Journal of the American Medical Informatics Association, 24(e1), 2017, e18–e27
doi: 10.1093/jamia/ocw087
Advance Access Publication Date: 7 August 2016
Research and Applications

Research and Applications

eHealth patient-provider communication in the United States: interest, inequalities, and predictors

Kiara K Spooner,[1] Jason L Salemi,[1] Hamisu M Salihu,[1] and Roger J Zoorob[2]

[1]Department of Family and Community Medicine, Baylor College of Medicine, Houston, Texas and [2]Baylor College of Medicine, Houston, Texas

Corresponding Author: Kiara K Spooner, DrPH, MPH, Department of Family and Community Medicine, Baylor College of Medicine, 3701 Kirby Drive, Suite 600, Houston, TX 77098, USA. E-mail: Kiara.Spooner@bcm.edu; Tel: 713-798-3725; Fax: 713-798-7940

Received 22 January 2016; Revised 5 April 2016; Accepted 30 April 2016

ABSTRACT

Objective: Health-related Internet use and eHealth technologies, including online patient-provider communication (PPC), are continually being integrated into health care environments. This study aimed to describe sociodemographic and health- and Internet-related correlates that influence adult patients' interest in and electronic exchange of medical information with health care providers in the United States.

Methods: Nationally representative cross-sectional data from the 2014 Health Information National Trends Survey ($N = 3677$) were analyzed. Descriptive statistics and multivariable regression analyses were performed to examine associations between patient-level characteristics and online PPC behavior and interests.

Results: Most respondents were Internet users (82.8%), and 61.5% of information seekers designated the Internet as their first source for health information. Younger respondents (<50 years), Hispanics, those from higher-income households, and those perceiving access to personal health information as important were more likely to be interested in online PPC. Despite varying levels of patient interest, 68.5% had no online PPC in the last year. However, Internet users (odds ratio, OR = 2.87, 95% CI, 1.35-6.08), college graduates (OR = 2.92, 95% CI, 1.42-5.99), and those with frequent provider visits (OR = 1.94, 95% CI, 1.02-3.71) had a higher likelihood of online PPC via email or fax, while Hispanics and those from higher-income households were 2–3 times more likely to communicate via text messaging or phone/mobile apps.

Conclusion: Patients' interest in and display of online PPC-related behaviors vary by age, race/ethnicity, education, income, Internet access/behaviors, and information type. These findings can inform efforts aimed at improving the use and adoption of eHealth technologies, which may contribute to a reduction in communication inequalities and health care disparities.

Key words: electronic patient-provider communication, eHealth, national health survey

INTRODUCTION

Rapid advances in the Internet and technology have greatly changed how health information is accessed and communicated. Recent results from a Pew Research Center national survey indicated that 81% of adults in the United States (US) are Internet users, and among those, approximately three-quarters have searched for health information online.[1] Besides facilitating instantaneous access to health information, the online environment supports a diversity of health communication and eHealth opportunities (Internet-delivered or technology-enhanced health services).[2–4] One such eHealth endeavor that has been increasingly integrated into many health care systems is online patient-provider communication (PPC).[5–7]

Electronic or online communication between patients and providers purports a number of potential benefits, such as shared decision-making, increased provider productivity, and improved quality of care.[6,8,9] Despite these promising benefits, and national research and policy efforts promoting adoption, equitable access and meaningful use of health information technology[10,11] recent prevalence estimates of online PPC (20–30%) remain low.[4,12]

Several studies have documented the trends and correlates of Internet access, as well as patient-level factors identified as influential in health information–seeking behaviors and Internet-based health communication.[1,4,5,13,14] Estimates indicate that Internet access is increasing nationwide,[1,4,5] and greater access to health information online has been linked to improved health knowledge and PPC.[15,16] Yet evidence also suggests that a digital divide (ie, inequitable access and disparities in the use of technology) still exists among lower socioeconomic status (SES), racial/ethnic minority, and other medically underserved populations.[4,17–21] Further, although limited, prior research suggests that patients' level of interest in using eHealth tools is associated with their access of electronic health records (EHRs) and online PPC behaviors, and is reflective of a desire for increased self-care.[22–29]

As the landscape of communication and technology continually evolves,[30] so do the correlates of online PPC, warranting further examination of the most current health communication data. Moreover, given that factors linked to incongruent Internet access and exchange of health information are shared with those of existing health disparities (eg, age, race/ethnicity, SES),[31] an increased understanding of these correlates could assist in maximizing the Internet as a tool for achieving high-quality PPC and positive health outcomes.[15,32] Thus, this study aims to (1) describe current online health-seeking and communication behaviors in the United States, and (2) identify patient-level sociodemographic and health- and Internet-related characteristics associated with interest in and electronic exchange of various types of health information with health care providers.

METHODS

Study design, data source, and sample

We conducted an analysis of cross-sectional data from the Health Information National Trends Survey (HINTS) 2014. Administered biennially to adults 18 years and older by the National Cancer Institute, HINTS is a nationally representative survey that monitors the evolution of health information and communication.[33] HINTS 4 Cycle 4 data ($N = 3677$) were collected between August and November 2014 via self-administered mailed questionnaires. The final overall response rate for the survey was 34.4%. Although low, this response rate is comparable to those of previous HINTS iterations and other national surveys.[34] Additional HINTS 4 methodology details, including the 2-stage stratified sampling design, have been described elsewhere.[35]

Measures

Data from several survey items were included to capture respondents' self-reported characteristics: sociodemographic (age, gender, race/ethnicity, education, marital status, employment, annual household income); health-related (general health, cancer history, medical condition diagnosis, health coverage, regular provider, frequency of provider visits); and Internet-related (general Internet use [*ever go online to access the Internet or World Wide Web, or to send and receive e-mail (yes/no)*], offer of online access to personal health information (PHI) by a health care provider, importance and frequency of online PHI access). Other study variables included health information–seeking behavior and first source (*ever looked for information about health or medical topics from any source (yes/no)*; *where did you go first?)*, and communication device ownership.

Online PPC was measured by asking respondents to select 1 or more devices/modes of communication used in the last year to *exchange medical information electronically with a health care provider*. To differentiate the devices/modes by advances in technology and telecommunication, the 7 response options were then grouped into 3 categories: first-generation (email and fax), second-generation (text message, phone/mobile device app, video, social media), and none.

Interest in online PPC was assessed by inquiring about respondents' level of interest in exchanging 9 types of medical information with health care providers. To enhance interpretability, information types were classified into 3 categories: administrative (appointment reminders, general health tips, medication reminders); general health (vital signs, lifestyle behaviors, symptoms); and private (specific lab/test results, diagnostic information, digital images/video). Likert scale responses for these items were then recoded to represent increasing interest (eg, 4 = *not at all* to 4 = *very interested*), and summed into composite scores ranging from 3 to 12 for each type.

