FINAL PROGRESS REPORT

Title of Project: Self-management via Health Kiosk by Community-residing Older Adults

Principal Investigator and Team Members:

Principal Investigator

Judith T. Matthews, PhD, MPH, RN

Co-Investigators

Scott Beach, PhD
Daniel Buysse, MD
Karen Courtney, PhD
Sandra Engberg, PhD, RN, CRNP
Jennifer Lingler, PhD, RN, FNP
Kathleen McTigue, MD
Richard Schulz, PhD
Marjorie Skubic, PhD
Asim Smailagic, PhD
Jessie Van Swearingen, PhD, PT

Consultants

Rachel Hess, MD, MS
Lisa Morrow, PhD

Staff

Julie Klinger, MA
Eileen Cole, RN
Anders Weinstein, MA
Abby Neft, BS
Amber Barton
Sally Hostein, BA
Nicole Viviano, MS

Organization:

Lead

University of Pittsburgh

Contracts

Carnegie Mellon University, University of Missouri, University of Victoria

Inclusive Dates of Project: 09/30/2014 – 09/29/2019 (NCE: 9/30/2019 – 9/29/2020)

Federal Project Officer: Derrick Wyatt, MSN, RN-BC, CPHIMS

Acknowledgment of Agency Support: This project was supported by the Agency for Healthcare Research and Quality.

Grant Award Number: 5R01HS022889

STRUCTURED ABSTRACT

Purpose: We aimed: to determine whether and how health kiosks situated in community settings would be used, particularly by older adults; to identify factors that influenced such use; and to explore the relationship between kiosk use and health resource utilization.
Scope: Multi-user health kiosks equipped with physical measurement devices, surveys, and health intervention modules were deployed for up to 18 months in 13 venues: senior centers, senior housing communities, continuing care retirement communities, and a public library.
Methods: This was a prospective observational study with embedded cognitive-behavioral interventions designed for self-administration at the kiosk. Assessments were conducted at baseline, 6, 12, and 18 months, and health resource utilization was tracked monthly. After the first three assessments, health intervention modules were recommended that promoted strategies for self-monitoring and managing health in general and specifically in relation to sleep, bladder control, mood, and diet, weight, and physical activity. Individuals who screened positive or expressed a desire to improve in a particular area were offered a recommendation to complete the corresponding health intervention module. All others could opt for a health promotion version of the module.
Results: Usable data from 242 participants (M=72.93 years, SD=8.90; 80% female; 76% white) revealed a heterogeneous sample with significant ($p<.05$) differences across venues in age, race, marital status, education, income, household size, experience with consumer technology, and selected screening measures. Although intention to use the health kiosk was fairly high (M=5.98 on a 7-point scale) at baseline, considerable attrition affected ascertainment of assessment data and module completion. Data analysis is ongoing.

Key Words: multi-user health kiosk, aging, self-management; sleep, bladder control, emotional health and, lifestyle behavior behavioral change

PURPOSE

Objectives of Study

Primary Aims

Aim 1 – Describe the self-management needs, motivations, design preferences, and patterns of health kiosk use among diverse community-residing older adults in congregate settings

Aim 2 – Determine factors that influence intensity of kiosk use among older adults with a range of needs for a healthier lifestyle and improved self-management of chronic disease

Secondary Aim

Aim 3 – Explore emergency room visits, hospitalizations, and inpatient stays in skilled nursing facilities, rehabilitation facilities, and psychiatric facilities during kiosk access

SCOPE

Background

This project in response to *PA-11-199 Understanding User Needs and Context to Inform Consumer Health Information Technology Design* focused principally on older adults' perceptions of, motivations to use, and patterns of use of an adaptive, community-based, multi-user health kiosk. The kiosk enabled individual users to measure and monitor selected health-related parameters, learn about and try evidence-based strategies for optimizing health and function, and share selected assessment findings with their primary care providers. Our overarching objective was to understand factors influencing older adults' use of the health kiosk as a measurement and intervention delivery system, relative to their needs and interests in adopting a healthier lifestyle.

Wearable devices, mobile apps, and patient portals are empowering Americans to monitor and manage their health. However, older adults tend to be less engaged with these health information technologies (HIT) that typically have not been designed with this demographic in mind. Being poorer, disabled, or living in areas without comprehensive cell phone or internet service tends to further limit older adults' access to and use of HIT. Thus, we embarked upon refining and deploying a novel HIT solution in community venues serving older adults, and then observing whether and how it was used and by whom. Our HIT solution was an accessible, user-friendly, multi-user kiosk at which users could obtain and record physical measurements, respond to an array of questionnaires, and interact with health intervention modules that encouraged adoption of strategies to prevent or ameliorate common topics of concern, particularly to older adults: self-management of health, sleep, bladder control, emotional health, and lifestyle behaviors. The 13 venues where we deployed 10 health kiosks comprised senior centers, senior housing communities, continuing care retirement communities, and a library.

Context

Health Kiosk Design – We constructed our health kiosk (see Figure 1) to be of maximal benefit to older adults by being easy and intuitive to use, responsive to sensory deficits due to impaired hearing or vision, and respectful of privacy concerns. Its devices, surveys, educational content, and feedback displays were intended to be interpretable by adults whose demographic and health characteristics and functional capabilities varied widely. Each custom-built kiosk leveraged off-the-shelf components and was easy to move and store, if desired.

Figure 1. Health Kiosk Setup

Each kiosk desk was paired with an adjustable-height chair (not depicted in Figure 1) and a Rice Lake 540-10-1 or 550-10-2 digital seated scale integrated with the on-board computer, which enabled immediate screen display of the reading as well as tracking of the user's weight over time. The kiosk desk had lockable wheels and side cabinets for securing hardware and storing extra supplies (e.g., sanitizing wipes, printer paper, key fobs, disposable earphone covers). Embedded in its drawer were an RFID reader; a flip phone for contacting our team, if needed; an Omron BP652 wrist blood pressure monitoring device with wrist cuff; and a Vernier hand dynamometer that was also integrated with the on-board computer. Atop the kiosk desk were an adjustable-height touch-screen monitor, a printer, headphones, and a stylus with built-up handle for tapping buttons on the touch-screen display, the latter found to be easier/less tiring than tapping with a finger. Headphones were provided rather than speakers, to protect privacy and minimize distraction. At venues where the position of the kiosk made it likely that passersby would see what a participant was viewing on the touch-screen, we surrounded the touch-screen with a privacy shield or added a 5'X6' privacy screen to the set up. Our intent was not to shield participants altogether from being seen using the health kiosk, but rather to prevent others in the vicinity of the kiosk from seeing and hearing module content or measurements that could be considered sensitive pertaining to, for instance, bladder control, emotional health, and weight. Locked within one of the side cabinets of the desk were a small form-factor BRIX Pro 3.3 GHz computer for running Windows 10 and a Peplink cellular modem-router, USB hub, surge protector, and wireless keyboard and mouse, the latter for use only by our team when starting the kiosk. An uninterruptable power source (UPS) provided temporary backup in case of a power outage. Our participating study sites provided power to the kiosk via a single outlet.

The health kiosk software was implemented as a Windows desktop application written in the C# language for the .NET platform using the WPF application framework. The software effectively ran in

kiosk mode, taking over the full screen with a borderless window that blocked users from accessing the underlying Windows system. No physical keyboard was available to participants. Instead, an on-screen keyboard was displayed on the touch-screen whenever alphanumeric input was requested. If a participant logged on but left the kiosk idle for five minutes (e.g., while conversing with someone or taking a break to go to the restroom), the kiosk would automatically logoff and the participant would have to logon again to resume use.

The kiosk computer was configured with Windows' built-in BitLocker full disk encryption. A USB boot key containing the Bitlocker encryption key had to be inserted in the physical computer in order to boot it. Thus, even if the computer were stolen and the hard disk removed, it would have been impossible to get any data from it without the encryption key. Remote troubleshooting was enabled through TeamViewer remote access software. Data gathered at the kiosk were wirelessly transmitted using https via a local dedicated, password-protected WiFi hotspot created by the Peplink cellular modem-router through which the kiosk connected to its database servers at the University of Pittsburgh over a cellular data service. The connection was encrypted using AES_256 with HMAC_SHA1 for message authentication and ECDHE_RSA as the key exchange method. Specifically, data went to an upload service API on the University Center for Social and Urban Research web server which relayed the data into database and file servers at the Network Operations Center.

