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In-Home Technology Training Among Socially Isolated Older Adults: Findings From the Tech Allies Program

Jessica Fields[1], Anupama Gunshekar Cemballi[1], Cathy Michalec[2], Debbie Uchida[2], Kami Griffiths[3], Heather Cardes[4], Jacqueline Cuellar[5], Anna Haseltine Chodos[1], and Courtney Rees Lyles[1]

Abstract

Technology has the potential to increase social connectedness among older adults, but one-third do not use the internet. We formed a community partnership, Tech Allies, providing tablets, broadband, and 1:1 training to isolated older adults. In a pragmatic pilot trial, participants were randomized into intervention ($n = 44$) and waitlist ($n = 39$) groups. Volunteers provided eight weekly, in-home iPad lessons. Surveys assessed self-reported loneliness, social support, technology use, and confidence at baseline and follow-up. A subgroup completed in-home interviews. The intervention group showed no change in loneliness, marginally significant improvement in social support and technology confidence, and significant increase in technology use. Among the waitlist group, no changes were observed. Interviews showed some participants felt more connected to the world, and many expressed increased technology confidence. Key implementation lessons on program feasibility are discussed. Embedding training within existing community-based programs holds promise as a potentially sustainable mechanism to provide digital training to older adults.

Keywords

technology, loneliness, social support, mixed methods, evaluation

Background and Objectives

In the United States, one-third of adults ages 65 years and older report never having used the internet, and about one-half do not have broadband services at home (Anderson & Perrin, 2017). Technology use is even lower among non-White and low-income older adults (Choi & Dinitto, 2013; Gordon & Hornbrook, 2016; Mitchell et al., 2018). Older adults face numerous barriers to technology use (French et al., 2019), including low self-confidence (Czaja et al., 2006; Jung et al., 2010; Siren & Knudsen, 2017), lack of access to affordable devices and broadband (K. Chen & Chan, 2013; Vaportzis et al., 2017), and lack of ongoing (as opposed to one-time) training (Moult et al., 2018; Peek et al., 2016). Social support plays a key role in facilitating older adults' technology adoption; thus, it may be particularly challenging for older adults with low social support to overcome barriers to technology use (Tsai et al., 2017). However, many non-users express interest in free technology training, reflecting an unmet interest and need for core skill building (Anderson & Perrin, 2017; Betts et al., 2019; Vaportzis et al., 2017).

Despite these barriers to older adults' technology use, recent years have shown a proliferation of technology-based interventions targeting older adults (Matthew-Maich et al., 2016; Schulz et al., 2015), many aimed at reducing the poor mental and physical health outcomes associated with loneliness (Cacioppo et al., 2006; Hawkley et al., 2006; Leigh-Hunt et al., 2017; Perissinotto et al., 2012) and lack of social support (Cornwell & Waite, 2009; Holt-Lunstad et al.,

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[1]University of California San Francisco, San Francisco, CA, USA
[2]Little Brothers - Friends of the Elderly, San Francisco, CA, USA
[3]Community Tech Network, Austin, TX, USA
[4]Community Tech Network, San Francisco, CA, USA
[5]University of California Berkeley, Berkeley, CA, USA

Corresponding Author:
Jessica Fields, Center for Vulnerable Populations at Zuckerberg San Francisco General Hospital and Trauma Center, University of California, San Francisco, 1001 Potrero Avenue, Building 10, Box 1364, San Francisco, CA 94143, USA.
Email: jessica.fields@ucsf.edu

2010). Some studies show that technology-based interventions may increase older adults' perceived social support (Delello & McWhorter, 2017; Quan-Haase et al., 2017) and reduce loneliness (Shapira et al., 2007; Szabo et al., 2018), and others suggest that technology's impacts are small to none (Y. R. Chen & Schulz, 2016; White et al., 2002) or may fade over time (Czaja et al., 2018).

While there is mixed evidence regarding whether technology training and use reduces older adults' loneliness and improves perceived social support, most of these studies have been conducted in highly controlled settings (Czaja et al., 2018; Szabo et al., 2018) or with highly educated samples (Delello & McWhorter, 2017), often with baseline digital skills (Tsai et al., 2017) and low levels of loneliness (Cotten et al., 2013). Very few studies have evaluated the impact of technology training on older adults' loneliness, social support, and technology use in real-world settings and assessed barriers and facilitators to technology training implementation. To address this gap, we formed a community-based partnership called Tech Allies, providing digital devices (tablets), internet access (through a discounted senior broadband program), and in-home 1:1 technology training to isolated older adults. We evaluated the program's effect on participants' loneliness, perceived social support, and technology use. In addition, we identified implementation and dissemination lessons for future interventions.

Research Design and Methods

Tech Allies was a partnership among Little Brothers - Friends of the Elderly (LBFE), a volunteer-based organization that provides home visits for isolated and lonely older adults; Community Tech Network (CTN), a digital literacy training organization; and the University of California, San Francisco (UCSF).

