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A Pilot Randomized Trial of an Intervention to Enhance the Health-Promoting Effects of Older Adults' Activity Portfolios: The Engaged4Life Program

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ABSTRACT

The purpose of this study was to evaluate the feasibility and outcomes of the Engaged4Life program, an intervention to encourage inactive community-dwelling older adults to embed physical activity, cognitive activity, and social interaction into their everyday lives in contexts that are personally meaningful and natural for them. Fifteen participants were randomized to the intervention group (technology-assisted self-monitoring of daily activity via pedometers and daily tablet-based surveys; psychoeducation + goal-setting via a 3-hour workshop; and peer mentoring via phone 2×/week for 2.5 weeks) and 15 to the control (technology-assisted self-monitoring only). Recruitment was shown to be feasible and efficient, but not able to reach the target for men. Retention rate was 83% and participants manifested high adherence and engagement with the intervention. Though this pilot trial was not powered to demonstrate significant differences between groups, daily steps increased by 431 (11% increase) from baseline to Week 4 for the intervention ($p < .05$), but decreased by 458 for the control, for a net difference of 889 steps ($p < .05$). Findings were sustained at Week 8 ($p < .01$). In a future trial, difficulties in recruiting men, barriers due to the technology-intensive design, and the optimization of secondary outcome measures should be addressed.

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Maintaining health and well-being throughout longer lives represents a significant public health challenge in this era of population aging. Research points to the importance of an active lifestyle, comprised of physical activity (PA), cognitive activity (CA), and social interaction (SI), in preventing or restoring poor health and functional decline (Bassuk, Glass, & Berkman, 1999; Berkman, 1995; Fried et al., 1998; Glass, De Leon,

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Marottoli, & Berkman, 1999; Seeman, 1996; Wagner, LaCroix, Buchner, & Larson, 1992; Wilson et al., 1999) as well as cognitive decline (Fratiglioni, Paillard-Borg, & Winblad, 2004; Wang, Karp, Winblad, & Fratiglioni, 2002). However, promoting and sustaining active lifestyles in adults of any age, and particularly in older adults, has proven to be difficult (Katula et al., 2007; Resnicow et al., 2002). In general, the majority of public health interventions aimed at promoting an active lifestyle have focused on increasing a single lifestyle behavior, i.e., PA (Chase, 2013; Zubala et al., 2017), CA (Ball et al., 2002; Klimova, 2016; Rebok & Balcerak, 1989), or SI (Heaven et al., 2013). Few have focused on increasing multiple lifestyle factors simultaneously and in contexts that are meaningful and natural for participants.

The Social Model of Health Promotion (SMHP), proposed by Linda Fried and colleagues in 2004, offers a framework for such an intervention. The SMHP's primary assertion is that roles or activities have health benefits to the extent that they require PA, CA, and SI, and that activities that carry personal meaning (PM) or confer a sense of purpose may have stronger health-promoting effects than activities that do not. This model has been extensively and rigorously tested through experimental studies of the Experience Corps program (Fried et al., 2004; Hong & Morrow-Howell, 2010; Varma et al., 2016), an elementary school-based community volunteering program designed to be intensive enough (15 hours per week) to get older adult participants out of the house and physically active in the community, cognitively stimulated by reading to children, and socially integrated by building relationship with children and teachers within the school, all toward a meaningful goal of improving the reading skills of children in their own communities. However, this program is not yet widely accessible in the US and is particularly inaccessible in rural areas. Further, formal volunteering is not necessarily an activity that is attractive or accessible to all older adults (Heaven et al., 2013; Jenkinson et al., 2013).

To overcome these barriers, our interest was in evaluating the feasibility and outcomes of what we call an "engagement model" of health promotion that applies the principles of the SMHP to older adults' daily lives and activities more generally. The engagement model empowers older adults to enhance or supplement their existing "activity portfolios"—i.e., the various activities that they engage with on a day-to-day basis—in ways that naturally incorporate PA, CA, and SI. Such an approach allows for personalization or tailoring that meets individual's specific needs, interests, and constraints, which has been strongly recommended in community based settings (Task Force on Community Preventive Services, 2002). Further, the approach emphasizes the prioritization of activities that are personally meaningful, allowing the goals of engagement to be varied (e.g., motivated by generativity, curiosity, or pleasure) so that health promotion motives can be ancillary.

In order to facilitate the desired behavior change that we hoped to see from this engagement approach (i.e., participants take on new or modify existing activities of their own choosing that can increase PA, CA, SI, and PM), it was important to embed evidence-based behavior change strategies into the intervention. In a meta-analysis by Chase (2013), a multi-component approach was found to be more successful than single-component approaches in changing health behavior. Chase (2013) also identified commonly employed behavior-change strategies from the health promotion intervention literature, which include: (1) behavioral strategies that introduce observable and participatory physical actions, e.g., technology-based approaches that involve prompting and self-monitoring, (2) cognitive strategies that aim to alter or enhance thought processes, attitudes, or beliefs related to a specific behavior, e.g., education and goal-setting activities, and barrier identification and management, and (3) social strategies that provide peer support and encouragement, e.g., peer mentoring. Thus, all three of these strategies were employed in a multi-pronged approach to facilitate the desired behavior change: (1) technology-assisted self-monitoring of daily activity via pedometers and daily tablet-based surveys (behavioral strategy); (2) psychoeducation + goal-setting via a 3-hour workshop (cognitive strategies); and (3) peer mentoring via phone 2×/week for 2.5 weeks (social strategy).

Such an approach has never been tested in a randomized controlled trial and little work has been done to provide a basis for designing such a trial. Thus, the aim of this pilot randomized controlled trial was to assess the feasibility and outcomes of the Engaged4Life program, a novel, multi-component intervention designed to encourage inactive community-dwelling older adults to increase multiple lifestyle factors simultaneously and in contexts that are meaningful and natural for them. The specific objectives were to: (a) explore the feasibility of the recruitment procedure, (b) evaluate participants' adherence to and engagement with the various study components, including overall retention rates, and (c) assess the primary and secondary outcomes of the intervention, compared to a technology-assisted self-monitoring only control group, for the purpose of informing future efficacy trials. Daily step-count (via FITBIT® pedometers at baseline, Week 4 and Week 8) was the primary outcome and daily CA, quantity and quality of SIs, and perceptions of meaning (via a daily tablet-based self-report survey at baseline and Week 4) were the secondary outcomes. We hypothesized that participants in the intervention group would experience increased daily steps (PA), as well as increased daily CA, quantity and quality of SIs, and perceptions of meaning from baseline to Week 4, compared to the control group. We also hypothesized that positive changes in daily steps would be maintained in the intervention group when assessed 1 month after the end of the intervention period.