Statistical analysis

SAS software version 9.4 (SAS Institute, Inc., Cary, NC, USA) was used to perform all statistical analyses. Multiple imputation was employed to account for missing data.[36,37] Specifically, IVEware software was used to impute values of missing data for key variables through multivariate sequential regression.[38,39] Variables representing the first source for health information (12.5%), income (10%), and race/ethnicity (8.8%) had the highest rates of missingness; all other variables had missingness levels <5%. To improve estimation, both study-related variables and auxiliary HINTS variables known to have strong association with key study outcomes and covariates (eg, home ownership, English-speaking proficiency, birth country) were included in the imputation model.[36]

We calculated descriptive statistics for all study variables. Multivariable logistic regression was used to generate crude and adjusted odds ratios (ORs) as well as 95% confidence intervals (CIs) for the associations between patient-level characteristics (ie, sociodemographic, health, Internet) and online PPC behaviors and interests. Multivariable linear regression models were utilized to estimate differences in mean online PPC interest levels across patient-level characteristics. All multivariable regression models were constructed to adjust for key sociodemographic and health- and Internet-related factors.

To account for the HINTS sampling design and calculate nationally representative estimates, we applied SAS survey procedures incorporating the jackknife variance estimation technique and HINTS-supplied survey weights. The survey weights were previously calibrated for age, gender, educational attainment, marital status, race, ethnicity, and census region, based on current US Census data.[35] Weights were also calibrated for 2 health-related variables (percent with health insurance and percent who ever had cancer), based on current National Health Information Survey data. The MIANALYZE procedure was then used to combine analyses from

Table 1. Patient-level sociodemographic and health- and Internet-related characteristics ($N = 3677$)

Characteristic	*n* (weighted %)
Age (years)	
18–34	475 (29.9)
35–49	788 (26.7)
50–64	1281 (25.4)
65+	1132 (18.0)
Gender	
Male	1453 (48.2)
Female	2224 (51.8)
Race/Ethnicity	
NH-white	1997 (61.5)
Hispanic	583 (14.7)
NH-black	574 (11.2)
NH-other	523 (12.5)
Education	
Less than high school	349 (12.1)
High school graduate	698 (18.1)
Some college	1139 (30.2)
College grad or higher	1490 (39.6)
Marital Status	
Married/living as married	1889 (56.0)
Not married	1788 (44.0)
Employment Status	
Employed	1797 (58.5)
Unemployed	210 (6.1)
Retired/homemaker/student	1326 (29.0)
Unable to work	344 (6.4)
Annual Household Income	
<$35 000	1453 (33.1)
$35 000 <$75 000	1153 (32.2)
$75 000+	1071 (34.7)
General Health	
Excellent/very good	1612 (47.8)
Good	1402 (38.9)
Fair/poor	664 (13.4)
Cancer History	
Yes	550 (8.6)
No	3127 (91.4)
Chronic Health Conditions[a]	
≥1	2506 (55.9)
0	1171 (44.1)
Health Coverage	
Insured	3234 (87.2)
Uninsured	443 (12.8)
Regular Provider	
Yes	2569 (64.0)
No	1108 (36.0)
Frequency of Provider Visits[b]	
None	553 (20.1)
1	504 (15.0)
2+	2620 (64.9)
Frequency of Online PHI Access[b]	
None	2715 (72.5)
1–2 times	463 (13.5)
3+ times	499 (14.0)
Offered Online PHI Access by HCP	
Yes	1230 (33.3)
No	2447 (66.7)
Interest in Online PPC, by Type of Medical/Health Information	
Appointment reminders	3003 (85.0)
General health tips	2710 (73.5)
Medication reminders	2618 (74.0)
Lab/test results	2761 (76.3)
Diagnostic information (eg, medical illnesses or diseases)	2487 (69.0)
Vital signs (eg, heart rate, blood pressure, glucose levels, etc.)	2681 (73.6)
Lifestyle behaviors (eg, physical activity, food intake, sleep patterns, etc.)	2541 (69.2)
Symptoms (eg, nausea, pain, dizziness, etc.)	2588 (72.4)
Digital images/video (eg, photos of skin lesions)	2332 (65.1)
Online PPC, by Mode[b]	
Email only	488 (13.8)
Fax only	75 (1.9)
Text message only	66 (1.8)
Apps only	49 (1.3)
Social media only	39 (0.8)
Video conference only	7 (0.1)
Multiple modes/devices	416 (11.7)
None	2538 (68.5)

[a]Refers to diabetes, hypertension, heart conditions (eg, heart attack, angina), chronic lung disease, asthma, arthritis, depression, or anxiety disorder.

[b]In the last 12 months.

HCP: health care provider; PHI: personal health information; PPC: patient-provider communication.

each multiply imputed dataset to generate final parameter and variance estimates.[36,40,41] Sensitivity analyses were conducted to compare the observed vs imputed data; we found no differences in the distribution of study variables between the 2 approaches. All analyses and CIs assumed a type I error rate of 5%. This study was granted exempt status by the Baylor College of Medicine Institutional Review Board.

RESULTS

Patient characteristics

Patients' sociodemographic and health- and Internet-related characteristics are provided in Table 1. The majority of study respondents were <50 years of age, female, non-Hispanic-white, college educated, employed, and had an annual household income of $75 000+. Most respondents had no history of cancer, perceived themselves as being in excellent or very good health, had health insurance, and reported frequent visits to a health care provider.

Supplemental Table 1 presents estimates of respondents' health information–seeking behavior, sources of health information, Internet use, online PPC behaviors, and electronic device ownership/use by patient-level characteristics. Seventy-five percent of the sample respondents reported owning a tablet computer, a smartphone, or both devices. Most respondents were general Internet users (82.8%) and reported having ever searched for health information from various sources (80.3%). Among the health information seekers, 61.5% indicated that the Internet was the first source consulted. Although most health information seekers reported the Internet as their first source, > 50% of older patients (65+ years), Hispanics, those with less than a high school education, and non-Internet users reported non-Internet sources (eg, books, brochures, or a doctor/health care provider) as their first source.

Between 65% and 85% of the population expressed interest in exchanging medical/health information electronically with health care providers, with variations by type of information. Despite high levels of interest, 68.5% of the study population reported no online PPC. Among respondents engaging in online PPC in the past year, email (13.8%) was the most common solitary mode/device used, followed by fax (1.9%) and text message (1.8%); 11.7% reported using multiple modes/devices (Table 1).

