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Cancer Health Impact Program (CHIP): Identifying Social and Demographic Associations of mHealth Access and Cancer Screening Behaviors Among Brooklyn, New York, Residents

Marlene Camacho-Rivera[1], Samuel L. Rice[2], Sehyun Oh[3], Manuel Paris[2], Ezinne Akpara[1], Justen Molina[1], Michael Obadina[1], Shireene Mcmillan[2], Joshua L. Mendez Aracena[5], Jason Morency[1], Rosario Costas Muniz[2], Francesca Gany[2,3,4], Carol L. Brown[7], Jason Gonsky[6], and Joseph R. Osborne[2,3,4]

Abstract

Background: The Bedford-Stuyvesant (BS) and Bushwick (BW) communities of central Brooklyn, New York, are located within the 50-mile core radius of Memorial Sloan Kettering's main catchment area. Cancer is the second leading cause of death among the predominantly African American and Hispanic neighborhoods, with BS and BW having higher prostate cancer and colorectal mortality rates than New York City as a whole. There is significant opportunity to design cancer interventions that leverage the accessibility and acceptability of mobile health (mHealth) tools among the BS and BW communities.

Methods: The Cancer Health Impact Program (CHIP) is a collaborative that was formed for this purpose. Through CHIP, we used a tablet-based, Health Information National Trends (HINTS)-based multimodality survey to collect and analyze social and demographic patterns of prostate cancer and colorectal cancer screening, as well as mHealth access, among BS and BW residents.

Results: Among 783 participants, 77% reported having a smartphone, 40% reported access to a mobile health application, 17% reported blood stool kit testing, and 26% of men reported PSA test screening. Multivariable logistic regression

models results demonstrated that participants who reported owning smartphones, but were unsure whether they had access to a health app, were also significantly more likely to report blood stool kit testing compared with participants without smartphones. In fully adjusted models, access to a health app was not significantly associated with PSA testing. Non-Hispanic white participants were 86% less likely to report blood stool kit testing when compared with non-Hispanic black participants [OR = 0.15; 95% confidence interval (CI) 0.02–0.49]. Participants with a prior history of cancer were three times more likely to report blood stool kit testing when compared with those without cancer history (OR = 3.18; 95% CI, 1.55–6.63).

Conclusions: For blood stool kit testing, significant differences were observed by race/ethnicity, cancer history, age, and smartphone use; for PSA screening, only age was significant in fully adjusted models.

Impact: Our results demonstrate that while access to smartphones and mobile health apps may be prevalent among minority communities, other social and demographic characteristics are more likely to influence screening behaviors.

Introduction

Despite progress over the last decade in the New York State Cancer Control Plan, cancer remains the second leading cause of death for all New Yorkers (1). As colorectal carcinoma screening tests can have the most direct effect on decreasing the burden of this disease on a population and addressing prostate cancer tackles the most common and profound source of disparate cancer out-

comes, we believe that these two cancers are among the most important disease control targets in the catchment area of Memorial Sloan Kettering Cancer Center (New York, New York).

Colorectal cancer is the third leading cause of cancer-related deaths in the United States and screening beginning at age 50 is associated with reduced morbidity and mortality according to U.S. Preventive Services Task Force (2). Recent studies indicate,

[1]Department of Community Health and Social Medicine, CUNY School of Medicine, New York, New York. [2]Department of Radiology, Weill Cornell Medical College, New York, New York. [3]Department of Epidemiology and Biostatistics, CUNY Institute for Implementation Science in Population Health, New York, New York. [4]Department of Research and Technology Management, Clinical Research Administration, Memorial Sloan Kettering Cancer Center, New York, New York. [5]Department of Radiology, Molecular Imaging and Therapy Service, Memorial Sloan Kettering Cancer Center, New York, New York. [6]Department of Medicine, NYC Health + Hospitals, Kings County Hospital Center, SUNY Downstate Medical School, New York, New York. [7]Department of Gynecology, Memorial Sloan Kettering Cancer Center, New York, New York.