Methods

Study design, setting, and participants

The study was an 8-week, parallel, 2-arm pilot randomized controlled trial. Recruitment started on August 1st and ended on August 31st, 2015. Outcome data were collected from September to November 2015. The trial was registered retrospectively with clinicaltrials.gov (NCT03337204, date: November 8, 2017) and approved by the Boston College IRB (protocol # 15.063.04) and the Massachusetts Executive Office of Elder Affairs' Elder Rights Review Committee. The study adheres to the CONSORT extension to pilot trials guidelines (Eldridge et al., 2016).

Participants were recruited from a diverse, middle-income city just outside of Boston, Massachusetts. This was city ranked in the upper quartile for population density and diversity when compared to the other cities and towns in Massachusetts and in the middle quartile for median household income and per capita income in 2016 (Massachusetts Hometown Locator, 2016). We partnered with the local senior center and advertised through the senior center's newsletter, which is published in the local newspaper and distributed to businesses and non-profits all over the city. We also distributed study flyers to community-based organizations in the area (i.e., the local Area Agency on Aging, churches, community centers), local businesses (e.g., hair dressers, grocery stores, barber shops, etc.), neighborhood bulletin boards, housing complexes, and word of mouth. Incentives for participation included a $50 VISA Gift Card, a FITBIT® Zip (Fitbit, Inc., San Francisco, USA), and free iPad® Mini (Apple, Inc., Cupertino, USA)Mini training. Interested individuals who called the study phone line were screened via telephone by two research assistants (2nd year masters-level social work students who had completed coursework in aging, trained by the first author).

Those who were eligible to participate were: (1) age 65 or older, (2) relatively inactive, as determined by a score of <10 on a modified version of the Health Enhancement Lifestyle Profile (Hwang & Peralta-Catipon, 2015) where only the domains of exercise, social and productive activity, and leisure were included, (3) a city resident, (4) willing to be randomly assigned, and (5) available for relevant study dates. In addition, those who were living in an assisted living/nursing home facility, had significant cognitive impairment (those with >2 errors on a six-item cognitive screener by Callahan, Unverzagt, Hui, Perkins, & Hendrie (2002)), or who reported that a doctor has told them that it is unsafe to participate in PA were ineligible to participate.

After interested individuals were screened for eligibility, as described above, the Tripod Random Allocation Software (http://mahmoodsaghaei.tripod.com/Softwares/randalloc.html) was used to generate the random allocation sequence using a 1:1 ratio. A blocking approach was used to ensure

close balance of the numbers in each group as we proceeded through recruitment. Intervention assignments were placed in sealed, non-translucent envelopes by the first author and screeners (trained research assistants) chose the envelopes, in sequence, to assign eligible individuals to an intervention group. This was done to conceal the random allocation sequence to the screeners until interventions were assigned. Participants were blinded to treatment group. Enrollees were mailed the informed consent and baseline self-administered survey and were asked to bring these completed forms to the study information and training session. See Figure 1

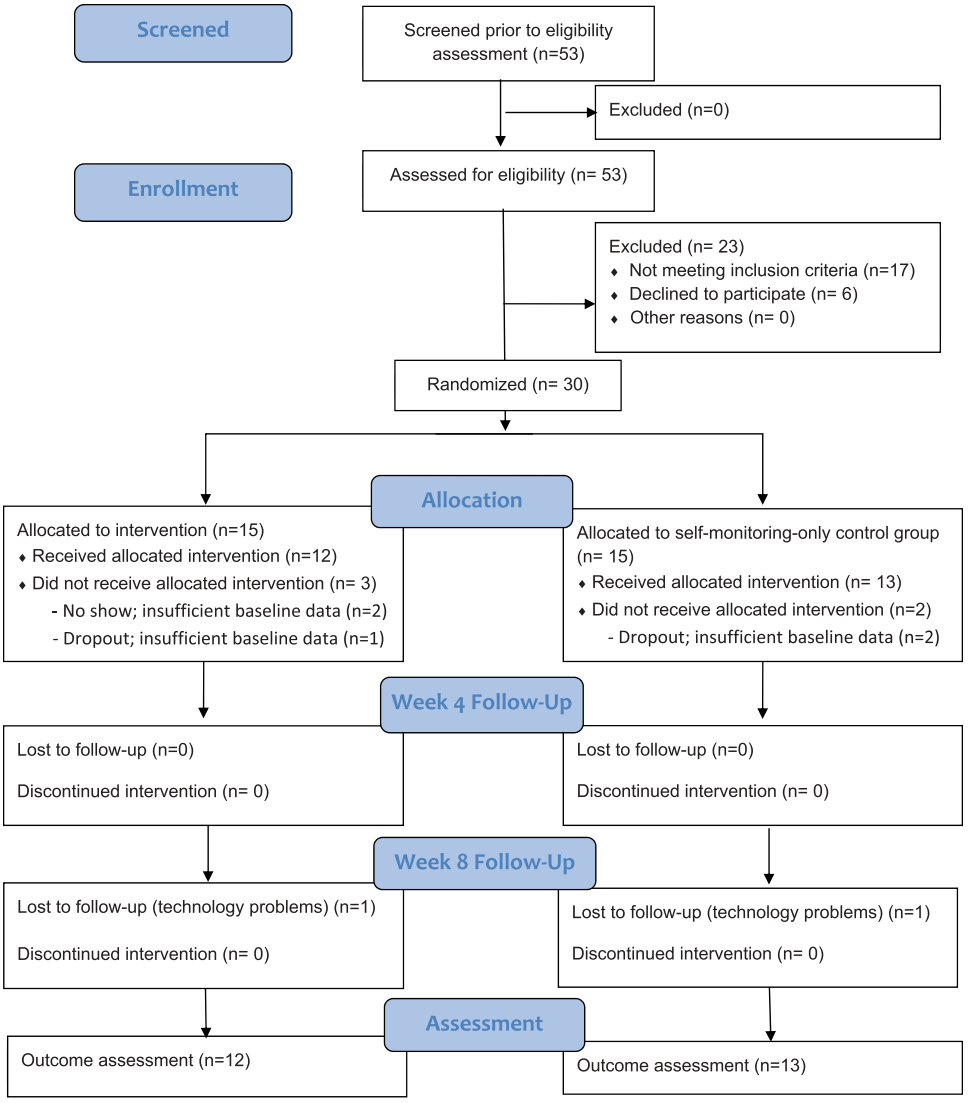

Figure 1. CONSORT* diagram summarizing flow of participants through the Engaged4Life Study. * Specifically the CONSORT extension to pilot trials (Eldridge et al., 2016)

for a CONSORT diagram (extension to pilot trials, Eldridge et al., 2016) of the flow of participants through the study. The goal was to have 15 individuals participate in each arm of the study with an equal balance of men and women, however as discussed in the results section, we had difficulty recruiting men and there was some loss of participants over the course of the study, thus the final sample for the outcome assessment was 12 for the intervention group and 13 for the control group.

