mHealth

--Manuscript Summary--

Manuscript ID	mHealth-17-98
Title	A Text Messaging-Based Intervention to Increase Physical Activity among Formerly Homeless Persons: Feasibility and Acceptability Findings from a Pilot Study
Running Head	Text-Messaging in PSH Feasibility Study
Keywords	exercise,pedometer,permanent supportive housing,text messaging,walking.
Abstract	Background: Formerly homeless persons in permanent supportive housing (PSH) experience high rates of health and mental health problems. This population also report high rates of cell phone use, so phone-based health promotion interventions may be effective. Methods: To understand the feasibility of such interventions, this six-week pilot study enrolled 13 persons living in PSH. Participants wore a pedometer, received motivational text messages, and responded via text to weekly depression screeners and step total requests. Follow-up interviews asked open-ended questions about study participation and satisfaction. Results: Participants were 53 years old on average, mostly female (54%), and mostly African-American (62%). Walking changes were limited, but participants reported increased quality of life during the intervention. Overall, the intervention was well-received and enjoyable for participants. Conclusions: The efficacy of utilizing cell phones to improve health and well-being among adults living in PSH requires further research, but these pilot findings suggest that such interventions are feasible and acceptable.
Section Title	Articles

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Abstract

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Key words: Exercise, pedometer, permanent supportive housing, text messaging, walking.

Introduction

Homeless persons experience high rates of chronic physical and mental health disorders (1, 2). Permanent supportive housing (PSH) pairs non-time-limited housing with wrap-around supportive services and is the principal accepted intervention for ending homelessness in the U.S. (3, 4). Persistent disparities in health among indigent populations call for improved access to appropriate healthcare as well as promotion of personal behaviors that can improve health. Safe and stable housing provides a foundation for healthcare and health promotion. There is therefore a need for health promotion and disease prevention services that can be implemented with homeless adults living in PSH. Given recent research findings identifying cell phone ownership and use as prevalent among homeless adults preparing to move into PSH (cite blinded for review), cell phones may be an effective means for disseminating health interventions in this population.

Mobile health (mHealth) interventions, which utilize cell phones and other digital technology for health promotion or disease prevention, have been identified in other populations as successful mechanisms for improving outcomes related to diet and exercise (5, 6), serious mental illness (7), and other preventive health behavior (8). The feasibility and acceptability of such interventions has not been examined among formerly homeless adults living in PSH, though some studies have used digital technology to intervene successfully with homeless populations. Phone-based motivational interviewing has been shown useful for smoking cessation and improvement of other health behaviors among a small sample of homeless persons receiving housing support at an outreach center in Australia (9). Pilot studies in the U.S.

have effectively utilized automated cell phone calls to improve medication adherence among homeless persons with co-occurring substance use and psychiatric disorders (10), and text messaging for appointment reminders among homeless veterans (11).

While these small-scale studies have been successful, homeless and formerly-homeless adults may still face unique challenges in adopting technology-based health interventions, particularly given that health issues associated with aging occur an average of 20 years earlier among homeless persons than in their housed counterparts (12). Aging-related health issues, particularly those related to vision, cognitive impairment, and arthritis may negatively impact the ability of homeless and formerly-homeless adults to effectively engage with technology-based interventions. Such interventions deserve investigation as means for enhancing health among formerly homeless persons in PSH, but the assessment of feasibility in this population is an important first step.

Given the need for effective interventions to improve the physical health of formerly-homeless persons, as well as concerns about the accessibility of such interventions, this paper presents feasibility and acceptability findings from a pilot study utilizing text messaging and pedometers to improve physical activity among formerly homeless adults living in PSH. This study is the first to our knowledge to introduce pedometers and text messaging as potential tools to monitor and improve physical activity among formerly homeless persons in PSH. We expected to find overall acceptance of this technology among persons in PSH due to the widespread use of cell phones, including among formerly homeless adults in permanent supportive housing (cite blinded for review). We also expected to find challenges in utilization that should be

acknowledged and addressed in developing and implementing such technology-based interventions.

Methods

Intervention Design

A systematic review found that few of the existing text-messaging interventions intended to improve health and health behavior were designed with reference to behavior change theory (13). There is evidence, however, that an intervention based on theory is more likely to be effective than one lacking a theoretical basis, since the former targets causal determinants of behavior and behavior change (14-16). We designed the text messaging-based intervention in the present study based on self-regulation techniques derived from Social Cognitive Theory (SCT) (17). These techniques were prompting self-monitoring, prompting goal setting, and providing feedback on performance. SCT posits that a person can achieve self-regulation by observing the behavior, identifying attainable short- and long-term behavior changes, and receiving information about the recorded behavior. Meta-regression analyses of interventions to promote physical activity and healthy eating indicate that these self-regulation techniques are associated with positive outcomes (18, 19). Moreover, a pilot study found that providing guidance in self-regulation to urban, low-income, Latino adults via a voice/text messaging-based intervention was feasible and accepted by participants (cite blinded for review).