Online PPC modes and interests

Several patient-level sociodemographic and health- and Internet-related characteristics were identified as predictors of online PPC (Table 2). Based on an unadjusted analysis of the sample, we observed online PPC to be associated with patients' age, race/ethnicity, SES, health status/access, general Internet use, and access of PHI. However, after adjusting for potential confounders, only a few associations remained statistically significant. Higher education, frequent provider visits (2+), perception that online PHI access was very important, and general Internet use were associated with 2–3 times increased odds of engaging in online PPC via email or fax (ie, first-generation modes), while Hispanics, NH-others, and those from higher-income households were more likely to have communicated with health care providers via text, phone apps, or social media (ie, second-generation modes). Predictors of online PPC common among both generational modes of communication included being offered online PHI access by a health care provider (OR = 1.63, 95% CI, 1.12-2.35 [first generation]; OR = 1.95, 95% CI, 1.29-2.97 [second generation]) and online PHI access behavior, with odds increasing in direct relationship to frequency of access.

Table 3 presents associations between patients' interest in electronically exchanging medical information (administrative, general health, private) with health care providers and patient-level characteristics. After controlling for confounders, respondents who were younger (<50 years), were Hispanic, had higher household incomes, frequently accessed PHI online, and perceived online PHI access to be important were significantly more likely to be interested in electronically exchanging all 3 types of medical information with providers. Among respondents reporting no online PPC in the past 12 months, having a higher household income (OR = 1.79, 95% CI, 1.03-3.11), frequently (3+ times) accessing PHI online (OR 2.06, 95% CI, 1.05-4.04), and perceiving online PHI access as important (very or somewhat) (OR = 6.82, 95% CI, 3.91-11.93 and OR = 3.73, 95% CI, 1.99-6.99, respectively) remained significant predictors of interest in online PPC, despite no reported online PPC engagement.

Multivariable linear models revealed that respondents' level of interest in electronically exchanging information with health care providers differed by the type of information (administrative, general health, private, or all) and across sociodemographic and health- and Internet-related characteristics (Supplemental Table 2). Age, race/ethnicity, income, health status, and PHI access perceptions/behaviors were associated with higher levels of interest in electronically exchanging all types of health information with providers.

DISCUSSION

Consistent with recent research,[4,22,23] findings from this nationally representative study highlight patients' increased interest in but low prevalence of online PPC. Most adults in our study were Internet users and reported the Internet as their first source for seeking health information.[1,4,42] Although the percentage of Internet users has steadily increased in recent years,[1] our findings point to a shift in the profile of US adults who use the Internet to communicate with health care providers.

With a few exceptions, such as education and frequency of provider visits, sociodemographic and health-related factors were not the dominant predictors of online PPC. Instead, several Internet-related factors such as general Internet use, being offered online PHI access, and frequency of online PHI access were consistently predictive of online PPC. These findings suggest that health care providers or practices may be able to influence patients' eHealth technology behaviors through consistent recommendations, reminders, and encouragement of use.[43] Surprisingly, Internet access has not always been a significant predictor of online PPC.[13] However, with a growing number of health care systems equipped with the infrastructure to support access to EHRs and online PPC,[44] it is reasonable to speculate that increased availability and use of eHealth technologies has followed. This observance may also be explained by the high levels of handheld computer tablet and smartphone ownership across varying demographics[45] and the increased ease and access to the Internet that these devices facilitate.

Findings from this study also suggest that the variance in Internet and eHealth technology use once ascribed to sociodemographic (eg, age, gender, race/ethnicity) and health-related factors is diminished once other factors such as income, technological advances, and social influences are taken into account.[46] However, the fact that education has remained predictive of online PPC over the years may reflect higher levels of eHealth literacy among the more educated.[47] This implies that, in order to increase patients' engagement in and benefits from eHealth tool usage, concerted national efforts should be aimed at increasing both eHealth and general health literacy skills among underserved and less educated populations.[48]

Further, although sociodemographic factors such as age, race/ethnicity, and income were not found to be predictive of online PPC via email or fax, our results revealed that Hispanics, NH-others (eg, Asians, multiple races), and those from higher-income households were more likely to have communicated with health care providers via text, phone apps, or social media. This increased likelihood of PPC via second-generation technology among Hispanics and other racial/ethnic minorities may be due to their reported higher use of text messaging as a common mode of communication,[49] greater utilization of various data applications on mobile devices,[50] and the perception that cell phones are a necessity, particularly in the absence of a home landline.[51] Moreover, even among resource-poor populations, communication via text messages and phone apps is typically more readily accessible and easier, encourages brevity, and does not require fluency in English. We describe this as *positive disparity adaptation*, a phenomenon in which linguistic barriers have been overcome through technological advances in communication.

Comparable to previous research, our findings also suggest significant patient interest in online PPC.[22,23] Younger respondents (<50 years), Hispanics, and those with higher household incomes were more likely to report interest in online PPC and to have significantly higher levels of interest compared to older, NH-white, and lower-income respondents. These findings are not surprising, given that younger individuals[52] and those with higher incomes tend to be avid adopters of technology.[20] Hispanics' increased interest may be attributed to previously suggested reasons for their online PPC behaviors, such as accessibility and the reduction in language-related barriers offered by communication via electronic means, compared to phone or in-person verbal communication. However,

Table 2. Odds of patients electronically exchanging medical information with HCPs by patient-level characteristics