Intervention

There were two study arms: the intervention arm and the self-monitoring-only control arm. The intervention arm received: (a) technology-assisted self-monitoring of daily activity via pedometers (to measure PA) and daily tablet-based surveys (to measure CA, SI, and PM), (b) psychoeducation + goal-setting (via a 3-hour workshop), and (c) one-on-one peer mentoring (via phone 2×/week for 2.5 weeks) to support goal implementation. The self-monitoring-only control arm received only component A, technology-assisted self-monitoring of activity engagement. The Engaged4Life program was designed by the core research team in partnership with two key groups: (1) an interdisciplinary advisory committee of academics/experts, and (2) ESC Discovery, a program of Empower Success Corps, based in Boston, MA, that has extensive expertise in delivering workshops intended to support and facilitate the exploration of new opportunities for meaningful engagement in later life, as well as training peers who can support such exploration.

Technology-assisted self-monitoring

Randomized participants were invited to a 1.5-hour study orientation/technology training session during which they received a FITBIT® Zip pedometer to wear daily (for the entire 8-weeks of the study) and received training on how to use an iPad® Mini tablet to complete a survey just before bed each night for an initial 7-day study period (T0, baseline) and then again for a second 7-day study period 4-weeks later (T1). The tablet survey asked questions about CA, SI, and PM activity engagement during that day. The first author of this paper developed the training materials (including a take-home manual) and led the training sessions. Research staff were available if participants had questions or needed troubleshooting help. A 2-day "warm-up" period was provided where participants could practice using the new technology before the 7-day baseline data tracking began. The training also emphasized good practices for remembering to wear the pedometer and completing the daily surveys.

Psychoeducation + goal-setting

There were two primary components to the 3-hour Engaged4Life Workshop, which was facilitated by a professional facilitator provided by our partners from the ESC Discovery program of Empower Success Corps: (1) psychoeducation and (2) goal-setting. In the psychoeducation module, participants receive information on how PA, CA, SI, and PM activity engagement affects health and well-being in later life. The imagery of a compass navigating the "The Road to an Engaged Life" is used as a metaphor and participants are guided through exercises and discussions focused on "continued engagement" as a key component of healthy aging using the four compass points for engaged living: Move (PA), Think (CA), Connect (SI), Enrich (PM). For each compass point, participants: (1) are provided with research-based information about *why* increasing their engagement in that domain is important, (2) participate in a brief demonstration, (3) receive guidelines around increasing engagement in the domain, and (4) are given a variety of examples and a resource guide with additional examples/local resources.

Participants are then asked to reflect, through a structured activity, on their current "activity portfolio" (i.e., list the activities they engage in on a day-to-day or weekly basis), and assess the extent to which these activities require them to be physically, cognitively, and socially active, and are personally meaningful. Peer mentors assigned to each group provide support and help with this activity as needed. In the goal-setting module, participants work in small groups with a peer mentor to set personalized, long- and short-term goals for themselves focused on either *enhancing* or *supplementing* their activity portfolios in ways that increase PA, CA, SI, and PM. Participants have broad latitude to choose any type of goal for themselves as long as they feel that goal(s)/activities are personally meaningful and they could find ways to embed PA, CA, and SI within or across the various new or enhanced activities. One participant, for example, decided this would be a good opportunity to rekindle her strained relationship with her daughter. Her short-term goals focused on reaching out to her daughter to make amends and then arranging to meet her daughter and granddaughter for an active outing a couple of days per week. These goals were not only extremely personally meaningful to her, but they also explicitly required increased PA (i.e., playing at a playground or going for a walk) and SI. Her long-term goal was to maintain a strong, positive relationship with her daughter and granddaughter moving forward and to make these outings an ongoing, regular occurrence.

One-on-one peer mentoring

Peer mentors were similar-age peers who have an interest in helping others achieve their personal goals. Most, but not all, of the peer mentors for this study lived in the same city as the participants. Peer mentors were recruited through referrals, screen-outs from main study (for scoring ≥10 on the HELP

screener), and alumni of the EngAGE Study, which was a study focused on active older adults led by the first author. Peer mentors attended a 2-hour training session consisting of the following components: (1) study overview, (2) roles and responsibilities of peer mentor, (3) communication and interpersonal skills, (4) active listening, critical thinking, and strategies for engaging participants, and (5) ethics and resources.

The five peer mentors were each assigned to mentor two–three study participants. They provided support and guidance in small group settings during the Engaged4Life Workshop and then the peer mentors followed-up with each of their mentees individually via phone. The original protocol indicated that the peer mentoring sessions would occur twice a week for *three* weeks. However, due to a religious holiday that fell on the Monday of Week 1, the Engage4Life workshop was pushed to that Wednesday, resulting in limited time to complete two peer mentoring sessions in Week 1. Thus, participants and mentors were instructed to complete one session during Week 1, and two during Weeks 2 and 3, for a total of five sessions over 2.5 weeks. During these phone calls, peer mentors checked-in with participants to see how they were doing implementing their short-term goals, provided moral support, and helped to brainstorm solutions for overcoming any barriers their mentees were facing in implementing their goals.

Measurements

Feasibility measures

To evaluate the feasibility of the recruitment procedure, we assessed *response to the recruitment materials* (expressed as the number of individuals screened over the 4-week recruitment period and the gender breakdown therein), *the speed of recruitment* (expressed as the number of participants recruited per week of the recruitment period), and *efficiency of the recruitment* (expressed as the ratio of randomized to screened individuals). To evaluate retention, we assessed *adherence to wearing the pedometer* (measured as the percentage of valid days, with a valid day being defined as one in which the pedometer registered a step count above zero) and *adherence to completing the daily activity engagement surveys. The percentage of participants who completed the study* was also evaluated and reasons for discontinuation were identified.

