on other target groups (e.g., Chib et al., 2009; Chib et al., 2010). These results highlight the unexploited potential of mHealth-supported campaigns to educate older adults about SBF behaviors for falls prevention as outlined in the research gap and delivered data to inform campaign designers about mHealth opportunities. This study also contributes to an understanding of how to conduct formative and evaluation research in combination with running an integrated campaign using ICTs for older adults. The CDC Evaluation Guide for Older Adult Clinical Fall Prevention Programs (Bergen & Shakya, 2019) demonstrates the relevance of program evaluation as this can help organizations improve care for older people, show program success, communicate future needs and required improvements, and streamline implementation.

In addition to our evaluation results, our formative research results showed the relevance of the SCT factors of knowledge, attitude, and self-efficacy in key campaign message development, for example, to address misconceptions such as the perception that falls cannot be prevented. Similar to our findings, the Prevention of Falls Network for Dissemination (ProFouND) summarizes that older people commonly consider falling an inevitable part of older age, accepting that they are at risk and not knowing that something can be done to prevent falls. This may prevent older adults from contacting falls prevention services (ProFouND, 2015). ProFouND suggests organizing local events for falls prevention to address misconceptions, highlighting their relevance to promote positive messages, enjoyment, peer involvement, and personalization (ProFouND, 2015). In this study, "social settings" and "fun" were reported to be especially important for older adults to engage in physical activities. In addition, tailored messages have been proven relevant to motivate older people to address their falls risk. Recent studies have tested new ways to communicate these tailored messages, such as audio-visual

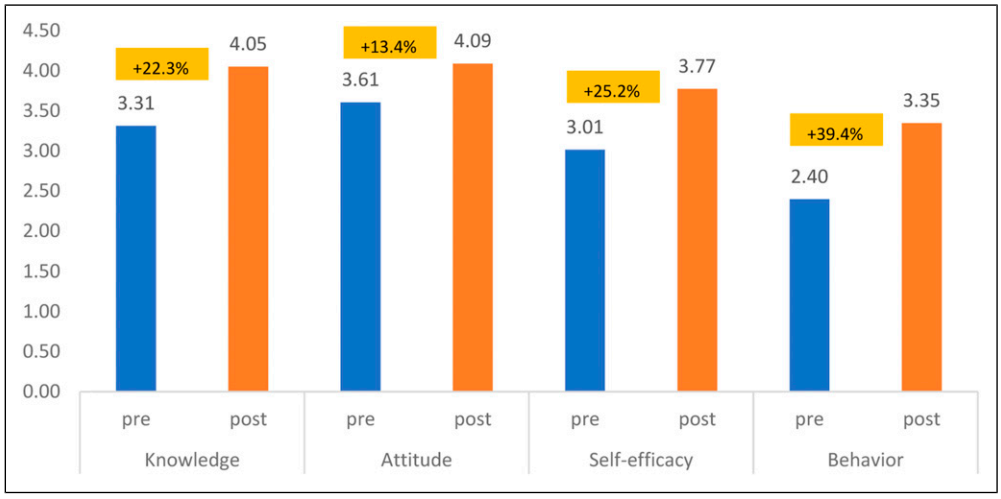

Figure 3. Change in scores from pre- to post-campaign in experimental group (n = 101, paired samples t-test, p < .05).

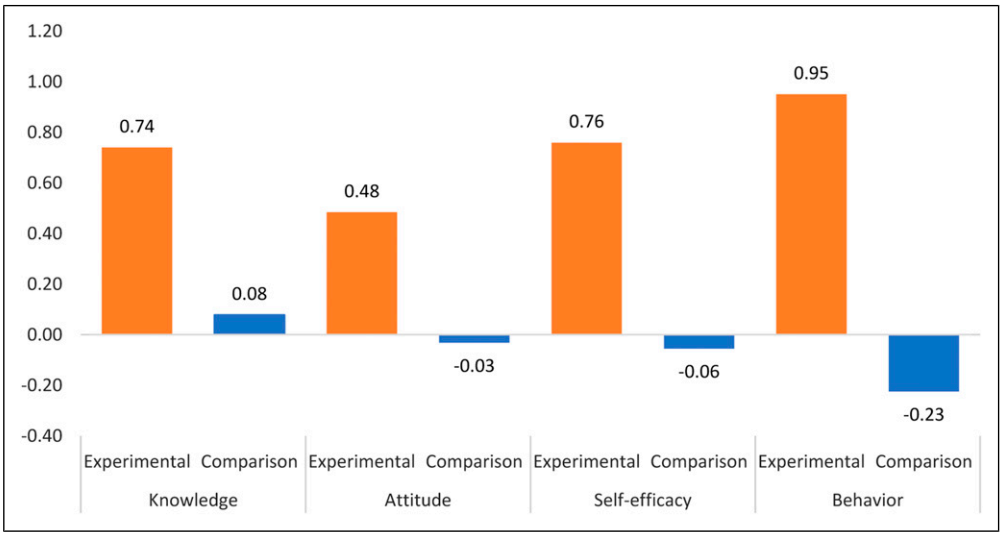

Figure 4. Change in scores from pre- to post-campaign in experimental group (n = 101) versus comparison group (n = 40, independent samples t-test).

