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A Tablet-Based Application to Enhance Social Connectedness for Individuals with a Cognitive Impairment: Results from the PRISM-CI Pilot Study

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Abstract

Social engagement is fundamental to successful aging and linked to better emotional, physical, and cognitive health. Maintaining social engagement is challenging for many older adults but especially for those with a cognitive impairment (CI). Information and communication technologies (ICT) can provide enhanced opportunities for social and cognitive engagement for older adults with a CI via increased information, education, and social connectivity access. This study used a pre-test post-test design to evaluate the feasibility, acceptability, and preliminary efficacy of the PRISM-CI software system, a tablet-based application designed to enhance access to resources, information, and social engagement, in 52 individuals with a CI between the ages of 65-88 years who had access to PRISM-CI for five months. Findings show that social isolation, loneliness, and depressive symptoms significantly decreased, and mobile device proficiency significantly increased, from baseline to follow-up. Results highlight ICTs potential to foster social engagement among older adults with a CI.

Introduction

The rapid growth in population aging, largely due to medical and technological innovations, has enabled older adults to live longer despite changes in physical and cognitive health. Social engagement, described as a fundamental human need across the lifespan, is a protective factor influencing physical/psychosocial outcomes, including better health, well-being, and reduced social isolation and loneliness (Hülür & Macdonald, 2020; Lydon et al., 2022). However, older adults often experience shifts in the structures of their social network and ability to remain socially engaged due to normative events in later life including bereavement, retirement, and/or worsening health (Roth et al., 2020).

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The high prevalence of social isolation and loneliness was deemed an epidemic in older adults before COVID-19 (Holt-Lunstad, 2017; Jeste et al., 2020). In fact, the U.S. Surgeon General issued a report declaring that the mortality impact of social isolation and loneliness is comparable to that caused by smoking up to 15 cigarettes a day, and even greater than that associated with obesity and lack of exercise (Murthy, 2023). Approximately 27% of adults 65+ both live and spend over half of their waking hours alone (Administration on Aging, 2020; Livingston, 2019). Diminished social networks, activity participation, and poor social support, even while controlling for confounding variables, are overlapping risk factors for both social isolation and dementia (Lydon et al., 2022). Thus, interventions aimed at enhancing social engagement hold potential to improve quality of life in older adulthood.

Social Engagement & Cognitive Impairment

Maintaining health promoting-relationships in later life becomes increasingly challenging in the presence of a cognitive impairment (CI). Mild Cognitive Impairment (MCI), a transitional stage between normal aging and dementia, impacts roughly 17% of the population – with cases expected to increase (Lydon et al., 2022). Although individuals with MCI can generally execute daily activities, they experience a modest decline in cognition greater than expected for one’s age and education (Lydon et al., 2022). Cognitive challenges may make it more difficult for older adults with a cognitive impairment to engage in fulfilling social interactions, which make them likely to become more socially excluded and withdraw from social situations to avoid feelings of embarrassment and frustration (Anderson, 2019).

Research has shown that individuals with CIs have lower rates of in-person socializing, smaller social networks, poorer quality of life, and heightened risk for depression and anxiety compared to those without (Fankhauser et al., 2017; Kotwal et al., 2016). Anderson (2019) found that those with MCI experience depressive symptoms at double the rate of healthy older adults. Because individuals with CIs experience greater loneliness and social isolation, these constructs represent potentially modifiable factors to target in behavioral interventions. However, health, mobility, and cognitive limitations may impede those with CIs from accessing adequate social support. Additional work is needed to identify and implement interventions that increase access to and provide opportunities for social engagement for those with CIs.

Technology & Social Engagement

Information and communication technologies (ICT) are critical tools that can broaden opportunities for social connections in those with mobility or geographic limitations (Hülür & Macdonald, 2020; Szabo et al., 2019). ICT has shifted the structure of social networks (e.g., closer kin/non-kin relationships) and the maintenance of such over time, and thus may be a compensatory mechanism for older adults with fewer in-person connections. However, the continuing immersion of ICT and digital platforms for everyday tasks (e.g., banking) may worsen the digital divide due to disparities in technology access. The Pew Research Center reported that government agencies have dedicated increased effort toward encouraging internet adoption in underserved areas, given that roughly 25% of those 65+ and those with household incomes under $30,000 report never using the internet (Perrin

& Atske, 2021; Vogels, 2021). Several studies have also shown that internet use is lower among older adults with lower cognition (Dequanter et al., 2022; Hamer & Stamatakis, 2014; Li et al., 2022).