Increased physical activity has been shown to improve a wide range of physical and mental health outcomes (20, 21). However, little research has examined physical

activity among homeless or formerly-homeless adults. The small body of extant research found mixed results, with sheltered homeless women (22) and a small sample of homeless adults in a smoking cessation program (23) reporting low rates of physical activity, while, in contrast, a large quantitative sample of homeless adults reported higher rates of adequate physical activity than persons in the general population (24).

Given the theoretical background and the health importance of physical activity, the current intervention aimed to increase physical activity by encouraging walking via goal-setting and motivational text messaging, self-monitoring walking using pedometers, and providing ongoing feedback on walking performance.

Study Sample and Procedures

Participants (n=13) enrolled in this study had completed a 12-month follow-up interview in an ongoing longitudinal study of 421 homeless adults moving into PSH in Los Angeles (cites blinded for review). Potential participants were selected if they had completed their final (12-month) interview in the longitudinal study, spoke English, and had reported lifetime diagnoses of comorbid chronic physical and mental health conditions. Potential participants were contacted and completed a second level of eligibility screening that assessed whether they: 1) had a cell phone and used/was willing to use text messaging, 2) planned to live in the LA area for the study duration, 3) not currently using a cane, walker, crutches, or wheelchair to assist with their walking, and 4) able to walk a flight of stairs without assistance. Fifty-four percent of those screened were eligible (n=14), and all but one eligible person participated in the study. The most common reason for study ineligibility was requiring walking assistance

(91.7%; n=11); the remaining person (8.3%) was ineligible because they did not use text messaging.

At the beginning of the intervention, a 30-minute, in-person, interviewer-administered survey using the Qualtrics offline survey app assessed participants' demographic characteristics and physical activity. Participants were given an electronic pedometer (Yamax Power Walker EX-510), which could be clipped to clothing or worn around the neck, and which provided weekly step totals. Study staff provided participants with detailed written and verbal instructions on pedometer use, and also assisted participants with the process of opting in to an online texting platform from their cell phones (25). Participants were given one-on-one assistance with utilizing text messaging, as needed.

After the first week, interviewers contacted participants by phone to assess first week step counts. Using a modified version of steps-per-day recommendations from Tudor-Locke and colleagues (26), interviewers calculated the weekly step goals for each participant. Step goals were intended to be moderate to ensure that inactive people would avoid injury, but still aimed to get participants as close as possible to recommended weekly numbers of steps. Goals increased each week. These calculations can be found in Table 1.

[TABLE 1 ABOUT HERE]

Intervention Procedures

During the intervention, participants received 24 text messages over the course of 6 weeks. Participants were able to choose the time of day that they received their messages; all messages were sent on the same day of the week. There were 4

messages each week: 2 knowledge-based and barriers-acknowledging statements about the positive benefits of physical activity on physical and mental health, meant to be motivational in nature; 1 question from the CES-D assessing depression in the past 7 days (27); and 1 text message asking the respondent to reply with their number of steps taken in the past week. If participants responded to the text message asking for weekly steps, study staff would provide text message feedback based on the calculated weekly step goals for the participant and their reported number of weekly steps.

[TABLE 2 ABOUT HERE]

At the conclusion of 6 weeks, participants completed a 45 to 60-minute follow-up interview during which they were asked the same questions as those in the first interview, along with qualitative, open-ended items assessing their experience with the intervention. To ensure that we received an accurate reporting of weekly step counts during the intervention, the interviewers logged weekly steps directly from the pedometers when they visited participants for the follow-up interview. These steps were used to calculate weekly and overall step changes. Specific measures are described below.

Measures

Participant Characteristics (Assessed at First Interview Only)

Participant characteristics included in this paper include demographics (age, gender, and race/ethnicity) assessed using items adopted or adapted from previous research (cites blinded for review). Participants were also asked total lifetime years spent in locations that constituted literal homelessness (temporary or emergency shelters, outside, abandoned building, garage or shed not meant for living in, indoor

public place, vehicle, and public transportation) (28). Participant time in PSH was measured by calculating the time between their move-in date and intervention start. Using a question adapted from the National Health Interview Study (29) with response options informed by research with homeless adults (29-31), participants were also asked about the types of chronic physical and mental health disorders they had been diagnosed with in their lifetime; count variables were created for the number of physical and mental diagnoses.