The front-end application stored as well as retrieved data from back-end database servers inside the University of Pittsburgh network firewall. The kiosk system relied on a RavenDB document database to store participants' survey responses and responses to additional questions in the health intervention modules. It used several mySQL databases for user records (participant ID, coded password, perks earned), user state (modules enrolled in and progress through sessions, date and time of use), kiosk messages, reserved time slots to use the kiosk, and all physical measurement values. Communication with the database servers depended on the dedicated PepLink cellular modem-router, a device designed for mobile applications to communicate over a cellular data network. The communication used an always-on IPSec Virtual Private Network (VPN) to ensure that data were encrypted end-to-end. Access to the database servers was otherwise restricted by firewall rules.

We made limited use of the web-based site Twilio.com, which was hosted externally in the Amazon Web Services cloud, to conduct a series of very brief telephone surveys between the first and second sessions of *Managing Your Health* (see **Health Intervention Modules**). Data thus gathered were encrypted within the Twilio environment based on the ISO 27001 framework and through https (secure sockets) using TLS 1.2 (SHA-256) between UCSUR's web server and the Twilio server. For added data security, all participants were assigned a unique research code number linked to their research record. They were also provided with an RFID-enabled key fob, and they assigned themselves a unique password for double authentication prior to accessing their kiosk account. Personally identifiable information associated with the codes was stored in a separate database from the research database.

Much of the kiosk operation involved presenting interactive assessment surveys and multimedia educational content. This content presentation was specified in a custom XML-based module description language together with associated media files. The language supported presentation of rich content with audio voiceover narration and presentation of surveys with questions of various forms (e.g., yes/no, multiple choice, fill-in-the-blank, 0-10 rating scale). The survey support included conditional branching logic, scoring via various metrics, and piping of earlier responses to display in later items. It was possible for a non-programmer with some technical literacy to author content directly in this notation, much of which as was done by the PI (Matthews). The surveys, module content, and resource files were all stored locally on the kiosk computer for efficient access. Updates to the module content and to the kiosk software itself were automatically downloaded nightly from a central source code server, enabling easy distribution of updates and fixes. Administrative support was provided by a special mode of the kiosk available only to members of our team with administrative privileges. This

enabled us to access maintenance and reporting functions while on-site at kiosk venues, and to access the data and a version of the kiosk software directly from secure Windows workstations at UCSUR.

Health Kiosk Features and Functionalities – We refined or added several custom features and functionalities to an earlier iteration of the health kiosk that had resulted from collaboration among members of our team (Matthews, Courtney, Smailagic) affiliated with the National Science Foundation-funded Quality of Life Technology Center, an engineering research center based at Carnegie Mellon University that involved CMU-Pitt partnership.

Single-session and Multi-session Modules – Our kiosks were situated in public spaces such as reception areas, meeting and computer rooms, and community centers that had varying amounts of foot traffic. To accommodate the possibility that a curious individual would approach a kiosk, want to learn independently about its purpose and capabilities, and enroll in our study, we created a series of single-session modules for *Guest Access*, *Eligibility Screening*, *Informed Consent*, and *Contact Information*. In practice, however, few people self-initiated exploration and consent at the kiosk. Rather, interested individuals typically met one-on-one with a member of our team and were introduced to the kiosk, screened for eligibility and, with rare exception, agreed to enroll via the *Informed Consent* module. This documented consent established the enrollee's kiosk account and enabled data capture of all of his or her subsequent interactions with the kiosk. After providing contact information at the kiosk, receiving their key fob, specifying a password, and being shown how to logon, most participants declined further assistance before proceeding to use the kiosk on their own. A follow-up call by our study coordinator confirmed their contact information and that of their primary care provider (PCP).

Logon Sequence – Each time participants visited the health kiosk, they encountered the Welcome Screen, passed their key fob in front of the START sign on the drawer, and entered their password to access their account. A series of screens prompted them to put on and adjust the headphones; check, reply to, and print messages from our team; and see how many chances they had accumulated for a $20 drawing we conducted weekly for participants at each venue. Chances were based on "Kiosk Perks" earned by completing study activities in the preceding week (e.g., *Baseline Assessments* (200 perks); health intervention session (50 perks). The logon sequence concluded with the *Home Screen,* which revealed their scheduled activities (see Figure 2).

Figure 2. Welcome and Home Screens

Assessment Batteries – After a brief, single-session *Orientation* module, participants completed the self-administered portion of the *Baseline Assessments* during one or more visits to the kiosk, ideally within 4 weeks. Concurrently, they met individually with our team at their kiosk venue for assessment of cognitive and physical function. A subset of the measures was repeated during a 4-week window 6, 12, and 18 months after the first baseline survey was completed.

Prompts and Cues – After finishing the last *Baseline Assessments* survey, participants were prompted to begin the first of six sessions of the *Managing Your Health* module, which provided a foundation for the cognitive-behavioral approach that we threaded throughout four additional, multi-session modules focused on

Sleep, *Bladder Control*, *Emotional Health*, and *Lifestyle* (see **Health Intervention Modules**). Such a prompt automatically appeared whenever a participant finished a single-session module or one of the sessions in a multi-session module. If not completed immediately, the new module or session was posted on the participant's *Home Screen* and featured a progress bar showing the percentage completed and the topic or survey next up in the queue. Physical measurement buttons for blood pressure, pulse, weight, and grip strength appeared on the *Home Screen* at a minimum of every 6 months, although participants could specify a more frequent interval (e.g., daily, twice weekly, weekly, every 2 weeks, etc.). Tapping *Do Something Else* on the *Home Screen* permitted the participant to select non-scheduled health intervention modules or physical measurements (e.g., measuring weight or blood pressure sooner than the scheduled interval).

Visual Display and Voice-over – Nearly 9,000 screens formed the modules' visual display for gathering self-report and physical measurement data, presenting educational content, and offering feedback on self-monitored behavior inputted by participants. Survey items were typically depicted in 40 pt Tiresias font. All screens were accompanied by voiceover scripted and recorded by the PI (Matthews), both to elaborate on what was displayed on the screen and to accommodate participants with low vision or low literacy. Participants could go back to revise responses or review content before finishing a module or session, and selected screens permitted them to advance to the next screen without having to listen to the entire voiceover audio. This latter feature, which was only enabled for survey items, was developed to accommodate participants who could read and respond faster than the time required to listen to the entire voiceover, especially when response options were repetitive in the same survey. To ensure fidelity in delivering educational content in the health intervention modules, participants could *not* advance to the next screen until the voiceover ended.

Illustrated Step-by-step Instructions and Explanations – Text-based instructions and educational content were augmented with photos, simple graphs and diagrams, and audio and video clips. Our rationales for this multimedia approach were (1) to facilitate completion of tasks at the kiosk such as logging on and off; applying the headphones and adjusting them to optimize preferred sound quality; using the blood pressure monitoring device, seated scale and grip dynamometer; and uploading or inputting data from devices used to track behavior between sessions, and (2) to simplify concepts (e.g., health behaviors vs. habits) or describe processes such as setting and evaluating SMART goals; understanding the biological clock and sleep drive; and performing bladder training and pelvic floor muscle exercises.

Logoff Sequence and Visit Reminders – At the end of each kiosk visit participants could self-schedule one or more visit(s) over the next two weeks. Each scheduled visit triggered an automated phone reminder issued via Twilio at 5 pm the evening before the reserved time slot. Before logging off, participants also viewed a summary of the activities completed during the visit and the number of Kiosk Perks earned for the next weekly drawing, and they were instructed to remove the headphones and replace them on the charging cradle.

Recommendations Algorithm – We developed a complex algorithm for recommending health intervention modules to participants, based on the findings from their *Baseline*, *6*, and *12-month Assessments*. Specific criteria for recommending each module are described below (see **Health Intervention Modules**). After completing the assessment batteries at each time point, participants were advised to check the *Recommendations* posted on their *Home Screen*.

