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Mobile Health Technology Knowledge and Practices Among Patients of Safety-Net Health Systems in Washington State and Washington, DC

Sharon S. Laing, PhD,^{1,2} Muhammad Alsayid, MD, MPH,^{2,3} Carlota Ocampo, PhD,⁴ Stacey Baugh, PsyD⁴

¹Nursing and Healthcare Leadership Program, University of Washington Tacoma, Tacoma, WA; ²Health Services Department, University of Washington School of Public Health, Seattle, WA; ³Department of Medicine, University of Massachusetts Medical School, Worcester, MA; ⁴Department of Psychology, Trinity Washington University, Washington, DC

Purpose	Mobile health technology (mHealth) can reduce health disparities, but research on the health behaviors of low-income patients is needed. This study evaluates mHealth knowledge and practices of low-resource safety-net patients.
Methods	We administered a 47-item questionnaire to 164 low-income patients accessing services at community health centers in the state of Washington and Washington, DC. Predictor variables included demographic factors: age, race, ethnicity, income. Outcome variables were smartphone knowledge (smartphones as a wellness tool), medical app knowledge (availability of medical-based apps), smartphone practices (ever used smartphones for wellness), health apps practices (ever used health-based apps), and medical apps practices (ever used medical-based apps). Multivariate logistic regression assessed relationships between predictor and outcome variables.
Results	Mean age was 35.2 years (median: 34), and study cohort (N=159) consisted of mostly women (68%), white race (36%), and income of <\$20,000/year (63%). Outcomes: 71% and 58% reported knowledge of using smartphones for wellness and knowledge of medical apps, respectively; 76% used smartphones for wellness, with adults 50+ years of age significantly less likely than younger adults (odds ratio [OR]: 0.94, 95% confidence interval [CI]: 0.88–0.99); 48% used health apps, with adults 50+ years of age less likely than younger adults (OR: 0.95, 95% CI: 0.91–0.99) and respondents earning <\$20,000/year less likely than higher earners (OR: 3.13, 95% CI: 1.02–9.57); and 58% used medical apps, with Hispanics/Latinos significantly more likely than non-Hispanics/Latinos (OR: 6.38, 95% CI: 1.04–39.02).
Conclusions	Safety-net patients use mobile devices for health promotion. Age and income are important predictive factors, suggesting a more tailored design of the technology is required for broad engagement and health equity. (<i>J Patient Cent Res Rev.</i> 2018;5:204-217.)
Keywords	knowledge; practices; safety-net patients; mobile health promotion; telehealth; smartphone

A recent roundtable discussion of health care and government leaders and health policy analysts concluded that hand-held devices, including smartphones, tablets, and mobile applications (apps), can improve patient-doctor relationships and thus improve health outcomes.¹ For low-income communities

disproportionately impacted by chronic diseases, potential benefits can be significantly impactful.

Mobile health technology (mHealth) is “medical and public health practices supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and other wireless devices.”² Among the wireless technology used for mHealth interventions, short message service (SMS) and mobile health apps are deployed most frequently. Mobile health apps can promote self-care management

Correspondence: Sharon S. Laing, PhD,
University of Washington Tacoma, 1900 Commerce Street,
Box 358421, Tacoma, WA 98402 (laings@uw.edu)

and increase access to useful health information that supports wellness.³ Medical-based apps are mobile apps that “may transform a mobile platform into a regulated medical device” and include technologies that facilitate disease self-management, tools that organize and track a health condition, and devices that provide valuable health information.³ Apps, SMS, and wireless sensors are used with mobile phones to implement mobile health promotion.

Research studies demonstrate how mHealth can be used to effectively promote patient health care engagement. For preventive care, studies have shown moderate effects of SMS and mobile apps in supporting physical activity,⁴ increasing attendance at medical appointments,⁵ and improving smoking cessation at 6-month follow-up.⁶ Mobile health interventions also have helped with chronic disease management, with clinical studies reporting reductions in glycosylated hemoglobin levels ranging from 0.5% to 1.9%,⁷⁻⁹ improved management of cardiovascular outcomes,^{10,11} and reductions in depressive symptomatology.¹²

Though research on the value of mHealth in promoting wellness continues to proliferate, the majority of these studies do not target the communities most affected by poor health outcomes – low-income individuals. To be sure, there is a growing subset of interventional studies addressing chronic disease management in low- and middle-income countries;¹³⁻¹⁶ however, within high-income countries such as the United States, there are few mHealth clinical studies specifically targeting low-income or safety-net patients (ie, patients served by community health centers [CHCs]).