Quality of Life, Physical Activity Limitations, Walking Self-Efficacy, and Depressive Symptoms (Assessed at Both Interviews)

The 11-point quality of life scale was adopted from the RAND HIV Cost and Services Utilization Study (32). We adapted an item from the SF-12 to assess the impact of physical pain on usual physical activities (e.g., walking, climbing stairs) in the past week (33). A 16-item measure with a 4-point Likert scale from “not at all confident” to “very confident” assessed participants’ confidence in their ability to walk every day given several potential barriers (e.g., weather, pain, safety, stress, clothing) and was adapted from McAuley (34). The 10-item Center for Epidemiological Studies-Depression (CES-D) questionnaire was used to assess frequency of depressive symptoms in the past week (27).

Qualitative Perceptions of the Intervention (Assessed at Follow-up Only)

The follow-up questionnaire assessed experiences with technology, walking, and other aspects of the intervention; all measures were adapted or adopted from previous research by the authors (cite blinded for review). Participants rated their ease in receiving and replying to intervention text messages (7-point scale: “extremely easy” to

"extremely difficult") and their likelihood of recommending the intervention to others (5-point scale: "extremely likely" to "extremely unlikely"). Open-ended short answer items assessed why participants would or would not recommend the intervention, what they would change about the program, and other intervention experiences.

Other qualitative items assessed thoughts on the overall number of text messages, problems receiving messages, impressions about message content, and thoughts on using text messages to communicate with people about physical activity. Participants were also asked what they enjoy or dislike about walking, reasons why they did not walk when they should have, how study participation impacted their walking, and thoughts on setting walking goals, as well as experiences with the pedometer, including ease of use and how helpful a pedometer was in awareness of walking.

All study protocols were approved by the authors' institutional review board.

Data Analysis

All quantitative analyses are descriptive and were conducted in Stata Version 14 (35). Qualitative data was open-coded utilizing an inductive thematic coding process. All interviews were co-coded by two researchers, and any differences were resolved through consensus. Coded, qualitative responses were then sorted into categories as reported, accompanied by illustrative quotes.

Results

Quantitative Findings

Study Sample

[TABLE 3 ABOUT HERE]

As shown in Table 3, participants in this study averaged 52.5 years of age, were about half female (54%), and mostly African-American (62%). Their average lifetime duration of literal homelessness was 4.5 years, and they had been living in PSH for an average of 1.2 years when they participated in the intervention. Having comorbid chronic physical and mental health conditions was an eligibility criterion for this study; on average, participants had 3.8 chronic physical health conditions and 2.5 chronic mental health conditions.

Response Rates, Step Count Changes, Mental Health and Other Characteristics

As shown in Table 4, the overall text message response rate during the intervention was nearly 76%. This rate includes responses to text messages asking for the previous week's step totals from the pedometer, and those requesting responses to the depressive symptom item. For the depressive symptom item, the response rate was 81.3%; for the pedometer step totals, it was 67.7%. Weekly response rates varied, peaking at 85% in Weeks 1 and 4, and bottoming out at 69% in Weeks 2 and 6.

During the first week of study participation, 75% of participants increased their weekly steps; however, the proportion of respondents continuing to increase steps went down in subsequent weeks (see Figure 1). Looking at overall changes in the number of weekly steps from the beginning to the end of the intervention, slightly more than half (54%) of participants increased their weekly steps. Among those who increased their overall number of steps, the increase averaged about 54% over their steps in Week 1.

[FIGURE 1 ABOUT HERE]

[TABLE 4 ABOUT HERE]

Also shown in Table 4, the self-reported quality of life score increased for more than half of study participants (62%), depressive symptom score decreased for 50%, and barriers to walking decreased for two-thirds (67%). However, pain levels worsened for nearly 40% of participants during the intervention.

The vast majority of study respondents (92%) found it moderately or extremely easy to receive study texts, while 70% found it moderately or extremely easy to reply to those texts, and 92% would recommend this intervention to others.

Qualitative Findings

Two overarching themes emerged based on the coding of open-ended responses from the follow-up interviews. One theme pertained to technology utilization (i.e., text messaging, pedometers), and the other theme reflected thoughts and experiences surrounding the physical activity of walking.

Technology Utilization

Setting up the Texting Program

Some participants encountered technical difficulties setting up their phones to receive text messages from the third-party text messaging service. Three of 13 participants (23%) were unable to receive text messages through the online messaging system because their cell phone carrier blocked messages sent from “short code” (i.e., phone numbers less than 10 digits). One participant was able to contact their carrier and have this remedied, while the other two were unable to correct this issue and their text messages had to be sent manually via email to text. We also had two respondents

change phone numbers during the study. Both respondents contacted the study team to provide their new phone numbers, but one of those numbers could not receive the short code-based messages. One participant also accidentally opted out of the text messages and had difficulty opting back in.

Receiving and Responding to Text Messages

Most participants reported positive or neutral experiences with receiving motivational texts and responding to question texts during the study. We provided detailed instructions and technical support during the first interview, and participants reported appreciating this support:

- "[The interviewer] helped me learn exactly what I was doing with that phone. So I felt confident to do it."