The digital divide became hugely apparent during COVID-19, putting those with lower technology proficiency at greater risk for both disrupted healthcare and isolation due to being unable to navigate the digital infrastructure (i.e., telehealth; videoconferencing) required to participate in such activities. Older adults are also at risk for digital exclusion, which encompass barriers beyond technology access (i.e., technology literacy, perceived ability, and lack of support/instruction) and limit an individuals ability to navigate and meaningfully benefit from ICT (Borg et al., 2019; Francis et al., 2019; Seifert et al., 2021). Digitally excluded older adults have been reported to be at greater risk for poor mental health compared to technology-proficient peers (Mubarak & Suomi, 2022).

Despite the existing digital divide across age and income, the gap has started to narrow with the adoption of key technologies, including social media and smartphones, growing markedly in the last decade (Faverio, 2022). Increasing access to and adoption of ICT may ameliorate adverse cognitive, mental, and physical health outcomes in older adults (Antonucci et al., 2017). A multidisciplinary framework can help elucidate the specific pathways by which ICT can facilitate positive outcomes. Consistent with seminal theories such as the "use it or lose it" hypothesis, ICT use facilitates diverse opportunities for cognitive enrichment and learning, which are important predictors of cognition in later life (Hertzog et al., 2008). Furthermore, the robust evidence base highlighting the significance of social engagement in cognitive aging underscores ICTs potential to enhance social interactions and alleviate feelings of loneliness and social isolation which may, in turn, positively influence cognition (Hertzog et al., 2008). Indeed, both cross-sectional and longitudinal research have found ICT use to be associated with reduced loneliness, isolation (Cotten et al., 2013; Czaja et al. 2018; Gadbois et al., 2022), depression (Wang et al., 2019), and suicidal ideation (Jun & Kim, 2017), along with better health and well-being (Lifshitz et al., 2018; Wan et al., 2022). Longitudinal work has found that the relationship between internet use and depression operate via increases in communication and social network enhancement (Jun & Kim, 2017; Lam & Lee, 2006). Additionally, one mixed-method study found that older adults in retirement communities who were provided with an iPad and in-depth training reported closer family relationships and enhanced social connections (Delello & McWhorter, 2017).

Technology & Cognitive Impairment

Despite the rapid acceleration of technology-based interventions to improve social support in older adults, little attention has been paid to the variability of older adult subgroups (Hargittai et al., 2019), and whether such interventions are efficacious in those with CIs. Studies examining ICT to improve/rehabilitate cognitive functioning have increased (Ge et al., 2018; Jung et al., 2021), but more work is needed examining ICTs potential to improve psychosocial outcomes specifically among those with a CI. One small study (Demiris et al., 2016) examining a virtual pet companion in 10 MCI participants reported improved scores on the Montreal Cognitive Assessment (MoCA) and the MOS Social

Support Survey, and lower depressive symptoms at three-month follow-up. Leone et al. (2018) examined InTouch, a tablet application to enhance social communication, and found no differences between those with and without MCI in either use or adoption. Another study examining a gaming intervention found that participants who received three weekly, 50-minute trainings showed improved MoCA and depressive symptom scores at 8-weeks compared to controls (Xue et al., 2021). Our group (Czaja et al., 2020) found that aging adults with a CI that completed a computer-based functional skills program demonstrated significant improvements post-training on the trained functional tasks. Additionally, Yu et al. (2022) examined the relationship between the diversity, frequency, and type of internet use among aging adults from the China Family Panel Studies, and found that both breadth and depth of internet use was associated with better cognition (assessed via vocabulary). The substantial evidence documenting the high prevalence of and adverse consequences associated with social isolation in older adults also highlights the potential for interventions targeting social connectedness to improve quality of life and well-being. Applying ICT to such efforts provides flexibility and augmented opportunities for older adults with varying needs and abilities to remain socially engaged. However, as demonstrated by Moxley et al. (2022) technology adoption is contingent on users' perceived value, benefit, and confidence with respect to use, and are thus key factors for consideration in ICT-based interventions for diverse older adults.

Current Study

The Personalized Reminder Information and Social Management System (PRISM) is a software application designed to support social connectivity, prospective memory, knowledge, and resource access in older adults. An iterative user-centered design approach was used, involving older adults in the development of the software, training, and support materials. System development was informed by well-established technology frameworks highlighting the importance of attitudes regarding *ease of use* and *usefulness* of technology as a driving force underlying ICT adoption (i.e.,Technology Acceptance Model, Davis, 1985; Unified Theory of Acceptance and Use of Technology, Venkatesh et al., 2016). Further, the CREATE Model (Boot et al., 2020) emphasizes the need to design systems that consider individual characteristics, the demands placed on users' capabilities, and the sociocultural/physical environments in which users are embedded. Systems and design considerations focused on achieving optimal system-user fit can facilitate older adults' comfort with and actual adoption of technology.