Recommendations Module – During this single-session module participants were reminded of the health intervention modules available at the kiosk before learning which module(s) their assessments

suggested could be of benefit. Posted on the *Home Screen* the next time they viewed it was a "Consider" session for each recommended module, such as *Consider the Sleep Module*. This session offered more specifics about what engaging in a recommended module would entail, including the topics, number, and duration of sessions at the kiosk; whether devices or data tracking at home was involved; and how many Kiosk Perks could be earned. Participants were asked for agreement to take part in the module or, if they chose not to, their reason for declining. In rare instances when assessment findings suggested no need to do a module, or *any* of the modules (i.e., the participant had no sleep, bladder control, or emotional health concerns and was of normal weight, physically active, and indicated no desire to improve in these areas), the algorithm suggested considering doing the modules listed on the *Do Something Else* screen for the purpose of health promotion.

Provider Recommendations and Reports – PCPs were sent an introductory letter describing the Health Kiosk Project, and they were asked to indicate which physical measurements (and how often) and health intervention modules they would suggest their patient complete. During the course of the study we implemented a single-session module *See What Your PCP Recommends* which enabled participants to see their PCP's suggestions, (re)schedule the frequency of their physical measurements accordingly, and print a list of the recommended health intervention modules.

We also developed custom reports that we faxed to PCPs (and other providers, at the participant's request). One report summarized physical measurements (BP, pulse, weight, and grip strength) and screening survey results pertaining to sleep, bladder control, mobility, and mood. Another report summarized weight and physical activity data for participants who engaged in the *Lifestyle* module. The third report provided the participant's score on the Montreal Cognitive Assessment (MoCA) conducted during performance-based assessments at baseline and 12 months. Each report included the previous reports' findings, to provide context over time. When either of the first two reports was sent to a provider, the participant received a message at the kiosk indicating that it was sent and could be viewed and printed, if desired. MoCA reports were not be shared with participants, but rather we encouraged providers to discuss the findings with their patients as they saw fit.

Infection control – No measurements involving blood or body fluids were performed at the kiosk. All kiosk desks were supplied with sanitizing wipes so that participants could wipe down surfaces such as the desk surface, headphones, and stylus before and/or after use. It was our practice from the time each kiosk was deployed (pre-COVID) until its removal from a venue to provide these supplies for site staff, participants, and our team to use. Notably, all of our venues were closed to the public, including to our participants, by March 19, 2020, when the Pennsylvania Stay at Home order was issued by the governor.

Settings

We partnered with several organizations in southwestern Pennsylvania to place our 10 health kiosks in 13 locations over the course of the study. Our partners were the Baptist Home Society, the Jewish Community Center of Greater Pittsburgh, Lutheran Senior Life, Presbyterian Senior Care, the Vincentian Collaborative, Whitehall Public Library, and community-based senior centers serving the Hill District in Pittsburgh and the Monroeville, Penn Hills, and Monaca communities within a 35-mile radius of the University of Pittsburgh. In all, we deployed health kiosks to three low-income senior housing communities, six senior citizen centers, three continuing care retirement communities (CCRCs), and one public library (see Table 1).

Two of our kiosks served a total of five venues due to changing circumstances over the course of the study. After participants at Vincentian Villas stopped using the kiosk, we relocated it to the Hill House Senior Services Center. When that venue closed due to the dissolution of its parent organization (Hill House Association), we moved the kiosk to the senior center operated by its new owner/operator, Macedonia Family and Community Enrichment (FACE). A second kiosk that was originally deployed at

Table 1. Venues where kiosks were deployed

Venue	Address	Municipality/ Neighborhood
Senior Housing Communities		
Baptist Manor	493 Castle Shannon Blvd., Pittsburgh, PA 15235	Mt. Lebanon
Silver Lake Commons	935 Frankstown Avenue, Pittsburgh, PA 15208	Pittsburgh/Homewood
York Commons	4003 Penn Avenue, Pittsburgh, PA 15224	Pittsburgh/Lawrenceville
Senior Citizen Centers		
Hill House Senior Center	2038 Bedford Avenue, Pittsburgh, PA 15219	Pittsburgh/Hill District
Jewish Community Center	5738 Forbes Avenue, Pittsburgh, PA 15217	Pittsburgh/Squirrel Hill
The Center at the Mall	284 Beaver Valley Mall Blvd., Monaca, PA 15061	Monaca Borough
Macedonia FACE Senior Center	2114 Centre Avenue, Pittsburgh, PA 15219	Pittsburgh/Hill District
Monroeville Senior Citizen Center	6000 Gateway Campus Blvd., Monroeville, PA 15146	Monroeville
Penn Hills Senior Center	147 Jefferson Road, Penn Hills, PA 15235	Penn Hills
Continuing Care Retirement Communities (CCRCs)		
Longwood at Oakmont	500 Route 909 , Verona, PA 15147	Plum Borough
Providence Point	500 Providence Point Blvd., Pittsburgh, PA 15243	Scott Township
Vincentian Villa	911 Vincent Way, Pittsburgh, PA 15237	McCandless Township
Public Library		
Whitehall Public Library	100 Borough Park Drive, Pittsburgh, PA 15236	Whitehall Borough

the Monroeville Senior Center was moved to Penn Hills Senior Services Center when our dedicated space for the kiosk at Monroeville had to be repurposed for other center activities. For all but the move from Vincentian Villas to Hill House, a subset of participants continued their participation in our Project at the new location. Even though the new venues were within a few blocks or a few miles of the old venue, many participants who withdrew found the new locations inconvenient or unfamiliar, or they lacked transportation to get there. For reporting purposes, we have combined data for venues where participants used the kiosk at two sites.

Participants

Individuals were eligible to take part in the Health Kiosk Project if they were 21 years of age or older, worked at the venue or lived independently or in an assisted living environment, were able to read and understand English, and could respond to eligibility screening questions and provide informed consent. Excluded were skilled nursing facility residents at the CCRCs. Our venues varied widely in their minimum age requirement (i.e., 50 to 65 years) for program participation or residency, with the exception of Whitehall Public Library which served people of all ages.

Our intent was to achieve a sample that reflected the spectrum of demographic, health, and functional characteristics typically observed among individuals at such sites, including staff, rather than restrict it to selected characteristics or conditions.

METHODS

Study Design

Our investigation was essentially an observational study with embedded intervention modules, as depicted in Figure 3. As indicated above, following completion of the baseline, 6, and 12-month assessment batteries

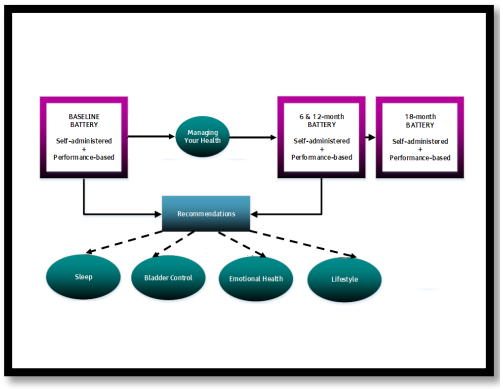

Figure 3. Overview of Study Design

participants received recommendations to complete modules on topics for which they had screened positive and/or had indicated the desire to improve in the next 6 months. The 18-month battery of assessments permitted comparison of data from the previous time points.

Assessment Batteries

Self-administered Measures – Participants began the *Baseline Assessments* by rating how easy to use and useful they thought the health kiosk would be (Technology Acceptance Model)[1] and by indicating their intention to use it over the next 6 months. They responded to questions about their sociodemographic profile; medical conditions; vision and hearing; number of prescribed and over-the-counter medications and vitamins and nutritional supplements taken regularly; physical functional status (Late Life Function & Disability Instrument);[2,3] need for assistance, use of assistive devices, and caregiving responsibilities, if any; quality of life (Rand MOS SF-20);[4] health literacy (Newest Vital Sign),[5] patient activation (Patient Activation Measure);[6] satisfaction communicating with health care providers (Medical Interview Satisfaction Survey);[7] self-efficacy pertaining to health promotion and prevention behaviors; chronic disease self-management (Self-efficacy for Managing Chronic Disease Scale;[8] technology use, attitudes, and privacy concerns; and their use of ERs, hospitals, and skilled nursing, psychiatric, and rehabilitation facilities in the previous month.