Most respondents (69.2%) reported that they thought the number of texts they received each week was the right amount, and three people (23.1%) would have liked to receive more text messages.

Participants reported three major aspects of the study texts that they felt were positive: 1. They conveyed *important information* ("They were informative. I learned some things."; "I enjoyed reading them because it's something new."), 2. The texts *made them feel cared for* ("I liked the concern that came. Asking how I felt made me feel cared for as a person."; "It helped me know there was someone there and they cared."), and 3. They *provided motivation for walking* ("It was encouraging."; "I think [the texts] are important because it makes me change.").

Participants also reported some negative feelings surrounding the text messages. These fell into two major categories: 1. *Feeling unsure about which messages they were supposed to respond to*, and 2. Being *discouraged or feeling anxiety when they did not meet their walking goals*.

The technical aspects of text messaging were particularly difficult for one study participant. This participant reported feeling overwhelmed by the number of texts, and being fearful of giving the wrong answer and causing problems for the study. He expressed confusion about which texts he was supposed to respond to, and reported that sometimes his fear of sending the wrong response would keep him from sending anything. This respondent also had his phone turned off toward the end of the study because he did not have money to pay the bill. During his follow-up interview the respondent told the interviewer that he hoped he did not “mess up the study” or was not a “bad participant.”

Participants had several suggestions for improving the text messaging component of the study, including wanting to respond to all texts, getting notifications/reminders about meeting their walking goals, and wanting tips on calories and/or nutrition (“Tie in together nutrition and eating habits.”; “[If I don’t meet my goal] someone would notify me to give me a pusher.”).

Using the Pedometer

Participants reported generally positive experiences using the pedometer and seemed to enjoy having a *visual representation* of how much they were walking:

- “I wouldn't recognize all the walking I was doing without the pedometer.”

- “[The pedometer] was very helpful. I didn't realize how much I can walk.”
- “[Using the pedometer] validates what I did. This is what I earned.”
- “Very helpful to see my efforts with [the pedometer].”

Though the majority of the respondents felt the pedometer was *easy to wear and use* (61.5%), others had *trouble checking for the previous week’s steps* (“Had a difficult time navigating through the menus and understanding what the abbreviations stood for.”), *forgetting the pedometer* (“Some mornings I would forget to put it on.”; “If my son didn’t remind me I would have forgotten it more often.”), or had *difficulty wearing it*:

- “At times [the pedometer] was in the way. If I had my sunglasses and earphones the pedometer would interfere.”
- “After a while having [the pedometer] around my neck was a problem.”
- “Sometimes it bothered me wearing [the pedometer] so I would put it inside my shirt.”

Of note, one participant had her pedometer stolen after the first week of study participation; we replaced the pedometer and she continued in the study.

Participants had several suggestions for improving the pedometer experience, including having a *wrist-worn design* (“Attach to my wrist like a watch.”; “Make the pedometer a wrist watch.”) or a *different way to attach to clothing* (“The clip should have been stronger like a dental grip. It fell off me when I tried to run.”; “The clip kept falling from my pants.”), and having *additional features*, such as a heartbeat monitor and calorie count.

Physical Activity

Participants reported many positive aspects of walking and physical activity, most commonly those related to improved motivation and mental health outcomes. Respondents discussed motivation in several ways, including 1. *General motivation for walking* (“The study kept me walking.”; “If I didn’t reach my goal I’ll start walking in my place. It’s motivating.”; “It has made me change some of my routes to walk a little longer instead of shortcuts.”), 2. Motivation related to *meeting or beating their walking goals* (“I seem to be more interested in taking my walks and like watching the numbers change [on the pedometer].”; “It was a plan to see if I could whoop my goals.”; “Every day I know I need to walk. Half way through the day if I'm not halfway to the goal it motivates me to do it right then and there. I'm going to walk somewhere to get those steps in.”; “It was fun to accomplish my walking goals almost every week.”), and, 3. *Feeling motivated and productive in general* (“It keeps me conscious of getting up every day and makes me feel like I'm doing a form of exercise. Makes me feel conscious of dedicating myself to get up every day, get out and move. I've spent more days dressed during these 6 weeks, getting my hair done, opening the house, so I can be ready to get out than I had in the past before this study.”; “I like that I feel less guilty about my level of inactivity because it showed me I walk around more than I give myself credit for.”).

Participants described walking as having a *positive impact on their mood, stress, and other aspects of their mental health*:

- “It clears my head and reduces my stress.”
- “Makes me feel good about myself.”
- “I’m under a lot of pressure lately and walking lately helps me release stress better.”

- “I think it's a good thing to set goals every day to get up and go on a walk. Especially with me being depressed the study motivated me and it does keep me in a better spirit.”
- “[What I liked most] was paying attention to myself.”