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however, that colorectal cancer has been rising in younger adults (under the recommended screening age of 50). During the most recent 10 years for which data are available (2005 to 2014), incidence rates declined by 3.8% annually for colon cancer and by 3.5% annually for rectal cancer among adults 55 years of age and older, but increased by 1.4% and 2.4%, respectively, among those younger than age 55. Furthermore, Hispanic and African Americans younger than 50 years of age have had higher relative frequencies for colorectal cancer compared with other racial and ethnic groups, with Hispanics patients <50 having the highest increase for both colon (RF = 0.300% per year) and rectal cancer (RF = 0.248% per year). In addition, there are well-documented racial and ethnic disparities in colorectal cancer screening with lower uptake observed among Hispanics and African Americans compared with non-Hispanic whites. We recognized these notable racial disparities would warrant further investigation, and we sought to identify novel strategies for increased uptake of noninvasive screening methods, such as home stool blood testing kits.

In 2018, it is estimated that there will be 164,690 new cases of prostate cancer diagnosed and approximately 29,430 people will die of this disease, making it the most common cancer in men (3, 4). Race is a confirmed, nonmodifiable risk factor for prostate cancer with a 2.5-fold greater risk of lethal prostate cancer in African American compared with Caucasian males (5). One can attribute at least 34.8 per 100,000 excess African- American (AA) male deaths per year to this disparity, which is retained despite corrections for access to healthcare [OR 2.26; 95% confidence interval (CI), 1.43–3.58; ref. 6)]. As a result, this disparity is one of the most profound questions in cancer discovery and health equity. While PSA screening has caused a significant decline in prostate cancer–specific mortality over the past two decades, new, controversial screening guidelines have created uncertainty that can result in a potentially deleterious effect with an increased risk for those most at risk for lethal prostate cancer: AA males between 40 and 55 years old (7). Therefore, we determined it was important to better understand the patterns of cancer-information seeking behavior in a predominantly African American component of the MSK catchment to design information-rich interventions in the future for those most at risk (8).

Over time, the amount of people in the United States looking for health information online has steadily increased. From 40% in 2002 to 72% in 2013 according to a report by the Pew Internet and American Life Project (9). The development of Web- and mobile-based health-related applications is increasing, with the goal of facilitating health behavior changes and support of patients in chronic disease self-management and prevention, including cancer education and self-management. Results from a recent systematic review of cancer-focused smartphone apps observed that there are over 295 apps available for use by the general public, 13% of which were developed to assist in early detection (10). Seventy-seven percent of U.S. adults now have a smartphone, more than double the share that Pew Research Center measured in its first survey on smartphone ownership in mid-2011. Across all age groups, only those ages 65 and older (46% of whom own smartphones) fall below majority ownership. On the other hand, those ages 18 to 49, those in higher-income households, and individuals living in urban areas are coming closer and closer to saturation adoption. In addition, there are no differences in smartphone ownership among different racial and ethnic groups, with 77% of non-Hispanic whites and Hispanics, and 75% of non-Hispanic blacks reporting smartphone ownership. These eHealth developments have elevated the importance of assessing the extent to which access to and use of technology has improved health among the most vulnerable populations in particular (11).

The Health Information National Trends Survey (HINTS) collects nationally representative data routinely about the American public's use of cancer-related information. The HINTS targets American adults age 18 and older, to assess their knowledge of, attitudes toward, and use of cancer- and health-related information (12). One of the priority areas of HINTS is to assess changing patterns and needs related to cancer information access and usage, to inform cancer-related intervention and programmatic opportunities. Studies from HINTS have found an increase in searches for cancer-specific health information, with upwards of two thirds of respondents stating that they had used the internet to look up health information for other people (13). Studies from HINTS that have focused on eHealth have been consistent with other national surveys, identifying no evidence of a digital use divide by race/ethnicity. However, use of eHealth tools for cancer-specific information has been identified as being notably lower among Hispanics. HINTS 2005 data reveal that 83% of Spanish-speaking Hispanics have never looked for cancer information. Further differences were observed according to English fluency; 52% of non-Hispanics have looked for information about cancer compared with just 37% of English-speaking Hispanics and 17% of only Spanish-speaking Hispanics. As previously stated, the majority of Hispanic respondents to HINTS 2005 reported never seeking cancer information from any source; in addition, those Hispanics who sought cancer information expressed dissatisfaction with their search. Hispanics also reported lower confidence in their ability to obtain cancer information. Given the state of the national evidence on prostate and colorectal cancer screening disparities and the opportunity to leverage HINTS survey data and measures, the Cancer Health Impact Program (CHIP) was created at Memorial Sloan Kettering Cancer Center in New York City.