Sample

LBFE recruited participants from their network of isolated and lonely older adults in the San Francisco Bay Area from July 2017 through December 2018. Participants were recruited by phone in cohorts of 6 to 12 individuals, roughly one cohort each month, and randomized into two study arms: an intervention group and a 2-month waitlist group, to function as a control. Participants were deemed eligible for the small trial based on the following criteria, assessed through a screening interview: (a) at least 65 years old, or if disabled, at least 60 years old; (b) receive fewer than two social visits each month; (c) English-speaking; (d) expressed a need for in-depth technology training; and (e) able to understand and provide informed consent. Reasons for delays and dropouts were recorded at all steps, including survey completion, internet setup, and weekly trainings. A total of 83 participants were enrolled, with 44 randomized to the intervention arm and 39 to the waitlist arm (see Figure 1). The sample reflected the general LBFE population in terms of gender balance (53% female) and a mean age of 75 years (see Table 1). The UCSF institutional review board approved the study (No. 16-21234).

Intervention

Participants took part in eight weekly, 1:1 digital training sessions, which LBFE incorporated into their existing volunteer-based friendly visitor program. LBFE recruited and CTN trained volunteers as technology instructors prior to the in-home technology sessions. LBFE coordinated delivery of program materials and participant internet access. Participants each received a tablet (refurbished iPad 2, iPad Air, or Android tablet with prepaid data, depending on inventory and internet connection), a tablet case, a stylus, broadband access through Comcast Internet Essentials (a low-cost internet program for low-income households) or a hot spot device, and a certificate of completion at the end of the program. Internet connection was paid by LBFE for the duration of the program, after which participants could choose to continue their internet service for approximately US$10/month. Participants were allowed to keep their tablet, case, and stylus after completing the program, at no cost.

CTN created a learner booklet for each participant, outlining curriculum topics by week, including step-by-step visual guides and practice exercises. The eight sessions covered (a) getting to know the iPad (hardware, touch screen, typing, voice dictation); (b) using the iPad (operating system, getting online, searching for information); (c) online safety (passwords, phishing, viruses); (d) email (creating an account, sending email, using the camera); (e) email safety (opening and replying to emails, identifying spam); (f) communicating via apps and FaceTime; (g) online communities (social media); and (h) having fun and wrap-up (entertainment, learning, shopping).

Quantitative Data Collection

UCSF designed and implemented a mixed-methods evaluation of the program. Surveys were administered to participants upon enrollment at baseline and (for the waitlist group only) after the 2-month waiting period (see Supplementary Figure 1). Follow-up surveys after the completion of the 8-week training program were conducted for the intervention group by LBFE and UCSF (follow-up surveys were administered outside the 8-week window for participants who experienced delays in starting their training to ensure the data capture was from after training completion). Verbal informed consent was obtained prior to survey

