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**Title:** Examining the prevalence and perceived utility of mobile health applications among recently incarcerated homeless adults

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**Word Count:**

**Abstract**

Mobile technologies may enable remote provision of physical and mental health services for recently incarcerated homeless adults (RIHA). The purpose of this study was to examine the prevalence and perceived utility of mobile technology to support health behavior change among RIHA. Participants (*N*=324) enrolled in an ongoing RCT at a homeless shelter in Dallas, Texas were included in the current cross-sectional analyses.Overall, 28.4% (92/324) of participants had an active cell phone, of which, 84.8% (78/92) were smartphones. Most participants believed that smartphone apps could help change their actions or behaviors (265/324, 82.8%); however, only a quarter had ever used an app for this purpose (81/324, 25.1%). Apps were most commonly used for physical activity (42/81, 51.2%) and food/calorie tracking (41/81, 50.0%). Findings highlight a willingness to use mobile technologies and future studies should examine if smartphone apps that address mental health and heath behaviors are feasible in RIHA.

**Introduction**

An estimated 580,466 individuals experience homelessness on a given night in the United States.1 Individuals experiencing homelessness are disproportionately represented in the criminal justice system.2 Recently incarcerated homeless adults (RIHA) are defined as individuals who were released from jail within the past 60 days and are currently homeless .3 RIHA report a greater prevalence of mental illness, substance use disorders, and are at increased risk for re-arrest compared with recently incarcerated domiciled adults.4–6 Timely, consistent, and easily accessible physical and mental health services may reduce recidivism, and improve health among RIHA.7 Thus, novel methods of contacting and intervening with RIHA are needed.

A significant percentage of individuals experiencing homelessness use mobile technologies, including mobile phones, texting, apps, and e-mail.8,9 For instance, our previous work has determined that cell phone ownership is common among adults experiencing homelessness. Other studies have indicated that adults experiencing homelessness use mobile technology for many reasons, including connection with peers and family members, safety (e.g., access to emergency services), and communication with current or potential employers. Furthermore, adults experiencing homelessness report willingness to use mobile technologies to stay engaged in their healthcare, including receiving provider calls, as well as healthcare appointment reminders through text or call.10 However, mental health services are traditionally only provided in person for adults experiencing homelessness, making it difficult for this population to access sorely needed services.

The primary purpose of the current study is to examine the use of digital media and mobile technologies among RIHA, including phone ownership, data plan access, use of social media, and overall internet use. The perceived utility of mobile health applications to help change or manage health behaviors among RIHA will also be examined. This information may be used to determine the feasibility of smartphone-based interventions that are specifically designed for RIHA.

**METHODS**

**Participants and Procedures**

Data from the first 324 participants that enrolled in an ongoing three-armed randomized controlled trial in Dallas, Texas are used for the current cross-sectional study. Data collection began in 2018 and additional details about the parent study have been published previously.3 Individuals were eligible for the parent trial if they: 1) were released from Dallas County Jail within the past 60 days, 2) anticipated continued residence in the Dallas area for the next year, 3) were enrolled in the Homeless Recovery Program offered at the shelter where the study takes place, 4) were willing to attend in-person baseline, randomization, and follow up assessment visits scheduled at 1-, 3-, and 6-months post randomization, 5) received a score ≥4 on the Rapid Estimate of Adult Literacy in Medicine-Short form11 indicating an English literacy level greater than the 6th grade, and 6) received a score >24 on the Mini-Mental State Exam,12 indicating no substantial cognitive impairment.

Upon release from Dallas County Jail, individuals who reported being homeless received a flyer that briefly described the study. Interested individuals were screened by study staff at the shelter, and those who qualified for the study completed the informed consent and were asked to complete a series of baseline questionnaires on tablet computer. Participants were then scheduled for a randomization visit approximately 72 hours after the baseline visit and were randomized into one of three study conditions. Participants were compensated for completing each in-person visit. The University of Oklahoma Health Sciences Center and University of Texas Health Sciences Center Institutional Review Boards approved the study procedures.

**Measures**

*Demographics.* Each participant completed a series of questionnaires during the baseline visit that assessed demographic characteristics, including sex, race/ethnicity, age, marital status, and years of completed education. Participants also answered questions regarding length of homelessness and arrest history.