Characteristic/Covariate	First-Generation Communication Mode (email, fax)		Second-Generation Communication Mode (text, apps, video, social media)	
	COR (95% CI)	AOR (95% CI)	COR (95% CI)	AOR (95% CI)
Age (years)				
18–34	2.21 (1.43, 3.41)*	1.40 (0.67, 2.91)	1.81 (1.11, 2.95)*	1.47 (0.73, 2.97)
35–49	1.58 (1.18, 2.11)*	1.06 (0.54, 2.09)	1.81 (1.21, 2.71)*	1.37 (0.73, 2.56)
50–64	2.04 (1.49, 2.80)*	1.54 (0.84, 2.82)	2.02 (1.41, 2.89)*	1.63 (0.97, 2.72)
65+	Ref	Ref	Ref	Ref
Gender				
Male	Ref	Ref	Ref	Ref
Female	1.00 (0.73, 1.35)	1.04 (0.73, 1.49)	0.87 (0.63, 1.19)	0.88 (0.61, 1.27)
Race/Ethnicity				
NH-white	Ref	Ref	Ref	Ref
Hispanic	0.48 (0.32, 0.72)*	1.11 (0.70, 1.76)	1.67 (1.20, 2.32)*	2.65 (1.68, 4.17)*
NH-black	0.65 (0.42, 1.01)	0.87 (0.56, 1.36)	1.33 (0.83, 2.14)	1.52 (0.86, 2.72)
NH-other	0.81 (0.40, 1.62)	0.97 (0.45, 2.08)	1.72 (1.00, 2.96)	1.87 (1.06, 3.32)*
Education				
Less than high school	Ref	Ref	Ref	Ref
High school graduate	1.85 (1.00, 3.41)*	1.38 (0.70, 2.73)	0.80 (0.47, 1.37)	0.94 (0.47, 1.86)
Some college	4.49 (2.66, 7.58)*	1.98 (1.06, 3.69)*	1.14 (0.70, 1.84)	1.10 (0.55, 2.20)
College grad or higher	8.38 (4.50, 15.60)*	2.92 (1.42, 5.99)*	1.81 (1.18, 2.79)*	1.36 (0.65, 2.81)
Marital Status				
Married/living as married	Ref	Ref	Ref	Ref
Not married	0.94 (0.66, 1.33)	1.34 (0.91, 1.98)	0.91 (0.64, 1.29)	1.13 (0.75, 1.69)
Employment Status				
Employed	Ref	Ref	Ref	Ref
Unemployed	0.77 (0.22, 2.69)	1.18 (0.39, 3.55)	0.85 (0.40, 1.78)	0.84 (0.35, 2.00)
Retired/homemaker/student	0.75 (0.51, 1.12)	1.18 (0.66, 2.09)	0.65 (0.46, 0.93)*	0.89 (0.52, 1.53)
Unable to work	0.70 (0.39, 1.23)	1.31 (0.60, 2.89)	0.89 (0.52, 1.52)	0.87 (0.43, 1.78)
Annual Household Income				
<$35,000	Ref	Ref	Ref	Ref
$35,000 < $75,000	1.42 (0.91, 2.22)	1.01 (0.56, 1.80)	1.10 (0.75, 1.61)	0.98 (0.63, 1.53)
$75,000+	3.87 (2.23, 6.73)*	2.05 (0.97, 4.34)	2.17 (1.52, 3.09)*	1.75 (1.04, 2.95)*
General Health				
Excellent/very good	Ref	Ref	Ref	Ref
Good	0.68 (0.47, 0.98)*	0.87 (0.56, 1.37)	0.82 (0.58, 1.16)	0.85 (0.58, 1.23)
Fair/poor	0.51 (0.30, 0.88)*	1.10 (0.55, 2.20)	0.90 (0.59, 1.38)	1.05 (0.66, 1.69)
Cancer History				
Yes	Ref	Ref	Ref	Ref
No	1.30 (0.95, 1.80)	1.29 (0.84, 1.97)	0.85 (0.49, 1.48)	0.86 (0.46, 1.60)
Chronic Health Conditions[a]				
0	Ref	Ref	Ref	Ref
≥1	0.81 (0.60, 1.09)	0.91 (0.62, 1.34)	1.00 (0.71, 1.41)	1.09 (0.73, 1.63)
Health Coverage				
Insured	2.79 (1.75, 4.45)*	1.11 (0.60, 2.04)	1.04 (0.69, 1.59)	0.66 (0.38, 1.14)
Uninsured	Ref	Ref	Ref	Ref
Regular Provider				
Yes	1.65 (1.17, 2.32)*	1.10 (0.70, 1.74)	1.50 (1.07, 2.09)*	1.36 (0.90, 2.06)
No	Ref	Ref	Ref	Ref
Frequency of Provider Visits[b]				
1	1.72 (0.96, 3.10)	1.00 (0.48, 2.10)	0.99 (0.54, 1.82)	0.79 (0.39, 1.63)
2+	2.91 (1.76, 4.79)*	1.94 (1.02, 3.71)*	1.63 (1.11, 2.40)*	1.30 (0.79, 2.14)
None	Ref	Ref	Ref	Ref
Frequency of Online PHI Access[b]				
1–2 times	6.05 (3.92, 9.36)*	3.27 (2.03, 5.26)*	2.86 (1.98, 4.14)*	1.94 (1.24, 3.03)*
3+ times	10.95 (7.66, 15.65)*	4.93 (3.14, 7.75)*	6.80 (4.86, 9.51)*	4.14 (2.56, 6.70)*
None	Ref	Ref	Ref	Ref
Perceived Importance of Online PHI Access				
Very important	5.49 (2.91, 10.38)*	2.40 (1.12, 5.16)*	2.90 (1.28, 6.58)*	1.99 (0.93, 4.29)
Somewhat important	2.70 (1.27, 5.71)*	1.73 (0.73, 4.07)	1.84 (0.74, 4.56)	1.48 (0.67, 3.31)
Not at all important	Ref	Ref	Ref	Ref

(continued)

Table 2. Continued

Characteristic/Covariate	First-Generation Communication Mode (email, fax)		Second-Generation Communication Mode (text, apps, video, social media)	
	COR (95% CI)	AOR (95% CI)	COR (95% CI)	AOR (95% CI)
Offered Online PHI Access by HCP				
Yes	5.00 (3.62, 6.90)*	1.63 (1.12, 2.35)*	3.53 (2.64, 4.73)*	1.95 (1.29, 2.97)*
No	Ref	Ref	Ref	Ref
Internet User				
No	Ref	Ref	Ref	Ref
Yes	8.69 (4.52, 16.73)*	2.87 (1.35, 6.08)*	1.32 (0.93, 1.87)	0.67 (0.41, 1.10)

*Statistically significant $P < .05$.

[a]Refers to diabetes, hypertension, heart conditions (eg, heart attack, angina), chronic lung disease, asthma, arthritis, depression, or anxiety disorder.

[b]In the last 12 months.

AOR: adjusted odds ratio (adjusted for all patient-level sociodemographic and health- and Internet-related characteristics); COR: crude odds ratio; HCP: health care provider; PHI: personal health information; PPC: patient-provider communication; Ref: reference group; 95% CI: 95% confidence interval.

more research is needed to explore factors specifically related to increased online PPC interest among Hispanics.

In addition to the above-mentioned, a few patient-level characteristics were uniquely associated with interest in exchanging specific types of information. For example, we observed significantly higher levels of interest in exchanging general health and private information among those reporting ≥1 chronic health conditions, suggesting that they may perceive online PPC as a way to assist in managing their health.[53] Further, it is important to point out that previous evidence suggests that most patients commonly use email to communicate non-acute issues and concerns that are less sensitive.[54–57] However, our findings are unique in that they identify the range of information (ie, administrative, general, private) that patients from varying backgrounds would be interested in exchanging electronically.

Our analysis also reveals that even among those who had not communicated online with health care providers in the past year, characteristics such as higher income as well as being offered and having positive perceptions of and frequent online access to PHI were predictive of interest in online PPC. These observations may point to the above-mentioned factors as being the strongest predictors for this. However, since we lack data on whether this subgroup of study respondents have *ever* engaged in online PPC, it is possible that these observations simply reflect respondents who did not engage in online PPC in the past year but had done so previously.