Participants reported that walking allowed them to *enjoy the outdoors* (“Fresh air. Seeing the birds. Seeing people.”), *walk their pets* (“I get to be with my dogs and they look forward to it, which makes me like it.”), *interact with family* (“My son was very involved and he consistently checked how many miles I walked daily. I even called my mother to let her know.”), and *commute* (“I enjoy walking. It’s the only way I can get around since I don’t have a car.”; “I'm not doing walking just for fun, I'm doing walking as needed to get from point A to point B.”). Participants also stated that walking made them *feel more normal and less isolated* (“Gets me out of my apartment and makes me feel like a normal member of society.”; “I just enjoyed it. It made me now conscious to every day get up and walk. It helps me to not isolate myself. Meet new people, have conversations.”).

When discussing the negative aspects of walking, participants mentioned both internal and external factors that impacted their ability to walk or their enjoyment of walking. The most common internal factors that impeded walking or made participants think negatively about walking were 1. *Mental health, including social anxiety and depression* (“I wasn’t feeling good emotionally. All kinds of doubt and panic and dread. Fear people will start conversations. Anything I can do to avoid people I do.”; “Feeling depressed makes it hard to get moving.”; “My emotions kick in and it stops anything I do. My mental health keeps me from having any confidence in doing anything.”), 2.

Physical pain (“My knees hurt when I walk.”; “My feet hurt.”; “I wasn’t feeling good. Physically sick from my HIV and mentally.”), and, 3. *Lacking motivation* (“I'm pretty good with thinking up the goals but follow through with them isn't as easy as making them up. In my mind I want to be a great walker and be a walking body. There's no excuse. I want to be more fit.”; “I was too lazy to get up from watching TV.”).

Less common internal factors included *forgetting to walk*, having *family obligations* that interfered with walking, feeling *like goals were unrealistic*, feeling that they were already *active enough*, and *disliking walking* in general (“Walking is not my thing unless I really have to go somewhere.”)

External factors that limited participants’ ability or desire to walk were primarily *bad weather or air quality* (“Feeling uncomfortable with the heat and the smoke in the air made it seem healthier not to exercise.”; “The weather was too hot.”) and *not having an appealing location in which to walk*:

- “Don’t like running into aggressive people in the street.”
- “Wish I had easier access to nicer places to walk through.”
- “Need to walk far to see something interesting. In NYC you could walk a block and see so many things and people. Skid Row is so blighted. The expensive high rises have people that won’t even look at you. What is there to see?”
- “Creepy people in my neighborhood that I have to walk past.”
- “Dislike this area.”
- “I don’t have any interest in walking in my neighborhood.”

General Study Suggestions

Participants had several general suggestions about possible improvements for future intervention programs, including:

- Longer study period (“Make the study longer. It should be about 12 weeks. 6 doesn't give a person enough time to make any changes.”)
- Include nutrition tips and information
- Pay more money
- Have a diary portion
- Have a phone application rather than texting (“Had it been an app and not living in Skid Row I’d be open to using it on a regular basis.”)
- Have competitions with other users
- Incorporate interesting destinations (“I wish I had a goal to reach like a treasure hunt. Like go to local museums to make it more exciting and asking how many steps did you take to get there. Give people choice[s] to walk somewhere beyond their neighborhood.”)

Limitations

Because this is a small pilot study focused on feasibility and acceptability, we are not able to present data on efficacy or make claims about statistically significant behavior changes. Some participants also experienced technical difficulties with the text messaging system and their pedometers; this provided us with valuable feedback about the feasibility of this program, but also reduced the number of useable observations. Finally, given time constraints, we did not include a true baseline measure of participant steps (steps prior to study participation), but rather measured steps during the first week of study participation.

Discussion

This study of an intervention utilizing pedometers and texting to promote physical activity (i.e. walking) is the first to be conducted among homeless adults living in PSH. Our investigation of feasibility, acceptability, and preliminary evidence of behavior

change through intervention will inform future, innovative efforts to improve the health of formerly homeless persons in housing.

Given the high rates of cell phone ownership and use among formerly homeless adults (cite blinded for review), evidence of acceptability, and suggestive evidence of change in walking behavior and particularly quality of life, these findings suggest that technology-based interventions hold promise as an additional channel through which to improve PSH residents' health and wellbeing. Systematic reviews have demonstrated that physical activity can reduce symptomology among persons with serious mental illness (21) and can decrease the risk of obesity, coronary heart disease, type 2 diabetes mellitus, Alzheimer's disease and dementia (20). As such, mHealth interventions focused on physical activity may also prove effective in reducing costlier use of health services and improving quality of life.

This brief text message-based intervention also demonstrated that PSH residents enjoyed using their cell phones to receive health information for behavior modification. Although increase in participants' walking behavior appeared limited overall and was most distinct during the first two weeks, this pilot suggests that technology-based interventions hold promise for formerly-homeless persons and warrants additional investigation.

