

Current Trends in Patients' Adoption of Advanced E-Health Services

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Abstract

This paper presents a fine-grained, longitudinal analysis of demographic factors contributing to adoption by patients of advanced e-health services in the areas of transaction, communication, and personal support. The research uses Health Information National Trends Survey (HINTS), conducted in 2003, 2005, and 2007 by the U.S. National Cancer Institute. The findings show that while use of advanced e-health services is increasing overall, adoption trends vary substantially by service and by patients' demographic characteristics.

1. Introduction

In recognition that healthcare providers are offering an increasing number of e-health services to patients, researchers have begun to conduct targeted studies to test generic models of technology adoption in this setting and to identify unique factors that drive adoption of provider-delivered e-health services. Most studies have addressed patients' adoption of informational e-health services which provide encyclopedic health-related content [12][23][27] or of e-health portals which typically aggregate informational e-health with a variety of advanced e-health services, including transactions, communication, and personal support (e.g., [26][27][43][44]).

This paper addresses two aspects of patients' adoption of e-health that have received little attention in the prior literature: (1) longitudinal analysis of trends in adoption of advanced e-health services, including trends based on demographic factors, and (2) investigation of distinct e-health services in addition to aggregated services.

Demographic factors have been shown to be important in determining use of many online services, including online shopping [1], Internet search [13], and financial applications [37]. In addition, demographic trends in use of Internet technologies are changing over time [19]. We believe similar demographic trends are likely to occur in use of advanced e-health services, given the structural need of some demographic groups, such as the elderly, for greater access to health care [5].

Carefully describing e-health adoption trends is an important way to help designers and administrators enhance and expand e-health services in directions that accommodate patients and remove impediments to their use of e-health.

Although overall demand for e-health is high, this does not necessarily mean all services will be successful or will remain successful over time. The 2008 Survey of Health Care Consumers conducted by Deloitte Center for Health Solutions [8] finds the Internet has become the single most important source of health information, and three-quarters of U.S. respondents now want their healthcare provider to supply advanced online services, such as access to test results and medical records, appointment scheduling, and electronic communication. Yet even as overall demand for e-health has escalated and e-health has succeeded in general, patients have rejected numerous advanced e-health services, ranging from diabetes decision support [34], asthma self-management [36], and personal health records [15], leading to underuse or outright failure of the service.

In order to avoid similar negative outcomes in the future, we propose it is necessary to study patients' adoption of advanced e-health services through fine-grained research designs that can distinguish among both specific e-health services and major classes of users and that can provide evidence of longitudinal trends. In this paper we apply data from the 2003, 2005, and 2007 Health Information National Trends Survey (HINTS) administered by the U.S. National Cancer Institute to assess e-health adoption trends of three representative advanced e-health services across five demographic population groupings. The demographic factors we assess are income, age, gender, race/ethnicity, and education.

2. Background and Research Questions

This section describes the theoretical background for examining distinct e-health services. It then discusses five demographic factors including income level, age, gender, race/ethnicity, and education, along with previous empirical work that has examined the relationship of these factors to Internet use in general

and e-health use in particular. Based on these discussions, we propose six research questions.

2.1. Adoption of Distinct E-Health Services

Where prior adoption studies address advanced e-health services, such as support for online transactions, communication, and peer support, these services typically have been assessed as integral contributors to an overarching e-health application, such as an e-health portal [26]. Researchers have proposed that IT adoption studies should encompass a more feature-centric view of technology [22]. This theoretical perspective recognizes that as individuals use technology different features emerge, and users' perceptions change regarding the nature and usefulness of features. Thus, the technology features an individual uses frequently vary over time [24]. We apply this theoretical perspective to examine adoption of distinct advanced e-health services.

RQ1: Are advanced e-health services being used at similar or different rates?

2.2. Income Level

Income level, a key indicator of socioeconomic status, is generally correlated with Internet use to the degree that individuals with higher income levels have an increased ability to pay for computer hardware, software, and Internet access [10]. Research finds that individuals with lower income levels are less likely to adopt broadband access [19], shop online [1], and use search engines [13]. Current research reports that e-health access rates are much lower for low income than for mid-to-upper income groups [6]. However, some studies show income level has no effect on individuals' intentions to adopt online services, e.g., financial services [16]. Thus, it is not clear what effect income level will have on e-health use and whether the effect will vary over time. The desire to inform this issue leads to our second research question.

RQ2; What U.S. trends in e-health use are associated with income level?