*Cell phone/smartphone information/ownership.* Participants were asked “Do you have an active cell phone?” (0=no, 1=yes). If participants answered yes, they were then asked “Who pays for your cell phone service?” (1=government, 2=family or friend, 3=someone else, 4=I pay for my cell phone service). Participants answered “How many ‘talk’ minutes does your plan have?” (0=0-200, 1=201-400, 2=401-600, 3=Unlimited, 4=I use a ‘pay as you go’ or prepaid phone). Participants with active cell phones were asked “Is your cell phone a smart phone?” (0=no; 1=Yes, I have an Android smartphone, 2=Yes, I have an Apple smartphone (iPhone); 3=Yes, I have a Smartphone that is not Apple or Android”). Smartphone owners were asked “Does your phone service include a data plan?” (0=No; 1=Yes, but my data plan is limited; 2=Yes, my plan includes unlimited data). Participants were also asked “How many times has your phone number changed in the past year?” (0, 1, 2, 3, 4, 5 or more).

*Social media/internet use.* Participants were asked “Which of the following forms of media do you use?” (1=email, 2=Facebook, 3=Google Plus, 4=Twitter, 5=blogs, 6=Instagram, 7=Snapchat, 8=LinkedIn, 9=None of the above). Participants were asked about internet usage, “How often do you access the internet?” (0=Never, 1=About once a month, 2=About once per week, 3=2 or 3 times per week, 4=4 to 6 times per week, 5=About once per day, 6=About twice per day, 7=Every few hours or more). Participants were also asked “Do you have an active Facebook page?” (0=No, 1=Yes). If the participant answered yes, they were then asked “How often do you check or post on Facebook?” (0=Never, 1=About once a month, 2=About once per week, 3=2 or 3 times per week, 4=4 to 6 times per week, 5=About once per day, 6=About twice per day, 7=Every few hours or more).

*Smartphone app to change actions and behaviors.* At the baseline visit, participants were asked a series of questions to assess opinions about their prior use of and perceived utility of smartphone applications to support behavior change. Specifically, participants were asked: 1. “Do you believe that a smartphone app can help you to change your actions or behaviors?” (0=No, 1=Yes), 2. “Have you ever used a smartphone app to manage one or more health-related issues?” (0=No, 1=Yes), and 3. those who answered “Yes” were asked “What type of health related issue?” (food/calorie tracking, medication reminders, mood manager, physical activity, sleep tracking, smoking cessation, stress reduction, weight loss or tracking, and other).

**Statistical Analyses**

Descriptive analyses were conducted to report participant characteristics, including: sociodemographic background, lifetime homelessness, lifetime incarceration, physical and mental health, and access to a mobile phone and data plans. Descriptive analyses were also conducted to report beliefs about whether (a) a smartphone app can help them change their actions and behaviors and (b) whether an app could manage one or more health-related issues. Statistical analyses were conducted using R version 4.1.013 in RStudio version 1.4.171714 with the following packages: tidyverse,15 freqtables,16 meantables.17

**RESULTS**

Participants (*N*=324) were predominantly male (84.9%), Black or African American (59.9%), and, on average, 39.8 years old (*SD*, 10.9). A majority of participants were high school graduates (223/324, 68.8%) and very few reported that they were currently employed (27/324, 8.3%). Almost one third of participants (94/324, 29.0%) reported their general health to be less than good, with the average number of poor physical (*M* = 7.2, *SD* = 9.9) and mental health days (*M* = 11.7, *SD* = 11.1) noted. Participants also reported their lifetime total months homeless (*M* = 49.0, *SD* = 69.2) and lifetime years in jail (*M* = 5.6, *SD* = 6.3). See Table 1.

*Prevalence of mobile technology use among RIHA.* Overall, 28.4% (92/324) of participants currently owned a mobile phone. Importantly, 83.6% (271/324) of all participants reported that they owned a mobile phone in the past year and that their number was changed at least once during that time (205/271, 75.6%). Among participants that currently owned a mobile phone, 87.0% (80/92) had an unlimited talk plan and 53.3% (49/92) of those individuals paid for their own phone service. Most of those with mobile phones (78/92, 84.8%) had smartphones, the vast majority of which used the Android operating system (74/92, 80.4%). Most who owned a smartphone had an unlimited data plan (52/78, 66.6%). See Table 1.