Participants were screened for sleep difficulties (Insomnia Severity Index);[9] bladder control concerns (Bladder Control Self-assessment Questionnaire);[10] and depressive mood (Patient Health Questionnaire-8.[11] They rated their desire to improve managing their health and dealing with health care providers, and their sleep; diet, weight, and/or physical activity; mobility; bladder control; and mood. They indicated their #1 and #2 priorities among all but the first of those topics. Because all participants were automatically offered the *Managing Your Health* module upon completion of the *Baseline Assessments*, priority given to that topic would not have figured into our recommendations algorithm. Participants also measured their weight, blood pressure, pulse, and grip strength at the kiosk. If they had diabetes and their own glucose monitoring device at home, they were invited to input their most recent fasting serum glucose (blood sugar) reading and track it regularly at the kiosk.

If values obtained for selected measures (e.g., blood pressure, pulse, depression) were out of normal range, participants immediately saw the result graphically displayed on the touch screen and a message recommending action they should take. For example, for blood pressure readings above or below guidelines from the American Heart Association they were advised to re-take the measurement after 5 minutes of rest and, if still out of range, discuss the values with their PCP, or seek immediate medical attention for very high or very low readings.

Health care utilization was ascertained monthly as the kiosk or, if not provided there, we attempted to obtain the information by phone. At 6, 12, and 18 months the System Usability Scale[12] was self-administered and participants updated their medical conditions, medications, need for assistance, and caregiving status. They repeated selected baseline self-administered measures: Rand MOS SF-20, Late Life Function & Disability Instrument, Patient Activation Measure, Medical Interview Satisfaction Survey, Self-efficacy for Managing Chronic Disease Scale, Insomnia Severity Index, Bladder Control Self-assessment Questionnaire, and Patient Health Questionnaire-8. They again rated their desire to improve managing their health and dealing with health care providers, and their sleep; diet, weight, and/or physical activity; mobility; bladder control; and mood, and they once more specified their #1 and #2 priorities for improvement. Measures of weight, blood pressure, pulse, and grip strength were obtained, as was self-report of the most recent fasting blood sugar among participants with diabetes.

Performance-based Measures – Cognitive and physical function were assessed at baseline when participants met with our team at their kiosk venue. Two screening measures of cognitive function were administered: the Montreal Cognitive Assessment (MoCA)[13] and the Computer Assessment of Memory

and Cognitive Impairment (CAMCI®).[14] The latter is a touch screen-enabled, self-administered, computerized tool that has been normed based on studies involving persons age 21 and older. Because the CAMCI was validated for research purposes but not clinical application, only the results of the MoCA were shared in reports to PCPs. Both measures of cognitive function were re-administered at the 12-month time point. Physical measures of height, pulse, blood pressure, and grip strength (using a Jamar digital hand grip dynamometer) were obtained and tasks were performed to assess lower extremity function and balance (Short Physical Performance Battery,[15] motor skill (Figure of 8 Walk),[16,17] endurance (6-minute Walk Test),[18] and functional mobility (Timed Up and Go Test).[19] These physical measures and tasks were repeated at 6, 12, and 18 months. In a small subset of participants (n=15), we simultaneously pilot tested software developed by our colleagues at the University of Missouri for the Kinect One depth camera, to measure performance of several mobility and balance tasks including the Timed Up-and-Go Test and the Figure of 8 Walk Test.

Health Intervention Modules

Managing Your Health – This 6-session module was automatically offered to all participants upon completion of their *Baseline Assessments*. Topics included: 1) principles of self-management including health promotion, disease prevention, and acute and chronic disease management; 2) challenges of changing a health behavior vs. making it a habit; 3) identifying and solving health problems; 4) identifying priorities, setting SMART goals, and specifying meaningful personal rewards to sustain behavior change; 4) being prepared and assertive when communicating with health care providers during medical visits, whether alone, accompanied by another person, or accompanying someone with or without dementia.

Pre/post Intervention Measures (prior to Session 1 as part of the *Baseline Assessments* and repeated in the *6, 12, and 18-month Assessments)*

- Patient Activation Measure
- Medical Interview Satisfaction Survey
- Self-efficacy for Managing Chronic Disease Scale
- Questions ascertaining self-efficacy pertaining to health promotion and prevention behaviors

Interim Measures and Educational Content

Session 1: Problem Solving for Health – We conducted 5-item surveys via automated Twilio telephone service on a daily basis over the course of a week following completion of this session. The surveys asked participants about their physical activity, napping, and fruit and vegetable intake. These data were summarized graphically during Session 2, for the purpose of illustrating how such displays of behavior tracked between kiosk visits would serve as feedback regarding their self-monitoring/ management efforts. Because many telephone calls were missed/not answered, we decided against further use of Twilio for collecting data for other modules. Instead, we subsequently offered participants tracking sheets to print at the end of a session, complete at home, bring back to the next session, and enter the data at the kiosk. Although we originally thought that paper-and-pencil tracking followed by manual data entry by the participant would be too cumbersome and time consuming, participants who used the tracking sheets typically readily entered their data.

Session 2: Setting SMART Goals – No measures were obtained.

Session 3: Making New Habits Stick – Participants identified a hypothetical behavior (e.g., flossing teeth regularly, getting enough sleep to feel well rested, or getting routine medical and dental exams and screenings) that they might intend to start, stop, or improve, to use as an example for developing a SMART goal and specifying a preferred reward. Participants tracked performance of the behavior and how/whether they rewarded themselves for it over the next 7 days.

Session 4: Dealing with Providers – In addition to entering their tracking data related to the hypothetical behavior, participants were asked to recall their most recent medical visit. For 10 commonly discussed topics, such as results of blood work or other diagnostic tests, nutritional intake, sleep habits, and one's well-being, they were asked if each topic was addressed and, if so, who raised it. They rated how prepared and successful they were in discussing each topic and how skilled they were at listening carefully to what was said, watching for nonverbal cues, taking time to process information, and interpreting verbal and nonverbal signals, being punctual and organized, describing symptoms clearly, and giving specific examples. Finally, they were asked which of these communication behaviors they would most like to improve.

Session 5: Ways of Conducting Yourself – Participants were asked what they would most like to change when preparing for their next medical visit, for example, identifying 3 questions or concerns to bring up early in the visit or making a list of medical problems, medications, and supplements including how much, how often, why, and who prescribed.

Session 6: Visits with Someone Else – If/when accompanied by or accompanying someone else (with or without dementia) to a medical visit, participants were asked what they would change (e.g., deciding beforehand who will be in the exam room, introducing the extra person and saying why he or she is there, asking the extra person to keep track of what the doctor says). Questions about communicative success were asked about the most recent such visit.

Sleep – This module was recommended based on these criteria: Insomnia Severity Index total score ≥ 10, score ≥ 2 on desire to improve sleep in the next 6 months, sleep designated as #1 or #2 most important behavior to improve, and/or sleep given the highest rating among the behaviors to improve. The module, adapted from the Brief Behavioral Treatment for Insomnia (BBTI) intervention,[20] consisted of 9 sessions and involved loaner devices (Sleep Diary tablet and Actiwatch) used for 7-day stretches on two occasions. Topics included: 1) mechanisms of sleep regulation (e.g., homeostatic sleep drive, biological clock); 2) healthy sleep habits; 3) stimulus control procedures including regular sleep times and avoiding excessive time awake in bed; and 4) sleep restriction, designed to maximize homeostatic sleep drive.

Pre/post Intervention Measures (Session 1 and Session 8)

- Insomnia Severity Index
- Pittsburgh Sleep Quality Index[21]
- PROMIS Sleep Disturbance Scale and PROMIS Sleep-Related Impairment Scales[22]
- Geriatric Depression Scale[23]

Pre/post Intervention Measures (between Sessions 1 and 2 and between Sessions 8 and 9)

- 7-day sleep diary
- 7-day wrist actigraphy

Interim Measures and Educational Content

Session 1: Devices and Assessment – After completing the abovementioned self-report measures, the participant met with a member of our team to receive two loaner devices (ASUS sleep diary tablet and Respironics Actiwatch 2) and to learn how to use them.