Building on the above mentioned frameworks, the PRISM system provides users with personalized instruction, training, and support (Czaja et al., 2015). In a multi-site randomized controlled trial of 300 older adults at-risk for social isolation, PRISM condition participants reported significantly reduced loneliness and increased social support and well-being compared to an attention control condition at 6-month follow-up (Czaja et al., 2018). Although group differences were not maintained at 12-months, PRISM participants still demonstrated improvements compared to baseline, in addition to increases in computer self-efficacy, proficiency, and comfort at 6- and 12-months. Based on this evidence and the prevalence of social isolation in those with CIs, we conducted a pilot trial to evaluate the feasibility and acceptability of an adapted tablet-based version of PRISM - 'PRISM-CI' - for individuals with a CI. We also gathered preliminary data on the potential of PRISM-CI with respect to improving psychosocial outcomes. We hypothesize that providing personalized instruction and resources to enhance technology proficiency, in conjunction with enhanced and more user-friendly opportunities for social connections via features such as Zoom and email, would foster social connectivity in this population.

Methods

Design

The current study was a pilot feasibility trial utilizing a pre-post research design conducted in New York City. Participants were enrolled for 5-months and the study protocol was amended to accommodate virtual participation to help offset problems with isolation imposed by the COVID-19 shut down in NYC. The protocol was approved by the site's Institutional Review Board.

Participants

Participants were recruited using a multi-pronged sampling approach including presentations/lectures at community centers, newspaper advertisements, and participant referrals. Inclusion criteria included: 1) aged 65+; 2) able to read English at the 6^{th} grade level; 3) exhibits a CI indicated by subjective cognitive complaints; and 4) scoring between 28-33 (age and education adjusted) on the Telephone Interview for Cognitive Status (Brandt et al., 1988; Cook et al., 2009; Knopman et al., 2010; Lacruz et al., 2013); and scoring either a) between 14-18 (maximum= 22) on the ALFI Mini Mental State Exam (MMSE) (Folstein et al., 1975; Larner, 2017; Raina et al., 2015) *or* 22-26 (maximum= 30) for in-person MMSE administration. Individuals were excluded if they reported visual or hearing impairments that could not be corrected without glasses or a hearing aid, a motor impairment that would interfere tablet use, and/or exhibited no evidence of CI.

PRISM-CI

PRISM-CI's adapation was informed by prior work focused on the implementation of an ICT-based intervention for older adults with varying levels of CI (Czaja et al., 2020). The study's Principal Investigators also conducted a heuristic analysis to tailor the PRISM design/content to be suitable for those with CI. A heuristic analysis is a method for identifying design problems in a user interface. In this case, the PIs evaluated the interface and features of PRISM-CI against design guidelines for aging adults (e.g., Boot et al., 2020) with a focus on aging adults with a CI. The heuristic analysis informed system changes including a simplied interface and fewer features to enhance usability as well as modifications to the training protocol. Features included were based on potential relevance and value, particularly for older adults who are at risk for social isolation (see Czaja et al. (2015; 2018) for detail on design and development process of PRISM). The software was also pilot tested with two participants who provided feedback to inform refinements prior to study commencement.

Participants received a Samsung Galaxy Tab E with PRISM-CI software, linked to a secure server at Weill Cornell Medicine. Participants were unable to add other applications or delete PRISM-CI. Internet access via a wireless SIM card was provided for the study duration. The software included a hub with access to a simplified, user-friendly integrated package of features including: *internet*; a *Health* feature with vetted links to health topics on MedlinePlus.gov; *Contacts* (Google Contacts); *Email* (Gmail); *Calendar* (Google Calendar); a *Learning* feature with Main Topics, How-to Topics and History Topics; *Games; Video Chat* (Zoom); a *Home* screen displaying the weather, a quote and picture of the day, and a reminder to check one's email and calendar (Figure 1). Functionalities such as daily quotes and weather updates were implemented to personalize the user experience and motivate continued engagement with the tablet throughout the study. Participants were also given a Help manual that provided step-by-step information regarding basic system procedures such as "how to" send an e-mail; set up the calendar, etc.

Protocol/Contact Schedule

Interested participants completed a telephone eligibility screening. For those eligible, participants provided consent and a home baseline (n=13) assessment was scheduled. After lockdown measures were implemented due to COVID-19 in March 2020, participants' baseline assessments were administered through telephone and online surveys (n=40).