Overall, 88.6% (287/324) of participants reported accessing the internet at least weekly, with 46.0% (149/324) accessing the internet every few hours. The majority of participants reported using email (250/324, 77.2%) and Facebook (227/324, 70.1%), but few participants used platforms like Google Plus, Twitter, blogs, Instagram, Snapchat, or LinkedIn. Further, most participants reported posting or checking their Facebook page at least weekly (170/220, 81.4%) with 46.8% (103/220) indicating they even check their page at least daily. See Table 1.

*Perceived utility and prevalence of mobile technology for health-related issues among RIHA.* The majority of participants believed that smartphone apps can be used to change actions or behaviors (265/324, 82.8 %); however, only a quarter of participants had ever used an app for this purpose (81/324, 25.1%). Among those who had used an app to manage a health behavior, most reported app use for multiple health behaviors (xx.x%). The most common health behavior apps used were for physical activity (42/81, 51.2%), food/calorie tracking (41/81, 50.0%), and medication reminders (40/81, 48.8%).

**Discussion**

Study findings indicate that RIHA regularly access and use mobile technologies (e.g., email, Facebook, Internet). Further, most RIHA believe that smartphone apps can help them to change their actions or behaviors. However, most RIHA participants reported that they had never used apps for this purpose. Scalable and secure mobile health interventions are needed to increase access to empirically supported treatments for RIHA, in order to increase access to high quality treatments that may short circuit the revolving door of incarceration and homelessness.

Despite lower current smartphone ownership in RIHA compared with previous studies conducted in populations of adults experiencing homelessness,8,9 most RIHA (i.e., 83.6%) reported phone ownership in the past year and most reported weekly use of the internet (88.6%), weekly use of Facebook (55.2%), and current use of email (77.2%). RIHA may have lower rates of current smartphone ownership than other adults experiencing homelessness because their property may have been confiscated when they were arrested and they have not yet reestablished wireless service. Upon release from incarceration, distribution of low-cost smartphones that are pre-loaded with therapeutic content and links to care providers could result in improved mental health, adherence to recommended health behaviors, and reduce recidivism among RIHA.

While there are a number of strengths of this study, in particular the sample size, there are also some limitations. First, this study was cross-sectional. While the cross-sectional design allowed us to identify the frequency/proportion of key study variables (e.g., smartphone ownership), longitudinal data is need to understand whether these variables change over time. Second, the study took place in one shelter in Dallas, Texas, which may limit the generalizability of study findings to other cities or non-urban areas. Third, this study used a convenience sample, which could have resulted in underrepresentation from some groups of adults experiencing homelessness. For instance, homeless adults who avoid or do not obtain services from homeless shelters. Finally, data for the current study was collected from participants who were enrolled into a three-armed randomized controlled trial that assessed the benefit of a smartphone app to increase case management and treatment service utilization. Participants who elected to enroll in the trial may have had a greater access to mobile technologies than participants who declined enrollment.

Overall, the use of mobile technology is surprisingly high among RIHA, yet few interventions are currently available, and even fewer have been empirically tested for clinical utility in this population of underserved and understudied adults. The results of the current study indicate future mobile interventions that utilize secure websites, email, private Facebook groups/pages, phone calls, texts, and/or smartphone applications could be used to engage RIHA in mental health and health behavior change interventions.

**References**

1. Sleet DA, Francescutti LH. Homelessness and Public Health: A Focus on Strategies and Solutions. *International Journal of Environmental Research and Public Health*. 2021;18(21):11660. doi:10.3390/ijerph182111660

2. Diamond B, Burns R, Bowen K. Criminalizing Homelessness: Circumstances Surrounding Criminal Trespassing and People Experiencing Homelessness. *Criminal Justice Policy Review*. Published online December 28, 2021:08874034211067130. doi:10.1177/08874034211067130

3. Reingle Gonzalez JM, Businelle MS, Kendzor D, Staton M, North CS, Swartz M. Using mHealth to Increase Treatment Utilization Among Recently Incarcerated Homeless Adults (Link2Care): Protocol for a Randomized Controlled Trial. *JMIR Res Protoc*. 2018;7(6):e151. doi:10.2196/resprot.9868

4. Greenberg GA, Rosenheck RA. Jail incarceration, homelessness, and mental health: a national study. *Psychiatr Serv*. 2008;59(2):170-177. doi:10.1176/ps.2008.59.2.170

5. Metraux S, Culhane DP. Homeless Shelter Use and Reincarceration Following Prison Release\*. *Criminology & Public Policy*. 2004;3(2):139-160. doi:10.1111/j.1745-9133.2004.tb00031.x