As the field of cancer communication has undergone a major revolution due to these technological advancements, frameworks for assessing health promotion, behavior change, and communication have also evolved. These conceptual models include expanded ecological frameworks to explain relationships among individuals, organizations, built and natural environments, societal processes, and personal and population-health within the context of new media (14). Within CHIP, we adopted a social ecological framework, which characterized factors associated with cancer ranging from individual-level biological and sociobehavioral factors, through interpersonal and institutional factors (e.g., such as physician patient communication and access to health services), to societal factors including mass media and changes to screening guidelines (15). These factors were considered relative to cancer outcomes across the continuum including knowledge of cancer causes and risk, cancer screening behaviors, and treatment and care for those with a prior or current cancer history. For the purposes of this study, CHIP hoped to better characterize prostate and colorectal cancer screening behaviors, health information seeking, and smartphone use within two predominantly African American and Hispanic communities in the Cancer Center's catchment area with the goal of improving local education and prevention initiatives for adults at increased risk for cancer and for community members who may be at lower risk for developing cancer, but may be involved with

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cancer-related health information seeking for family members and friends. The aims of this study were (i) to identify social and demographic patterns of prostate cancer and colorectal cancer screening and (ii) to examine the associations between smartphone and health app use and screening behaviors among CHIP participants.

Materials and Methods

Study design—the CHIP of Brooklyn

The CHIP is a consortium of local academic institutions, medical centers, and community organizations collaborating to analyze and improve access to cancer services through education and prevention efforts in Brooklyn, New York, through the collection of local surveillance data and strengthening of community-based partnerships. Through the CHIP, we used a multipronged grassroots recruitment strategy (e.g., faith-based sites, community health centers, barber and beauty shops, etc.) within the Bedford-Stuyvesant (BS), and Bushwick (BW) communities to recruit approximately 400 residents in each of these neighborhoods. A proportional quota sampling frame based on the racial and ethnic demographics of BS and BW residents was used to recruit study participants; of the approximately 200,000 adults (18+) living in BS and BW, approximately 45% self-identify as black or African American, and approximately 40% of the residents self-identify as Hispanic respectively.

The study was approved by the Institutional Review Board of Memorial Sloan Kettering Cancer Center (MSK X17-004). Participants recruited into the study completed an anonymous tablet-based survey of 40 items administered by trained interviewers. For completion of the survey, participants received a $15 gift card. Surveys were conducted from May 2017 to February 2018 with a total of 783 participants recruited into the study, reaching nearly 98% of our targeted sample.

Survey design and measures

Measures used in the study were validated items obtained from the National Cancer Institute's Health Information National Trends Survey (HINTS) Cycles 2 and 4, which was the first cycle of HINTS that included questions about adoption of mHealth applications (16). Survey items focused on knowledge and behaviors of cancer screening for prostate and colorectal cancer, as well as use mobile devices and health-related mobile applications (mHealth). To minimize health literacy and limited English proficiency (LEP) concerns on our ability to elicit health information from our Hispanic participants, we offered the survey in both English and Spanish. Unlike the self-administered nationwide HINTS survey, CHIP surveys were interviewer administered to minimize literacy bias. Prior to study commencement, surveys were pilot tested in English and Spanish among a sample of community members to minimize participant time burden and maximize response rates.

Cancer screening behaviors

PSA screening questions were derived from HINTS 2 (2005) and HINTS 4 Cycle 1 (2011) to assess: (i) beliefs, knowledge, and perceived risk about prostate cancer and screening (in light of the controversial U.S. Joint Preventative Task Force in 2012 recommendation against PSA) and (ii) screening and referral by PCP. Colorectal cancer screening questions were derived from HINTS 2 (2005) and assessed: (i) beliefs, knowledge, and perceived risk

about colorectal cancer and screening and (ii) colorectal cancer screening history (e.g. colonoscopy, sigmoidoscopy, and blood stool test) and referral history by medical care providers. Our primary outcomes were self-reported usage of a home kit for a blood stool test (1 = Yes; 2 = No) to assess colorectal cancer screening history and self-report of PSA testing (1 = Yes; 2 = No) among men.

Access to mobile devices and health apps

We selected two questions from HINTS to characterize participant's health-related app access on the smartphone. The first question "Please indicate if you have each of the following. Mark all that apply." provided participants the following options (1 = Tablet computer like an iPad, Samsung Galaxy, Motorola Xoom, or Kindle Fire; 2 = Smartphone, such as an iPhone, Android, Blackberry, or Windows phone; 3 = Basic cell phone only; 4 = I do not have any of above). We categorized participants who selected the second option under the label "smartphone+." A secondary HINTS question was asked of the smartphone+ group (664 of 783 participants) to probe access to health apps on their smartphone ["On your tablet or smartphone, do you have any software applications or "apps" related to health?" (1 = Yes; 2 = No)]. On the basis of responses to the previous two questions, we derived a new variable according to whether participants had a health-related app on their smartphone (Smartphone+/App+) or not (Smartphone+/App−).