Enrolled participants were mailed a study tablet. Individuals (n=3) who were enrolled in the study prior to March 2020 received three home tablet training visits. Participants enrolled after March 2020 (n=50) participated in four virtual trainings with a study team member to accommodate the switch to a virtual protocol. Participants requesting additional training received another session focusing on the topic(s) of their choice. The training included a basic touchscreen tutorial, followed by training and practice on the PRISM-CI features. Participants received independent homework assignments to complete after Sessions 2 and 3. All participants received a "check-in" call one week after the final training session to determine if they experienced any difficulty using the PRISM-CI system. Follow-up assessments were conducted at 5-months. Participants were compensated $30 per assessment. Following study completion, participants were able to keep the tablet, but PRISM-CI was uninstalled and the tablet was remotely reset for other applications if desired by the participant.

Measures

Demographics.—Sociodemographic characteristics, including gender, age, education, race/ethnicity, number of people in household, income, occupation, and self-rated health.

Social support.—The Medical Outcome Study (MOS)-Social Support Survey (Sherbourne & Stewart, 1991) is an 18-item measure assessing four domains of social support: emotional/informational (8-items; α = .94), tangible (4-items; α = .91), affectionate (3-items; α = .95), and positive social interaction (3-items; α = .96). Participants rated how often each type of support was available to them on a 5-point scale ranging from 1 (*none of the time*) to 5 (*all the time*). Reliability for the 18-item scale was .94.

Social isolation.—The Friendship Scale (Hawthorne, 2006) includes six items assessing social isolation. Responses are rated from 1 (*almost always*) to 4 (*not at all*). Higher scores indicate lower levels of isolation (greater social connectedness) (α = .74).

Loneliness.—The Revised UCLA Loneliness Scale (Russell et al., 1980) is a 20-item measure assessing subjective feelings of loneliness and isolation. Participants respond to a series of questions ranging from 1 (*never*) to 4 (*almost always*). Higher scores reflect greater feelings of loneliness (α = .92).

Depressive Symptoms.—The Center for Epidemiological Studies—Depression scale (Radloff, 1977) is a 20-item measure asking participants to rate the presence of depressive symptoms over the previous week. Response options range from 0 (*rarely/none of the time*) to 3 (*most/all the time*). Summed scores range from 0–60, with higher scores indicative of greater depressive symptoms (α = .77).

Participants also completed several technology-related proficiency and attitudinal measures:

Attitudes toward Computers Questionnaire.—A 15-item measure (Jay & Willis, 1992) assessing computer attitudes on three dimensions: comfort, efficacy, and interest. Responses are provided on a five-point Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*). Items were reversed, and a mean score was calculated such that higher scores reflect more positive attitudes toward technology (α = 87).

Technology Readiness Index (TRI).—A 16-item measure (Parasuraman & Colby, 2015) assessing readiness to adopt technologies across four dimensions: optimism (α = .85), innovativeness (α = .87), discomfort (α = .77), and insecurity (α = .74). Participants rated their agreement with each statement from 1(*strongly disagree*) to 5 (*strongly agree*). The ‘insecurity’ and ‘discomfort’ subscale items were reverse scored; a total mean score was calculated, with higher scores indicating greater technology readiness.

Mobile Device Proficiency Questionnaire (MDPQ), *Modified*.—The MDPQ (Roque & Boot, 2018) assesses overall mobile device proficiency as well as proficiency across eight activity domains, including communication, data/file storage, and troubleshooting/maintenance. Participants rate their ability to perform 16 operations on a smartphone or tablet using a five-point scale ranging from 1 (*never tried*) to 5 (*very easily*). Cronbach’s α = 97; higher scores reflect greater proficiency.

Usability.—At 5-month follow-up, participants completed a 10-item PRISM System Usability Scale, adapted from Davis (1989) by the Center for Research and Education on Aging and Technology Experience (Czaja et al., 2015; 2018), which assesses perceptions, usefulness, and usability of the PRISM-CI system. Participants responded to each item on a Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*; α = .88). Responses are converted with scores ranging from 0-100. Usability was also assessed with the 32-item PRISM System Evaluation Questionnaire, which asked participants to indicate their level of agreement on a series of statements evaluating PRISM-CI across domains including *Satisfaction* (α = .95), *Efficiency* (α = .96), *Difficulties* (α = .95), *Use* (α = .88), *and*

Usefulness (α = .91). Higher scores on both measures reflect greater usability. Participants also completed one open-ended item providing suggestions for additional features for future iterations of PRISM-CI.

Data Analysis

Descriptive statistics were computed for all study variables to examine baseline characteristics and to screen for missing data and normality. Chi-square and independent samples *t*-tests were conducted to examine differences in categorical and continuous variables, respectively, at baseline, as well as to identify differences between study completers versus non-completers. Preliminary differences between baseline and 5-month follow-up on psychosocial (depressive symptoms, loneliness, social support, social isolation) and technology-related (attitudes toward technology; mobile device proficiency) variables were assessed via paired samples *t*-tests. An intention-to-treat approach via a series of linear mixed-effects models was used to estimate within-subject effects at two assessment points. Time was a fixed factor, with participants were included as random factors, in the models. This method is generally robust to small sample sizes and tolerant of missing data. Effect sizes were calculated using Cohen's *d*. Due to the small sample and the conservative nature of multiple comparison adjustments, adjustments were not made to reduce risk of Type II error (Feise, 2002; Rothman, 1990). A significance value of $p<.05$ was used for all analyses.