There are some limitations that should be considered when designing future programs. Cell phone-based interventions that rely on text message delivery from a short code sender may not be the most effective, as 31% of participants throughout the study could not receive such messages. Many participants in the parent study reported having smartphones (cite blinded for review); thus, a smartphone app might prove more

accessible and feasible for this type of intervention. However, some limitations of smartphone apps should be considered, including high cost for application design and the need to make the app available on multiple phone operating systems. Further, the frequency of walking (number of steps) appeared to decline after the first two weeks, suggesting that in addition to potential modifications in the technology, future interventions may need to incorporate motivational interviewing (36) or behavioral activation (37) protocols to promote continued participation and thus efficacy.

Finally, that participation in this intervention appeared to be associated with quality of life (both quantitatively and qualitatively) is of value in its own right. Quality of life in PSH has received less attention than outcomes related to housing retention and physical health, yet it is a universally desired and fundamental aspect of human existence recognized by the World Health Organization (38). Improvements in quality of life should be considered important outcomes alongside more traditional measures of health and wellness within permanent supportive housing.

Overall, this research identified text messaging and the use of pedometers as a feasible and promising option for improving the health and wellbeing of persons living in PSH. The majority of participants enjoyed being a part of the technology-based intervention, were able to successfully interact via text-messaging, and saw positive improvements in walking behavior and/or quality of life. Despite these promising findings, we also identified some areas of potential concern with technology-based programs for persons in PSH, including varying levels of ability to interface with technology and problems with the receipt of text messages from short code senders. Future research is needed to fully understand the efficacy of such interventions, but this

pilot work suggests that providers should be considering technology-based interventions as feasible and acceptable for improving health and wellbeing among adults in permanent supportive housing.

Acknowledgements: Blinded for submission.

Disclosure: The authors have not published these findings, nor is this manuscript currently under consideration at any other journal. The authors do not have any financial interests to disclose.

References

1. Fazel S, Geddes JR, Kushel M. The health of homeless people in high-income countries: descriptive epidemiology, health consequences, and clinical and policy recommendations. Lancet. 2014;384(9953):1529-40.
2. Hwang SW, Burns T. Health interventions for people who are homeless. Lancet. 2014;384(9953):1541-7.
3. Byrne T, Fargo JD, Montgomery AE, Munley E, Culhane DP. The Relationship between Community Investment in Permanent Supportive Housing and Chronic Homelessness. Soc Serv Rev. 2014;88(2):234-63.
4. Rog DJ, Marshall T, Dougherty RH, George P, Daniels AS, Ghose SS, et al. Permanent supportive housing: assessing the evidence. Psychiatr Serv. 2014;65(3):287-94.
5. DiFilippo KN, Huang WH, Andrade JE, Chapman-Novakofski KM. The use of mobile apps to improve nutrition outcomes: A systematic literature review. J Telemed Telecare. 2015;21(5):243-53.
6. Okorodudu DE, Bosworth HB, Corsino L. Innovative interventions to promote behavioral change in overweight or obese individuals: A review of the literature. Ann Med. 2015;47(3):179-85.
7. Naslund JA, Marsch LA, McHugo GJ, Bartels SJ. Emerging mHealth and eHealth interventions for serious mental illness: a review of the literature. J Ment Health. 2015;24(5):321-32.
8. Vodopivec-Jamsek V, de Jongh T, Gurol-Urganci I, Atun R, Car J. Mobile phone messaging for preventive health care. Cochrane Database Syst Rev. 2012;12:CD007457.
9. Bonevski B, Baker A, Twyman L, Paul C, Bryant J. Addressing smoking and other health risk behaviours using a novel telephone-delivered intervention for homeless people: a proof-of-concept study. Drug Alcohol Rev. 2012;31(5):709-13.
10. Burda C, Haack M, Duarte AC, Alemi F. Medication adherence among homeless patients: a pilot study of cell phone effectiveness. J Am Acad Nurse Pract. 2012;24(11):675-81.
11. McInnes DK, Petrakis BA, Gifford AL, Rao SR, Houston TK, Asch SM, et al. Retaining homeless veterans in outpatient care: a pilot study of mobile phone text message appointment reminders. Am J Public Health. 2014;104 Suppl 4:S588-94.
12. Brown RT, Hemati K, Riley ED, Lee CT, Ponath C, Tieu L, et al. Geriatric Conditions in a Population-Based Sample of Older Homeless Adults. Gerontologist. 2016.
13. Hall AK, Cole-Lewis H, Bernhardt JM. Mobile text messaging for health: a systematic review of reviews. Annu Rev Public Health. 2015;36:393-415.
14. Michie S, Johnston M, Francis J, Hardeman W, Eccles M. From theory to intervention: mapping theoretically derived behavioural determinants to behaviour change techniques. Appl Psychol. 2008;57(4):660-80.
15. Noar SM, Benac CN, Harris MS. Does tailoring matter? Meta-analytic review of tailored print health behavior change interventions. Psychol Bull. 2007;133(4):673-93.
16. Taylor N, Conner M, Lawton R. The impact of theory on the effectiveness of worksite physical activity interventions: A meta-analysis and meta-regression. Health Psychol Rev. 2011;6:33-73.