To evaluate participant engagement, we assessed *the percentage of participants who attended the workshop* and participants' *self-reported experience of the workshop* with regard to four dimensions: the overall quality of workshop, the style of the facilitator, the helpfulness of the content for them, and whether they learned new information. The response scale ranged from 1 (*poor*) to 5 (*excellent*). Engagement in the peer mentoring component of the intervention was assessed by asking peer mentors to complete session recording logs after each session with their mentees.

Specifically, we evaluated *the proportion of the prescribed peer mentor sessions completed, average length of individuals' sessions*, and *peer mentors' ratings of the session in four domains*: Do you feel the session was productive?, Do you feel the session was efficient?, Do you feel you provided support to your mentee?, and Do you think your mentee felt more confident at the end of the session?. The response scale ranged from 1 (*not at all*) to 4 (*very much so*). Those in the intervention group were also asked to rate their *satisfaction with their peer mentors along each of 12 dimensions* (e.g., "my peer mentor provided me with useful information," "my peer mentor regularly contacted me during the given times," and "my peer mentor is knowledgeable about how to overcome barriers"). The response scale ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). We report on each of these items separately.

Outcome measures

Though this was a pilot study that was not adequately powered to assess differences between groups, we evaluated several outcomes of the intervention for the purpose of informing a future trial. The primary outcome was *physical activity (PA)*, measured as the number of steps per day, which has been validated as a measure of free-living PA (Tully, McBride, Heron, & Hunter, 2014). The same FITBIT® Zip pedometers that were used for the technology-assisted self-monitoring portion of the intervention in both groups were employed to objectively measure steps/day. Mean daily step count from the first 7 days of wearing the pedometer was used as a baseline value (T0, Week 1), which began after the introduction/technology training session but before the Engaged4Life workshop. The T1 mean daily step count was calculated from the 7-day period starting 22 days after baseline data collection began (Week 4), which started during the last week of peer mentoring for the intervention group. And finally, the T2 mean daily step count was calculated from the 7-day period starting 50 days after baseline data collection began (Week 8), which was approximately 1-month post-intervention. FITABASE (https://www.fitabase.com/) was used to aggregate data across multiple FITBIT® devices for research purposes. The square root of the mean daily step count was used in analyses to normalize the distribution of this variable, as this transformation is commonly used for reducing right skewness and has been applied to step count data in multiple prior studies (Arredondo, Elder, Marshall, & Baquero, 2007; Ostendorf et al., 2018).

Secondary outcomes included daily CA, SI, and PM. As above, the same iPad® Mini tablets that were used for the self-monitoring portion of the intervention in both groups were employed to subjectively measure CA, SI, and PM through daily surveys that were completed each night before bed by participants. Participants were only asked to complete the daily CA, SI, and

PM surveys for the first 7 days of the study (T0, Week 1), and the 7 days starting 22 days later (T1, Week 4). The mean score across each 7-day period was used for analyses.

Cognitive activity (CA) was measured as the number of cognitively stimulating activities participants had engaged in that day from a list of 14 activities, plus 1 optional write-in activity, including reading books, magazines, or newspapers (including online); playing word games such as crossword, puzzles, or Soduku; and taking a class or attending an educational lecture. In the absence of existing daily measures, this measure was developed for the purposes of the current study based on the approach of Lachman, Agrigoroaei, Murphy, and Tun (2010), and with feedback from Engaged4Life advisory committee.

Social interaction (SI) questions focused on the quantity and quality of SIs engaged in that day. Quantity of SI was measured as participants' response to the question "In total, about how many hours did you spend engaging with others today (include in-person, by telephone, or by video; do NOT include email, text, or social media)?" The response options included: 1 (*not at all*), 2, (*less than 1 hour*), 3 (*1–2 hours*), 4 (*2–4 hours*), 5 (*4–6 hours*), and 6 (*6 or more hours*). Quality of SI's was assessed using two variables. Participants were asked to rate how stressful and how positive/uplifting their SIs were that day on a scale from 0 (*not at all*) to 6 (*extremely*). These measures were adapted from Dunton, Atienza, Castro, and King (2009).

Personal meaning (PM) was assessed using four questions that asked whether participants did anything that day that: (1) benefited others, (2) left them feeling personally satisfied or accomplished, (3) felt significant in the broader scheme of things, or (4) were personally meaningful. Response options ranged from 0 (*not at all*) to 2 (*to a great extent*). In the absence of existing daily measures, these items were developed for the purpose of the current study and averaged for a total score (Cronbach's α = .88).

Statistical analysis

Outcome analysis focused on testing differences across the two intervention arms (between-group differences) and across the T0 (Week 1), T1 (Week 4), and T2 (Week 8) assessment points for the primary outcome and across the T0 and T1 assessments points for the secondary outcomes (within-group differences), as well as the treatment-by-time interaction. First, demographic characteristics and outcome variables were evaluated at baseline for the total sample as well as for each arm of the intervention. *t*-Tests were used for continuous variables and Chi-Square tests were used for binary or categorical variables to evaluate the success of the randomization and identify factors that should be controlled for in outcome analyses.

Next, given the repeated measures design of the study where daily observations (Level 1) were nested within participants (Level 2, 25 participants), the multilevel mixed-effects linear regression procedure (xtmixed) available in Stata IC 13.1 was used to specify two-level linear mixed effects (LME) models. LME models examined whether outcome trajectories differed between each of the treatment groups across the study period, using restricted maximum likelihood estimation. LME accommodates missing data for participants with missing data points, thus models could use data from the subset of the sample who were lost to follow-up (see Figure 1). Intercepts and slopes were modeled as random effects; treatment, time, and treatment-by-time were modeled as fixed effects. Effect sizes were calculated from the unstandardized coefficients associated with treatment-by-time interactions using methods described by Feingold (2009) and reported in the variables' natural metric. Given the exploratory nature of this investigation and the small sample size, all analyses used $\alpha = 0.05$ for statistical significance without correction for number of tests.

Results

Feasibility results

Overall, recruitment was feasible and speed and efficiency was high. A total of 53 individuals responded to the recruitment materials by calling the study telephone line over the course of the 4-week recruitment period and all were screened for eligibility (see Figure 1), for an average of 13.25 (±7.5) screened per week. Of those 53, 23 were excluded from the study (74%, $n = 17$, were determined to be ineligible according to the study's inclusion/exclusion criteria, and 26%, $n = 6$, were eligible but declined to participate). Therefore, on average, 7.5 (±3.8) participants were recruited per week and for every 1.77 individuals screened, 1 was randomized. When we met our goal of 30 eligible participants, recruitment was closed.