Results

Sample

One hundred forty-seven individuals completed screening. Of these, 36 people were excluded due to ineligibility or lack of interest in (n=20), were unable to provide consent (n=3), or because they could not be reached to schedule an assessment (n=5). Of the n=83 who completed baseline assessments, n=31 were excluded due to MMSE scores being above the eligibility threshold. Fifty-two participants were enrolled in the PRISM-CI study (Figure 2).

Between baseline and follow up, one participant withdrew from the study prior to the first training session and n=4 withdrew between the first and second trainings. Additionally, n=2 participants withdrew from the study after completing all 3 training sessions, and n=3 were lost-to-follow up. A total of 42 participants completed the study (e.g., tablet training and use) and 5-month follow-up assessments. No significant group differences on sociodemographic and/or baseline variables emerged between study completers and those lost-to-follow up.

Participant demographic characteristics are shown in Table 1. Participants ranged in age from 65-88 years (*M*=75.54, *SD*=6.78), and included 41 females. A majority of participants identified as White (n=48), and scored an average of 17.45 (*SD*=.82) and 22.08 (*SD*=2.14), on the phone (n=40, 75.5%) and in-person (n=13, 24.5%) MMSE assessments, respectively. Twelve participants requested and received between 1-6 extra tablet training sessions, averaging 2.5 supplemental trainings.

Pre-Post-PRISM-CI

Table 2 presents descriptive statistics and paired samples *t*-tests examining differences in the psychosocial and technology-related outcomes between baseline and 5-month follow-up. Participants' average scores on depressive symptoms (p=.034), social isolation (p=.006), and loneliness (p<.001) measures significantly declined from pre-to post-test. Although the effect size for depressive symptoms was small (d=.29), social isolation and loneliness demonstrated moderate effects (*d*s=.41 and .52, respectively). Total social support measured via the MOS (in addition to MOS subscales measuring tangible, affectionate, and positive social interaction), significantly increased from pre-to-post-test with a moderate effect (d=.51, p=.001).

For the technology-related variables, results showed significantly higher mean scores on the total MDPQ, as well as on subscales measuring proficiency of mobile device basics (p=.004), communication (p=.042), internet (p=.005), and calendar use (p<.001). Apart from the communication subscale (d=.29), effect size estimates were moderate – with the calendar subscale demonstrating the largest effect (d=.65).

Linear Mixed Models—To examine within subjects' effects from pre- to post-test while accounting for potential confounds and missing data at follow-up, linear mixed models were employed to verify the paired samples *t*-tests presented above. Bivariate analyses were examined to determine baseline differences in sociodemographic, psychosocial, and technology-related variables. No significant differences emerged except for age, which was negatively related to TRI (r=−.29, p=.042) and MDPQ (r=−.58, p<.001) scores. Age was included as a covariate in subsequent analysis.

Results in Table 3 yielded largely consistent findings with those reported above. Controlling for age, significant pre-post-test differences were maintained on loneliness, social isolation, and total social support, in addition to MOS subscales capturing tangible, affectionate, and positive social interaction, all of which exhibited moderate effect sizes (range: .36-.50). Additionally, participants at follow-up exhibited significantly higher mean scores on the total MDPQ, as well as on subscales measuring proficiency regarding mobile device basics, communication, internet, and calendar use with moderate effect sizes (*d*s range from .42-.63).

Usability

Table 4 presents descriptive statistics for the two usability assessments. Participants scored an average of 68.15 (SD=17.82) on the System Usability Scale, which is consistent with the threshold metric of 68 representing adequate usability. Descriptively, 50% of participants reported willingness to use PRISM-CI in the future, and 54.3% of participants reported feeling very confident using the system. Results from the PRISM System Evaluation Scale indicate that participants favorably evaluated PRISM-CI regarding system satisfaction, efficiency, difficulties, use, and usefulness. Most agreed that PRISM-CI was easy to use and were satisfied with the amount of training received (68.5% and 77.1%, respectively), and 69.7% reported that PRISM-CI was enjoyable to use. Further, 60% of participants reported being comfortable using PRISM-CI within one week of training. Participants rated the *Internet* (71.4%), *Email* (65.7%), and *Learning* (53.1%) features as most valuable.