Low-income and safety-net patients present with substantial health challenges compared to the general population. And as revealed in a recent analysis, CHC patients in particular are poorer, report more chronic health conditions, have higher rates of obesity, and are more likely to be smokers than the overall low-income U.S. population.¹⁷ Low-income communities present with the highest rates of diabetes prevalence and appear less likely to be referred for care for this health condition.¹⁸ Research also has revealed poverty to be a reliable social determinant of cardiovascular diseases, including elevated blood pressure.¹⁹ Growing clinical research has shown that both diabetes and cardiovascular

diseases can be managed using mHealth interventions,⁷⁻¹⁰ thus demonstrating the potential value of mobile health technologies in improving patient health outcomes for low-income communities. Using mHealth approaches to increase outreach to the most vulnerable patients, wherever they are, can result in long-term benefits of better patient engagement and improved health outcomes.

In order to intervene with a given patient population, one must understand the cognitive and behavioral factors (knowledge and practices) of the target community so that customized health interventions can be developed. Although descriptive data on mHealth practices of the U.S. population in general and on specific demographics therein are available,²⁰ to our knowledge, there are no inferential-level data that outline mHealth knowledge and practices of low-income, safety-net patients in the United States. Such information could inform the development of tailored behavioral and policy-related mHealth strategies to support this community.

The objective of the current study is to evaluate mHealth knowledge and practices, and to identify the relevant sociodemographic predictors of these practices, among low-income patients accessing services at CHCs in two regions — the state of Washington and Washington, DC.

METHODS

Setting and Sample

The study team partnered with 5 CHC sites in Washington State and Washington, DC, to sample a total of 164 respondents. In western Washington, 103 patients were randomly selected from HealthPoint CHCs. HealthPoint is a regional community-supported and not-for-profit health system that offers comprehensive and coordinated health care services such as medical, dental, naturopathic, behavioral health, social services, and case management care. We partnered with HealthPoint because of the institution’s history of providing health services to low-income, racially diverse, and underserved communities. Further, HealthPoint centers are scattered throughout the northern region of western Washington, and the residents in that region are racially and ethnically diverse.

In Washington, DC, patients comprised a convenience sample of 61 patients from 3 community and human services centers. The centers offer community health

care, human services support, case management/coordination services, sexually transmitted disease testing, and support care to clients. The range of individuals seen includes the marginalized and underserved: members of the bilingual LGBT community; low-income women and girls of color living with or at risk for HIV/AIDS; and substance-abusing individuals.

All study procedures and protocols were approved by the institutional review boards of HealthPoint (Renton, WA), Eastern Washington University (Cheney, WA), and Trinity Washington University (Washington, DC).

Instrument

We used a 47-item instrument of mostly closed-ended questions to evaluate the knowledge and practices of CHC patients. The survey was available in both English and Spanish to support majority populations served by the CHCs. The instrument assessed patients' practice/use of mobile health technology (smartphones and health-based mobile apps) and perceptions of health care services received. Three sections comprised the survey. Section A presented 9 items addressing demographic characteristics including age, gender, race, education, employment status, and income. Section B presented 18 items that queried respondents about 1) general knowledge/awareness of mobile devices; 2) mobile device ownership, including medical and health-based mobile apps; and 3) use frequency of mobile health devices. Section C consisted of 20 questions that queried respondents about health-related experiences, including types of services received, availability of and accessibility to health care resources, chronic disease prevention support, and health care delivery satisfaction.

Survey Administration

The authors commenced survey administration in September 2014 and concluded in November 2015. The initial contact with patients varied slightly at the two sites. In Washington, DC, patients were informed about the study by staff and given the option to come to the centers on the days that investigators were administering questionnaires. In Washington State, investigators approached each person who entered the waiting area of the facility. (Figure 1 shows recruitment schema for both sites.) After

initiating contact, researchers at both sites informed prospective participants that the purpose of the survey was to understand patients' knowledge/awareness and practice/use of mobile health technology and to learn about their perception of care at the health care facility.

To be included in the study, the prospective respondent must have 1) been in possession of a smartphone; 2) reached 18 years of age; and 3) had at least two face-to-face contacts with a professional at the center within the last 12 months. The patients at both sites who agreed to participate in the study and who met the eligibility criteria were taken to a private room where they completed a written informed consent document followed by the 47-item self-administered questionnaire, after which, researchers remained in the room to answer questions. At the conclusion, each participant received a \$10 gift certificate, was debriefed about the study, and had all questions answered. The entire process, including obtaining consent, survey administration, and debriefing lasted approximately 1 hour for each patient.

Measured Variables: Knowledge/Awareness Factors

To assess knowledge/awareness of mobile health technology, investigators queried respondents about level of awareness of two categories of mobile health technology: the capability of smartphones to provide wellness information; and the availability of mobile health apps to support health care management (ie, medical-based apps).

Smartphone Use for Wellness: Respondents were required to answer *yes* or *no* to the following statement, "Some people use smartphones/mobile devices as part of patient wellness, prevention, and treatment programs. For example, patients can go on the internet to get medical information about their health including going to such sites as WebMD, MDadvice, MedicineNet and NetDoctor. Were you aware that you can use your smartphones as part of your health care and wellness plan?"