Covariates

Various covariates were evaluated, including, BS/BW residency, gender, age, race/ethnicity, health insurance status ("Do you have any kind of health care coverage, including health insurance, prepaid plans such as HMOs, government plans such as Medicare, or Indian Health Service?"), education level, occupational status, income range, and the history of cancer diagnosis ("Have you ever been diagnosed as having cancer?").

Analytic plan

A total of 783 individuals completed the CHIP survey and were included in the analytic sample. A total of 620 participants completed the English version of the survey and the other 163 participants completed the survey in Spanish. χ^2 test was used to assess the relationship between outcomes and the sociodemographic variables. To control for Type I error, we set our significance level at $P < 0.05$. We used multivariable logistic regression to model the fitted odds that race/ethnicity, age, gender, health insurance status, education, employment, income, neighborhood of residence, and history of cancer independently and differentially predicted smartphone and health app access. We subsequently used multivariable logistic regression to model the fitted odds that social and demographic variables, as well as smartphone and health app access, independently predicted likelihood of having reported use of a stool blood test kit and receipt of PSA screening test (in men only). We calculated ORs and 95% confidence intervals (CI) utilizing complete case analyses with listwise deletion for each model. We used R programming language for all data modeling and analyses conducted in this study.

Results

Table 1 displays the descriptive statistics for the analytic sample of 783 participants. Approximately 70 percent of

Table 1. Sociodemographic characteristics of CHIP participants (N = 783)

Sociodemographics	n (%)
BS/BW residence (n = 783)	
No	234 (29.9)
Yes	549 (70.1)
Gender (n = 783)	
Female	419 (53.5)
Male	340 (43.4)
Other	24 (3.1)
Health plan (n = 782)	
No	88 (11.3)
Yes	685 (87.6)
Others	9 (1.2)
Education (n = 783)	
Less than college	331 (42.3)
College graduate or more	445 (56.8)
Others	7 (0.9)
Occupation (n = 783)	
Unemployed	90 (11.5)
Employed	542 (69.2)
Others	151 (19.3)
Income (n = 781)	
Under $50,000	339 (43.4)
$50,000 or greater	348 (44.6)
Others	94 (12.0)
Cancer (n = 783)	
No	735 (93.9)
Yes	48 (6.1)
Age (n = 674)	
18–34	302 (44.8)
35–39	66 (9.8)
40–44	87 (12.9)
45–49	48 (7.1)
>50	171 (25.4)
Smartphone (n = 783)	
No	183 (23.4)
Yes	600 (76.6)
Health app (n = 664)	
No	386 (58.1)
Yes	266 (40.1)
Others	12 (1.8)
Blood stool test (n = 780)	
No	596 (76.4)
Yes	131 (16.8)
Others	53 (6.8)
PSA Test (n = 339)	
No	233 (68.7)
Yes	89 (26.3)
Others	17 (5.0)

participants resided in our target neighborhoods of BS and BW, with 30% residing in other areas of Brooklyn, NY. Fifty-five percent of participants identified as female, with near equal representation of non-Hispanic black participants compared with Hispanic participants (45% and 42%, respectively). Participants more frequently reported higher levels of socioeconomic status across all measures, with 57% reporting a college degree or more, 69% were currently employed, and 45% reported having an income of $50,000 or more. Six percent of participants reported having ever experienced a diagnosis of cancer (N = 48). Seventy-seven percent of participants reported having access to a smartphone (N = 600); 40% reported use of a mobile health application. Seventeen percent of participants reported use of a blood stool test kit and among men, 26% reported having received PSA test screening.

Predictors of smartphone and health application access

As displayed in Table 2, there were several statistically significant differences in smartphone and health application use by sociodemographic characteristics. Women were statistically significantly more likely than men to report using a health application (61% vs. 37%, P = 0.029), but no significant differences were observed with smartphone use. Non-Hispanic black participants were more likely to report smartphone and health application use than other racial and ethnic groups (53% of respondents reporting both smartphone and health application use) while Hispanic participants comprised 53% of respondents reporting not having a smartphone (P = 0.019). Participants who were insured, had a college degree or more, were employed, and had incomes of $50,000 or more, were all statistically significantly more likely to report both smartphone use (P < 0.0001 for each measure). Notably, we did not observe any significant differences in smartphone and health application use across all age categories. In addition, participants with a history of cancer diagnosis were significantly less likely to report smartphone ownership and health application access when compared with those no prior cancer history (P = 0.008).