However, when it came to our a-priori goal to recruit equal numbers of men and women into the study, recruitment efforts were less successful. Of those 53 who were screened, 41 (77%) were women and 12 (23%) were men. We reached our quota of eligible women ($n = 15$) by the third week of recruitment and started placing additional women that screened eligible on a wait list. Despite increased efforts to recruit men, such as reaching out to community-based organizations that tend to serve men like Veterans of Foreign Wars and American Legions, we did not reach our target for men by the end of our 4-week recruitment window, and chose to accept the women on the waitlist into the study rather than delay the start date. In total, 30 individuals—22 (73%) women and 8 (27%) men—were randomized.

Five of the 30 participants, or 17% of those who were randomized, dropped out of the study (see Figure 1). These included: (1) one male and one female participant in the intervention group who were no-shows for the study orientation/training; and (2) a female participant in the intervention group and two male participants in the control group who discontinued immediately after the initial training session due to dissatisfaction with the required technology component of the study. All of the study drop-outs occurred before baseline outcome data were collected (i.e., at the technology training stage). This initial drop-out might have been avoided if baseline data had been collected prior to randomization and if the self-monitoring component/outcome assessment was less technology intensive, which was overwhelming to some participants. The overall retention rate was 83% and the final sample size for outcome assessment was 25, with 12 in the intervention group (9 women and 3 men) and 13 in the control group (11 women and 2 men).

The 25 participants manifested high adherence to the study protocol and the intervention group also exhibited a high level of engagement with the various components of the intervention. Participants wore the pedometer on 93% (±8) of the days during the 8-week intervention period and completed the daily self-report activity data (via tablet) on 94% (±15) of the 14 days (two 7-day periods) that they were asked to complete surveys.

Finally, among those who were in the intervention group (n = 12), we evaluated participant engagement (see Table 1). The Engaged4Life Workshop was attended by 12/12 (100%) participants were highly satisfied, on average, with satisfaction item means ranging from 4.38 to 4.77 on a scale of 1 (*poor*) and 5 (*excellent*). On average, 4 out of the 5 prescribed peer mentoring telephone sessions (80%) were completed (M = 4.0 ± 1.04). All peer mentors completed structured session recording logs to quantify participant engagement in the peer mentoring sessions (completed immediately after each session). Peer mentoring sessions ranged in length from 10 to 60 minutes (M = 27.83 ± 9.23). Peer mentors reported, on a scale of 1 (*not at all*) to 4 (*very much so*), that the sessions were highly productive (M = 3.53 ± 0.58), efficient (M = 3.42 ± 0.63), that they provided support to their mentee (M = 3.53 ± 0.58) and that their mentee felt more confident at the end of the session (M = 3.34 ± 0.59). Finally, the intervention group was highly satisfied, overall, with their peer mentors, with satisfaction item means ranging from 4.00 to 4.57 on a scale of 1 (*strongly disagree*) to 5 (*strongly agree*). However, it appears that there is room for improvement with regard to peer mentor knowledge about community resources (M = 4.00 ± 0.88), whether peer mentoring, per se, has helped them feel empowered to change their activity levels for the better (M = 4.08 ± 1.12), or to improve their activity roadmap (M = 4.00 ± 0.91), and enjoyment of working on a one-on-one basis with the peer mentor (M = 4.00 ± 0.91).

Table 1. Measures evaluating feasibility: Participant engagement in the intervention.

	Mean	*SD*	Range
Participants' evaluation of the Engaged4Life Workshop			
Overall quality of workshop[a]	4.54	0.78	3–5
Style of Facilitator[a]	4.77	0.60	3–5
Helpfulness of the content for you[a]	4.38	0.77	3–5
Did you learn new information today?[a]	4.38	0.77	3–5
Peer Mentor Ratings of Participant Engagement in the Peer Mentoring Sessions			
Number of sessions completed	4.00	1.04	2–5
Length of session (minutes)	27.83	9.23	10–60
Do you feel the session was productive?[b]	3.53	0.58	2–4
Do you feel the session was efficient?[b]	3.42	0.63	2–4
Do you feel you provided support to your mentee?[b]	3.53	0.58	2–4
Do you think your mentee felt more confident at the end of the session?[b]	3.35	0.59	2–4
Participants' Satisfaction with Peer Mentor			
My peer mentor provided me with useful information.[c]	4.29	0.83	2–5
My peer mentor regularly contacted me during the given times.[c]	4.57	0.51	4–5
My peer mentor made an effort to get to know me.[c]	4.43	0.65	3–5
I made an effort to get to know my peer mentor.[c]	4.21	0.70	3–5
My peer mentor is knowledgeable about community resources.[c]	4.00	0.88	3–5
My peer mentor is skilled at facilitating discussions.[c]	4.43	0.65	3–5
My peer mentor is knowledgeable about how to overcome barriers.[c]	4.14	0.86	3–5
Overall, my peer mentor has been helpful.[c]	4.43	0.65	3–5
Peer mentoring has helped me feel empowered to change my activity levels for the better.[c]	4.08	1.12	1–5
I feel like my activity roadmap has improved as a result of peer mentoring.[c]	4.00	0.91	2–5
I enjoy working on a one-on-one basis with my peer mentor.[c]	4.00	0.91	2–5
Peer mentoring has made me better prepared to implement positive changes in my activity.[c]	4.15	0.99	2–5

[a]Those in the intervention group were asked to rate their experience with the Engaged4Life Workshop (at the end of the workshop) with regard to these four dimensions on the following response scale: 1 = *Poor* to 5 = *Excellent*.

[b]Peer mentors were asked to rate their experience after each peer mentoring session with regard to the these four dimensions on the following response scale: 1 = *Not at all* to 4 = *Very much so*.

[c]Those in the intervention group were asked to rate their satisfaction with their peer mentors along each of these 12 dimensions (at T1) on the following response scale: 1 = *Strongly Disagree* to 5 = *Strongly Agree*.

Evaluation of primary and secondary outcomes

Baseline characteristics are reported in Table 2 on the 25 individuals for whom we have outcome data. The majority of participants were women (80%), non-Hispanic White (92%), retired (68%), and married (52%). The sample mean for education was 4.72, falling between an associate's degrees and a bachelor's degree, and the mean total household income for the sample was 4.32, falling between $60k–79k and $80k–99k per year. At baseline, the mean number of steps/day was approximately 4,547 (±398). Less than 5,000 steps per day are considered sedentary (Tudor-Locke et al., 2011).

Though this pilot randomized controlled trial was not powered to demonstrate significant differences between study groups, findings provide some important information for future efficacy trials. At baseline, the control group (5,363 ± 322) had a higher average number of steps/day than the

Table 2. Baseline characteristics of total sample and by treatment arm.