Finally, it is noteworthy that many of the characteristics associated with *interest* in online PPC are the same as those associated with actually *engaging* in online PPC. This observed concordance may be an indication that patients' interest serves as a mediating factor[58] in the use of eHealth technologies. However, research (eg, mediation analysis) with additional patient-, provider-, and system-level factors is needed to more concretely examine the relationship between interest and eHealth use. Conversely, the observation that overall interest levels were higher than rates of online PPC suggests that providers may not be engaging patients in discussions about available eHealth services[59] or that some patients lack the necessary skills to properly use the Internet and associated eHealth technologies. This inequitable interest and disparity may be addressed through marketing strategies (eg, media campaigns, printed materials) that collectively aim to increase awareness and educate patients on the benefits of available eHealth technologies. Additionally, providing skills training and eHealth technologies tailored to the various needs of patient populations may increase adoption, particularly among those with limited eHealth literacy and technological skills.

Limitations

Although this study yields valuable results, it is not without limitations. First, the HINTS cross-sectional study design and reliance on self-reported data does not permit causal inferences. Additionally, the low response rate of the survey increases potential biases, particularly those due to nonresponse and sampling. However, the sampling and weighting strategy employed by HINTS survey administrators allowed for minimization of biases, as well as improved national representativeness and generalizability of the findings.[34,35,60] For instance, when compared to the demographic and housing estimates for the 2014 US population, our prevalence estimates closely align for characteristics such as age (eg, 65 years and older: 18.8% [US Census], 18.0% [this study]), gender (eg, females: 51.4% [US Census], 51.8% [this study]), and race/ethnicity (eg, NH-whites: 62.8% [US Census], 61.5% [this study]).[61] Also, compared to previous research using complete case analyses, our use of multiple imputation for missing data may have contributed to a reduction in biases, as well as more precise and valid results.[36,37]

Furthermore, even though HINTS data provide a snapshot of patients' interests and behaviors related to electronic communication with health care providers, our results do not offer insights into their justifications. Thus, future research is needed to qualitatively examine patient-level factors that intrinsically impede or influence use of eHealth technologies. Another study shortcoming is that we are unable to comment on the role that provider-level characteristics (eg, opinions, system-level policies, reimbursement issues, and workload)[8,55,62] may have had in facilitating or impeding online PPC. For example, investigating the frequency, quality, and perceived value of providing eHealth services, as well as the impact on health care practices, is warranted. Such additional exploration into eHealth utilization may elucidate processes and pathways needed to increase usage and establish best practices for online PPC.

CONCLUSION

Effective communication between patients and providers is integral to improving health outcomes and quality of care.[63] With enduring technological advances and increased access to the Internet and various eHealth tools, a more in-depth understanding of the factors

Table 3. Odds of patients' interest in electronically exchanging medical information with HCPs by patient-level characteristics

Characteristic/ Covariate	Administrative Information Interest[a]		General Health Information Interest[b]		Private Information Interest[c]		Combined Information Interest[d]	
	All[e] AOR (95% CI)	No online PPC[f] AOR (95% CI)	All[e] AOR (95% CI)	No online PPC[f] AOR (95% CI)	All[e] AOR (95% CI)	No online PPC[f] AOR (95% CI)	All[e] AOR (95% CI)	No online PPC[f] AOR (95% CI)
Age (years)								
18–34	1.92 (1.19-3.11)*	1.54 (0.82, 2.89)	1.74 (1.08, 2.80)*	1.38 (0.84, 2.28)	2.39 (1.49, 3.84)*	2.12 (1.28, 3.49)*	1.57 (1.01, 2.45)*	1.18 (0.71, 1.98)
35–49	1.74 (1.22-2.49)*	1.43 (0.89-2.30)	1.82 (1.17-2.83)*	1.43 (0.85-2.42)	2.24 (1.42-3.54)*	1.99 (1.16-3.40)*	2.05 (1.39-3.02)*	1.48 (0.92-2.37)
50–64	1.21 (0.84-1.73)	1.01 (0.64-1.61)	1.09 (0.72-1.65)	0.89 (0.54-1.45)	1.27 (0.84-1.90)	1.13 (0.69-1.83)	1.20 (0.82-1.74)	0.87 (0.54-1.40)
65+	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Gender								
Male	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Female	0.80 (0.59-1.08)	0.78 (0.55-1.12)	1.05 (0.83-1.32)	1.02 (0.75-1.37)	0.83 (0.64-1.06)	0.90 (0.68-1.19)	0.85 (0.67-1.08)	0.85 (0.63-1.14)
Race/Ethnicity								
NH-white	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Hispanic	2.65 (1.74-4.05)*	2.86 (1.75-4.68)*	1.68 (1.13-2.50)*	1.57 (0.98-2.50)	1.23 (0.84-1.80)	1.28 (0.81-2.02)	1.64 (1.11-2.43)*	1.62 (0.99-2.65)
NH-black	2.50 (1.56-4.00)*	2.91 (1.64-5.14)*	1.35 (0.84-2.17)	1.40 (0.81-2.40)	0.89 (0.58-1.37)	1.14 (0.66-1.98)	1.35 (0.89-2.03)	1.55 (0.93-2.58)
NH-other	1.35 (0.86-2.11)	1.15 (0.69-1.93)	1.24 (0.80-1.93)	0.99 (0.60-1.65)	1.08 (0.67-1.72)	0.96 (0.57-1.62)	1.42 (0.95-2.12)	1.20 (0.69-2.07)
Education								
Less than high school	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
High school graduate	1.01 (0.67-1.54)	0.94 (0.57-1.55)	1.00 (0.66-1.52)	1.07 (0.65-1.74)	0.79 (0.49-1.29)	0.85 (0.47-1.53)	0.95 (0.61-1.47)	0.88 (0.49-1.56)
Some college	1.22 (0.79-1.86)	1.10 (0.66-1.82)	1.26 (0.81-1.95)	1.23 (0.74-2.05)	1.07 (0.66-1.74)	1.09 (0.63-1.86)	1.23 (0.78-1.95)	1.05 (0.60-1.84)
College grad or higher	0.92 (0.61-1.39)	0.85 (0.51-1.43)	1.41 (0.91-2.17)	1.59 (1.00-2.54)	1.38 (0.90-2.12)	1.53 (0.95-2.46)	1.08 (0.71-1.64)	1.04 (0.63-1.74)
Marital Status								
Married/living as married	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Not married	0.98 (0.70-1.37)	0.95 (0.61-1.48)	1.23 (0.88-1.73)	1.13 (0.76-1.69)	1.23 (0.91-1.64)	1.12 (0.77-1.63)	1.09 (0.80-1.48)	1.11 (0.75-1.63)
Employment Status								
Employed	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Unemployed	1.51 (1.01-2.27)*	1.40 (0.83-2.37)	0.85 (0.43-1.66)	0.96 (0.53-1.71)	0.97 (0.59-1.59)	0.79 (0.43-1.45)	1.08 (0.56-2.09)	1.04 (0.53-2.03)
Retired/ homemaker/ student	1.09 (0.75-1.58)	0.97 (0.61-1.54)	1.10 (0.76-1.59)	0.91 (0.57-1.44)	1.21 (0.83-1.78)	1.06 (0.68-1.67)	1.13 (0.80-1.60)	0.87 (0.55-1.35)
Unable to work	1.03 (0.62-1.72)	1.37 (0.79-2.39)	1.21 (0.82-1.79)	1.44 (0.88-2.34)	1.00 (0.65-1.53)	1.23 (0.73-2.07)	0.99 (0.63-1.55)	1.33 (0.79-2.23)
Annual Household Income								
<$35 000	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
$35 000 < $75 000	1.32 (0.91-1.92)	1.33 (0.84-2.09)	1.25 (0.88-1.78)	1.18 (0.74-1.86)	1.11 (0.79-1.57)	1.08 (0.70-1.68)	1.26 (0.86-1.84)	1.13 (0.69-1.84)
$75 000+	1.71 (1.07-2.75)*	1.82 (1.03-3.19)*	2.16 (1.40-3.33)*	1.98 (1.13-3.50)*	1.65 (1.03-2.66)*	1.59 (0.93-2.71)	1.71 (1.09-2.67)*	1.79 (1.03-3.11)*
General Health								
Excellent/very good	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Good	1.19 (0.90-1.57)	1.17 (0.82-1.67)	1.16 (0.86-1.56)	1.26 (0.88-1.80)	0.95 (0.72-1.25)	1.08 (0.77-1.51)	1.07 (0.82-1.39)	1.06 (0.77-1.45)
Fair/poor	1.20 (0.83-1.73)	1.13 (0.71-1.79)	1.15 (0.79-1.69)	1.14 (0.70-1.87)	0.99 (0.65-1.51)	0.97 (0.59-1.62)	1.13 (0.77-1.65)	1.05 (0.66-1.70)
Cancer History								
Yes	0.85 (0.64-1.13)	0.84 (0.58-1.20)	0.92 (0.66-1.28)	0.96 (0.67-1.38)	0.90 (0.62-1.31)	1.06 (0.71-1.61)	1.02 (0.72-1.44)	1.06 (0.72-1.57)
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref

(continued)

Table 3. Continued

Characteristic/ Covariate	Administrative Information Interest[a]		General Health Information Interest[b]		Private Information Interest[c]		Combined Information Interest[d]	
	All[e] AOR (95% CI)	No online PPC[f] AOR (95% CI)	All[e] AOR (95% CI)	No online PPC[f] AOR (95% CI)	All[e] AOR (95% CI)	No online PPC[f] AOR (95% CI)	All[e] AOR (95% CI)	No online PPC[f] AOR (95% CI)
Chronic Health Conditions[g]								
0	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
≥1	1.19 (0.88-1.61)	1.14 (0.79-1.65)	1.32 (0.98-1.79)	1.17 (0.82-1.67)	1.32 (0.96-1.80)	1.34 (0.90-2.00)	1.22 (0.92-1.62)	1.04 (0.72-1.51)
Health Coverage								
Insured	0.91 (0.60-1.37)	1.00 (0.60-1.67)	0.85 (0.57-1.26)	0.98 (0.61-1.58)	0.96 (0.67-1.38)	1.00 (0.64-1.57)	0.89 (0.61-1.32)	0.99 (0.61-1.60)
Uninsured	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Regular Provider								
Yes	1.03 (0.78-1.36)	0.94 (0.67-1.32)	1.19 (0.82-1.73)	1.12 (0.72-1.73)	1.05 (0.73-1.51)	0.86 (0.58-1.29)	0.97 (0.72-1.31)	0.87 (0.61-1.25)
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Frequency of Provider Visits[h]								
1	1.13 (0.71-1.82)	1.05 (0.62-1.79)	0.89 (0.61-1.30)	1.02 (0.70-1.50)	1.09 (0.77-1.55)	1.03 (0.67-1.58)	1.08 (0.73-1.59)	1.16 (0.73-1.85)
2+	1.22 (0.79-1.90)	1.21 (0.73-2.02)	0.78 (0.51-1.18)	0.70 (0.43-1.16)	0.94 (0.64-1.38)	0.89 (0.55-1.44)	0.90 (0.62-1.30)	0.92 (0.58-1.46)
None	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Frequency of Online PHI Access[h]								
1–2 times	1.90 (1.13-3.18)*	1.43 (0.71-2.88)	1.69 (1.21-2.36)*	1.34 (0.80-2.25)	1.95 (1.26-3.02)*	1.58 (0.98-2.57)	1.62 (1.05-2.53)*	1.18 (0.65-2.13)
3+ times	2.90 (2.03-4.13)*	2.40 (1.31-4.39)*	2.07 (1.24-3.45)*	1.63 (0.76-3.50)	2.31 (1.52-3.50)*	1.88 (0.96-3.65)	2.28 (1.52-3.40)*	2.06 (1.05-4.04)*
None	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Perceived Importance of Online PHI Access								
Very important	4.15 (2.63-6.56)*	4.54 (2.49-8.27)*	6.07 (3.74-9.85)*	6.67 (3.85-11.55)*	7.77 (4.51-13.38)*	8.93 (4.79-16.63)*	5.74 (3.47-9.50)*	6.82 (3.91-11.93)*
Somewhat important	3.01 (1.90-4.77)*	3.73 (2.15-6.48)*	3.58 (2.14-5.97)*	3.85 (2.14-6.93)*	3.85 (2.18-6.82)*	4.44 (2.37-8.33)*	2.94 (1.65-5.24)*	3.73 (1.99-6.99)*
Not at all important	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Offered Online PHI Access by HCP								
Yes	1.35 (0.97-1.89)	1.30 (0.90-1.90)	1.38 (1.03-1.84)*	1.55 (1.12-2.14)*	1.47 (1.06-2.04)*	1.38 (0.96-1.98)	1.34 (0.98-1.83)	1.40 (0.97-2.04)
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Internet User								
Yes	1.13 (0.79-1.61)	1.29 (0.87-1.93)	0.89 (0.64-1.23)	0.90 (0.63-1.30)	0.82 (0.57-1.17)	0.91 (0.59-1.40)	0.89 (0.63-1.26)	0.98 (0.64-1.50)
No	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref

*Statistically significant $P < .05$.

[a]Reflects interest in exchanging administrative information.

[b]Reflects interest in exchanging general health or medical information.

[c]Reflects interest in exchanging private information.

[d]Reflects interest in exchanging all 3 types of medical or health information.

[e]Estimates are based on the entire study population ($N = 3677$).

[f]Estimates are based on respondents reporting no online PPC in the last 12 months ($n = 2538$).