Medical-Based Apps to Support Clinical/Health Care Management: To assess patients' awareness of specific mobile apps that support patient clinical and health care management, respondents were required to answer

Figure 1. Recruitment of patients from community health centers (CHC) in Washington State and Washington, DC, 2014–2015.

yes or no to the following statement, “Some mobile applications are *medical-based* — that is, they help to promote health by reminding patients to take medications and helping patients to refill their prescriptions. Were you aware that such applications are available?”

Measured Variables: Practice/Use Factors

Mobile health technology practices were defined as 1) using smartphones for wellness; 2) using medical-based mobile apps; and 3) using health-based apps. Investigators queried patients with specific question(s) targeting each category.

Using Smartphone for Wellness: To assess patients’ use of smartphones for health and wellness, researchers asked respondents two questions: 1) “Have you ever used your smartphone or a mobile device to get information about your health or as part of a wellness plan?” Patients were required to give a yes or no response. 2) “If you have used your smartphone/

mobile device to *access health information*, how often would you say you’ve used it this way?” Patients were given the following choices: one or more times daily, one or more times each week, one or more times each month, less than every few months, and never used smartphones in this way. Respondents were designated as “users” of smartphone for wellness if they answered affirmatively to the first question and/or identified a frequency of using their smartphones for wellness.

Using Medical-Based Mobile Apps: To assess patients’ use of medical-based apps, investigators posed two questions to patient respondents: 1) “Have you ever used mobile applications for any of the medical purposes described?” Patients were required to give a yes or no response. 2) “Please indicate which among the following medical-based ways you have used your mobile applications.” Choices included locate pharmacist/doctor, prescription refill, medication reminders, tracking heart rate, tracking blood pressure,

and tracking blood glucose. Respondents were designated “users” of medical-based mobile apps if they answered affirmatively to the first question and/or specified an app that they currently owned.

Using Health-Based Apps: We defined a health-based app as a mobile application for preventive health care, including tracking caloric intake or engagement in meditation/relaxation. To assess patients’ use of health-based apps, two questions were posed: 1) “Have you ever used a health-based mobile application?” Patients were required to give a *yes* or *no* response. 2) “What type of health app do you have?” Respondents were provided with choices: calorie count, step count, smoking cessation, meditation/relaxation, and other health apps. Respondents were designated “users” of health-based mobile apps if they answered affirmatively to the first question and/or indicated an app currently owned.

Statistical Analyses

Descriptive analyses were conducted to describe demographic characteristics of the full sample as well as site-specific respondent characteristics (DC and Washington State). Demographics analyzed included gender (male or female), age (categorized as 18–29, 30–49, and ≥ 50 years of age), and race (white, African American, Asian, American Indian, Alaska Natives, Mixed White Indigenous, Native Hawaiians, Pacific Islanders, and other). A separate racial category, “multiple races” combined the last six racial groups due to low numbers in each race category; thus, four race categories were analyzed — White, African American, Multiple Races, and Other. Ethnicity was defined as identification as Hispanic/Latino ethnicity or non-Hispanic/Latino. Employment was defined as full-time employment, part-time employment, unemployed, and not working/not looking; the “not looking” category referred to individuals in school, retirees, disabled individuals, or homemakers. Income was defined as less than or equal to \$20,000/year or more than \$20,000/year. Education was defined as high school-educated or higher or less than high school-educated. We assessed differences in demographic characteristics between the two study sites using chi-squared analyses and reported P-values for each demographic factor.

Descriptive analysis was used to identify raw counts and proportions of “yes” responses for each knowledge

factor (knowledge of using smartphone for wellness, knowledge of medical-based apps) by the relevant demographic groups. The same approach was used to describe the practice factors (use of smartphone for wellness, use of health-based apps, use of medical-based apps). Finally, we reported proportions for the following: frequency of using smartphone for wellness, types of health apps owned, and types of medical apps owned.

Multivariate logistic regression analyses were performed to assess the association between each factor (for knowledge and practice) and demographic characteristics. The models consisted of all relevant demographic factors with odds ratios (OR) reported for 95% confidence intervals. Data were analyzed using STATA/IC Version 14.2 (StataCorp LLC, College Station, TX).

RESULTS

Description of Full Sample

Response rate of patients who were approached in the CHCs in Washington State was 35%. Among the 295 patients approached, only 18 indicated nonownership of smartphones, thus 94% of patients were smartphone owners (Figure 1). Due to substantial missing data for 5 respondents, data were analyzed for 159 respondents. The mean age of this cohort was 35.2 years (standard deviation: 12.24) and ranged from 18 to 81 years. The sample comprised mostly of women (68%), adults age 30–49 years (52%), Whites or African Americans (36% and 31%, respectively), income below \$20,000/year (63%), and higher than high school-level education (53%).