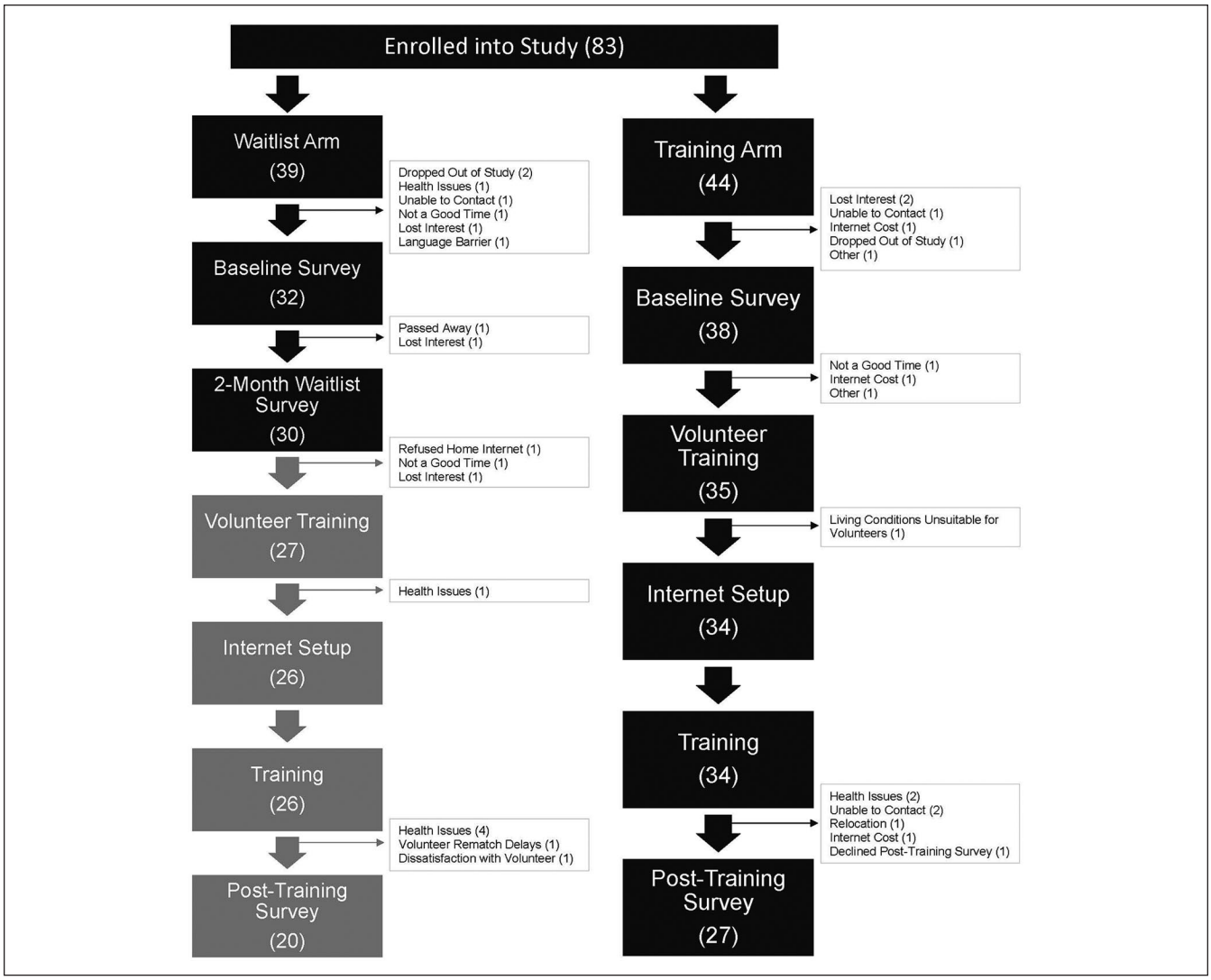

Figure 1. Participant enrollment and reasons for dropout.

administration. Once enrolled, multiple rounds of phone outreach to participants and detailed documentation of barriers to program participation were used to track implementation strategies and challenges.

Quantitative Outcome Variables

Primary outcomes. All outcome measures were dichotomized for analysis, as we expected responses to be highly skewed given our recruitment pool and small sample size. The three-item UCLA (University of California, Los Angeles) Loneliness Scale was used to measure loneliness (Hughes et al., 2004). Participants were considered lonely if they reported "often" or "some of the time" to any of the three scale items, as has been done in previous studies (Perissinotto et al., 2012).

A subset of the Interpersonal Support Evaluation List (ISEL) was used to measure perceived social support, with one item selected from each of the four domains of social support: tangible, belonging, self-esteem, and appraisal (Cohen & Hoberman, 1983). Participants were considered to have no perceived social support if they reported "probably false" or "definitely false" to any of the four domains.

To measure technology use, participants were asked whether or not they used the internet at least occasionally (yes/no; Perrin & Duggan, 2015). In addition to overall use, participants were asked how frequently they used the internet. Participants who used the internet also self-reported confidence in core technology skills: (a) searching for information online and (b) using email (Lyles et al., 2019). Participants were considered confident in these basic digital

Table 1. Participant Demographics at Baseline (Sample With Complete Baseline and 2-Month Data).

Participant Characteristic	Waitlist arm ($n = 30$)	Intervention arm ($n = 27$)	Total	p value
Age, *M* (*SD*)	76 (7.4)	74 (8.5)	75 (7.9)	.28
% Female	57 (17)	48 (13)	53 (30)	.52
% White or Caucasian	53 (16)	67 (18)	60 (34)	.31
% Completed high school or less	40 (12)	50 (13)	45 (25)	.45
% Yearly household income less than US$20,000/year	62 (16)	77 (17)	69 (33)	.24
% Limited English proficiency[a]	13 (4)	12 (3)	13 (7)	.84
% No cell phone	30 (9)	33 (9)	32 (18)	.79
% Fair or poor health[b]	53 (16)	56 (15)	54 (31)	.87
% Frequent mental distress[c]	14 (3)	29 (6)	21 (9)	.26
% Frequent physical distress[d]	44 (11)	46 (11)	45 (22)	.90
% Frequent functioning interference[e]	31 (8)	41 (9)	35 (17)	.46

[a]Speaking English less than "very well" (U.S. Census Bureau, 2017). [b] Self-report of general health as "fair" or "poor" (Centers for Disease Control and Prevention: Health-Related Quality of Life [CDC HRQOL], 2018b). [c] Participants were asked, "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" 14 or more days considered frequent mental distress (CDC HRQOL, 2018a). [d] Participants were asked, "Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?" 14 or more days considered frequent physical distress (CDC HRQOL, 2018a). [e] Participants were asked, "During the past 30 days, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation?" 14 or more days considered frequent functional interference (CDC HRQOL, 2018a).

skills if they felt "somewhat," "quite a bit," or "extremely" confident in both searching for information and using email, as has been done in previous studies (Lyles et al., 2019). Participants who reported never using the internet were assumed to have no confidence with these digital skills.

Secondary outcomes. To assess skills achieved after completion of the Tech Allies training, participants in the intervention arm were asked about their skill level for the topics covered. Participants were considered to have achieved each skill if they responded that they could perform the activity "without help" or "with little help."