Results from the multivariable logistic regression model predicting health application access (Table 3) demonstrated that male participants were 36% less likely to report using a health app (OR = 0.64; 95% CI 0.46–0.90). Participants who reported having a college degree or more were 82% more likely to report health app access compared with those with less than a college degree (OR = 1.82; 95% CI 1.25–2.66). Ownership of health insurance was marginally associated (P = 0.08) with health app access (OR = 1.73; 95% CI 0.94–3.31). Results from the multivariable logistic regression model predicting smartphone access only (Table 4) demonstrated differences in access by various measures of socioeconomic status. Participants who were employed or who had a college degree or more were nearly 2.5 times more likely to own a smartphone than those who were unemployed or had less than a college degree (OR = 2.42, 95% CI 1.42–4.09 and OR = 2.42, 95% CI 1.61–3.66, respectively). Ownership of health insurance was also significantly and positively associated with smartphone ownership (OR = 2.28, 95% CI 1.35–3.82), while income and cancer history were marginally associated with smartphone ownership.

Multivariable logistic regression models predicting prostate cancer and colorectal cancer screening behaviors

To examine the associations between sociodemographic characteristics, smartphone and health app access, and prostate cancer and colorectal cancer screening behaviors, we first explored bivariate associations between each characteristic and PSA screening (among male participants) and blood stool kit testing (among male and female participants) independently. For PSA and blood stool kit testing, we considered the following variables in the bivariate analyses: residence in BS or BW compared with other neighborhoods, race/ethnicity, age, health insurance status, education, occupation, employment, income, cancer history, smartphone, and health app access. For blood stool kit testing, gender was also considered in bivariate analyses. Any variables statistically significantly associated with PSA screening or blood stool kit testing in bivariate analyses (P < 0.05) were included in the multivariable logistic regression models (results in Supplementary Tables).

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Table 2. Demographic variables associated with smartphone and app usage

Sociodemographics	Smartphone−	Smartphone+/App−	Smartphone+/App+	Others	P
BS/BW residence					
No	48 (26.2)	97 (27.6)	87 (36.4)	2 (22.2)	0.067
Yes	135 (73.8)	255 (72.4)	152 (63.6)	7 (77.8)	
Gender					
Female	98 (53.6)	169 (48.0)	146 (61.1)	6 (66.7)	0.029
Male	80 (43.7)	169 (48.0)	89 (37.2)	2 (22.2)	
Others	5 (2.7)	14 (4.0)	4 (1.7)	1 (11.1)	
Race/ethnicity					
Non-Hispanic black	65 (35.5)	157 (44.6)	127 (53.1)	4 (44.4)	0.019
Hispanic	97 (53.0)	147 (41.8)	79 (33.1)	5 (55.6)	
Non-Hispanic white	10 (5.5)	28 (8.0)	19 (7.9)	0 (0.0)	
Others	11 (6.0)	20 (5.7)	14 (5.9)	0 (0.0)	
Health plan					
No	37 (20.2)	36 (10.2)	13 (5.5)	2 (22.2)	<0.001
Yes	142 (77.6)	311 (88.4)	225 (94.5)	7 (77.8)	
Other	4 (2.2)	5 (1.4)	0 (0.0)	0 (0.0)	
Education					
Less than college	121 (66.1)	145 (41.2)	60 (25.1)	5 (55.6)	<0.001
College graduate or more	58 (31.7)	205 (58.2)	178 (74.5)	4 (44.4)	
Others	4 (2.2)	2 (0.6)	1 (0.4)	0 (0.0)	
Occupation					
Unemployed	37 (20.2)	35 (9.9)	18 (7.5)	0 (0.0)	<0.001
Employed	86 (47.0)	263 (74.7)	189 (79.1)	4 (44.4)	
Others	60 (32.8)	54 (15.3)	32 (13.4)	5 (55.6)	
Income					
Under $50,000	105 (57.4)	143 (40.7)	87 (36.6)	4 (44.4)	<0.001
$50,000 or greater	48 (26.2)	172 (49.0)	124 (52.1)	4 (44.4)	
Others	30 (16.4)	36 (10.3)	27 (11.3)	1 (11.1)	
Cancer					
No	164 (89.6)	329 (93.5)	233 (97.5)	9 (100.0)	0.008
Yes	19 (10.4)	23 (6.5)	6 (2.5)	0 (0.0)	
Age					
18–34	54 (34.8)	144 (46.5)	102 (50.5)	2 (28.6)	0.120
35–39	16 (10.3)	34 (11.0)	15 (7.4)	1 (14.3)	
40–44	21 (13.5)	41 (13.2)	24 (11.9)	1 (14.3)	
45–49	9 (5.8)	20 (6.5)	18 (8.9)	1 (14.3)	
> 50	55 (35.5)	71 (22.9)	43 (21.3)	2 (28.6)	