Table 1 shows the comparison between Washington State and Washington, DC, sites. All sociodemographic characteristics were similar for both sites, except for race, employment status, and household income. At the DC site, there were significantly more African American respondents (57% vs 18%, $P < 0.01$), patients reporting being unemployed (40% vs 16%, $P < 0.01$), and individuals earning less than \$20,000/year (82% vs 52%, $P < 0.01$).

Knowledge/Awareness Factors

As seen in Table 2, 71% of CHC patients were aware that smartphones can be used to access health information and 58% knew about the availability of medical-based apps.

Table 1. Sociodemographic Characteristics of Study Participants by Site of the Community Health Centers, 2014–2015

Demographic characteristic	Total cohort (N=159)	Washington State (n=103)	Washington, DC (n=56)	P
Gender, n (%)				0.61
Male	50 (31.6)	34 (33.0)	16 (29.1)	
Female	108 (68.4)	69 (67.0)	39 (70.9)	
Age bracket, n (%)				0.88
18–29 years	54 (34.2)	36 (35.0)	18 (32.7)	
30–49 years	82 (51.9)	52 (50.5)	30 (54.5)	
50+ years	22 (13.9)	15 (14.5)	7 (12.7)	
Mean age, years (SD)	35.2 (16.2)	36.5 (12.6)	32.8 (21.3)	
Median age, years (IQR)	34 (27, 45)	37 (26, 46)	33 (27, 42)	
Race, n (%)				<0.01
White	53 (36.1)	49 (51.0)	4 (7.8)	
African American	46 (31.3)	17 (17.7)	29 (56.9)	
Multiple Races*	15 (10.2)	7 (7.3)	8 (15.7)	
Other (not specified)	33 (22.4)	23 (24.0)	10 (19.6)	
Ethnicity, n (%)				0.17
Hispanic/Latino	40 (26.8)	22 (23.2)	18 (33.3)	
Non-Hispanic/Latino	109 (73.2)	73 (76.8)	36 (66.7)	
Employment, n (%)				<0.01
Full-time	41 (28.1)	31 (31.3)	10 (21.3)	
Part-time	37 (25.3)	25 (25.3)	12 (25.5)	
Unemployed	35 (24.0)	16 (16.2)	19 (40.4)	
Retired/homemaker/not looking for work	33 (22.6)	27 (27.3)	6 (12.8)	
Household income, [†] n (%)				<0.01
At or below \$20,000/year	89 (62.7)	47 (51.6)	42 (82.4)	
More than \$20,000/year	53 (37.3)	44 (48.4)	9 (17.6)	
Education, n (%)				0.27
High school or less	74 (46.8)	45 (43.7)	29 (52.7)	
Higher than high school	84 (53.2)	58 (56.3)	26 (47.3)	

*Includes Asians, American Indians, Alaska Natives, Mixed White Indigenous, Native Hawaiians, and Pacific Islanders. Due to small counts in each race, the group “Multiple Races” was created.

[†]Income less than \$20,000/year represented the U.S. Department of Health and Human Services Federal Poverty Level guideline for a 3-member household.

Bold indicates significant at the $P < 0.05$ level. IQR, interquartile range; SD, standard deviation.

Knowledge of Smartphone for Wellness: The primary demographic characteristics of patients who reported having an awareness of smartphones to acquire wellness information were female gender (72%), age 30–49 years (74%), White race (72%), Hispanic/Latino ethnicity (70%), high school education or higher (74%), income more than \$20,000/year (75%), and employment part-time (87%) (Table 2). None of the demographic

factors emerged as a significant independent predictor of knowledge of smartphone for wellness in the multivariate regression analysis (Table 5).

Knowledge of Medical Apps: Dominant demographic characteristics of the sample reporting an awareness of medical app were female gender (66%), age 18–49 years (60%), African American and Multiple Races

Table 2. Mobile Health Technology Knowledge of Community Health Center Patients by Demographic Factors, 2014–2015

Demographic characteristic	Knowledge of smartphone use for wellness	Knowledge of medical apps
Total study cohort, n (%)	110 (71.0) [†]	91 (58.0)
Gender, n (%)		
Male	33 (68.8)	19 (39.6)
Female	76 (71.7)	71 (65.7)
Age bracket, n (%)		
18–29 years	34 (68.0)	32 (60.4)
30–49 years	61 (74.4)	49 (60.5)
50 years and above	14 (63.6)	9 (40.9)
Race, n (%)		
White	38 (71.7)	25 (47.2)
African American	31 (68.9)	31 (67.4)
Multiple Races*	10 (73.3)	10 (66.7)
Other (not specified)	23 (69.7)	17 (53.1)
Ethnicity, n (%)		
Hispanic/Latino	26 (70.3)	26 (66.7)
Non-Hispanic/Latino	74 (68.5)	60 (55.6)
Education, n (%)		
High school or less	48 (67.6)	40 (55.6)
Higher than high school	62 (73.8)	50 (59.5)
Household income, n (%)		
< \$20,000	62 (70.5)	49 (55.1)
\$20,000 and above	39 (75.0)	30 (57.7)
Employment status, n (%)		
Full-time	29 (72.5)	20 (50.0)
Part-time	32 (86.5)	24 (64.9)
Unemployed	21 (61.8)	19 (54.3)
Retired/homemaker/not looking for work	18 (56.3)	19 (59.4)
Location, n (%)		
Washington State	74 (72.5)	49 (48.5)
Washington, DC	36 (67.9)	42 (75.0)