Session 2: Sleep Basics – Following a weeklong period of wear, the Actiwatch 2 device was retrieved from the participant and brought back to our office for download to a docking station before transmission to our database server. (A summary of the data was presented to the participant during Session 3.) Sleep diary data recorded twice daily (morning and bedtime) on the tablet pertained to bed times, wake times, sleep onset latency, wakefulness during sleep, total sleep time, and selected behaviors (e.g., napping, meal size, and alcohol intake). The tablet was preconfigured to connect

automatically to the kiosk's WiFi hotspot when in range. Guided by step-by-step instructions, participants wirelessly transmitted their sleep diary data for immediate graphical display of their sleep efficiency. ***Sleep diary data uploads and feedback continued through Session 9.*** Questions also asked about unusual behaviors during sleep (walking, kicking, punching, screaming); restless legs; snoring, gasping, breathing pauses; and difficulty falling or staying asleep.

Session 3: Importance of Routine – In addition to the sleep diary upload, questions were posed about sleep habits (e.g., only going to bed when sleepy, going to bed, waking up, and getting up at the same time every day; getting out of bed if unable to fall asleep; limiting naps and nap times); usual sleep-wake schedule; behaviors associated with insomnia; and activities the participant could do to change sleep habits, before specifying a new sleep schedule aligned with BBTI principles. **The participant rated: confidence adhering to that new schedule; how sensible/logical suggested strategies would be in reducing sleep problems; expected success, improvement, and effort required; and the likelihood of recommending BBTI to others. These ratings continued through Session 8.**

Session 4: Effect of Sleep on Health – Questions focused on sleep quality overall and the extent to which the participant had changed sleep habits, adhered to target times for going to bed and getting up. The participant was also asked about habits such as heavy meals in the evening, caffeine after lunch or later, tobacco use, alcohol before bedtime, and inactivity and, if so, what small steps could be taken to alter those behaviors.

Session 5: Being Active to Promote Sleep – If the participant reported not sleeping well or feeling tired, the sleep schedule could be adjusted, and he or she was asked if the small steps to improve habits identified in Session 4 were being taken.

Session 6: Relaxation to Promote Sleep – The participant categorized activities engaged in since the last session as energy conserving or energy expending and was asked how they affected well-being. One of three relaxation techniques (deep breathing, breaking the habit of thinking in bed, progressive muscle relaxation) selected by the participant was explained, illustrated, and practiced.

Session 7: More Ways to Relax – Questions again focused on the quality of sleep and whether changes to activity habits were being tried. Adjustments were made, if needed, to the sleep schedule, and the remaining two relaxation techniques were presented and practiced.

Session 8: Assessment of Your Progress – The participant was questioned about sleep quality and efforts to create an environment conducive to sleep, and he or she was encouraged to perform relaxation techniques if still not sleeping well. All pre/post measures were repeated, including 7 days of self-monitoring using the sleep diary tablet and Actiwatch 2.

Session 9: Final Review and Tips – The module concluded with graphical display of the participant's pre vs. post sleep efficiency (derived from actigraphy data), review of BBTI principles, and encouragement to continue recommended strategies for improving sleep.

Bladder Control – This module, adapted from a Pelvic Floor Muscle Training Intervention developed at the University of Pittsburgh,[24] consisted of 5 educational sessions and was recommended based on these criteria: Bladder Control Self-assessment Questionnaire total score ≥ 4, score ≥ 2 on desire to improve bladder control in the next 6 months, bladder control indicated as priority #1 or #2 among health behaviors to improve in the next 6 months, bladder control given the highest rating among the behaviors to improve, and/or rating ≥ 2 in response to "Is it difficult to hold urine when you get the urge to go?" or "Do you leak urine?" Participants could continue to self-monitor their bladder control weekly for as long as they wished, and repeated progress evaluations, which would permit assessment of the extent to which any gains achieved in bladder control were maintained, were posted 28 days after each completed evaluation. Topics included: 1) bladder control mechanisms; 2) types of urinary incontinence (UI); 3) strategies (i.e., bladder training and/or pelvic floor muscle exercises) for dealing with stress, urge, or mixed UI; and 4) guidance regarding fluid and caffeine intake, smoking, weight control,

constipation, and when to call the PCP. Explanations were interspersed with clips from the "Treating Urinary Incontinence" video produced by and with permission from Family Health Media, Charlottesville, VA.

Pre/post Intervention Measures (Session 1 and Session 6)

- Urinary Incontinence Assessment to determine symptoms, type of UI, and current pelvic floor muscle exercise behavior
- Incontinence Impact Questionnaire (IIQ-7)[25]

Interim Measures and Educational Content

Session 1: Assessments & Bladder Control Basics – After responding to the Pre-intervention measures and learning the basic mechanics of bladder control, the participant was asked to complete and bring back to Session 2 a 7-day Bladder Diary and a 3-day Voiding Log regarding the number of voids and intervals between voids during waking hours, number of incontinent episodes and incontinent pads used, symptoms occurring with leaking urine (i.e., coughing, laughing, lifting, changing positions), and leaking after the urge to urinate.

Session 2: Behavioral Treatment of Incontinence – Bladder Diary and Voiding log data were entered by the participant at the kiosk, after which a summary was provided and pelvic floor muscle exercise (PFME) technique and bladder training (BT) were introduced. Based on the participant's type of UI, a recommendation was made to begin BT and/or perform PFME according to the step-by-step instructions provided and consistent with a personal SMART goal developed during the session. The participant specified how many fewer leaking episodes were his or her target for the next 4 weeks. **Tracking and input of 7-day Bladder Diary data continued through Session 6 and as often as weekly thereafter, as long as the participant desired to do so.**

Session 3: Strategies to Prevent or Stop Leaking – Diary data were entered and summarized, and step-by-step instructions for bladder training were explained and illustrated. All participants received a recommendation to continue doing PFME at home, and they developed a personal SMART goal related to PFME performance. Those with urinary frequency included their BT plan in their SMART goal. **The participant rated confidence adhering to that new schedule; how sensible/logical suggested strategies would be in reducing leaking episodes; expected success, improvement, and effort required; and likelihood of recommending the PFME and/or BT approach to others. These ratings continued through Session 5.**

Session 4: What Else Can Help to Stay Dry – Diary data entry, provision of summary feedback and a recommendation for continuing BT and/or PFME based on type of UI, and setting a new SMART goal for the interval between sessions continued. The participant was asked about using a previously identified reward as an incentive to adhere to planned BT or PFME. Modifying other behaviors (e.g., fluid and caffeine intake, smoking, weight control, avoiding constipation) was encouraged.

Session 5: Making New Bladder Habits Stick – In addition to entering diary data and receiving summary feedback and reinforcement of recommended BT and/or PFME behavior, the participant was reminded of strategies described in *Managing Your Health* (Session 3) that have been shown to promote adherence. He or she was asked to complete the Bladder Diary and 3-day Voiding Log before Session 6.

Session 6: Bladder Control Checkpoint – All post-intervention measures were self-administered, and data collected during Session 2 were contrasted with current data, to reveal progress that may have been made. The participant set a new 4-week UI target which would be evaluated and could be revised every 28 days.

Bladder Control – Ongoing Self-management – In addition to being able to continue tracking UI symptoms, the participant could review the illustrated/video clip-augmented educational content from

Sessions 1-5 (e.g., how bladder control works, bladder training and pelvic floor muscle exercise techniques, etc.) on a weekly basis, for as long as desired.

Emotional Health – This 5-session module was recommended based on these criteria: Personal Health Questionnaire-8 total score ≥ 3, score ≥ 2 on desire to improve mood in the next 6 months, mood indicated as priority #1 or #2 among health behaviors to improve in the next 6 months, and/or mood given the highest rating among the behaviors to improve. Topics included: 1) factors that can influence emotional health; 2) common symptoms of mood problems, especially anxiety and depression; 3) potential triggers and causes; 4) clarification of myths vs. facts about emotional health and its treatment in older adults; and 5) self-support strategies for improving mood and managing stress. Module content was drawn from publicly available educational materials from the National Alliance on Mental Health and the National Institute on Aging Age Pages.

Pre/post Intervention Measures (Session 1 and Session 5)

- Questions adapted from the National Health Interview Survey, 2015 version, about use of mental health services, prescribed medications, and cost as a barrier to obtaining mental health care (pre) in the past 12 months and (post) since completing Session 1
- Personal Health Questionnaire-8 (PHQ-8)[26]
- Generalized Anxiety Disorder-7 (GAD-7)[27]

Interim Measures and Educational Content

Session 1: Assessment – After completing pre-intervention measures, participants who screened positive for anxiety and/or depression were apprised via a pop-up message on the kiosk screen that their responses suggested they may be anxious or depressed and their PCP would be notified. Our attempts to reach these participants to encourage further evaluation and treatment, if necessary, typically revealed an existing diagnosis and plan of treatment. Participants designated statements about mental health and aging as myth or fact, after which the rationale for the correct response was provided. A take-home assignment involved rating one's mental preparation for expected major life events (e.g., retirement, change in living arrangements, the eventual need to accept help), connection with family and friends, and exercise habit, for consideration during Session 2.