17. Bandura A. Self-Efficacy: The Exercise of Control. New York: W.H. Freeman and Company; 1997.
18. Dombrowski S, Sniehotta F, Avenell A, Johnston M, MacLennan G, Araujo-Soares V. Identifying active ingredients in complex behavioural interventions for obese adults with obesity-related co-morbidities or additional risk factors for co-morbidities: a systematic review. Health Psychol Rev. 2012;6(1):7-32.
19. Michie S, Abraham C, Whittington C, McAteer J, Gupta S. Effective techniques in healthy eating and physical activity interventions: a meta-regression. Health Psychol. 2009;28(6):690-701.
20. Reiner M, Niermann C, Jekauc D, Woll A. Long-term health benefits of physical activity--a systematic review of longitudinal studies. BMC Public Health. 2013;13:813.
21. Rosenbaum S, Tiedemann A, Sherrington C, Curtis J, Ward PB. Physical activity interventions for people with mental illness: a systematic review and meta-analysis. J Clin Psychiatry. 2014;75(9):964-74.
22. Wilson M. Health-promoting behaviors of sheltered homeless women. Fam Community Health. 2005;28(1):51-63.
23. Kendzor DE, Reitzel LR, Businelle MS. Characterizing Stressors and Modifiable Health Risk Factors Among Homeless Smokers: An Exploratory Pilot Study. Health Educ Behav. 2015;42(5):642-7.
24. Taylor EM, Kendzor DE, Reitzel LR, Businelle MS. Health Risk Factors and Desire to Change among Homeless Adults. Am J Health Behav. 2016;40(4):455-60.
25. call-em-all. 2016 [Available from: https://www.call-em-all.com/.
26. Tudor-Locke C, Craig CL, Aoyagi Y, Bell RC, Croteau KA, De Bourdeaudhuij I, et al. How many steps/day are enough? For older adults and special populations. Int J Behav Nutr Phys Act. 2011;8(1):1.
27. Andresen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: evaluation of a short form of the CES-D (Center for Epidemiologic Studies Depression Scale). Am J Prev Med. 1994;10(2):77-84.
28. Homelessness NAtE. Changes in the HUD definition of “homeless.” 2012.
29. Council NHCftH. Homelessness & health: What’s the connection? . 2011.
30. Bassuk EL, Buckner JC, Perloff JN, Bassuk SS. Prevalence of mental health and substance use disorders among homeless and low-income housed mothers. Am J Psychiatry. 1998;155(11):1561-4.
31. Hwang SW. Homelessness and health. CMAJ. 2001;164(2):229-33.
32. Hays RD, Spritzer KL, McCafl‘rey D, Cunningham W, Eggan F, Crystal S. The HIV Cost 8 Services Utilization Study (H CS US) Measures of Health-Related. 1998.
33. 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;34(3):220-33.
34. McAuley E. The role of efficacy cognitions in the prediction of exercise behavior in middle-aged adults. J Behav Med. 1992;15(1):65-88.
35. StataCorp. Stata Statistical Software: Release 14. College Station, TX: StataCorp LP2015.
36. Miller WR, Rollnick S. Motivational Interviewing: Preparing People To Change Addictive Behavior. New York: Guilford Press; 1991.
37. Kanter JW, Manos RC, Bowe WM, Baruch DE, Busch AM, Rusch LC. What is behavioral activation? A review of the empirical literature. Clin Psychol Rev. 2010;30(6):608-20.

38. World Health Organization. The World Health Organization Quality of Life assessment (WHOQOL): position paper from the World Health Organization. Soc Sci Med. 2005;41(10):1403-9.

Table 1. Weekly Step Increase Calculations Based on Week 1 Steps.

Week 1 Steps	Weekly Increase
<7,000	14-30% per week
7,000-17,499	Variable percentage to reach 38,500 steps by Week 6
17,500-34,999	Variable percentage to reach 49,700 steps by Week 6
35,000-52,499	Variable percentage to reach 70,000 steps by Week 6
52,500+	8-10% per week

Table 2. Text-Messages

Knowledge-Based Message Examples

Physical activity can help you manage stress and feel less tired. Once you become active, you’re likely to have more energy than before.

Being active will help you get in shape and look good. Keep up your walking!

Barriers-Acknowledging Message Examples

Feeling too lazy or tired to go on a walk? Plan on walking during times of the day when you tend to feel most energetic.

Schedule walking as you would schedule an important appointment. Block off these times in your schedule.