*Includes Asians, American Indians, Alaska Natives, Mixed White Indigenous, Native Hawaiians, and Pacific Islanders. Due to small counts in each race, the group “Multiple Races” was created.

[†]Indicates 110 of 155 = 71%. Due to missing data in total respondents for “use” variable, the study reported a higher proportion for “use of smartphone for wellness” compared to “knowledge of smartphone for wellness.”

race (67%), Hispanic/Latino ethnicity (67%), high school education or higher (60%), income more than \$20,000/year (58%), and part-time employment (65%) (Table 2). Multivariate logistic regression analysis of demographic predictors revealed that only gender, age, and study site were significant unique contributors to knowledge of

medical-based apps. Women were significantly more likely than men to report an awareness of medical-based apps when all other demographic predictors were adjusted (OR: 3.52, 95% CI: 1.35–9.20). Adults 50 or more years old were significantly less likely to indicate an awareness of medical-based apps compared to adults

Table 3. Mobile Health Technology Practices of Community Health Center Patients by Demographic Factors, 2014–2015

Demographic characteristic	Ever use smartphone for wellness	Ever use medical-based apps	Ever use health apps
Total study cohort, n (%)	103 (76.3) [†]	64 (58.2)	72 (48.3)
Gender, n (%)			
Male	28 (70.0)	13 (48.1)	19 (38.8)
Female	74 (78.7)	50 (61.0)	52 (52.5)
Age bracket, n (%)			
18–29 years	36 (83.7)	16 (48.5)	26 (52.0)
30–49 years	55 (76.4)	41 (67.2)	42 (53.8)
≥50 years	11 (57.9)	6 (40.0)	4 (19.0)
Race, n (%)			
White	36 (87.8)	18 (58.1)	25 (50.0)
African American	30 (69.8)	21 (58.3)	17 (41.5)
Multiple Races*	10 (71.4)	6 (50.0)	5 (38.5)
Other (not specified)	18 (66.7)	11 (50.0)	16 (48.5)
Ethnicity, n (%)			
Hispanic/Latino	27 (81.8)	22 (75.9)	20 (57.1)
Non-Hispanic/Latino	67 (72.8)	38 (51.4)	46 (43.8)
Education, n (%)			
High school or less	46 (75.4)	29 (56.9)	31 (47.0)
Higher than high school	56 (76.7)	34 (58.6)	40 (48.8)
Household income, n (%)			
< \$20,000	56 (71.8)	33 (55.0)	35 (42.7)
≥ \$20,000	35 (79.5)	23 (62.2)	28 (53.8)
Employment status, n (%)			
Full-time	28 (82.4)	14 (60.9)	20 (50.0)
Part-time	25 (71.4)	13 (44.8)	19 (54.3)
Unemployed	23 (74.2)	15 (60.0)	14 (46.7)
Retired/homemaker/not looking for work	18 (81.8)	15 (68.2)	13 (40.6)
Location, n (%)			
Washington State	67 (82.7)	34 (54.0)	47 (46.5)
Washington, DC	36 (66.7)	30 (63.8)	25 (52.1)

*Includes Asians, American Indians, Alaska Natives, Mixed White Indigenous, Native Hawaiians, and Pacific Islanders. Due to small counts in each race, the group “Multiple Races” was created.

[†]Indicates 103 of 135 = 76%. Due to missing data in total respondents for the “use” variable, the study reported a higher proportion for “use of smartphone for wellness” compared to “knowledge of smartphone for wellness.”

18–49 years old (OR: 0.95, 95% CI: 0.91–0.99). Finally, CHC patients in Washington, DC, were significantly more likely to report an awareness of medical-based apps compared to CHC patients residing in Washington State (OR: 3.77, 95% CI: 1.09–13.01). No other demographic factors significantly predicted awareness of medical-based mobile apps (Table 5).

Practice/Use Factors

Table 3 presents the three practice/use factors: use of smartphone for wellness, use of health-based apps, and use of medical-based apps. More than three-quarters (76%) of respondents reported using smartphones for wellness; more than one-half (58%) reported using medical-based apps; and 48% used health-based apps

including apps that track caloric intake and apps that track number of steps taken.