	Total sample (N = 25)				Intervention (N = 12)		Self-monitoring-only control (N = 13)		Sig.[f]
	Mean/%	*SD*	Min	Max	Mean/%	*SD*	Mean/%	*SD*	
Outcome measures									
Steps per day (square root)[a]	67.43	19.96	23.13	100.49	61.15	20.87	73.23	17.94	
Daily no. of cognitive activities[b]	4.60	1.48	1.86	7.86	4.52	1.84	4.68	1.14	
Daily social interactions (SI)									
No. of hours spent in SI[b]	4.14	0.78	2.57	5.57	4.07	0.81	4.21	0.77	
Stressful SI[b]	0.38	0.55	0	1.57	0.40	0.61	0.37	0.51	
Positive/uplifting SI[b]	3.65	1.37	0	5.14	3.73	1.58	3.58	1.19	
Daily personal meaning[b]	1.21	0.41	0.54	1.89	1.32	0.41	1.11	0.40	
Demographic characteristics	72.92	6.65	65	91	75.75	8.04	70.31	3.73	*
Age									
Female	80.00%				75.00%		84.6%		
Retired[c]	68.00%				76.92%		61.54%		
Married	52.00%				53.85%		46.15%		
Non-Hispanic White	92.00%				100.00%		84.62%		
Education[d]	4.72	1.59	2	7	3.83	1.53	5.54	1.20	**
Total household income[e]	4.32	2.34	1	8	3.91	2.51	4.73	2.20	

[a]Assessed objectively via FITBIT® Zip pedometer, daily steps were averaged across the 7 days within person and then averaged across people.

[b]Assessed through daily surveys; daily scores were averaged across the 7 days within person and then averaged across people.

[c]Participant reported officially retiring from a paid job and no longer working for pay.

[d]1 = some high school; 2 = high school diploma or GED; 3 = some college, no degree; 4 = 2-year college degree; 5 = 4-year college degree; 6 = master's degree,7 = doctoral degree; 8 = professional degree (MD, JD).

[e]1 = under $20,000, 2 = $20,000–$39,999; 3 = $40,000–$59,999; 4 = $60,000–$79,999; 5 = $80,000–$99,999; 6 = $100,000–$119,999; 7 = $120,000–$139,999; 8 = $140,000 and above.

[f]Significance levels represent *t*-tests between the intervention group and the control group for continuous variables and Chi-square tests for binary variables.

*p<.05; **p<.01

intervention group (3,739 ± 436); however, these differences did not reach a level of statistical significance. The intervention group was, on average, older (77.75 years and 70.31 years, respectively, $t[23] = -2.20$, $p < .05$) and had lower education (3.83 and 5.54, respectively, $t[23] = 3.12$, $p < .01$) than the control group. Thus, all outcome analyses were adjusted for age and education.

Findings of LME models (see Table 3) reveal that daily steps increased by an average of 431 (11% increase) from baseline to T1 for the intervention group ($p < .05$), but decreased by 458 for the control (see Figure 2). Further, the significant treatment-by-time interaction for the T1 model indicates the intervention group improved compared to the control group by 889 steps ($p < .05$). This result is comparable to effect sizes observed in walking interventions of similar intensity for older adults (Tudor-Locke et al., 2011). Findings were sustained at T2, such that daily steps remained significantly higher relative to baseline for the intervention group (an increase

Table 3. Impact of the Engaged4Life intervention versus self-monitoring-only control on outcome measures.

	T0, Baseline	T1, 4-week follow-up	T2, 8-week follow-up	Effect Size, %
PRIMARY OUTCOME				
Steps per day (raw), *M/SE*[a]				
Intervention group	3,887.53(16.24)	4,318.26(18.45)	4,164.30(21.67)	11, 7
Self-monitoring-only control group	5,364.49(14.86)	4,906.35(17.00)	4,758.82 (19.81)	−9, −11
Steps per day (square root), B(95% CI)[b]				
Treatment (ref = intervention group)	-	−9.26(−23.52, 5.00)	−11.55(−26.72, 3.61)	
Time (ref = post-test T1 or post-test T2)	-	−4.57(−9.02, −0.11)*	−4.60(−9.21, 0.014)*	
Treatment × Time	-	7.76(1.62, 13.90)*	9.45(3.11, 15.80)**	
SECONDARY OUTCOMES				
Daily No. of cognitive activities, *M/SE*[a]				
Intervention group	4.53(0.41)	4.69(0.44)		4
Self-monitoring-only control group	4.69(0.39)	4.71(0.42)		0
Daily social interactions (SI) No. of hours in SI, *M/SE*[a]				
Intervention group	4.07(0.21)	3.99(0.21)		−2
Self-monitoring-only control group	4.21(0.20)	4.43(0.20)		5
Stressful SI, *M/SE*[a]				
Intervention group	0.39(0.16)	0.52(0.14)		33
Self-monitoring-only control group	0.38(0.16)	0.22(0.13)		−42
Positive/uplifting SI, *M/SE*[a]				
Intervention group	3.73(0.39)	3.51(0.40)		−6
Self-monitoring-only control group	3.59(0.37)	3.20(0.38)		−11
Daily personal meaning, *M/SE*[a]				
Intervention group	1.32(0.11)	1.28(0.11)		−3
Self-monitoring-only control group	1.11(0.11)	1.00(0.10)		−10
Daily No. of cognitive activities, B(95% CI)[b]				
Treatment (ref = intervention group)	-	−0.37(−1.82, 1.06)		
Time (ref = post-test T1)	-	−0.16(−0.62, 0.31)		
Treatment × time	-	0.12(−0.52, 0.75)		
Daily social interactions (SI) No. of hours in SI, B(95% CI)[b]				

(*Continued*)

Table 3. (Continued).

	T0, Baseline	T1, 4-week follow-up	T2, 8-week follow-up	Effect Size, %
Treatment (ref = intervention group)	-	0.11(−0.56, 0.78)		
Time (ref = post-test T1)	-	0.07(−0.33, 0.47)		
Treatment × time	-	−0.29(−0.84, 0.27)		
Stressful SI, B(95% CI)[b]				
Treatment (ref = intervention group)	-	−0.62(−1.06, −0.19)		
Time (ref = post-test T1)	-	−0.14(−0.56, 0.27)		
Treatment × time	-	0.30(−0.28, 0.87)		
Positive uplifting SI, B(95% CI)[b]				
Treatment (ref = intervention group)	-	−0.28(−1.58, 1.02)		
Time (ref = post-test T1)	-	0.22(−0.40, 0.85)		
Treatment × time	-	0.17(−0.69, 1.02)		
Daily personal meaning, B(95% CI)[b]				
Treatment (ref = intervention group)	-	−0.36(−0.71, 0.00)		
Time (ref = post-test T1)	-	0.04(−0.17, 0.24)		
Treatment × time	-	0.07(−0.21, 0.35)		

Note: *$p < .05$; **$p < .01$

[a]Adjusted means based on results of Linear Mixed Effects Models adjusted for age and education.