6. Myrstol BA, Fitzpatrick KM. Risk Factors and the Duration of Homelessness among Drug-Using Arrestees: Evidence from 30 American Counties. *Journal of Drug Issues*. 2011;41(4):523-560. doi:10.1177/002204261104100405

7. Thurman W, Semwal M, Moczygemba LR, Hilbelink M. Smartphone Technology to Empower People Experiencing Homelessness: Secondary Analysis. *Journal of Medical Internet Research*. 2021;23(9):e27787. doi:10.2196/27787

8. Rhoades H, Wenzel SL, Rice E, Winetrobe H, Henwood B. No digital divide? Technology use among homeless adults. *Journal of Social Distress and Homelessness*. 2017;26(1):73-77. doi:10.1080/10530789.2017.1305140

9. Raven MC, Kaplan LM, Rosenberg M, Tieu L, Guzman D, Kushel M. Mobile Phone, Computer, and Internet Use Among Older Homeless Adults: Results from the HOPE HOME Cohort Study. *JMIR Mhealth Uhealth*. 2018;6(12):e10049. doi:10.2196/10049

10. McInnes DK, Sawh L, Petrakis BA, et al. The Potential for Health-Related Uses of Mobile Phones and Internet with Homeless Veterans: Results from a Multisite Survey. *Telemedicine and e-Health*. 2014;20(9):801-809. doi:10.1089/tmj.2013.0329

11. Davis TC, Long SW, Jackson RH, et al. Rapid estimate of adult literacy in medicine: a shortened screening instrument. *Fam Med*. 1993;25(6):391-395.

12. Bleecker ML, Bolla-Wilson K, Kawas C, Agnew J. Age‐specific norms for the Mini‐Mental State Exam. *Neurology*. 1988;38(10):1565-1565. doi:10.1212/WNL.38.10.1565

13. R Core Team. *R: A Language and Environment for Statistical Computing.*; 2021. https://www.R-project.org/

14. RStudio Team. *RStudio: Integrated Development Environment for R.*; 2021. http://www.rstudio.com/.

15. Wickham H, Averick M, Bryan J, et al. Welcome to the Tidyverse. *Journal of Open Source Software*. 2019;4(43):1686. doi:10.21105/joss.01686

16. Cannell B. *Freqtables: Make Quick Descriptive Tables for Categorical Variables*.; 2020. Accessed January 3, 2022. https://CRAN.R-project.org/package=freqtables

17. Cannell B. *Meantables: Make Quick Descriptive Tables for Continuous Variables*.; 2020. Accessed January 3, 2022. https://CRAN.R-project.org/package=meantables