Additional survey measures. The survey also captured demographic information about participants, including their age, gender, race/ethnicity, educational attainment, yearly household income, English proficiency (U.S. Census Bureau, 2017), and mental and physical functioning (CDC HRQOL, 2018b).

Qualitative Data Collection

Approximately one-quarter of participants completed semi-structured, in-depth interviews at baseline and after training, discussing their reasons for participating in Tech Allies, attitudes about internet and technology, desired learning outcomes, and perceptions about how learning to use technology would impact their health. Post-training interviews included discussion of participants' experiences in the program, reflections on program implementation (e.g., program structure), and plans for future technology use. Participants were identified through phone outreach and were selected for interviews if they expressed strong feelings about signing up for the program (either positive or negative) to ensure respondents reflected a range of attitudes about technology. Interviews lasted 60 minutes on average and were audio-recorded. Written informed consent was obtained prior to interviews. Authors J.F., A.G.C., and J.C. conducted interviews.

Analysis

Quantitative and qualitative data were analyzed independently and then compared to determine whether they support, explain, or contradict each other, in accordance with the convergent parallel mixed-methods approach (Creswell & Clark, 2010).

Quantitative analysis. First, we examined whether there were significant differences in demographics between each study arm at baseline using *t*-tests for continuous variables and chi-squared comparisons for categorical variables.

Next, to examine whether there were significant differences in our primary outcomes *within* each study arm over time, we used paired exact McNemar's tests (Cochran, 1950). For the intervention group, this meant comparing baseline and post-training surveys; for the waitlist group, this meant comparing baseline and 2-month surveys (completed prior to starting their training sessions).

To determine whether there were significant differences in our primary outcomes *between* study arms, we then used exact logistic regression models (Mehta & Patel, 1995) comparing the impact of intervention versus waitlist arm on each outcome. This meant comparing the intervention group's post-training surveys and the waitlist group's 2-month surveys, adjusting for baseline differences in the outcome measures

within each respective adjusted model. Exact statistical analyses were used because of the study's small sample size, as some of the cells formed by the outcomes by training arm tables had fewer than five observations.

Finally, for the secondary outcomes of specific technology skills acquired after training among the intervention group, we report simple proportions of self-reported basic digital skills to determine the most common topics covered during the sessions.

All quantitative analyses were conducted using Stata IC 15.1 (StataCorp LLC, College Station, TX).

Qualitative analysis. Interview transcripts were analyzed through qualitative description (Sandelowski, 2000), using a combination of deductive and inductive approaches (i.e., open coding) using Dedoose 8 software (SocioCultural Research Consultants LLC, Los Angeles, CA). Authors J.F. and A.G.C. read the interview transcripts independently before analyzing them, using open coding to identify themes and subthemes. The entire University of California (UC) team (J.F., A.G.C., J.C., A.H.C., and C.L.) reviewed and provided comments on the final codebook. When there was disagreement, C.L. established agreement on codes. Study staff halted further enrollment in the interview portion of the study after consensus that thematic saturation had been reached.

Results

Of the 83 participants enrolled, 44 were randomized to the intervention arm ($n = 27$ with complete post-training survey data) and 39 to the waitlist arm ($n = 30$ with complete 2-month waitlist survey data, see Figure 1). Our analytic sample was diverse with respect to income and educational attainment (see Table 1). Chi-squared and *t*-tests showed no significant differences between study arms for these demographic characteristics.

The primary reasons for participant dropout included (a) health problems, including chronic mental and physical health challenges as well as major hospitalizations and surgeries; (b) participants losing interest in technology training or in getting connected to the internet at home; (c) challenges in contacting participants; and (d) participants' concerns about ongoing internet costs after completion of the program. In addition, many participants experienced delays in starting training. Primary reasons for delays, outside those previously mentioned, included (a) scheduling delays between volunteers and participants for the instructional sessions, between participants and program staff for data collection, and between volunteers and program staff for volunteer training; (b) delays in identifying a volunteer match for a specific individual or neighborhood location; and (c) challenges in setting up home internet/devices, particularly for participants living in buildings not serviceable by Comcast or not eligible for Comcast's low-cost internet service. Delays were primarily in starting training, although some participants did experience delays in completing training, with a median completion time of 70 days.

Quantitative Results

Primary outcomes. We found no change in loneliness from baseline (waitlist = 67% lonely, intervention = 92% lonely) to 2 months (waitlist = 66% lonely, intervention = 88% lonely) within either study arm (both arms: $p = 1.0$; see Figure 2A). Although we observed improvement in perceived social support over time within the intervention arm (baseline = 80% no perceived social support, 2-month = 62% no perceived social support), this change was not significant ($p = .13$), and we observed no change in the waitlist arm (baseline = 59% no perceived social support, 2-month = 50% no perceived social support, $p = .63$; see Figure 2A). We observed significant improvement in technology use from baseline to 2 months within the intervention arm (baseline = 33% no internet or email use, 2-month = 0% no internet or email use, $p = .004$), and no change over time within the waitlist arm (baseline = 53% no internet or email use, 2-month = 60% no internet or email use, $p = .63$; see Figure 2B). Within the intervention arm, we also observed improvement in confidence in digital skills (baseline = 52% little to no confidence searching for information online and using email, 2-month = 35% little to no confidence, $p = .13$) and no change in the waitlist arm (baseline = 76% little to no confidence, 2-month = 77% little to no confidence, $p = 1.0$; see Figure 2B).