2.3. Age

Younger individuals have positive attitudes towards computers [40], and use of the internet tends to be lower in elderly populations compared to use among adolescents and young adults [14]. This situation is compounded among the elderly by lack of access and low awareness of services that are available via the Internet [17]. As a group, older adults have heightened needs for both health information [42] and health services [5], many of which can be fulfilled through

the Internet. Over time it is predictable that Internet usage by older adults will increase as a function of generational shifts; a Kaiser [23] survey reports that the proportion of 50-64 year-olds who have gone online is more than twice as high as among those 65 and older. Yet most studies of the impact of age on Internet usage implement cross-sectional designs which tell little about associated trends, with the result that there is little research addressing age-related trends in e-health use. The need to clarify the role of age in e-health adoption prompts our third research question.

RQ3: What U.S. trends in e-health use are associated with age?

2.4. Gender

Although men dominated use of the Internet in its early days, the proportion of women and men now online is roughly equivalent [12]. However, relative usage by gender depends heavily on contextual factors [9]. Men continue to use the Internet more to find news, weather and sports information [12]. Yet Kim and Forsythe [25] report no difference between genders in adoption of online shopping application while Wilson and Lankton [43] note that women comprise nearly 80% of users who volunteered to participate in their study of e-health adoption. In addition, divergent factors appear to be important in driving information technology (IT) use by women vs. men [2][41], and interact differently with the web than women [40]. These findings suggest that between-gender differences may be important in predicting adoption of various e-health services, however, we did not find any prior studies that focus on this issue. This situation prompts our fourth research question.

RQ4; What U.S. trends in e-health use are associated with gender?

2.5. Race/Ethnicity

Minority groups currently represent over a third of the U.S. population and will cumulatively account for more than half the population by 2050 if current trends continue [39]. A recent report shows slow growth in broadband technology use among Blacks [19]. Other research shows that Blacks and Hispanics utilize home computers and the Internet less than Whites [3][11]. Yet Blacks and Hispanics are significantly more innovative than Whites in television use, e.g., through researching new programming and subscribing to digital cable [3]. Although the prior research indicates that a digital divide exists between Whites and minorities corresponding to socioeconomic differences [33], we did not find any empirical studies that address recent trends in e-health adoption by these groups.

Thus, we address this issue in our fifth research question.

RQ5: What U.S. trends in e-health use are associated with race and ethnicity?

2.6. Education

Education level is an important component of an individual's socioeconomic status [20]. A higher education level can increase one's knowledge about the Internet, thus increasing how comfortable one feels about transacting online [1]. Computer users with higher education have less anxiety and better attitudes toward microcomputers than users with lower education [21]. Recent reports show that educated individuals use the Internet more than less educated individuals [19], are more likely to use search engines [13], and are more likely to shop online [1]. However, little is known about how education will affect e-health adoption over time. Thus our final research question addresses this issue.

RQ6: What U.S. trends in e-health use are associated with educational achievement?

3. Research Method

This study uses data from the Health Information National Trends Survey (HINTS), conducted in 2003, 2005, and 2007 by the U.S. National Cancer Institute. The survey applies a national probability sampling methodology to assess U.S. residents' knowledge and perceptions regarding cancer information and other issues surrounding healthcare [7]. HINTS is directed toward documenting changing patterns in use of health information (especially relating to cancer), identifying health communication trends, assessing how cancer risks are perceived, and testing theories relating to health communication [18]. The present study utilizes a subset of HINTS data relating to respondents' use of the Internet for healthcare purposes and demographic data.

HINTS data were collected by telephone interviews (in English and Spanish language) and online questionnaires. The 2003 HINTS data were collected between October 2002 and April 2003; 2005 data were collected between February and August of 2005; and 2007 data were collected between January and May of 2008. List-assisted, random digit samples of all telephone exchanges in the U.S. were used to develop a nationally representative sample of households. Residents of age 18 and above were recruited to participate in the surveys. A total of 6369 individuals completed the HINTS 2003 survey, 5586 completed the 2005 survey, and 4092 completed the random digit dial version of the 2007 survey (a postal mail version

of the HINTS survey was tested in 2007; to maintain consistency with prior surveys the mail-survey data were not used in our analysis). In the present study, we eliminated data from non-Internet users, from individuals who did not complete e-health use measures, and from race/ethnicity categories that did not include sufficient numbers of respondents to support analysis. This resulted in a study sample of 6142 with 2319 responses from the 2003 survey, 1591 from the 2005 survey, and 2232 from the 2007 survey.