[g]Refers to diabetes, hypertension, heart conditions (eg, heart attack, angina), chronic lung disease, asthma, arthritis, depression, or anxiety disorder.

[h]In the last 12 months.

AOR: adjusted odds ratio (adjusted for all patient-level sociodemographic and health- and Internet-related characteristics); HCP: health care provider; PHI, Personal health information; PPC: patient-provider communication; Ref: reference group; 95% CI: 95% confidence intervals.

influential to the use of eHealth technologies is essential. Such information may inform efforts aimed at increasing eHealth uptake, and subsequently bolster enhanced patient-provider communication, higher quality of care, and improved health outcomes.

FUNDING

This research was supported by the Health Resources and Services Administration, an agency of the US Department of Health and Human Services, grant number T32 HP10031. The funding source/study sponsor had no role in the study design; collection, analysis, and interpretation of the data; writing of the report; or decision to submit the manuscript for publication.

COMPETING INTERESTS

The authors have no competing or conflicts of interest.

CONTRIBUTORS

K.K.S. conceptualized and designed this study, with substantial continuous input from J.L.S., H.M.S., and R.J.Z. K.K.S. and J.L.S. developed and implemented the statistical analysis plan and interpreted the results. K.K.S. prepared the manuscript. All authors contributed considerably to the critical review and revision of the final manuscript.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *Journal of the American Medical Informatics Association* online.

ACKNOWLEDGMENTS

The content is solely the responsibility of the authors and does not necessarily represent the official views of the Health Resources and Services Administration or the United States Department of Health and Human Services.

REFERENCES

1. Fox S, Duggan M. *Health Online*. 2013. http://pewinternet.org/Reports/2013/Health-online.aspx. Accessed June 1, 2015.
2. Eysenbach G. What is e-health? *J Med Internet Res*. 2001;3(2):E20.
3. Oh H, Rizo C, Enkin M, *et al*. What is eHealth (3): a systematic review of published definitions. *J Med Internet Res*. 2005;7(1):e1.
4. Prestin A, Vieux SN, Chou WY. Is online health activity alive and well or flatlining? Findings from 10 years of the Health Information National Trends Survey. *J Health Commun*. 2015;20(7):790–798.
5. Beckjord EB, Finney Rutten LJ, Squiers L, *et al*. Use of the internet to communicate with health care providers in the United States: estimates from the 2003 and 2005 Health Information National Trends Surveys (HINTS). *J Med Internet Res*. 2007;9(3):e20.
6. Zhou YY, Kanter MH, Wang JJ, *et al*. Improved quality at Kaiser Permanente through e-mail between physicians and patients. *Health Aff (Millwood)*. 2010;29(7):1370–1375.
7. Hesse BW, Nelson DE, Kreps GL, *et al*. Trust and sources of health information: the impact of the Internet and its implications for health care providers: findings from the first Health Information National Trends Survey. *Arch Intern Med*. 2005;165(22):2618–2624.
8. Liederman EM, Lee JC, Baquero VH, *et al*. The impact of patient-physician Web messaging on provider productivity. *J Healthc Inf Manag*. 2005;19(2):81–86.
9. Ralston JD, Carrell D, Reid R, *et al*. Patient web services integrated with a shared medical record: patient use and satisfaction. *J Am Med Inform Assoc*. 2007;14(6):798–806.
10. Health Information Technology for Economic and Clinical Health (HITECH) Act. 2009. https://www.healthit.gov/policy-researchers-implementers/health-it-legislation. Accessed June 1, 2015.
11. Healthy People 2020. Health communication and health information technology. 2014. http://www.healthypeople.gov/2020/topics-objectives/topic/health-communication-and-health-information-technology. Accessed November 1, 2015.
12. Health Information National Trends Survey. HINTS 4 Cycle 4 summary data and estimated U.S. population values. 2014. http://hints.cancer.gov/question-details.aspx?PK_Cycle=6&qid=761. Accessed November 1, 2015.
13. Lustria ML, Smith SA, Hinnant CC. Exploring digital divides: an examination of eHealth technology use in health information seeking, communication and personal health information management in the USA. *Health Informatics J*. 2011;17(3):224–243.
14. Laz TH, Berenson AB. Racial and ethnic disparities in internet use for seeking health information among young women. *J Health Commun*. 2013;18(2):250–260.
15. Baker L, Wagner TH, Singer S, *et al*. Use of the Internet and e-mail for health care information: results from a national survey. *JAMA*. 2003;289(18):2400–2406.
16. Tian Y, Robinson JD. Incidental health information use on the Internet. *Health Commun*. 2009;24(1):41–49.
17. Chou WY, Hunt YM, Beckjord EB, *et al*. Social media use in the United States: implications for health communication. *J Med Internet Res*. 2009;11(4):e48.
18. Chou WY, Prestin A, Lyons C, *et al*. Web 2.0 for health promotion: reviewing the current evidence. *Am J Public Health*. 2013;103(1):e9–e18.
19. Jackson LA, Zhao Y, Kolenic III A, *et al*. Race, gender, and information technology use: the new digital divide. *Cyberpsychol Behav*. 2008;11(4):437–442.
20. Jansen BJ. Use of the internet in higher-income households. 2010. http://pewinternet.org/Reports/2010/Better-off-households.aspx. Accessed November 1, 2015.
21. Wang JY, Bennett K, Probst J. Subdividing the digital divide: differences in internet access and use among rural residents with medical limitations. *J Med Internet Res*. 2011;13(1):e25.
22. Lee JL, Choudhry NK, Wu AW, *et al*. Patient Use of Email, Facebook, and Physician Websites to Communicate with Physicians: A National Online Survey of Retail Pharmacy Users. *J Gen Intern Med*. 2016;31(1):45–51.
23. Schickedanz A, Huang D, Lopez A, *et al*. Access, interest, and attitudes toward electronic communication for health care among patients in the medical safety net. *J Gen Intern Med*. 2013;28(7):914–920.
24. Zickmund SL, Hess R, Bryce CL, *et al*. Interest in the use of computerized patient portals: role of the provider-patient relationship. *J Gen Intern Med*. 2008;23 (Suppl 1):20–26.
25. Zulman DM, Nazi KM, Turvey CL, *et al*. Patient interest in sharing personal health record information: a web-based survey. *Ann Intern Med*. 2011;155(12):805–810.
26. Wakefield DS, Mehr D, Keplinger L, *et al*. Issues and questions to consider in implementing secure electronic patient-provider web portal communications systems. *Int J Med Inform*. 2010;79(7):469–477.
27. Wakefield DS, Kruse RL, Wakefield BJ, *et al*. Consistency of patient preferences about a secure Internet-based patient communications portal: contemplating, enrolling, and using. *Am J Med Qual*. 2012;27(6):494–502.
28. Cawdron R, Issenman RM. Patient web-resource interest and internet readiness in pediatric inflammatory bowel disease. *J Pediatr Gastroenterol Nutr*. 2002;35(4):518–521.
29. Fowles JB, Kind AC, Craft C, *et al*. Patients' interest in reading their medical record: relation with clinical and sociodemographic characteristics and patients' approach to health care. *Arch Intern Med*. 2004;164(7):793–800.