Participants' open-ended responses also detailed several feature-specific suggestions for future iterations of PRISM-CI, including access to streaming services (e.g., Spotify, YouTube); e-Library services for individuals and/or as a group feature to facilitate social interactions (e.g., "Book Clubs"); and "brain games" with interactive activities focused on cognitive training.

Discussion

Loneliness and social isolation are pervasive risk factors for deleterious physical and mental health outcomes particularly among individuals with a CI. The current study examines the feasibility of PRISM-CI, an ICT tablet-based skills training program tailored for individuals with a CI, and to explore preliminary impacts on depressive symptoms, loneliness, and social support, and technology attitudes/proficiency, at baseline and 5-month follow-up. We hypothesized that use of the PRISM system would lead to greater technology proficiency, and use of specific features such as email (promoting contact with family, friends, PRISM staff), camera/photo sharing, and Zoom would provide enhanced opportunities to foster social connectivity.

Our findings are consistent with research demonstrating the benefits of ICT on loneliness, isolation, along with subjective health and well-being (e.g., Gadbois et al., 2022; Hartanto et al., 2020; Lifshitz et al., 2018). ICTs broadens opportunities for individuals with cognitive, health, and/or mobility problems to remain engaged in their social networks (Hülür & Macdonald, 2020). Our results have implications with respect to fostering technology adoption in those with CIs, specifically because individuals with limited internet experience are put at an extreme disadvantage given increased reliance on these technologies in daily life. Providing both access to and training for older adults enhances self-efficacy with technologies, which subsequently increases their likelihood to adopt such systems. Our findings underscore the potential benefit of ICTs to foster social connectivity among individuals with a CI. Results suggest that access to ICTs are especially warranted during events such as the COVID-19 pandemic when social connectively was limited.

PRISM-CI was designed to provide users with access to an array of features beyond the Internet, including e-mail, games, and learning. Zoom videoconferencing was also introduced based on participant feedback, which supplemented opportunities for social interaction. Participants reported increased social support and reduced isolation and loneliness at follow-up, highlighting the potential for ICTs to enhance quality of life and well-being in older adults with CI. Findings also showed that participants exhibited more favorable attitudes toward technology as well as increased technology proficiency. These results are important given the ubiquitous nature of technology in society, and indicate that comfort and self-efficacy are critical for the adoption of general technologies. Our data not only highlight important system features that may better facilitate social connectivity that warrant further study, but also provides meaningful insight into the feasibility of providing technology training remotely to older adults with CIs.

Difficulty learning to use new ICTs is a common barrier to adoption and most older adults reported needing assistance learning new technologies. The majority of PRISM-CI users reported that the system was easy to use and were comfortable with use within a short amount of time after training sessions. These findings reflect studies in the cognitive aging field (Charness et al., 2001; Czaja et al., 2020), which indicates that older adults, even those with CIs, are capable of and willing to learn new skills related to ICT.

Study findings should be considered within its limitations, including the small sample size, a single pre-post research design, and lack of a control group. Future research should evaluate PRISM-CI in a randomized controlled trial with more than two time-points to ascertain the impact of ICT on psychosocial well-being in those with CIs. The study sample was mostly white, limiting the generalizability of findings to other groups. Future research replicate these findings in more diverse populations with adequately powered sample sizes. The study was largely conducted during the COVID-19 pandemic which may have impacted the findings, such that older adult participants' may have been more likely to participate due to lockdown measures. However, it is important to note that our study's findings are in line with other studies examining the potential for the PRISM system to foster increased technology proficiency and better psychosocial outcomes. Future research should evaluate specific patterns of internet use to provide valuable information for system refinements.

Overall, the current study highlights the importance of providing augmented opportunities for social connection via ICTs to reduce risk of social isolation and loneliness in older adults with a CI. Merely having access to technology is not sufficient for adoption, systems must also be perceived as useful and useable with adequate training and support measures in place. As innovations in technology continue to become immersed in daily life, those without access to meaningful technologies will contribute to enhanced disparities. Our results underscore the importance of enhancing access to as well as communicating the perceived value of ICTs to provide opportunities for older adults with CIs to remain socially connected and engaged.

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What this paper adds

- The findings underscore the potential of technology in terms of enhancing opportunities for social engagement and quality of life for older adults with a cognitive impairment.
- Technology applications can augment opportunities for social engagement and reduce feelings of loneliness.
- The results demonstrate that older adults with a cognitive impairment are receptive to and can successfully learn to interact with new technology systems.

Application of study findings

- This study demonstrates the potential benefits of technology for adults aging with a cognitive impairment.
- The findings also underscore the importance of a user-centered design approach to the design of technology applications and of providing training and technical support.
- Further, the findings provide information regarding features and functionality of technology systems important for this population, which can help to guide future technology applications.

Figure 1.
PRISM Home Page and Feature Menu.