3.1. Demographic Factors

Independent variables in our research design consist of five demographic factors (income level, gender, age, race/ethnicity, and education) assessed in 2003, 2005, and 2007. All measures are categorical. Income level is grouped at two levels—less than or equal to \$25,000 vs. greater than \$25,000—based upon prior research indicating that Internet use patterns differ primarily between low- and mid-levels of socioeconomic status [4][20]. Age is grouped at two levels—18 to 64 vs. 65 or over—based upon prior research indicating that Internet use patterns differ categorically between these age groups [14]. Gender is measured as male vs. female. Race/ethnicity is grouped into Hispanic, White, or Black categories based upon respondents' self-report. Response rates in other race/ethnicity categories were too low to support effective analysis, thus respondents in these categories were not included in the present study. Education was grouped into two levels corresponding to completion of high school equivalency or less vs. completion of some college or a college degree. This division is based upon prior research using similar categories (e.g. [12]). The number of responses for each demographic measure used in the analysis is shown in Table 1.

3.2. Advanced E-Health Services

Dependent variables in the research design were collected as participants' Yes/No responses to survey items representing use of three types of advanced e-health services. The survey items take the following form:

“In the past 12 months have you done the following things while using the Internet?”

- “Bought medicine or vitamins online?” (This item represents a transactional e-health service, hereafter referenced as *Buy Online*.)
- “Participated in an on-line support group for people with a similar health or medical issue?” (This item represents a peer support service, hereafter referenced as *Support Group*.)

- “Used e-mail or the Internet to communicate with a doctor or a doctor's office?” (This item represents a communicational e-health service, hereafter references as *Talk to Doctor*.)

Table 1. Demographic Measures

	No. Responses	Percent
Income Level		
<= 25,000	1066	17.4%
25,000 +	5075	82.6%
Age		
18 – 64	5240	85.3%
65 +	902	14.7%
Gender		
Male	2302	37.5%
Female	3840	62.5%
Race/Ethnicity		
Hispanic	399	6.5%
Black	562	9.2%
White	5181	84.3%
Education		
<= High School	1655	27.0%
> High School	4487	73.0%

4. Results

We examined our research questions using MANOVA in order to assess overall e-health use as well as distinct aspects of informational and transactional e-health uses. The six independent variables are between-subject measures representing the five demographic variables and survey year. Income level, age, gender, and education were assessed at two levels corresponding to the descriptions in the Demographic Factors section. Race/ethnicity was assessed at three levels (Hispanic, Black, and White), and survey year also was assessed at three levels (2003, 2005, and 2007).

MANOVA was conducted using SAS GLM with Type III sum of squares. We incorporated replicate weights as recommended by the National Cancer Institute for conducting multi-year analysis with HINTS data [35]. The dependent variables have only a small correlation (r ranges from .063 to .107, $p < .001$) which is well within the range that can be handled effectively by MANOVA [31]. With large sample sizes, as in the present study, MANOVA is robust to effects of unbalanced cell sizes [38] and use of dichotomous dependent variables Mandeville [29][30]. *Post hoc* Scheffé tests were conducted to analyze differences in race/ethnicity and survey year, in which

three levels were assessed. The Scheffé test is used to distinguish which categories differ statistically within a multi-group analysis.

4.1. Adoption of Distinct E-Health Services

The multivariate results indicate that all the demographic factors we tested have significant main effects on adoption of advanced e-health services when these are viewed as a grouped factor (see Table 2). However, the univariate results reveal that adoption patterns vary substantially among the e-health services we studied. Use of Buy Online (Scheffé test, 2003 vs. 2007, $p = .008$) and Talk to Doctor (Scheffé test, 2005 vs. 2007, $p = .042$) e-health services grew across the studied period. However, use of Support Groups was flat overall (see Figure 1). Use of each service is directly associated with at least two demographic factors, but only education is significantly associated with use across all the services. Gender and income are associated with two of the services, and age and race/ethnicity each are associated with only one service.

Interactive relationships follow a similar pattern. The multivariate results show a significant interaction between year and gender, however, this interaction appears only in the Talk to Doctor univariate results. Other interactions appear in the univariate results for Buy Online (year by age) and Support Group (year by race/ethnicity). These findings suggest in answer to research question 1 that advanced e-health services are being adopted at different rates both across the overall patient population and among population subgroups.

4.2. Income Level

Several trends emerged in analysis of research question 2. Income is an important predictor of buying online and use of personal support services. Individuals with higher incomes are much more likely to purchase medicines or vitamins online (see Table 3) while those with lower incomes use online support groups at a higher rate. A year-by-income interaction appears for Talk to Doctor. While use of this service increased across income levels, the increase was larger for individuals with higher incomes.

Table 2. Results of Multivariate and Univariate Analysis.