In exact regression models examining differences between groups at the 2-month time point, there were similar patterns. Specifically, there were significantly higher rates of technology use and confidence within the training arm compared with the waitlist arm, but no differences between arms for loneliness and perceived social support (see Table 2). More specifically, those in the intervention group had 91.20 the odds of reporting technology use (95% confidence interval [CI] = [11.02, +Infinity]) and 8.99 the odds of reporting confidence in their technology skills (95% CI = [1.55, 96.57]) compared with those in the waitlist group.

Additional sensitivity analyses examining frequency of internet use identified similar trends of improvement as overall technology use, with statistically significant improvement in the intervention group, and no significant change in the waitlist group.

Secondary outcomes. Figure 3 shows the breakdown of curriculum topics included in training materials and training arm participants' self-reported confidence levels in each skill at follow-up, including if the topic was not covered by their volunteer trainer. The majority of participants who completed the Tech Allies program reported high confidence in using tablet hardware (80%), interacting with the tablet (72%), getting online (88%), managing online safety (80%), using email (76%), using the tablet's camera (54%), and managing email safety (68%).

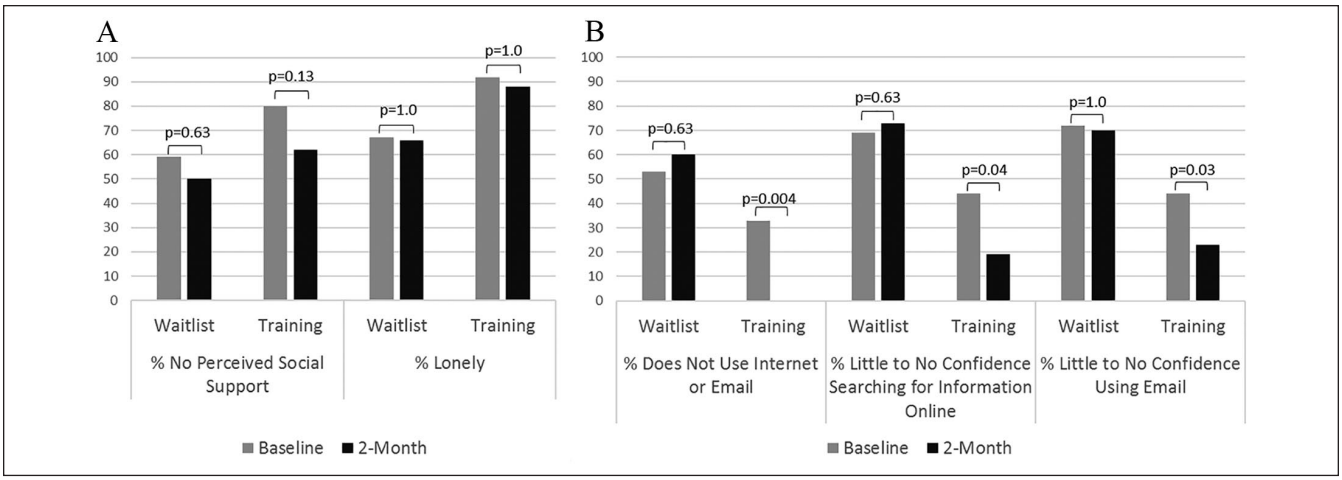

Figure 2. Within-arm differences in primary and secondary outcomes: (A) Within-arm differences in perceived social support and loneliness and (B) within-arm differences in technology use and confidence.

Table 2. Between-Arm Differences in Primary and Secondary Outcomes.

Outcomes	Adjusted odds ratio	95% CI	Adjusted for
Loneliness	1.37	[0.10, 15.62]	Baseline loneliness
Social support	1.45	[0.24, 10.88]	Baseline social support
Technology use	91.20[a]	[11.02, +Infinity]	Baseline technology use
Technology confidence—searching for information and using email	8.99	[1.55, 96.57]	Baseline technology confidence in searching for information and email use

Note. CI = confidence interval.
[a]Median unbiased estimate from exact logistic regressions, resulting in a wide CI because of the 100% rate of technology use among the training group at follow-up.

Qualitative Results

Baseline interview findings. Twenty baseline interviews were conducted, and results demonstrated that digital literacy among participants was low overall, as evidenced by the reasons participants gave for wanting to participate in the program (see Table 3): "I mean there are so many [things I want to learn]—I am so non-technical it's unbelievable." Baseline interviews elucidated that loneliness was a central driver of program participation; many participants wanted to communicate and connect with people online to reduce feelings of loneliness: "The email of course is very tempting to me because I do—do love to be able to contact friends who are away." Participants also discussed wanting to learn to use the internet to accomplish tasks in their lives more easily and efficiently. Some participants felt strongly that the information they wanted to find was no longer available in any other way, that using the internet would be faster or more efficient, or that the wealth of information available on the internet would enrich their lives: "Nowadays, it's impossible to live without Internet."