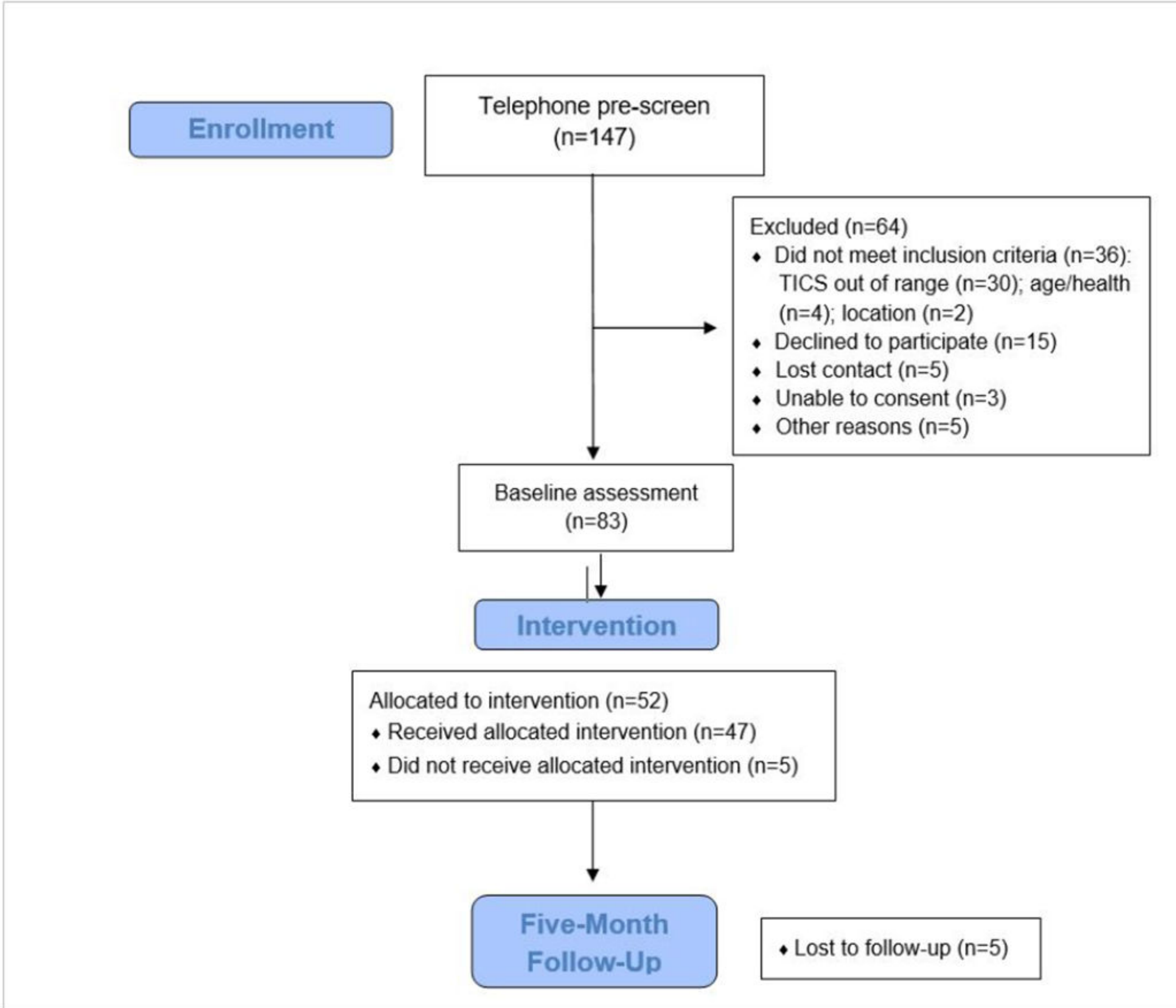

Figure 2.
Consort diagram for PRISM-MCI trial.

Table 1.

Demographic information for study participants at baseline (n=53)

Variable	n(%)	M	SD
TICS		22.08	2.14
Telephone MMSE (n=40)		17.45	.82
In-Person MMSE (n=13)		22.08	2.14
Age		75.54	6.78
Gender (female)	41 (77.4)		
Race/Ethnicity			
White Caucasian	48 (90.6)		
Black/African American	3 (5.7)		
Asian	1 (1.9)		
No Primary group	1 (1.9)		
Education			
≤ High School	4 (7.5)		
Some College	7 (13.2)		
College	28 (52.8)		
Postgraduate	14 (26.4)		
Income			
<$30,000	15 (42.9)		
$30,000-$59,999	6 (17.1)		
$60,000+	14 (40.0)		
Refused/Missing	18 (34.0)		
Number of People in Household		0.56	0.69
Occupational Status			
Employed Full-Time	1 (2.1)		
Employed Part-Time	2 (4.3)		
Retired	40 (85.1)		
Other	3 (6.4)		
Health Conditions			
Arthritis	24 (53.3)		
Cancer	2 (4.2)		
Diabetes	5 (10.9)		
Heart Disease	7 (14.9)		
Hypertension	17 (35.4)		

* *Note*. TICS = Telephone Interview for Cognitive Status. MMSE= Mini Mental Status Exam (adjusted for age and education levels).