Session 2: Emotional Health Basics – No additional measures were obtained. Rather, this educational session focused on triggers and symptoms of depression and anxiety, how to discuss them with health care providers, and when to seek medical evaluation.

Session 3: Stress and Well-being – All participants self-administered the Perceived Stress Scale[28] and one other measure of stress; < age 65: Holmes-Rahe Social Readjustment Rating Scale[29]; ≥ age 65: Elders Life Stress Inventory[30] prior to discussion of the impact of stress on mood.

Session 4: Talking with Others and Your Doctor – No measures were obtained. Symptoms of depression and anxiety were reviewed, and strategies were suggested for ways to initiate discussion of such symptoms with family, confidants, and health care providers.

Session 5: Review and Assessment – Pre-intervention measures were repeated, followed by review of self-support strategies for managing stress, engaging in guided meditation, discussing emotional health concerns, and seeking medical evaluation.

Lifestyle – This module was recommended based on these criteria: Overweight or obese body mass index (< 65 years: BMI ≥ 25 kg/m^2; ≥ 65 years: BMI ≥ 30 kg/m^2); ≥ 1 weight-related cardiovascular risk factor (hypertension, dyslipidemia, diabetes, or impaired fasting glucose); score ≥ 2 on desire to improve diet, weight, and/or physical activity; or designated this area as priority #1 or #2 to improve in the next 6 months. This module was an adaptation of the Goal-focused Online Access to Lifestyle Support (GOALS) program[31] based on the Diabetes Prevention Program (DPP). It comprised 16 behavioral lessons offered

one week apart, followed by 8 monthly booster sessions. Self-monitoring of diet, weight, and physical activity continued weekly throughout the first 16 sessions as well as during the 8 months of booster sessions. A 7-session health promotion version was available to participants who did not meet the recommendation criteria. Consistent with the original online GOALS program, participants could review completed sessions including their responses to questions posed during presentation of educational content. Topics addressed are summarized under **Interim Measures and Educational Content** below.

Pre/post Intervention Measures

- Weight (Orientation and Sessions 16 and 24)
- Starting the Conversation to assess nutrition (Sessions 1, 16, and 24)
- PA Behavioral Risk Factor Surveillance System physical activity items (Sessions 1, 16, and 24)
- 7-day step count using the Omron HJ-720ITC pedometer (after Orientation and Sessions 8 and 16)

Interim Measures and Educational Content

Orientation: Surveys and GOALS Intro – After completing the pre-intervention measures, the participant learned that the objective of GOALS was to lose 7% of their weight by establishing a healthier eating and physical activity routine, in order to prevent or better manage diabetes. **A daily fat gram goal was specified based on the participant's weight; the goal was revised if indicated by weight measurements obtained at each session.** Unlike the other health intervention modules, this one was augmented with a lifestyle coach who messaged the participant and loaned him or her a downloadable Omron HJ-720ITC pedometer for two 7-day periods of data collection. A food scale, fat/calorie counter book, and Omron HJ325 pedometer were also provided, to facilitate self-monitoring between sessions.

Session 1: Getting Started Losing Weight – After the loaner pedometer was retrieved by our lifestyle coach for later download at our office, the participant entered his or her step counts and time spent in physical activity tracked over 7 days, which were summarized and graphically displayed. Potential benefits of GOALS were explained and safe, gradual change in diet and physical activity was encouraged. **Developing a physical activity plan for the week, self-monitoring its implementation, and entering physical activity data at the next session continued through Session 24. Each GOALS lesson concluded with 4-6 questions and answers intended to reinforce the session's educational content.**

Session 2 through Session 16 – Fat content of various foods and typical meals were discussed, and the participant learned how to use the fat/calorie counter book to self-monitor fat intake relative to his or her daily fat gram goal. **As with physical activity, printable tracking sheets for self-monitoring food, fat, and calorie intake were provided at the end of each session and brought to the next session for manual entry, summary, and graphical display of trends over time.** Educational content focused on strategies to support healthy eating, engage in enjoyable physical activity (≥ 2½ hours/week), take charge of one's choices, and problem solve common challenges (e.g., social cues, eating out, stress).

Session 17 through Session 24 – Monthly booster sessions addressed ongoing challenges: managing social events and holidays, persisting with self-monitoring and portion control, making time for physical activity, avoiding excuses and lapses, being assertive, and staying motivated. **During this 8-month period the participant was prompted to continue weekly self-monitoring of weight and daily monitoring of fat and calorie intake and physical activity.**

Interviews – We conducted in-person, semi-structured interviews with a subset of our participants who were purposively selected to represent high and low intensity kiosk users and those with high and low levels of need (i.e., having various health intervention modules recommended or not). We explored their motivations for using the kiosk; what influenced how much they did so (e.g., location, availability, ability to reserve, weekly drawing); how much they minded using devices, tracking their behavior, and checking messages at the kiosk; and whether they had privacy concerns about using it. We asked what they most disliked and liked about the kiosk, and whether they would recommend it to other people.

Limitations – We undertook this investigation principally to learn whether and how community-residing older adults would use a multi-user kiosk to self-administer interventions and monitor their progress toward improving selected personal health concerns. As anticipated, recruitment and retention were challenging. There was minimal interest in residential settings where the kiosk appeared to become a "potted plant" – easily bypassed as people went about their daily routines which, for many, appeared to involve limited venturing out of the apartment. We had somewhat more success in senior centers and the library, although space constraints often resulted in kiosks being situated in less-than-ideal locations (e.g., locked or remote room or building, busy lobby area) that were made available to us.

Attrition occurred, as anticipated, for a variety of reasons such as when participants moved away or withdrew to take care of a family member, spent weeks or months out of town, enrolled out of curiosity but lost interest or lacked time to engage with all sessions of a health intervention module, ran out of things to do at the kiosk, or became ill or died. We also lost participants when we had to move a kiosk from one venue to another, as well as following the tragic mass shooting which occurred at the Tree of Life Synagogue in October 2018 and derailed participation for several weeks while one of our venues, the Jewish Community Center in Squirrel Hill, became a hub for community support.

Preliminary evaluation of our data reveals minimal missing data for the surveys that were self-administered at the kiosk. Although participants could skip questions, this rarely occurred. Likewise, performance-based data is largely complete for those who met with our team; missing data typically reflect instances when safety concerns identified either by the participant or our team resulted in a decision not to perform a task. That said, we had some participants who completed only some or none of the self-administered surveys at the kiosk at baseline, 6, 12, or 18 months and/or were unavailable or unwilling to do the performance-based measures at those time points. Similar issues of missing data plagued our efforts to collect health care utilization data. Though participants could respond to all monthly surveys at the kiosk, those who did not we attempted, with varying success, to reach by phone. We can only surmise that data collection might have been more complete had we paid participants once both components were completed (e.g., $50 upon completion of the self-administered AND the performance-based measures at each time point) instead of conducting the weekly drawing at each site.

RESULTS

Due to the COVID-19 pandemic, the Health Kiosk Project was interrupted when stay-at-home orders were implemented in Pennsylvania and all of our kiosk venues closed to the public. It was several months before we could sanitize and retrieve the kiosks that were still in the community. Once retrieved, the kiosk desks, devices, and other components were again sanitized, inventoried, and sent to university storage. We are in the early stages of collating and qualitatively and quantitatively analyzing the massive amount of data we collected from all sources. Published findings will be provided to AHRQ.

Two hundred seventy one enrollees provided informed consent to participate. After 253 (93%) participants viewed the 10-minute Orientation module, 242 (89%) described their demographic profile, health and functional status, need for assistance, and caregiving responsibility, if any. Thus, our usable data pertains to these 242 participants. Here we provide preliminary findings for the sample and for their completion of assessment batteries and health intervention modules.