Many participants also expressed a desire to better understand the internet in order to not feel left behind from the modern world: "I want to keep up-to-date. I think I'm behind—you know, just the feeling of you're behind the times." Finally, participants were drawn to the structure of the Tech Allies program, specifically the once-a-week sessions and 1:1 pairing with an instructor. Numerous participants expressed that this structure and their existing positive relationship with LBFE were central drivers of their participation, whereas they may have chosen not to participate in other technology training programs in the past.

Post-training interview findings. Despite seeing no change in loneliness and perceived social support from survey data, the 15 post-training interviews uncovered a more nuanced picture of how participants' feelings of connection related to improving technology skills and digital literacy (see Table 4). Some expressed feeling more connected to the modern world because they had gained a greater understanding of technology, even if their skills were still improving, and some conveyed feeling that the tablet had become a companion for them: "[The program was] very helpful . . . in making people more communicative . . . and more confident, more contemporary. So I feel like [there are] people around you." While recognizing that they had more to learn, many participants expressed feeling more confident navigating technology and less scared of digital devices: "I feel a little more at

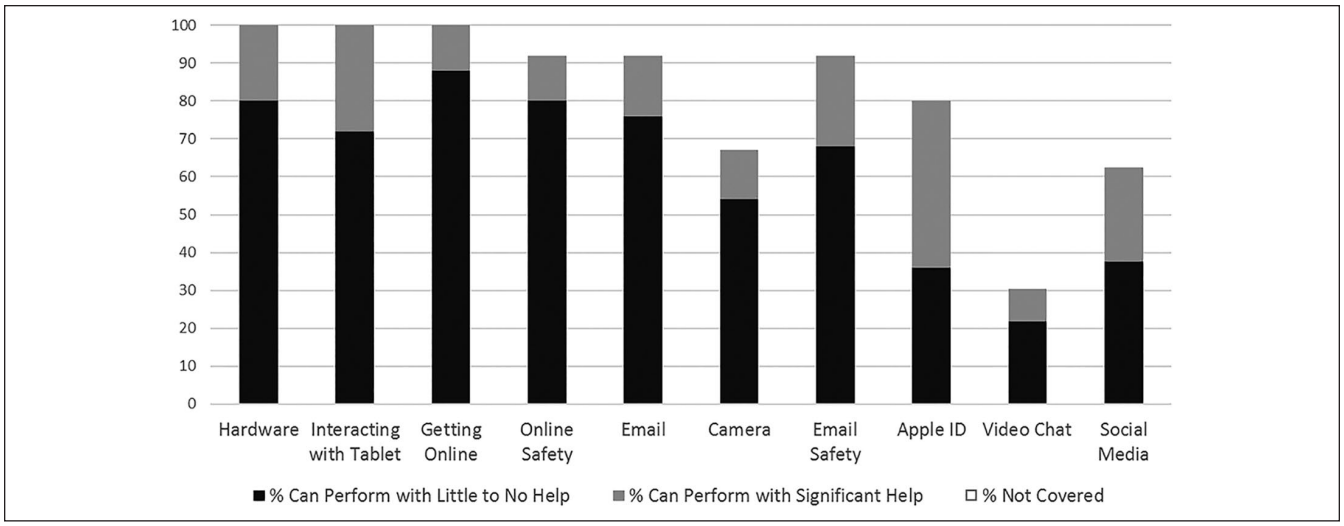

Figure 3. Topics covered and online activity independence after training, intervention group.

Table 3. Motivations for Joining the Tech Allies Program.

Theme	Illustrative quotes (baseline interviews)
I feel lonely and want people to talk to.	"[The internet] would improve my quality of life considerably . . . considering that I'm disabled and house-bound . . . I need, uh, an ability to reach out to the world from here more than when I used to be able to just go." (Participant 20, used internet monthly or less at baseline)
I need the internet to get things done.	"I want to learn how to send specific items, how to send photograph to my friends . . ." (Participant 5, used internet daily at baseline)
The world is moving forward without me.	"I'm too old for this world. That's the problem. I know it. I know. It's not going to change. It's only going to get worse." (Participant 8, no internet use at baseline)
I am drawn to the structure of this specific program.	"But the fact that they're gonna deal with one item at a time, that makes it I think very much more possible." (Participant 12, no internet use at baseline.)

ease with a lot of computers." Participants discussed the ways in which they used technology to reconnect with family and friends and to connect with the outside world through news, videos, and looking up information: "[Using technology] totally opened me up to these friends that I've lost touch with." For others, human contact with the volunteer instructor and program staff contributed significantly to heightened feelings of connectedness: "It [the program] certainly has made me happier because I really enjoy [the instructor], and having lost my friends like I did and my family like I've just done recently, it was at least some contact for me." In addition, preexisting isolation proved to be a barrier in achieving a greater sense of connection to the outside world; participants expressed that they were unsure of who they would communicate with online, particularly as many had few living relatives or friends: "I don't have too many people . . . and so, it [how I communicate with people] hasn't changed much." Finally, other participants felt that technology had the potential to change communication, but they either had not yet developed sufficient digital skills to reach that point or were not interested in using digital technology to communicate with others (preferring in-person, phone, or written communication instead). When asked about how the technology training changed how she communicates or connects with others, one participant responded, "I think it will have. But I, so far, have not been agile enough to even connect the [email] addresses of my friends."