30. Blake KD, Chou W-YS, Prestin A, *et al*. Cancer prevention and control in the changing communication landscape. *J Natl Cancer Inst Monogr*. 2013;47:131–132.
31. Richardson LD, Norris M. Access to health and health care: how race and ethnicity matter. *Mt Sinai J Med*. 2010;77(2):166–177.
32. Viswanath K, Kreuter MW. Health disparities, communication inequalities, and eHealth. *Am J Prev Med*. 2007;32(5 Suppl):S131–S133.
33. Nelson DE, Kreps GL, Hesse BW, *et al*. The Health Information National Trends Survey (HINTS): development, design, and dissemination. *J Health Commun*. 2004;9(5):443–460.
34. Finney Rutten LJ, Davis T, Beckjord EB, *et al*. Picking up the pace: changes in method and frame for the health information national trends survey (2011-2014). *J Health Commun*. 2012;17(8):979–989.
35. Westat. Health Information National Trends Survey 4 (HINTS 4) Cycle 4 Methodology Report. 2015. http://hints.cancer.gov/instrument.aspx. Accessed August 1, 2015.
36. Moser RP, Naveed S, Cantor D, *et al*. Integrative analytic methods using population-level cross-sectional data. 2013. http://hints.cancer.gov/docs/HINTS_IDA_Report.pdf. Accessed July 1, 2015.
37. Sterne JA, White IR, Carlin JB, *et al*. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. *BMJ*. 2009;338:b2393.
38. Raghunathan TE, Solenberger PW, Howewyk JV. IVEware: Imputation and Variance Estimation Software. 2012. http://www.isr.umich.edu/src/smp/ive/. Accessed January 1, 2015.
39. Raghunathan TE, Lepkowski JM, Van Hoewyk J, *et al*. A multivariate technique for multiply imputing missing values using a sequence of regression models. *Surv Methodol*. 2001;27(1):85–96.
40. Berglund PA. An introduction to multiple imputation of complex sample data using SAS v9. 2. 2010. http://support.sas.com/resources/papers/proceedings10/265-2010.pdf. Accessed December 1, 2015.
41. SAS Institute Inc. *SAS/STAT® 13.2 User's Guide*. Cary, NC: SAS Institute Inc.; 2014.
42. Chou WS, Liu B, Post S, *et al*. Health-related Internet use among cancer survivors: data from the Health Information National Trends Survey, 2003–2008. *J Cancer Surviv*. 2011;5(3):263–270.
43. Varsi C, Gammon D, Wibe T, *et al*. Patients' reported reasons for non-use of an internet-based patient-provider communication service: qualitative interview study. *J Med Internet Res*. 2013;15(11):e246.
44. DesRoches C, Painter MW, Jha AK, editors. *Health Information Technology in the United States, 2015: Transition to a Post-HITECH World*. Princeton, NJ: The Robert Wood Johnson Foundation; 2015.
45. Anderson M. Technology Device Ownership: 2015. 2015. http://www.pewinternet.org/2015/10/29/technology-device-ownership-2015. Accessed October 29, 2015.
46. Hesse BW, Gaysynsky A, Ottenbacher A, *et al*. Meeting the Healthy People 2020 goals: using the Health Information National Trends Survey to monitor progress on health communication objectives. *J Health Commun*. 2014;19(12):1497–1509.
47. Kontos E, Blake KD, Chou WY, *et al*. Predictors of eHealth usage: insights on the digital divide from the Health Information National Trends Survey 2012. *J Med Internet Res*. 2014;16(7):e172.
48. Neter E, Brainin E. eHealth literacy: extending the digital divide to the realm of health information. *J Med Internet Res*. 2012;14(1):e19.
49. Jenssen BP, Mitra N, Shah A, *et al*. Using digital technology to engage and communicate with patients: a survey of patient attitudes. *J Gen Intern Med*. 2016;31(1):85–92.
50. Smith A. Mobile Access. 2010. http://pewinternet.org/Reports/2010/Mobile-Access-2010.aspx. Accessed January 1, 2016.
51. Fox S, Livingston G. Latinos Online: Hispanics with Lower Levels of Education and English Proficiency Remain Largely Disconnected from the Internet. 2007. http://files.eric.ed.gov/fulltext/ED495954.pdf. Accessed September 1, 2015.
52. Olson KE, O'Brien MA, Rogers WA, *et al*. Diffusion of technology: frequency of use for younger and older adults. *Ageing Int*. 2011;36(1):123–145.
53. de Jong CC, Ros WJ, Schrijvers G. The effects on health behavior and health outcomes of Internet-based asynchronous communication between health providers and patients with a chronic condition: a systematic review. *J Med Internet Res*. 2014;16(1):e19.
54. Ye J, Rust G, Fry-Johnson Y, *et al*. E-mail in patient-provider communication: a systematic review. *Patient Educ Couns*. 2010;80(2):266–223.
55. Sittig DF. Results of a content analysis of electronic messages (email) sent between patients and their physicians. *BMC Med Inform Decis Mak*. 2003;3:11.
56. Roter DL, Larson S, Sands DZ, *et al*. Can e-mail messages between patients and physicians be patient-centered? *Health Commun*. *2008*;23(1):80–86.
57. Anand SG, Feldman MJ, Geller DS, *et al*. A content analysis of e-mail communication between primary care providers and parents. *Pediatrics*. 2005;115(5):1283–1288.
58. Hidi S, Renninger KA, Krapp A. Interest, a motivational variable that combines affective and cognitive functioning. In: RJ Sternberg, WM Williams, eds. *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.; 2004:89–115.
59. Menachemi N, Prickett CT, Brooks RG. The use of physician-patient email: a follow-up examination of adoption and best-practice adherence 2005-2008. *J Med Internet Res*. 2011;13(1):e23.
60. Cantor D, Coa K, Crystal-Mansour S, *et al*. *Health Information National Trends Survey (HINTS) 2007*. Rockville, MD: Westat; 2009.
61. U.S. Census Bureau. ACS Demographic and Housing Estimates: 2010-2014 American Community Survey 5-Year Estimates. 2016. http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_5YR_DP05&src=pt. Accessed March 28, 2016.
62. Katz SJ, Nissan N, Moyer CA. Crossing the digital divide: evaluating online communication between patients and their providers. *Am J Manag Care*. 2004;10(9):593–598.
63. Institute of Medicine. *Crossing the Quality Chasm: a New Health System for the 21st Century*. Washington, DC: National Academy Press; 2001.