Among male participants, multivariable logistic regression model for PSA test screening was performed. In the multivariable model, we observed a statistically significant association between age and report of PSA test screening. When compared with male participants in the youngest age category (18–34 years), participants in the 45–49 year range were three times more likely to have reported PSA testing and men ages 50 and older were 3.3 times more likely to have reported PSA testing (OR = 3.12, 95% CI 1.04–8.87 and OR = 3.31, 95% CI 1.52–7.39, respectively). Compared with non-Hispanic black participants, non-Hispanic whites were 85% less likely to having undergone a blood stool test (OR = 0.15; 95% CI 0.01–0.91); no statistically significant differences between Hispanic and non-Hispanic black men were observed.

As displayed in Table 5, results from the multivariable logistic regression model demonstrated that non-Hispanic white participants were 86% less likely to report blood stool kit testing when compared with non-Hispanic black participants (OR = 0.15, 95% CI 0.02–0.49). Participants with a prior history of cancer were three times more likely to report blood stool kit testing when compared with those without cancer history (OR = 3.18, 95% CI 1.55–6.63). Older participants were also statistically significantly more likely to report blood stool kit testing, when compared with those in the youngest age category (OR = 3.12, 95% CI 1.93–5.09 for participants in 50 or older category). Interestingly, participants who reported owning smartphones, but were unsure whether they had access to a health app were also significantly more likely to report blood stool kit testing compared with participants without smartphones.

Table 3. Multivariable logistic regression predicting health app usage only

	OR	2.5%	97.5%	P
Race/ethnicity				
Non-Hispanic black (ref)	1.00	1.00	1.00	
Hispanic	0.94	0.65	1.34	0.72
Non-Hispanic white	0.85	0.45	1.57	0.60
Others	0.84	0.41	1.67	0.62
Gender				
Female (ref)	1.00	1.00	1.00	
Male	0.64	0.46	0.90	0.01
Health plan				
No (ref)	1.00	1.00	1.00	
Yes	1.73	0.94	3.31	0.08
Education				
Less than college (ref)	1.00	1.00	1.00	
College graduate or more	1.82	1.25	2.66	<0.001
Occupation				
Unemployed (ref)	1.00	1.00	1.00	
Employed	1.17	0.65	2.17	0.61
Income				
Under $50,000	1.00	1.00	1.00	
$50,000 or greater	0.93	0.64	1.35	0.70
Cancer				
No	1.00	1.00	1.00	
Yes	0.51	0.22	1.12	0.11

Table 4. Multivariable logistic regression predicting smartphone usage only

	OR	2.5%	97.5%	P
Race/ethnicity				
Non-Hispanic black (ref)	1.00	1.00	1.00	
Hispanic	0.75	0.50	1.12	0.16
Non-Hispanic white	0.82	0.38	1.89	0.62
Others	0.66	0.31	1.53	0.31
Gender				
Female (ref)	1.00	1.00	1.00	
Male	1.06	0.73	1.54	0.75
Health plan				
No (ref)	1.00	1.00	1.00	
Yes	2.28	1.35	3.82	<0.001
Education				
Less than college (ref)	1.00	1.00	1.00	
College graduate or more	2.42	1.61	3.66	<0.001
Occupation				
Unemployed (ref)	1.00	1.00	1.00	
Employed	2.42	1.42	4.09	<0.001
Income				
Under $50,000	1.00	1.00	1.00	
$50,000 or greater	1.47	0.95	2.29	0.08
Cancer				
No	1.00	1.00	1.00	
Yes	0.55	0.28	1.11	0.09