Use of Smartphone for Wellness: The demographic characteristics of individuals reporting use of smartphone to acquire wellness information resulted in mostly female gender (79%), age 18–29 years (84%), White race (88%), Hispanic/Latino ethnicity (82%), high school education or higher (77%), income more than \$20,000/year (80%), and full-time employment (82%) (Table 3). Furthermore, as shown in Table 4, 34% used smartphones for wellness on a weekly basis. Another 16% of respondents reported never using smartphones to access wellness information. Multivariate logistic regression analysis revealed age and employment status to be unique and significant predictors of using smartphone for wellness. Adults 50 or more years old were significantly less likely to use their smartphones for wellness (OR: 0.94, 95% CI: 0.88–0.99). Patients

who reported working part-time also were significantly less likely to indicate using smartphones for wellness compared to patients who worked full-time (OR: 0.17, 95% CI: 0.03–0.83). No other demographic factor significantly predicted patients' use of smartphone for wellness (Table 5).

Use and Ownership of Health-Based Mobile Apps: The dominant demographic characteristics of patients who reported using health-based apps were female gender (53%), age 30–49 years (54%), White race (50%), Hispanic/Latino ethnicity (57%), high school education or higher (49%), income more than \$20,000/year (54%), and part-time employment (54%) (Table 3).

As evident in Table 4, the health-based apps that CHC patients were likely to report owning included calorie-tracking (38%), step-monitoring (28%), and meditation apps (25%). Patients were least likely to report owning apps that target smoking cessation (6%). More than one-third (37%) reported that they do not own a health app.

Multivariate logistic regression analysis revealed age and income to be significant independent predictors of patients' using health-based mobile apps (Table 5). Adults 50 or more years old were less likely to report ever using health apps (OR: 0.95, 95% CI: 0.91–0.99). Patients earning more than \$20,000/year were significantly more likely to report using health-based mobile apps compared to patients earning less than \$20,000/year, (OR: 3.13, 95% CI: 1.02–9.57).

Use and Ownership of Medical-Based Mobile Apps: The dominant demographic characteristics of respondents who reported using medical-based apps were female gender (61%), age 30–49 years (67%), African American and White race (58%), Hispanic/Latino ethnicity (76%), high school education or higher (59%), income more than \$20,000/year (62%), and retirees/homemakers/not looking for work employment status (68%) (Table 3). The medical-based apps that patients were likely to report owning were doctor/pharmacist locator (58%) and prescription refill (56%) and medication (34%) reminders (Table 4).

Multivariate logistic regression analysis of demographic factors revealed ethnicity to be the only significant independent predictor of patients using medical-based

Table 4. Frequency of Health Apps Used and Medical Apps Owned by Community Health Center Patients, 2014–2015

Use of Smartphone for Wellness	n (%)
Frequency of using smartphones for wellness	
1 or more times daily	19 (15.9)
1 or more times weekly	40 (33.6)
1 or more times each month	33 (27.7)
Less than every few months	11 (9.2)
Never used smartphones this way	16 (13.4)
Use of Health Apps	n (%)
Types of health apps owned	
Calorie count	37 (37.8)
Step count	27 (27.6)
Meditation	24 (24.5)
Other	24 (24.7)
Smoking cessation	6 (6.1)
Don't own a health app	34 (37.4)
Use of Medical-Based Apps	n (%)
Types of medical apps owned	
Doctor/pharmacist locator	37 (57.8)
Prescription refill	36 (56.3)
Medication reminder	22 (34.4)
Track other health condition (not specified)	20 (31.3)
Family support	17 (26.6)
Heart rate tracker	13 (20.3)
Blood pressure tracker	13 (20.3)
Mental health status tracker	10 (15.6)
Blood glucose tracker	6 (9.4)

Table 5. Multivariate Logistic Regression — Demographic Factors Are Predictor Variables; Mobile Technology Knowledge and Practice Factors Are Outcome Variables