Participants also provided feedback on the program (see Table 4). This included a desire for more total sessions and more frequent sessions with their volunteer instructors to provide additional opportunities for repetition and practice as well as more time to progress to advanced topics. While some participants did not regularly use the written materials provided as part of the program, others felt that more detailed visual and written instructions would be helpful.

Participants also highly valued having someone to guide them and answer their questions about the tablet: "[The instructor], when she comes, she says . . . 'don't do this, don't do that.' Somebody's there to guide you. Without that help . . . I would be lost." Some expressed a desire for more structure from their volunteer instructor, while others appreciated the highly customized, participant-driven approach. For many participants, their personality match with their instructor was central to their program experience.

Table 4. Qualitative Outcomes of the Tech Allies Program.

Theme	Illustrative quotes (post-training interviews)
Feelings of connectedness	
Feeling more connected to the world due to greater understanding of technology	"[Tech Allies is] giving me a little more confidence . . . you can feel kind of cut off for not knowing much about computers for one thing . . . but it [the program] has—it has helped me . . . just stay connected . . . and not so isolated." (Participant 65, used internet daily at baseline and after training)
Technology as a companion	"[The iPad has] become a member of the family which I never thought something like this would . . ." (Participant 54, no internet use at baseline, daily internet use after training)
Human contact (with program volunteers, friends/family, and beyond)	"[With this program] I look forward to something, you know? [O]therwise, nobody calls and—and if I call, one or two people, what can you ask every day: the same thing?" (Participant 73, no internet use at baseline, daily internet use after training)
No change in feelings of connection due to preexisting isolation	"Well, I think [how connected I feel to other people is] about the same. Uh-huh. I don't know—really know that many other people, you know." (Participant 63, no internet use at baseline, used internet monthly or less after training)
Digital skills and confidence	
Feeling more confident and less scared of technology	"[B]efore I just was afraid of touching, uh, iPad . . . Now I—I feel a little bit more confident." (Participant 5, daily internet use at baseline and after training)
Feeling a sense of accomplishment for learning something new	"I think [learning to use the internet] it's very valuable for seniors . . . the general feeling of accomplishment . . . we still can handle things like—like the internet. And, um, uh, I think that's a very positive thing." (Participant 12, no internet use at baseline, used internet every 2–3 weeks after training)
Ability to get things done	"[T]he best part . . . just learning how to get the information I needed." (Participant 8, no internet use at baseline, weekly use after training)
Need more practice/more to learn	"[T]he instructors did some things with [the iPad] that I can't—still didn't seem to master . . . I'm not the kind of person that if you show me once, then I know how to do it, you know." (Participant 63, no internet use at baseline, used internet monthly or less after training)
Participant feedback on program structure	
Importance of instructor	"It's really important the training is. I don't think it would work without the training if you're handing out [only devices]." (Participant 20, used internet monthly or less at baseline, daily use after training)
Weekly sessions	"I don't learn, of course, at the pace I used to learn which frustrates me, [but] I think that [the program is] set-up in a way that can accommodate a lot of needs." (Participant 54, no internet use at baseline, daily use after training)
Need more sessions and/or more frequent sessions	"[The sessions have] to be more frequent because I couldn't remember all the stuff she [the instructor] taught me." (Participant 51, weekly internet use at baseline, daily use after training)
Need better written materials	"[S]ome people might like a little more . . . documentation for troubleshooting." (Participant 20, used internet monthly or less at baseline, daily use after training)
Need better teaching skills from instructor	"[The instructor] went a little bit fast and I had a hard time keeping up with him . . ." (Participant 43, weekly internet use at baseline, every 2–3 weeks after training)
Personality of volunteer match	"[A] lot of it has to do with who you're—who's the person you're dealing with [as the instructor] . . . [T]he first person they sent here, I—um, uh, was not good a match for me at all. [S]he had no patience . . ." (Participant 27, daily internet use at baseline and after training)

Discussion

Our study was one of the first digital literacy training studies to be embedded within an existing community-based organizational structure. From our quantitative data, we found statistically significant improvements in internet use and self-reported skills when comparing older adults who had completed the technology training with a waitlist control group. In addition, although we did not find quantitative changes in loneliness, there was a trend toward improved perceived social support among the group that completed training. Our qualitative findings supported these quantitative results, with some participants expressing increased feelings of connectedness and others not, but with many expressing increased comfort using digital devices. Our qualitative results also provided insight on the specific types of social connection influenced by technology training outside our quantitative measures of loneliness, in particular feeling greater connection to the modern world. A strength of this study was the use of both quantitative and qualitative evaluation data to shed light on the ways technology training influences older adults' feelings of connection and digital confidence; using only one approach would not have yielded as full an understanding.