Discussion

Consistent with prior studies, we observed that women have reported increased access of mHealth tools for health-related purposes. Females also tend to have increased mHealth utilization due, in part, to their higher engagement in both health care–related online activities and increased use of general social media. We also observed differences in access to smartphone and health apps across race/ethnicity, with Hispanics reporting lower frequencies of smartphone ownership and health app access. However, these differences were not statistically significant after controlling for measures of socioeconomic financial limitations. Prior HINTS studies have reported lower rates of health information seeking among Hispanics, which may also be related to health literacy and limited English proficiency. This finding points to the opportunity to better explore the association between language ability and confidence and trust in health information sources

Table 5. Multivariable logistic regression for blood stool kit testing

	OR	2.5%	97.5%	P
Race/ethnicity				
Non-Hispanic black (ref)	1.00	1.00	1.00	
Hispanic	0.94	0.50	1.78	0.86
Non-Hispanic white	0.15	0.01	0.91	0.09
Others	0.87	0.18	3.06	0.84
Occupation				
Unemployed (ref)	1.00	1.00	1.00	
Employed	1.15	0.45	3.24	0.77
Income				
Under $50,000	1.00	1.00	1.00	
$50,000 or greater	0.63	0.32	1.22	
Cancer				
No	1.00	1.00	1.00	
Yes	1.90	0.57	6.61	0.30
Age				
18–34	1.00	1.00	1.00	
35–39	0.85	0.25	2.48	0.78
40–44	1.57	0.56	4.15	0.37
45–49	3.12	1.04	8.87	0.04
> 50	3.31	1.52	7.39	<0.001

among Hispanics more directly. We utilized education level as a segregate marker for literacy, we did not specifically identify or evaluate the participants specific overall literacy. The interplay between race/ethnicity and socioeconomic status among Hispanics also has implications for the design and dissemination of eHealth/mHealth cancer-related messaging.

Unlike prior studies, we did not observe statistically significant differences across age groups with respect to smartphone access with or without health apps. As our sample was mostly college educated, higher income, and mostly employed, it is possible that younger participants have had greater access to and are more comfortable with using technology in general, as well as for their health-related needs, compared with older respondents within HINTS (17). Our analysis identified individual proxies of limited socioeconomic status that are more reliably associated with mHealth access. In multivariable models, both education and occupation were predictive of smartphone access; however, only education was associated with health app access. Interestingly, income was not predictive of smartphone nor health app access in multivariable models. These findings are consistent with prior demographic studies of eHealth/mHealth access and suggest that, in considering technology use and health communication, some proxies for socioeconomic status, in particular education, may be more relevant than others (18). Diminished access among those less educated indicate that issues of health literacy and eHealth literacy may be important factors, especially when considering online cancer communication interventions targeted to racial and ethnic minorities, as in our sample.

Turning our attention to cancer screening behaviors, our analysis revealed no differences in PSA screening by race/ethnicity, proxies of socioeconomic status, or cancer history. Furthermore, we did not observe an association between smartphone or health app access and PSA screening. As men in our study were less likely to report access of health apps, other technology-based strategies (e.g., use of internet) for screening-related messaging may be more appropriate than cancer-related health apps. Consistent with several studies and screening recommendation guidelines, only age was associated with increased likelihood of PSA screening (19).

Our analysis yielded several interesting findings with implications for improving colorectal screening through the use of blood stool kit usage. We observed that non-Hispanic whites were less likely than non-Hispanic blacks to report use of a blood stool kit, while no differences were observed between blacks and Hispanics. One potential explanation for this observed difference is that non-Hispanic white participants that were eligible for colonoscopy testing may have been able to access colonoscopy testing through the New York State Cancer Services program, forgoing the need for fecal immunochemical testing. Among participants who met the recommended age eligibility for colonoscopy screening within our sample (N = 171), we observed that non-Hispanic white participants were significantly more likely than black and Hispanic participants to report having ever had a colonoscopy (70.8% for non-Hispanic whites, 61.6% for non-Hispanic blacks, and 53.3% for Hispanics; P < 0.001). We observed the strongest association between prior cancer history and reported use of a blood stool kit, demonstrating an opportunity to engage cancer survivors in continued prevention efforts through the use of mHealth technology. We observed a trend association for age and blood stool kit usage, which may indicate the blood stool kit

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as an acceptable method of colorectal cancer screening among younger individuals who do not meet the age criteria for recommended colonoscopy screening. Finally, we found a significant association between smartphone access and blood stool kit testing among a group of smartphone users with unknown health app access. As such, we are unable to discern whether the association is due to misclassification on health app access or if these participants are using smartphones to seek cancer-related information through other eHealth methods (e.g., internet information seeking, social media use).