Sample

Participants were predominantly female (n=194, 80%), white (n=185, 76%), married (n=90, 37%) or widowed (n=78, 32%) unemployed or retired (n=210, 77%), and living alone (n=122, 50%) or with one other person (n=97, 40%). They ranged in age from 45 to 98 years (M=72.93, SD=8.90), 8 of whom were under age 60. Non-white participants identified themselves as African-American (n=47, 19%), multi-racial (n=2, 1%), Asian (n=1, <1%), American Indian (n=1, <1%), or Other (n=1, <1%). English was the primary language for all but one participant, who was fluent in English as well. One-fourth of the sample

had a high school education, GED, or less (< HS: n=6, 3%; HS or GED: n=55, 23%), and 104 (41%) had graduated from college or had post-graduate education. Twenty six (11%) were Veterans. Household income ranged from <$20,000 (n=69, 30%) to ≥ $80,000 (n=45, 19%). Twenty four percent (n=58) of participants acknowledged having difficulty paying daily expenses.

The most common health conditions were arthritis (n=170, 70%), hypertension (n=140, 58%), high cholesterol (91, 38%), osteoporosis (n=74, 31%), depression or history of depression (n=62, 26%), anxiety (n=59, 24%), and diabetes (n=43, 18%). Among those with diabetes, 32 (74%) had their own glucose monitoring device at home. The majority of participants (n=172, 71%) rated their eyesight (with corrective lenses) and their hearing (with hearing aid) as good; 63 (26%) rated their vision and 56 (23%) rated their hearing as fair. Polypharmacy was common for regular consumption of ≥ 5 prescription medications (n=93, 38%), over-the-counter medications (n=24, 10%), and vitamin and nutritional supplements (n=50, 21%). One-third (n=54, 33%) used at least one type of assistive device (e.g., cane, walker, scooter, wheelchair) to augment their mobility. The mean Montreal Cognitive Assessment (MoCA) total score was 24.16 (SD=3.44). In all, 106 (44%) depended on others, typically a spouse or adult child, for assistance with activities of daily living (ADLs) or instrumental activities of daily living (IADLs); 40 (17%) provided care to others and found doing so to be somewhat stressful (M=2.13, SD=1.181 on a 1-5 scale).

Given the heterogeneity of our sample and diversity of venues (i.e., senior centers, senior housing, continuing care retirement communities [CCRCs], and library) where kiosks were deployed, we found significant (p<.05), though not unexpected, differences in age, race, marital status, education, income, household size, experience with consumer technology, and screening measures across venues. For instance, participants from senior housing and CCRCs were older; CCRC residents and library patrons were better educated and reported higher household incomes than those at other venues. Senior housing participants also received more assistance from others and had lower MoCA and health literacy scores. We also detected differences across venues for history of falls and fear of falling, bladder control symptoms, symptoms of depression, and the desire to improve diet, weight, and physical activity. In contrast, no differences were found across venues for self-efficacy managing chronic disease, satisfaction communicating with health care providers, or severity of insomnia.

Completion of Baseline and 6, 12, and 18-month Assessments

We collected detailed data regarding module/session completion and physical measurements every time a participant visited a kiosk, but we have not yet summarized and analyzed those data. As Table 2

Table 2. Assessment battery completion

Component	Enrolled	Baseline		6 Months		12 Months		18 Months	
		Begun	Completed	Begun	Completed	Begun	Completed	Begun	Completed
Self-administered									
Senior Center	164	150	116	48	39	32	18	15	13
Senior Housing	46	42	29	14	9	7	6	5	3
CCRC	37	34	24	11	7	7	5	5	5
Library	24	23	17	7	5	0	0	0	0
Total	**271**	**249**	**186**	**80**	**60**	**46**	**29**	**25**	**21**
Performance									
Senior Center	164	121	114	60	59	48	47	39	39
Senior Housing	46	29	27	17	17	16	16	15	15
CCRC	37	28	28	17	17	13	13	8	8
Library	24	21	21	16	16	1	1	0	0
Total	**271**	**199**	**190**	**110**	**109**	**78**	**77**	**62**	**62**

illustrates, participant attrition over the course of the study was considerable. Notable among findings from the *Baseline Assessments* are the Technology Acceptance Model scale ratings (1 very likely, 7 very unlikely) for perceived usefulness (M=1.86, SD=.76) and ease of use (M=1.77, SD=.79), attitude toward using the health kiosk to monitor and manage one's health (1 very good, 7 very bad: M=1.82, SD=.76), and intention to use the health kiosk over the next several months (1 strongly disagree, 7 strongly agree: M=5.98, SD=1.34). Regarding usability, mean ratings (1 not at all, 10 completely) at the outset suggested participants looked forward to using the kiosk (M=8.42, SD=1.74), were unlikely to be embarrassed to be seen using it (M=1.67, SD=1.62), and were moderate in views that using the kiosk would be an invasion of privacy (M=2.01, SD=1.91) and the benefits of use were worth any invasion of privacy that might result (M=6.57, SD=3.23).

Modules Considered vs. Initiated and Completed

Here we summarize the numbers of participants who considered engaging with each health intervention module—whether because it was recommended following completion of one of the assessment batteries or because a participant opted to pursue it via the *Do Something Else* screen—then agreed to do so and ultimately completed each session within a module. Attrition is clearly evident in the waning numbers, though part of our analysis will entail exploring how often attrition occurred when a kiosk was relocated to a different venue or when COVID-19 restrictions truncated participation.

Table 3. Session completion, by module

Module	Considered | Agreed	Session																		
		O*	1	2	3	4	5	6	7	8	9	10	11	12 13	14 17	18 19	20	21	22	23 24
Managing Your Health	**Offered 190**	N/A	168	143	143	112	102	95												
Sleep	**99|91**	N/A	84	70	68	65	65	62	58	49	49									
Bladder Control	**85|72**	N/A	68	61	51	47	44	41												
Emotional Health	**82|81**	N/A	76	71	62	56	52													
Lifestyle	**100|92**																			
GOALS	68|60	41	36	35	33	31	31	28	27	27	25	22	21	19	18	13	12	9	6	5
Health Promotion	32|27	24	18	18	15	15	14	14	12											

*O = Orientation Session

LIST OF PUBLICATIONS

Hotrabhavananda B, Mishra AK, Skubic M, Hotrabhavananda N, Abbott C. Evaluation of the Microsoft Kinect skeletal versus depth data analysis for Timed-up and Go and Figure of 8 Walk tests. Annu Int Conf IEEE Eng Med Biol Soc. 2016 Aug;2016:2274-2277. doi: 10.1109/EMBC.2016.7591183. PMID: 28268781.

Antonio MG, Courtney KL, Lingler JH, Matthews JT. Translating behavior change techniques to new delivery mediums. In: Lau F, Bartle-Clar JA, Bliss G, Borycki E, Courtney KL, Kuo AM-H, eds. Building Capacity for Health Informatics in the Future. IOS Press; 2017. doi: 10.3233/978-1-61499-742-9-18.

Takyi H, Watzlaf V, Matthews JT, Zhou L, DeAlmeida D. Privacy and security in multi-user health kiosks. Int J Telerehabil, 2017 Spring;9(1):3-14. doi: 10.5195/ijt.2017.6217 PMCID: PMC5546557

Courtney KL, Antonio M, Garnett A, Matthews JT. Applying the Behavior Change Technique Taxonomy to mobile health applications: a protocol. Stud Health Technol Inform. 2019;257:64-69. PMID: 30741174.

REFERENCES

[1] Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 1989 Sep;13(3):319-340. doi.org/10.2307/249008

[2] Haley SM, Jette AM, Coster WJ, Kooyoomjian JT, Levenson S, Heeren T, Ashba J. Late Life Function and Disability Instrument: II. Development and evaluation of the function component. J Gerontol A Biol Sci Med Sci. 2002 Apr;57(4):M217-22. doi: 10.1093/gerona/57.4.m217. PMID: 11909886.

[3] Jette AM, Haley SM, Coster WJ, Kooyoomjian JT, Levenson S, Heeren T, Ashba J. Late life function and disability instrument: I. Development and evaluation of the disability component. J Gerontol A Biol Sci Med Sci. 2002 Apr;57(4):M209-16. doi: 10.1093/gerona/57.4.m209. PMID: 11909885.