[b]Results of Linear Mixed Effects Models adjusted for age and education.

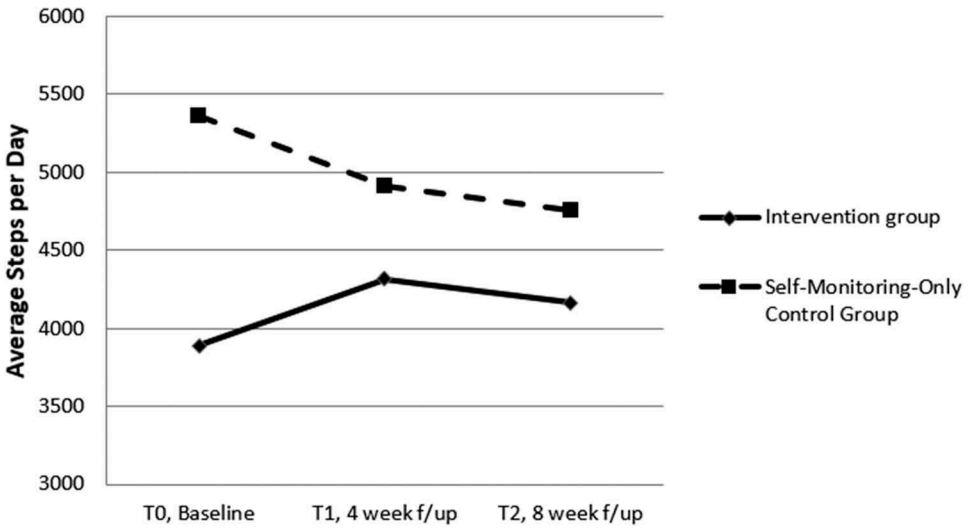

Figure 2. Average steps/day at baseline, 4-week, and 8-week follow-up by treatment arm. Note: Adjusted means based on results of Linear Mixed Effects Models adjusted for age and education

of 277 steps), but not the control (decrease of 606) and the intervention group improved compared to the control group by 883 steps ($p < .01$). It should be noted that the intervention group's average steps per day decreased by 154 steps between T1 and T2; however, this decrease was offset by the control groups' comparable decrease during the same time period (decrease of 148 steps).

With regard to the secondary outcome variables, daily number of cognitive activities increased slightly from baseline to T1 for the intervention group (an increase of .16 of an activity, or 4%), but not for the control group (a .02 increase, 0%). Daily number of hours in SIs actually decreased by 2% for the intervention group and increased by 5% for the control group. Stressful SIs increased by 33% for the intervention group and decreased by 42% for the control group. Positive/uplifting SIs decreased for both groups, and daily PM decreased for both groups, but slightly more so for the control group. However, none of these differences from baseline to T1 for either treatment arm were statistically significant, nor was there evidence that the intervention group was significantly different with regard to these outcome variables relative to the control group.

Discussion

Our "engagement model" of health promotion, guided by the SMHP, may be an effective approach for increasing active lifestyles among inactive, community-dwelling older adults. Findings from this pilot study indicate that recruitment was feasible, in that it was relatively fast and efficient; the

participants manifested excellent adherence to the study protocol and the intervention group exhibited a high level of engagement with the various components of the intervention; and outcome assessment results suggest that the intervention shows promise in increasing steps per day compared to the control group over both 4-week and an 8-week periods. This pilot study has also identified several issues that need to be addressed when designing future trials, namely the difficulties in recruiting men, barriers due to the technology-intensive design, and the optimization of secondary outcome measures.

Results in the context of other literature

Our approach in this study was similar in many respects to Varma et al. (2016), who reported on the effects of the Experience Corps program (a high-intensity community volunteering program for older adults also guided by the SMHP) on walking behavior specifically using a sex-stratified RCT. These authors found no effect after 12 months, and after 24 months, women, but not men, in the intervention group showed an increased amount of walking activity, averaging 1,500 greater steps/day compared with the control group, compared to women in the control group who showed a decline of 1,192 steps/day at 24 months compared to baseline. Unlike the lagged effect seen in the Experience Corps trial, in our study, the increase in the daily step count compared to the control group was detectable in the short term (4 and 8 weeks). This could be explained by the explicit use of behavioral, cognitive, and social behavior change strategies to encourage individuals to make changes in their activity portfolios with regard to PA, CA, SI, and PM immediately, whereas the changes to participants' activity portfolio more broadly took years in the Experience Corps study (and only in women). Also, while our small sample of men ($n = 5$) was too small to conduct gender subsample analyses, it would be important in future studies of the Engaged4Life intervention to assess whether there was a differential effect for women and men.

However, the Engaged4Life Program did not result in changes in cognitive or social well-being outcomes over the 4-week study period, but the Experience Corps program has shown effects on more distal cognitive and social outcomes (Barron et al., 2009; Carlson et al., 2008; Fried et al., 2004, 2013; Hong & Morrow-Howell, 2010). Our lack of findings with regard to more proximal measures of CA, SI, and PM may be due to the wide discretion that participants were given in how they chose to supplement or enhance their activity portfolios, all of which may have got participants out of the house and into the community more often (thus increasing walking behavior), but not all of which offered the same "dosage" of SI or cognitive stimulation. It could also be that the reason volunteering or taking on new

activities has an effect on outcomes such as health and well-being is because these activities serve as pathways to other productive social and civic activities, and it may be that the rewards and benefits of such an interventionmay only occur after a period of acclimation to the new activities.

In general, the improvements in the daily number of steps observed in our study were comparable to those reported in pedometer-based interventions in older adults. In a review of pedometer-based interventions with community-dwelling older adults populations, Tudor-Locke et al. (2011) found a weighted increase of approximately 775 steps/day; however, the studies reviewed ranged in length from short term (2 weeks) to long term (11 months). For our study, the intervention group improved compared to the control group by 883 steps at 4 weeks and by 889 steps by 8 weeks. In a pedomoter-based intervention of similar length (8 weeks), Culos-Reed, Stephenson, Doyle-Baker, and Dickinson (2008) found an increase from baseline of 914 steps. In a large trial with 571 primary care patients at risk of type 2 diabetes, a pedometer-based intervention (supported with an initial 3-h group-based structured education program) increased the mean daily step count by 411 after 12 months compared to control group (Yates et al., 2017), however, participants in this study had relatively high baseline PA levels (6,585 steps per day). In another primary care trial with baseline PA levels similar to what we saw in our study (4,771 steps per day) and a shorter follow-up period (8 weeks), improvements of 1,029 steps per day were observed, despite no additional education component (Glynn et al., 2014).