Although our research has yielded several important additions to the literature examining cancer-screening behaviors and eHealth use among urban minority populations, we note its limitations. First, the nonprobability sampling frame may limit generalizability of our study findings to other urban minority communities. Second, due to the cross-sectional study design and anonymity of the survey, we are unable to account for other unmeasured confounding variables or variables that may mediate or moderate observed associations between mHealth access and cancer screening behaviors. Third, while we were able to ascertain access to health app, we were unable to measure participant frequency of health app usage. To improve comparability of our findings with results from other HINTS studies, we included only validated items from the national survey. However, HINTS does not include questions regarding frequency of health app usage (20). Furthermore, our findings are consistent with other national surveys of health app access among U.S. adults (21). In addition, although surveys were interviewer-administered in both English and Spanish, the self-reported nature of the data may be subject to social desirability and response bias, particularly in the reporting of screening behaviors which individuals may know are recommended. Future studies could address this limitation by including review of medical records to assess cancer screening behaviors and more detailed questions on mHealth use and health information seeking patterns. Our study did not directly ascertain levels of health literacy of participants; as this may be less of a concern among our sample, given the higher levels of educational attainment, health literacy may be a challenge and should be considered when developing future mHealth programs. Finally, our study also did not consider additional behavioral or sociocultural factors such as length of stay, acculturation, chronic disease, or mental health comorbidities, or mistreatment and discrimination within the health care setting, which have also been associated with cancer screening patterns. Future studies should also examine the roles of these factors through the use of population-based study designs and include additional measures such as physician and medical mistrust, social media and internet-based health information usage patterns, and patient–provider communication.

This study provides illustrated access to smartphones and mHealth in the context of other social and demographic characteristics that influence cancer screening among a predominantly minority sample. Within our results, while differences in both mHealth access and prostate cancer and colorectal cancer screening patterns were observed by various demographic and health-related characteristics, access to mHealth tools was not significantly associated with prostate cancer screening or stool blood kit use. In the context of other social ecological factors, access to mHealth tools may be less important for increasing screening rates than addressing other behavioral, social, or structural factors, such as social support and social networks, routine access to health care services, and experiences of discrimination or mistreatment in the health care system (22–24). In addition, rather than focusing on leveraging mHealth accessibility to improve screening behaviors, mHealth tools may be more useful in optimizing cancer care through supporting cancer related decision making, as well as caregivers (25–27).

Potential opportunities to increase colorectal cancer screening rates through the use of blood stool kit testing emerged among two at-risk subpopulations: younger individuals and cancer survivors. Our results have important implications for clinical care and interventions aimed at reducing cancer disparities in minority communities through eHealth/mHealth tools that may be effective when included as a part of a multilevel strategy that considers tailoring to specific subgroups. For example, cancer screening interventions targeted to women and higher educated minorities may see success using health apps to address other barriers – such as improving family or community social support for cancer screening, while men and lower SES groups may benefit more from alternate eHealth forms of information dissemination, such as internet or direct communication, with health care providers to address routine access to health care services. Whenever possible, cancer care providers and public health researchers should consider additional characteristics such as age, gender, and educational background when targeting cancer screening disparities among minority communities within the context of familial, institutional, and community barriers to promoting screening.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Authors' Contributions

Conception and design: M.C. Rivera, M.A. Paris, R.C. Muniz, J.L.M. Aracena, F. Gany, C.L. Brown, J. Gonsky, J.R. Osborne
Development of methodology: M.C. Rivera, M.A. Paris, E. Akpara, S.J. Mcmillan, J.L.M. Aracena, F. Gany, J. Gonsky, J.R. Osborne
Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): M.C. Rivera, M.A. Paris, E. Akpara, J. Molina, S.J. Mcmillan, J.L.M. Aracena, J. Morency
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): M.C. Rivera, S. Oh, M.A. Paris, J.R. Osborne
Writing, review, and/or revision of the manuscript: M.C. Rivera, S.L. Rice, S. Oh, M.A. Paris, R.C. Muniz, M. Obadina, J. Morency, F. Gany, J.R. Osborne
Administrative, technical, or material support (i.e., reporting or organizing data, constructing databases): M.C. Rivera, M.A. Paris, E. Akpara, S.J. Mcmillan, J. Morency, J.R. Osborne
Study supervision: M.C. Rivera, F. Gany, J.R. Osborne

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