Depression Screener (CES-D)

Over the past 7 days, how often have you been bothered by feeling down, depressed or hopeless?

Steps Assessment

How many steps did you take last week? Review the weekly log on your pedometer and reply with the weekly number of steps.

Steps Feedback Examples

Great job! You're working hard to meet your goals. Now try increasing your daily steps to meet next week's goal.

Walking needs to be a regular habit to produce benefits. Make an effort to improve your walking in the next 7 days.

Table 3. PSH Walking Pilot Study Demographic, Homelessness, Housing, and Health Characteristics (n=13)

	%(n)/mean(SD)
Age	52.5 (5.6)
Gender	
Male	46.2 (6)
Female	53.9 (7)
Race/Ethnicity	
African-American/Black	61.5 (8)
White	23.1 (3)
Another race/ethnicity	15.4 (2)
Lifetime duration of literal homelessness (years)	4.5 (4.7)
Time in PSH (years)	1.2 (0.2)
Number of chronic physical health conditions	2.7 (1.7)
Number of chronic mental health conditions	3.5 (1.9)

Table 4. PSH Walking Pilot Study Response Rates, Step Changes, and Quantitative Outcomes (N=13)

	%(n)/mean(SD)
Text Message Response Rates	
Overall text response rate (range: 25.0%-100.0%)	75.6
Response rate to mental health items (range: 69.2%-100.0%)	81.3
Response rate to step counts requests (range: 53.9%-76.9%)	67.7
Response rate per week	
1	84.6
2	69.2
3	76.9
4	84.6
5	76.9
6	69.2
Steps	
Overall step changes	
Increase	53.9 (7)
Decrease	46.2 (6)
% change among those with step increases	153 (123)
% change among those with step decreases	63 (41)
Quality of life	
Improved	61.5 (8)
No change	23.1 (3)
Worsened	15.4 (2)
Pain	
Lessened	30.8 (4)
No change	30.8 (4)
Worsened	38.5 (5)
Barriers to walking	
Decreased	66.7 (8)
Increased	33.3 (4)
CES-D mean score (lower=less depression; range: 5-25)	
First interview	13.8 (5.9)
Follow-up	12.6 (6.7)
Decreased	50.0 (6)
No change	8.3 (1)
Increased	41.7 (5)
Found it extremely or moderately easy to:	
Receive study texts	92.3 (12)
Reply to study texts	69.2 (9)
Extremely likely/likely to recommend program	92.3 (12)

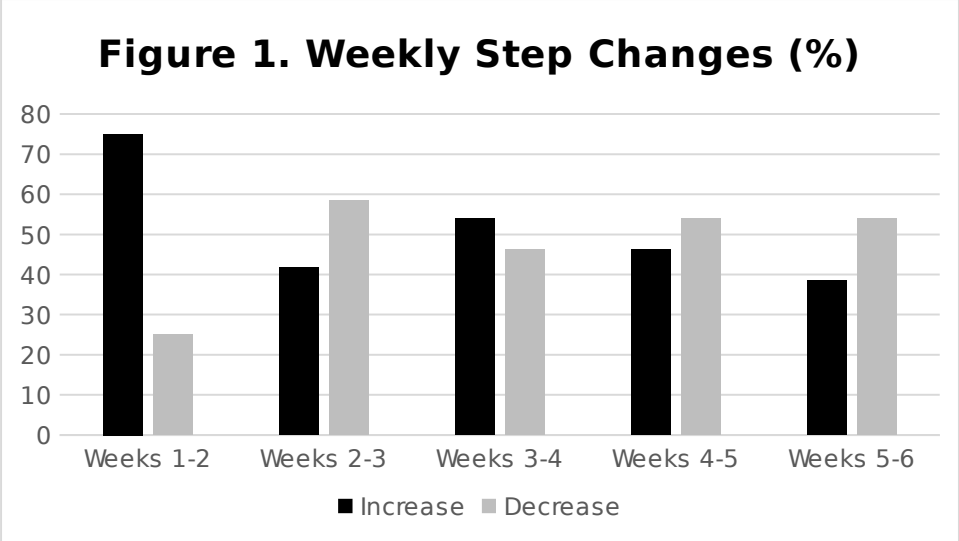
Figure 1. Weekly Step Changes (%)
80
70
60
50
40
30
20
10
0
Weeks 1-2
Weeks 2-3
Weeks 3-4
Weeks 4-5
Weeks 5-6
Increase
Decrease

A Text Messaging-Based Intervention to Increase Physical Activity among Formerly Homeless Persons: Feasibility and Acceptability Findings from a Pilot Study

Running Title: Text-Messaging in PSH Feasibility Study

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Acknowledgements: This work was supported by the National Institute on Drug Abuse [grant number R01 DA36345; PI: Dr. Suzanne Wenzel].