Interestingly, the control group had a higher number of steps per day than the intervention group at baseline (5,363 ± 322 vs. 3,739 ± 436). The control group was also younger, on average, and more educated than the intervention group. Thus, one potential explanation for the findings could be that there was simply more room for improvement in the intervention group than in the control group. However, it is possible that this observed difference could reflect an initial "start-up effect" for the control group of using the FITBIT® in the absence of any other upcoming programming. This explanation is supported by prior research on pedometer-only PA interventions, which tend to find that without any additional support or programming, activity levels increase initially and then drop off quickly (Sullivan & Lachman, 2016). This issue could have been prevented had baseline data collection occurred prior to randomization.

One of the strengths of our study is that we objectively assessed participant adherence to wearing the pedometer on a daily basis (93%) and completing the daily self-report activity survey (via tablet) (94%). This is a very important factor because low adherence can hinder what would be an otherwise well-designed intervention. Vetrovsky et al. (2018) found 83% pedometer wear adherence and Cadmus-Bertram, Marcus, Patterson, Parker, and Morey (2015) found 80%, however, neither of these studies was focused on an older

adult population per se. The comparatively high adherence levels observed in our study indicate that the 1.5-hour study orientation/technology training session, which emphasized good practices for remembering to wear the pedometer and completing the daily surveys, was an effective tool for increasing adherence.

One of the objectives of our pilot study was to explore the feasibility of the recruitment procedure because the success of research in community-based settings often depends on the recruitment of the target number of participants; indeed, many RCTs fail to recruit the actual target number. Our strategy of: (1) partnering with the local senior centers, (2) advertising widely throughout the community via both local newspapers and flyers posted across the community at local businesses, churches, non-profits, and housing complexes, and (3) offering a range of incentives that were well-described in recruitment materials, including a $50 VISA Gift Card, a FITBIT® Zip, and free iPad® Mini training, resulted in fast and efficient recruitment of the target number participants (n = 30) over a 4-week period. However, the approach did not reach the targeted number of men. This finding is consistent with a large body of literature reporting that men are often underrepresented in health promotion programs (see Anderson, Seff, Batra, Bhatt, & Palmer, 2016). Anderson et al. found that barriers to the participation of men in exercise programs include: women outnumbering men in the implementation sites and programs, perception of exercise programs as feminine, and preference for other activities. It seems that our Engaged4Life program could be attractive to men, in that it does not focus on an exercise program and does, in fact, allow individuals to choose activities that are of personal interest, but this was not necessarily emphasized in recruitment materials. Further, partnering with a senior center to implement the intervention, which may have a reputation in the community for being female-dominated, may have impeded the recruitment of men into the study.

Finally, retention in our trial (83%) was similar to Buman et al. (2011), who observed an 85% retention rate at the end of the trial and follow-up at 18 months was 61%. Vetrovsky et al. (2018), on the other hand, reported 100% retention. However, this may be explained by their pre-randomization procedure that demanded patients to upload their pedometer data to a website prior to randomization, which 27% failed to do. If this had been done post-randomization, the retention rate might have been much more in line with our study. In the Engaged4Life study, all of the study drop-outs occurred post-randomization, but prior to baseline outcome data collection (i.e., at the technology training stage). This initial drop-out might have been avoided if baseline data had been collected prior to randomization and if the self-monitoring component/outcome assessment was less technology intensive, which was overwhelming to some participants.

Limitations

Strengths of the study include the wide range of feasibility measures that were assessed, the randomized design to test the intervention effect compared to a self-monitoring-only control group, the use of both objective and subjective measures of activity engagement, and the 4-week and 8-week follow-ups. Nevertheless, this pilot study has some limitations to acknowledge and address in future studies. First, the sample size was small, and we were not able to follow participants beyond the 2-month period. Additionally, we focused on steps per day, which represents only one component of total PA and our measures of CA, SI, and PM were limited due to lack of standardized measures of daily activities in these domains. It is possible that these measures were not sensitive enough for our purposes. Finally, though the study sample included an at-risk segment of the older adult population (those at-risk for poor health due to sedentary lifestyles), the time and technological requirements of the trial and the use of volunteers may have resulted in selection of more health-conscious community members.

Implications for practice

The study was intended as a pilot study and yielded important findings supporting the feasibility of future trials, specifically:

(1) Recruitment of the target number of participants was fast and efficient over a 4-week period.
(2) Participants manifested excellent adherence to the study protocol.
(3) The Engaged4Life program was well accepted by participants in the intervention group who manifested high engagement in all components of the intervention.
(4) Though not sufficiently powered to demonstrate differences between groups, the study indicated that the intervention might have the potential to increase steps per day compared to the control group over both a 4-week and an 8-week period.

On the other hand, the study has also revealed possible areas for improvement:

(1) The difficulties in recruiting men may be addressed in future trials by tailoring recruitment strategies (e.g., using images of men in recruitment materials) and considering partnering with community-based organizations that are less female dominated.

(2) The drop-out of individuals due to feeling overwhelmed by the technology requirements could be addressed by using a less technology-intensive design, for example, by replacing the daily tablet-based surveys with paper and pencil surveys.
(3) Baseline data collection should occur prior to randomization.
(4) Explore alternative measures of secondary outcomes that might be more sensitive to change or that measure CA, SI, and PM in a more fine-grained manner.
(5) A longer follow-up of at least 12 months is generally required in health promotion interventions to assess the maintenance of the intervention effect; a future trial might consider continuing the peer mentoring phone calls accordingly.
(6) Explicate which components or combination of components is critical to the observed behavior change.

Conclusion

In sum, by testing the feasibility and outcomes of an "engagement model" of health promotion that applies the principles of the SMHP to older adults' daily lives and activities, we merge insights from both the productive aging (Morrow-Howell, Hinterlong, & Sherraden, 2001) and the health promotion literatures. More research is necessary to test the Engaged4Life program's efficacy and effectiveness over a longer period of time and to document the process mechanisms responsible for its effects on a larger scale.

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