Table 2.

Descriptive Statistics and Paired Samples *t*-Tests for Study Variables at Baseline and Follow-Up

	Pre-Test (n=53)		Post-Test (n=42)				
Variable	**M**	**SD**	**M**	**SD**	***t***	***p***	**Cohen's *d***
Psychosocial Variables							
Depressive Symptoms	13.71	7.24	11.6	7.7	1.81	**.034**	.29
Loneliness	42.65	10.45	37.46	10.39	3.23	**.001**	.52
Social Isolation Friendship Scale	17.27	4.3	19.12	4.3	2.63	**.006**	.41
MOS Social Support Survey							
Emotional Support	3.54	.95	3.85	.94	1.65	.053[¥]	.26
Tangible Support	3.12	1.30	3.69	1.16	2.90	**.003**	.45
Affectionate Support	3.14	1.51	3.65	1.32	3.80	**<.001**	.59
Positive Social Interaction	3.45	1.21	3.84	.96	2.24	**.015**	.35
Social Support Total	3.37	.95	3.78	.86	3.29	**.001**	.51
Technology Variables							
Technology Readiness Index	3.04	0.65	3.17	.60	1.58	.061[¥]	.26
Computer Attitudes Questionnaire	3.88	.59	3.91	.66	1.13	.135	.22
MDPQ							
Mobile Device Basics	3.96	1.24	4.45	.84	2.84	**.004**	.46
Communication	3.99	1.44	4.55	.68	1.78	**.042**	.29
File Storage	2.73	1.52	2.91	1.57	1.26	.107	.21
Internet	3.69	1.64	4.51	0.87	2.73	**.005**	.44
Calendar	3.30	1.73	4.18	1.19	4.01	**<.001**	.65
Entertainment	3.14	1.62	3.42	1.51	1.21	.118	.20
Privacy	2.97	1.46	3.21	1.30	.96	.171	.16
Troubleshooting	3.21	1.64	3.45	1.42	1.18	.122	.19
MDPQ Total	26.99	10.54	30.68	6.90	3.01	**.002**	.49

[*] *Note*.

[¥] = trending significance. MOS=Medical Outcomes Survey. MDPQ=Mobile Device Proficiency Questionnaire.

Table 3.

Linear Mixed Models using Age as a Covariate

Variable	Estimate	*t*	*p*	Cohen's *d*
Psychosocial Variables				
Depressive Symptoms	2.12	1.84	.077[¥]	.28
Loneliness	4.59	3.50	**<.001**	.50
Social Isolation (Friendship Scale)	1.69	2.90	**.006**	.43
MOS Social Support Survey				
Emotional Support	.257	1.97	.056[¥]	.32
Tangible Support	.522	3.27	**.002**	.47
Affectionate Support	.570	3.75	**<.001**	.36
Positive Social Interaction	.381	2.43	**.019**	.36
Social Support Total	.383	3.53	**<.001**	.45
Technology Variables				
Technology Readiness Index	.125	1.59	.125	.19
Computer Attitudes Questionnaire	.072	.803	.429	.06
MDPQ				
Mobile Device Basics	.445	3.23	**.002**	.46
Communication	.541	2.60	**.012**	.50
File Storage	.250	1.14	.262	.12
Internet	.816	3.35	**.002**	.63
Calendar	.901	4.12	**<.001**	.59
Entertainment	.242	1.36	.182	.18
Privacy	.158	1.22	.230	.17
Troubleshooting	.253	1.16	.253	.15
MDPQ Total	3.51	3.25	**.002**	.42

Note:

[¥] = trending significance. MOS=Medical Outcomes Survey. MDPQ=Mobile Device Proficiency Questionnaire.

Table 4.

PRISM-CI System Usability

Variable	Range	M	SD
System Usability Scale	0-100	68.15	17.82
PRISM System Evaluation Scale			
Satisfaction	5-35	25.66	8.63
Efficiency	7-49	29.40	10.95
Difficulties*	7-49	34.14	11.79
Use	5-25	17.11	5.73
Usefulness	5-35	22.94	7.88

Note. The difficulties subscale of the PRISM System Evaluation Scale is scored such that higher scores reflect fewer difficulties with using the system.