Variable	Odds ratio	95% CI
<u>Knowledge – awareness of using smartphone for wellness</u>		
Age	0.99	0.95, 1.03
Study site (ref: WA)	0.70	0.21, 2.28
Gender (ref: male)	2.56	0.96, 6.85
Education (ref: high school or less)	1.26	0.48, 3.31
Income (ref: <\$20,000/year)	1.45	0.47, 4.44
Employment (ref: full-time)		
Part-time employment	4.11	0.90, 18.84
Unemployment	0.63	0.18, 2.27
Retired/homemaker/not looking	0.49	0.14, 1.70
Ethnicity		
Hispanic/Latino	1.07	0.29, 3.90
Race (ref: White)		
African American	0.84	0.22, 3.13
Multiple Races	0.99	0.17, 5.64
Other	1.14	0.29, 4.41
<u>Knowledge – awareness of medical-based apps</u>		
Age	0.95	0.91, 0.99
Study site (ref: WA)	3.77	1.09, 13.01
Gender (ref: male)	3.53	1.35, 9.20
Education (ref: high school or less)	1.38	0.52, 3.66
Income (ref: <\$20,000/year)	2.55	0.83, 7.78
Employment (ref: full-time)		
Part-time employment	2.57	0.70, 9.49
Unemployment	0.75	0.19, 2.93
Retired/homemaker/not looking	2.01	0.55, 7.38
Ethnicity		
Hispanic/Latino	1.49	0.41, 5.41
Race (ref: White)		
African American	2.78	0.72, 10.74
Multiple Races	1.30	0.26, 6.42
Other	0.91	0.24, 3.39
<u>Practice – use of smartphone for wellness</u>		
Age	0.94	0.88, 0.99
Study site (ref: WA)	0.39	0.10, 1.49
Gender (ref: male)	1.63	0.47, 5.66
Education (ref: high school or less)	0.70	0.22, 2.27
Income (ref: <\$20,000/year)	1.33	0.31, 5.78
Employment (ref: full-time)		
Part-time employment	0.17	0.03, 0.83
Unemployment	0.25	0.05, 1.37
Retired/homemaker/not looking	0.64	0.09, 4.47
Ethnicity		
Hispanic/Latino	1.19	0.22, 6.35
Race (ref: White)		
African American	0.65	0.12, 3.57
Multiple Races	0.42	0.05, 3.45
Other	0.29	0.05, 1.70

Table 5 (continued). Multivariate Logistic Regression — Demographic Factors Are Predictor Variables; Mobile Technology Knowledge and Practice Factors Are Outcome Variables

Variable	Odds ratio	95% CI
<u>Practice – use of health apps</u>		
Age	0.95	0.91, 0.99
Study site (ref: WA)	1.93	0.59, 6.33
Gender (ref: male)	2.55	0.97, 6.73
Education (ref: high school or less)	0.83	0.33, 2.10
Income (ref: <\$20,000/year)	3.13	1.02, 9.57
Employment (ref: full-time)		
Part-time employment	1.24	0.36, 4.27
Unemployment	0.69	0.19, 2.51
Retired/homemaker/not looking	0.44	0.12, 1.62
Ethnicity		
Hispanic/Latino	0.76	0.21, 2.72
Race (ref: White)		
African American	0.52	0.14, 2.00
Multiple Races	0.22	0.04, 1.28
Other	0.90	0.25, 3.25
<u>Practice – use of medical-based apps</u>		
Age	0.99	0.96, 1.02
Study site (ref: WA)	0.57	0.13, 2.47
Gender (ref: male)	2.46	0.68, 8.98
Education (ref: high school or less)	0.76	0.24, 2.39
Income (ref: <\$20,000/year)	1.95	0.46, 8.37
Employment (ref: full-time)		
Part-time employment	0.61	0.13, 2.91
Unemployment	0.77	0.15, 4.06
Retired/homemaker/not looking	1.29	0.23, 7.35
Ethnicity		
Hispanic/Latino	6.38	1.04, 39.02
Race (ref: White)		
African American	1.78	0.33, 9.78
Multiple Races	0.51	0.08, 3.39
Other	0.24	0.04, 1.37

Bold indicates significant at the $P < 0.05$ level.

CI, confidence interval; ref, reference; WA, state of Washington.

apps. Hispanic/Latino adults were significantly more likely than those who did not indicate Hispanic/Latino ethnicity to report ever using medical-based mobile apps (OR: 6.33, 95% CI: 1.04–39.02).

DISCUSSION

A recent Blue Shield of California Foundation survey identified four keys to improve the health care experiences of low-income patients: *continuity* of care; *connectedness* between patients, care providers, and

staff; feeling *empowered* to address health care needs; and having clear and understandable information to promote *engagement*.²¹ For too long, low-income communities have lacked resources to meaningfully engage in their health care and thus feel connected to the health care system. Mobile health technologies like smartphones and health apps are widely accessible and relatively inexpensive tools that may potentially provide substantial support to lower-income patients who access health services through CHCs.

Our study demonstrated that mobile health technologies can be an effective tool for promoting health and wellness to safety-net patients and potentially provide continuity of care outside of clinic visits. Findings revealed strong awareness and past use of mobile health technologies to manage health and promote wellness. Further, a majority of safety-net patients report ownership of preventive care mobile health apps that target physical activity and weight management, and this result has favorable implications for managing the more prominent health risks (sedentary behavior, obesity) for the chronic diseases most prevalent in this community (diabetes, cardiovascular diseases). We identified specific demographics within the safety-net community likely to use health- and medical-based apps. Also noteworthy, however, are the safety-net demographics for whom mHealth tools might currently fall short and for whom more work is required to ensure engagement — the poorest safety-net patients and older-adult patient groups.