Table 5. Changes in Scores from Pre- to Post-Campaign Survey in Experimental versus Comparison Group.

		N	*M*	*SD*	*df*	*t*
Knowledge	Experimental	101	.74	.56	136.32	10.56***
	Comparison	40	.08	.19		
Attitude	Experimental	101	.48	.47	134.37	9.90***
	Comparison	40	−.03	.15		
Self-efficacy	Experimental	101	.76	.53	136.87	13.69***
	Comparison	40	−.06	.18		
Behavior	Experimental	101	.95	1.02	139	6.72***
	Comparison	40	−.23	.66		

Notes. Displayed are mean score differences from pre- to post-campaign survey results. ***p < .001.

messages as part of community falls prevention campaigns (de Jong et al., 2019).

Community approaches for increasing physical activity are important strategies to address older adults, especially by using participatory and cooperative strategies (Loss et al., 2020; Strobl et al., 2020). A systematic review by Lindsay Smith et al. (2017) reported that older adults with support for physical activity were more likely to be physically active in their leisure time, especially when supported by family members.

Yet, our results also emphasized the importance of directly communicating with older adults instead of prioritizing their caregivers. Older people do not want to burden their families and report a desire to retain their independence (Roupa et al.,

2010). Thus, *Ready, Steady, Go* encouraged self-care for falls prevention, and aimed at improving older adults' self-efficacy to encourage regular SBF exercises. Previous successful interventions to promote physical activity in older adults used cognitive-behavioral strategies rather than health education, prescriptions, or instructions alone (King, 2001). Effective strategies included goal setting and self-monitoring, receiving feedback and support, stimulus control, and relapse-prevention training (King, 2001). mHealth tools such as instant messaging, social media, or specific falls prevention apps offer promising channels to deliver content, support, and feedback to older people, particularly when integrated in a wider prevention program.

Study Limitations

First, while the team actively pitched to a wide range of media outlets since the launch of the campaign, opportunities for coverage decreased due to the outbreak of COVID-19 as media outlets were focused on stories related to the pandemic. A new story angle of home-based exercises for older adults was pivoted, since mass exercise programs were canceled due to the virus outbreak. Second, due to the small sample size of the experimental group with campaign exposure (n = 101), the results are not representative of the target population. Third, even though WhatsApp was an effective mHealth channel for behavioral change, there were no tools available to measure the reach of our messages and any forwarding behaviors. Fourth, we focused on smartphone use in the pre-campaign survey as our main area of interest, yet propose that the use of other smart devices could be added in future research.

Conclusion

The effectiveness of *Ready, Steady, Go* in changing older adults' behaviors provides future health campaign designers with alternatives to predominantly offline tactics that may not be sustainable. Sustainability should be a major aim of integrated health campaigns (Hawkins et al., 2011). By adopting more digitally focused solutions, limited campaign resources can be allocated more efficiently. Overall, the evaluation of the campaign impact illustrated how an integration of digital and mobile channels (such as Facebook, WhatsApp, Google Ads, or YouTube) for communicating supportive messages, increasing awareness, and promoting exercise sign-ups, in combination with offline engagements and media coverage, effectively provides means to reach older adults to encourage SBF exercise to reduce their risk of falling.

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Author Contributions

AYFT, JXJN, YTJW, and YSG collected, analyzed, and interpreted the data, and developed the campaign under supervision by A.C. N.B.S drafted the manuscript. A.C. reviewed the manuscript and provided detailed comments for improvement. All authors read and approved the final manuscript.

Declaration of Conflicting Interests

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Ethical Approval

Ethical review and approval provided by the Nanyang Technological University Review Board (FYP201920S1-010).

Informed Consent

Informed consent for participation was signed by all study participants.

Data Availability

The (anonymized, non-identifiable) datasets used and/or analyzed during the current study and additional information on the methodology (questionnaires, survey) are available from the corresponding author on reasonable request.

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Abbreviations
mHealth= mobile Health
ICTs = information and communication technologies
SCT = Social Cognitive Theory
SBF= strength, balance, and flexibility exercises
KAB = knowledge, attitude, behavior model

Supplemental Material

Supplemental material for this article is available online.

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