**Table 1**. Characteristics of participants who completed the Link2Care baseline assessments (n = 324).

| **Characteristic** | **Statistics** |
| --- | --- |
| Age, mean (sd) | 39.8 (10.9) |
|  |  |
| Gender, n (percent) |  |
| Male | 275 (84.9) |
| Female | 44 (13.6) |
| Other | 5 (1.5) |
|  |  |
| Race/Ethnicity, n (percent) |  |
| White, non-Hispanic | 54 (16.7) |
| Black, non-Hispanic | 194 (59.9) |
| Hispanic, any race | 42 (13.0) |
| Other race, non-Hispanic | 34 (10.5) |
|  |  |
| High school grad or GED, n (percent) |  |
| No | 101 (31.2) |
| Yes | 223 (68.8) |
|  |  |
| Employment status, n (percent) |  |
| Employed | 27 (8.3) |
| Unemployed, looking for work | 176 (54.3) |
| Unemployed, not looking for work | 47 (14.5) |
| Unable to work or disabled | 59 (18.2) |
| Other | 15 (4.6) |
|  |  |
| Lifetime months homeless, median (iqr) | 30.0 (53.6) |
|  |  |
| Lifetime years in jail, median (iqr) | 3.5 (6.7) |
|  |  |
| General health, n (percent) |  |
| Excellent | 57 (17.6) |
| Very Good | 70 (21.6) |
| Good | 103 (31.8) |
| Fair | 70 (21.6) |
| Poor | 24 (7.4) |
|  |  |
| N days out of past 30 physical health not good, mean (sd) | 7.2 (9.9) |
|  |  |
| N days out of past 30 mental health not good, mean (sd) | 11.7 (11.1) |
|  |  |
| Currently receiving mental health treatment, n (percent) |  |
| No | 136 (42.0) |
| Yes | 188 (58.0) |
|  |  |
| Have mobile phone, n (percent) |  |
| No | 232 (71.6) |
| Yes | 92 (28.4) |
|  |  |
| Mobile phone bill payer, n (percent) |  |
| Government | 10 (10.9) |
| Family or friend | 29 (31.5) |
| Someone else | 4 (4.3) |
| I pay for my cell phone service | 49 (53.3) |
|  |  |
| Talk minutes in mobile plan, n (percent) |  |
| 0-200 | 3 (3.3) |
| 201-400 | 4 (4.3) |
| 401-600 | 1 (1.1) |
| Unlimited | 80 (87.0) |
| I use 'pay as you go' or prepaid phone | 4 (4.3) |
|  |  |
| Is your mobile phone a smart phone, n (percent) |  |
| No | 14 (15.2) |
| Yes - I have an android phone | 74 (80.4) |
| Yes - I have an Apple smartphone (iPhone) | 3 (3.3) |
| Yes - I have a Smartphone that is not Apple or Android based | 1 (1.1) |
|  |  |
| Have data plan, n (percent)1 |  |
| No | 4 (5.1) |
| Yes, but my data plan is limited | 22 (28.2) |
| Yes, my plan includes unlimited data | 52 (66.7) |
|  |  |
| Times mobile number has changed in past year, n (percent) |  |
| 0 | 66 (24.4) |
| 1 | 62 (22.9) |
| 2 | 65 (24.0) |
| 3 | 29 (10.7) |
| 4 | 18 (6.6) |
| 5 or more  No phone in the past year | 31 (11.4)  53 (16.4%) |
|  |  |
| Types of media used, n (percent)2 |  |
| Email | 250 (77.2) |
| Facebook | 227 (70.1) |
| Google Plus | 127 (39.2) |
| Twitter | 29 (9.0) |
| Blogs | 9 (2.8) |
| Instagram | 86 (26.5) |
| Snapchat | 42 (13.0) |
| LinkedIn | 25 (7.7) |
| None | 28 (8.6) |
|  |  |
| Frequency of internet access, n (percent) |  |
| Never | 25 (7.7) |
| About once a month | 12 (3.7) |
| About once per week | 16 (4.9) |
| 2-3 times per week | 31 (9.6) |
| 4 to 6 times per week | 18 (5.6) |
| About once per day | 31 (9.6) |
| About twice per day | 42 (13.0) |
| Every few hours or more | 149 (46.0) |
|  |  |
| Frequency of Facebook use, n (percent) |  |
| Never | 22 (10.0) |
| About once a month | 19 (8.6) |
| About once per week | 13 (5.9) |
| 2-3 times per week | 29 (13.2) |
| 4 to 6 times per week | 14 (6.4) |
| About once per day | 32 (14.5) |
| About twice per day | 31 (14.1) |
| Every few hours or more | 60 (27.3) |
|  |  |
| Believe smartphone app can help change actions or behaviors, n (percent) |  |
| No | 55 (17.2) |
| Yes | 265 (82.8) |
|  |  |
| Used smartphone app to manage health-related issues, n (percent) |  |
| No | 242 (74.9) |
| Yes | 81 (25.1) |
|  |  |
| Type of issue managed with smartphone app, n (percent)3 |  |
| Food or calorie tracking | 41 (50.0) |
| Medication reminders | 40 (48.8) |
| Mood manager | 20 (24.4) |
| Physical activity | 42 (51.2) |
| Sleep tracker | 25 (30.5) |
| Smoking Cessation | 14 (17.1) |
| Stress reduction | 31 (37.8) |
| Weight loss tracking | 23 (28.0) |
| Other | 19 (23.2) |
|  |  |
| Number of issues managed with smartphone app, n (percent) |  |
| 1 | 11 (13.6) |
| 2 | 28 (34.6) |
| 3 | 16 (19.8) |
| 4 | 11 (13.6) |
| 5 | 4 (4.9) |
| 6 | 5 (6.2) |
| 7 | 3 (3.7) |
| 8 | 3 (3.7) |
| 9 | 0 (0.0) |
|  |  |
| 1Have data plan was only asked of participants who reported having a smart phone. | |
| 2Percentages sum to >100% because participants could select more than one response option. | |
| 3Percentages sum to >100% because participants could select more than one response option. | |