Engaging Lowest-Income Safety-Net Patients

Among safety-net patients, those with the lowest incomes (<\$20,000/year) appear less likely to have used preventive care and medical-based apps and, thus, mHealth in its current form appears to be a less effective health promotion tool for this demographic. This finding could be linked to challenges patients might be experiencing navigating some health apps. A recent study of low-income adults managing chronic diseases using mobile devices revealed that respondents could complete only 43% of all required tasks without assistance.²² In the study, patients were likely to report lack of confidence with the device and frustration with its design features and navigation components,²² and these elements might be linked to insufficient health literacy.²³ It is therefore important to consider that initial motivation and sustained interest in using mobile health devices might be bolstered by technologists developing devices that integrate user literacy in design features, which can extend mHealth reach to more safety-net patients.

Technology Reluctance of Low-Income Older Adults

Our findings revealed gaps in mobile technology practices among low-income *older* adults. Though recent reports show an increase in digital health care technology use, from 14% to 67%, among

senior adults in the last decade, drivers of increased usage had higher incomes and advanced education.²⁴ Furthermore, barriers to adoption and sustained use include lack of confidence in using electronic devices and physical disability limiting access.²⁵ Technologists might facilitate access by adapting technologies that support the unique physical and cognitive challenges of older-adult safety-net patients.

Additionally, given the rapid growth of technological developments, older adults will benefit when their primary care providers provide support for engaging in digital health care management. Though individuals over age 66 are likely to use health care system-sponsored websites if recommended by a health care provider,²⁶ physicians are still slow to engage their patients in digital health care management.^{27,28} Providers have a unique opportunity to promote mHealth tools to their older-adult safety-net population, which may positively impact overall health outcomes.

Persistent Gender Differences in Health Technology Engagement

Women safety-net patients are consistently and significantly more likely to use mobile health technology for self-care management compared to men. Women are more likely to engage in preventive care (including weight management monitoring) and health care management (prescription refills, monitoring a health condition) using mobile apps. The gender difference in health-seeking behaviors is well-documented,²⁹ but the disparity is more apparent when gender, race, and socioeconomic status (SES) are factors; differences in health-seeking behavior is of particular concern given the fact that ethnically and racially diverse low-SES men are more likely to report poor health status.³⁰ Mobile health technology can make a difference, particularly for men who are hesitant about having regular face-to-face engagement with a health care provider. Interventional apps can target the health issues shown to be of primary concern among men (depression, substance abuse, anxiety), all of which are potential risk factors for long-term chronic health challenges.³⁰

Additionally, research has presented the argument for “gender-specific medicine,” which involves identifying the unique health care needs of men and women, including the biological and physiological

factors that predict health care behaviors.³¹ Mobile health app developers must continue to tailor mobile apps to meet the specific needs of men and women, thus positively impacting the uptake of the innovation for both genders.

Limitations and Strengths

Two limitations of the study are the use of a niched population and possible selection bias. The study sampled CHC patients, which could limit generalizability of findings beyond this context. However, our study fills an important gap in existing knowledge since most investigations of digital health technology practices have largely targeted middle-income communities and ignored the populations represented in our sample. This is despite the fact that a substantial segment of the U.S. population does not have access to “traditional health services” and uses CHCs to address health care needs. Selection bias also could have occurred since the DC site used a convenience sample.

A prominent strength of the study is the fact that knowledge and practices were explored using a bicoastal sample. Information obtained about two geographically distinct patient groups enables the casting of a wider net in applying mobile health technologies to safety-net populations experiencing different vulnerabilities from disparate geographical contexts.

CONCLUSIONS

Low-resource safety-net patients demonstrated strong knowledge and initiated uptake of mobile health technologies. This finding is important because safety-net populations present with poor health outcomes, and digital health care tools can promote self-management and health care engagement. More work is needed to increase use among the lowest-income and older-adult safety-net patients so that the full health benefits that mHealth offers can be realized and health equity established for all patients. Part of the work might involve developing tools that simplify navigation and functionality for these two demographic groups. Additionally, research is needed to assess and predict sustained use of mobile health tools by low-resource communities, including factors affecting sustainability like cost of mobile applications.

Patient-Friendly Recap

- Low-income patients face substantial health challenges compared to the general population and are often served by safety-net community health centers.
- The authors surveyed community health center patients to ascertain their knowledge and use of mobile health technology.
- Respondents were aware of the value of mobile health tools to promote wellness and reported using smartphones and mobile apps for health care.
- Low-resource patient communities are capable of supporting clinical efforts to manage chronic disease via mobile technology.

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Author Contributions

Study design: Laing. Data acquisition or analysis: Laing, Alsaidid. Manuscript drafting: Laing. Critical revision: all authors.

Conflicts of Interest

None.

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