[4] Ware J Jr, Kosinski M, Keller SD. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. Med Care. 1996 Mar;34(3):220-33. doi: 10.1097/00005650-199603000-00003. PMID: 8628042.

[5] Weiss BD, Mays MZ, Martz W, Castro KM, DeWalt DA, Pignone MP, Mockbee J, Hale FA. Quick assessment of literacy in primary care: the newest vital sign. Ann Fam Med. 2005 Nov-Dec;3(6):514-22. doi: 10.1370/afm.405. Erratum in: Ann Fam Med. 2006 Jan-Feb;4(1):83. PMID: 16338915; PMCID: PMC1466931.

[6] Hibbard JH, Mahoney ER, Stockard J, Tusler M. Development and testing of a short form of the Patient Activation Measure. Health Serv Res. 2005 Dec;40(6 Pt 1):1918-30. doi: 10.1111/j.1475-6773.2005.00438.x. PMID: 16336556; PMCID: PMC1361231.

[7] Wolf MH, Putnam SM, James SA, Stiles WB. The Medical Interview Satisfaction Scale: development of a scale to measure patient perceptions of physician behavior. J Behav Med. 1978 Dec;1(4):391-401. doi: 10.1007/BF00846695. PMID: 755868.

[8] Lorig KR, Sobel DS, Ritter PL, Laurent D, Hobbs M. Effect of a self-management program on patients with chronic disease. Eff Clin Pract. 2001 Nov-Dec;4(6):256-62. PMID: 11769298.

[9] Bastien CH, Vallières A, Morin CM. Validation of the Insomnia Severity Index as an outcome measure for insomnia research. Sleep Med. 2001 Jul;2(4):297-307. doi: 10.1016/s1389-9457(00)00065-4. PMID: 11438246.

[10] Basra R, Artibani W, Cardozo L, Castro-Diaz D, Chapple C, Cortes E, De Ridder D, Pons ME, Haab F, Hohenfellner M, Kirby M, Milsom I, Van Kerrebroeck P, Vierhout M, Wagg A, Kelleher C. Design and validation of a new screening instrument for lower urinary tract dysfunction: the Bladder Control Self-assessment Questionnaire (B-SAQ). Eur Urol. 2007 Jul;52(1):230-7. doi: 10.1016/j.eururo.2006.11.015. Epub 2006 Nov 15. PMID: 17129667.

[11] Kroenke K, Strine TW, Spitzer RL, Williams JB, Berry JT, Mokdad AH. The PHQ-8 as a measure of current depression in the general population. J Affect Disord. 2009 Apr;114(1-3):163-73. doi: 10.1016/j.jad.2008.06.026. Epub 2008 Aug 27. PMID: 18752852.

[12] Brooke J. SUS: A quick and dirty usability scale. In: Jordan PW, Thomas B, McClelland IL, Weerdmeester BA, eds. Usability Evaluation in Industry. 1st ed. London: Taylor & Francis;1996: chapter 21.

[13] Montreal Cognitive Assessment: https://www.mocatest.org/

[14] Saxton J, Morrow L, Eschman A, Archer G, Luther J, Zuccolotto A. Computer assessment of mild cognitive impairment. Postgrad Med. 2009 Mar;121(2):177-85. doi: 10.3810/pgm.2009.03.1990. PMID: 19332976; PMCID: PMC2699993.

[15] Guralnik JM, Simonsick EM, Ferrucci L, Glynn RJ, Berkman LF, Blazer DG, Scherr PA, Wallace RB. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. J Gerontol. 1994 Mar;49(2):M85-94. doi: 10.1093/geronj/49.2.m85. PMID: 8126356.

[16] Hess RJ, Brach JS, Piva SR, VanSwearingen JM. Walking skill can be assessed in older adults: validity of the Figure-of-8 Walk Test. Phys Ther. 2010 Jan;90(1):89-99. doi: 10.2522/ptj.20080121. Epub 2009 Dec 3. PMID: 19959654; PMCID: PMC2802825.

[17] Lowry KA, Brach JS, Nebes RD, Studenski SA, VanSwearingen JM. Contributions of cognitive function to straight- and curved-path walking in older adults. Arch Phys Med Rehabil. 2012 May;93(5):802-7. doi: 10.1016/j.apmr.2011.12.007. PMID: 22541307; PMCID: PMC4878139.

[18] Guyatt GH, Sullivan MJ, Thompson PJ, et al. The 6-minute walk: a new measure of exercise capacity in patients with chronic heart failure. Can Med Assoc J. 1985;132(8):919-923. PMID: 3978515; PMCID: PMC1345899

[19] Timed Up & Go Test: https://www.cdc.gov/steadi/pdf/STEADI-Assessment-TUG-508.pdf

[20] Buysse DJ, Germain A, Moul DE, Franzen PL, Brar LK, Fletcher ME, Begley A, Houck PR, Mazumdar S, Reynolds CF 3rd, Monk TH. Efficacy of brief behavioral treatment for chronic insomnia in older adults. Arch Intern Med. 2011 May 23;171(10):887-95. doi: 10.1001/archinternmed.2010.535. Epub 2011 Jan 24. Erratum in: JAMA Intern Med. 2019 Jun 17; PMID: 21263078; PMCID: PMC3101289.

[21] Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res. 1989 May;28(2):193-213. doi: 10.1016/0165-1781(89)90047-4. PMID: 2748771.

[22] Yu L, Buysse DJ, Germain A, Moul DE, Stover A, Dodds NE, Johnston KL, Pilkonis PA. Development of short forms from the PROMIS™ sleep disturbance and Sleep-Related Impairment item banks. Behav Sleep Med. 2011 Dec 28;10(1):6-24. doi: 10.1080/15402002.2012.636266. PMID: 22250775; PMCID: PMC3261577.

[23] Yesavage JA, Brink TL, Rose TL, Lum O, Huang V, Adey M, Leirer VO. Development and validation of a geriatric depression screening scale: a preliminary report. J Psychiatr Res. 1982-1983;17(1):37-49. doi: 10.1016/0022-3956(82)90033-4. PMID: 7183759.

[24] McDowell BJ, Engberg S, Sereika S, Donovan N, Jubeck ME, Weber E, Engberg R. Effectiveness of behavioral therapy to treat incontinence in homebound older adults. J Am Geriatr Soc. 1999 Mar;47(3):309-18. doi: 10.1111/j.1532-5415.1999.tb02994.x. PMID: 10078893.

[25] Uebersax JS, Wyman JF, Shumaker SA, McClish DK, Fantl JA. Short forms to assess life quality and symptom distress for urinary incontinence in women: the Incontinence Impact Questionnaire and the Urogenital Distress Inventory. Continence Program for Women Research Group. Neurourol Urodyn. 1995;14(2):131-9. doi: 10.1002/nau.1930140206. PMID: 7780440.

[26] Kroenke K, Spitzer RL, Williams JB, Löwe B. The Patient Health Questionnaire Somatic, Anxiety, and Depressive Symptom Scales: a systematic review. Gen Hosp Psychiatry. 2010 Jul-Aug;32(4):345-59. doi: 10.1016/j.genhosppsych.2010.03.006. Epub 2010 May 7. PMID: 20633738.

[27] Spitzer RL, Kroenke K, Williams JB, Löwe B. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch Intern Med. 2006 May 22;166(10):1092-7. doi: 10.1001/archinte.166.10.1092. PMID: 16717171.

[28] Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav. 1983 Dec;24(4):385-96. PMID: 6668417.

[29] Holmes TH, Rahe RH. The Social Readjustment Rating Scale. J Psychosom Res. 1967 Aug;11(2):213-8. doi: 10.1016/0022-3999(67)90010-4. PMID: 6059863.

[30] Aldwin CM. The Elders Life Stress Inventory: Egocentric and nonegocentric stress. In: Stephens MAP, Crowther J, Hobfoll S, Tennenbaum D, eds. Stress and coping in later-life families. Washington, DC: Hemisphere Publishing Corporation;1990: 49-69.

[31] McTigue KM, Conroy MB, Hess R, Bryce CL, Fiorillo AB, Fischer GS, Milas NC, Simkin-Silverman LR. Using the internet to translate an evidence-based lifestyle intervention into practice. Telemed J E Health. 2009 Nov;15(9):851-8. doi: 10.1089/tmj.2009.0036. PMID: 19919191.