Overall, we did not find changes in loneliness among our participants. This could be due to the fact that clients of LBFE were already facing many contextual factors in their daily lives, such as physical disability and a lack of close friends and living relatives, that made their loneliness more systemic and harder to change (Barbosa Neves et al., 2019; Golden et al., 2009; Goll et al., 2015).

These findings are similar to other previously published work. For example, a large randomized trial of older adult technology training found significant improvements in loneliness and technology confidence at 6 months, but these effects were not maintained at 12 months (Czaja et al., 2018). Our study also differed from previously published work, filling a gap in the literature. Many studies of technology training and adoption among older adults focus on primarily White, highly educated, upper- or middle-class participants, many of whom already have access to digital devices (Cotten et al., 2013; Delello & McWhorter, 2017; Tsai et al., 2017). Other studies have focused on group classes (Jung et al., 2010), which add an additional social component to training, but can be challenging for older adults with limited mobility to attend. Furthermore, when considering the broader literature on interventions to address both the digital divide and loneliness, there is a clear need for more evidence—especially for studies like Tech Allies that combine community-based approaches which have the potential to be sustained over time (Mann et al., 2017).

Our study demonstrated multiple implementation-related successes. Most importantly, we found numerous synergies in the collaboration between nonprofit organizations and an academic research institution. The program was implemented into the workflow of LBFE, with assistance in curriculum development from CTN, and research coordination and evaluation by UCSF—allowing each organization to focus on areas in which they had deep experience. For example, without the partnership of LBFE, the identification and recruitment of both volunteers and older adults into this study would have taken much longer to complete, as LBFE had already built the trust and relationships with participants and volunteers needed to launch the program. This proved particularly critical in working with a vulnerable population facing many structural barriers to regular program participation, such as being homebound, highly isolated, and facing many health challenges. This echoes prior research showing that older adults themselves prefer digital training delivered 1:1 through a known and trusted organization (Betts et al., 2019). Furthermore, offering Tech Allies as an option for LBFE volunteers created the ability to easily onboard new volunteers eager to work on digital literacy training with a defined 8-week curriculum as a concrete way to socialize and connect with their matched older adult.

We also found several implementation-related barriers. First, while a waitlist helped improve the internal validity of the study, it may have created challenges when older adults experienced serious health events or other barriers to research participation. Second, the number of barriers we encountered with internet setup and Wi-Fi installation in the homes of older adults were substantial; greater attention from service providers is needed to allow for timely enrollment and setup into their low-income discounted programs. Leveraging volunteers to deliver curriculum content also presented challenges due to scheduling conflicts, volunteer dropout, geographic distance between volunteers and older adults, limited teaching and technology skills of volunteers, and balancing personality matches of volunteer/participant pairs. Despite these challenges, volunteers and integration into existing programming offer advantages to scale and maintain training like this in the future, even as we continue to improve the onboarding and volunteer matching process.

Limitations

Limitations to note in our study include a small sample size and modest loss-to-follow-up rate of 31%, limiting more robust statistical analyses. In future studies, strategies such as an active control group receiving social visits from a volunteer (rather than technology training) could be attempted to reduce attrition as well as disentangle potential changes in loneliness and perceived social support resulting from technology training from those resulting from interactions with volunteers and study staff. In addition, because our post-training survey was administered soon after training completion, we were unable to assess whether improvements in technology use and confidence were maintained over time. Our assessment of technology use and confidence also relied on self-report, and confidence in specific skills was only assessed post-training. Finally, our study did not assess cognitive function, which could be a confounder to participants' responsiveness to training.

Conclusion

Although participation in Tech Allies did not result in change in loneliness, it did result in an increase in technology use and improvement in digital skills. Moving forward, we see potential to partner with community-based organizations to maximize the impact in health technology interventions, as many of these organizations are already interacting with and providing services to older adults in their homes on a regular basis. To make this happen, we know that digital training can be a cornerstone of future programming in multiple domains. Our results show this will require good devices, easy and affordable broadband and Wi-Fi access, and clearly delineated curricula for digital skill building—policies focusing on only one or two of these domains will not be as successful as comprehensive programs that meet all these needs. There are a large number of health interventions that we would like to offer and spread to older adults to improve their ability to live independently and age in place. Programs like Tech Allies offer foundational elements of digital literacy and

access that can be expanded to include more focused topics as the curriculum extends into month- and year-long programs—for example, advance care planning, fall prevention, chronic disease management, and online patient portal use to manage health care tasks and visits could be woven into the program.

Authors' Note

The Institutional Review Board (IRB) of the University of California, San Francisco, approved this study (IRB Study Approval No. 16-21234).

Declaration of Conflicting Interests

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ORCID iD

Jessica Fields https://orcid.org/0000-0003-1131-6329

Supplemental Material

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