Factor	Multivariate Results*		Univariate Results					
	F	Sig.	Buy Online		Support Group		Talk to Doctor	
			F	Sig.	F	Sig.	F	Sig.
Year	3.15	.004	5.02	.007	1.72	ns	3.98	.019
Income	10.41	<.001	12.92	<.001	14.14	<.001	1.27	ns
Age	4.19	.006	6.40	.011	3.55	ns	1.40	ns
Gender	9.62	<.001	0.14	ns	21.40	<.001	5.06	.025
Race/Ethnicity	3.89	<.001	2.55	ns	6.47	.002	2.74	ns
Education	19.02	<.001	19.31	<.001	5.39	.020	40.53	<.001
Year * Income	2.05	ns	1.05	ns	0.59	ns	4.79	.008
Year * Age	1.41	ns	3.82	.022	0.49	ns	0.28	ns
Year * Gender	4.21	<.001	1.64	ns	0.85	ns	10.29	<.001
Year * Race/Ethnicity	1.55	ns	1.16	ns	2.75	.027	1.26	ns
Year * Education	0.81	ns	1.60	ns	0.13	ns	0.79	ns

*Wilks' Lambda

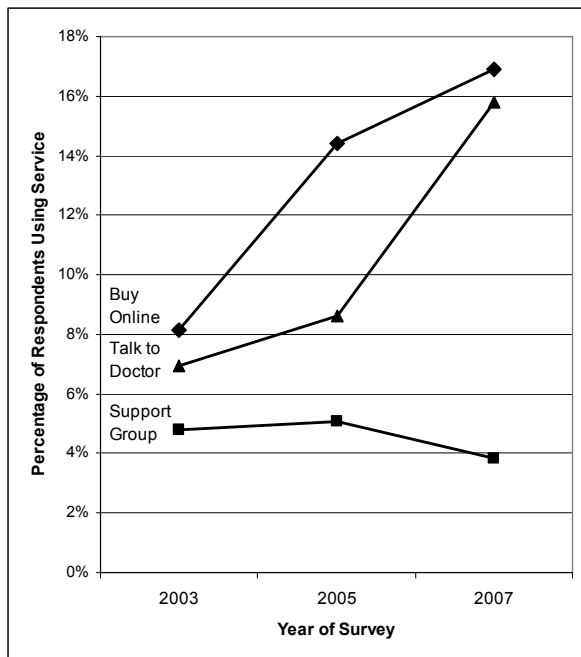


Figure 1. Overall Adoption Trends

4.3. Age

In analysis of research question 3, we find that more elderly make health-related purchases online than the younger demographic group, and this proportion has increased rapidly. Between 2005 and 2007, the percentage of older individuals who make online purchases grew more than twice as fast as the percentage of younger individuals (30.9% change for older vs. 12.8% change for younger). This trend appears to be responsible for the significant year-by-age interaction for the Buy Online e-health service noted in Table 2.

4.4. Gender

Three trends characterize the results relating to research question 4. Gender is an important predictor of adoption of online support groups and Internet communication with a doctor or doctor's office. Women access support groups at a rate nearly 70% higher than men, yet fewer women than men typically communicate online with physicians. Although a significant interaction appears between year and gender in adoption of the Talk to Doctor e-health service, this interaction arises from anomalous results in 2005 in which a higher percentage of women than men reported electronic communication with physicians as opposed to 2003 and 2005, when the rate for men was approximately one-third higher than for women.

Table 3. Group Mean % Use by Survey Year

Factor	2003	2005	2007	Overall Avg.
<i>Overall</i>				
Buy Online	8.3%	14.5%	16.9%	13.0%
Support Group	4.8%	5.2%	3.8%	4.5%
Talk to Doctor	7.0%	8.8%	15.8%	10.7%
<i>Gender</i>				
Male Buy Online	7.7%	13.3%	19.9%	13.6%
Male Support Group	3.1%	3.7%	2.7%	3.1%
Male Talk to Doctor	8.2%	7.3%	18.9%	11.9%
Female Buy Online	8.4%	15.0%	14.9%	12.5%
Female Support Group	5.8%	5.8%	4.5%	5.3%
Female Talk to Doctor	6.2%	9.3%	13.8%	9.8%
<i>Age</i>				
Younger Buy Online	8.0%	14.2%	16.0%	12.5%
Younger Support Grp.	5.0%	5.6%	4.0%	4.8%
Younger Talk to Dr.	7.1%	9.3%	16.1%	10.9%
Older Buy Online	10.2%	15.6%	20.4%	15.3%
Older Support Group	2.3%	2.3%	3.1%	2.6%
Older Talk to Doctor	5.6%	4.7%	14.8%	8.7%
<i>Income</i>				
Low-Inc. Buy Online	6.2%	10.5%	9.1%	8.4%
Low-Inc. Support Grp.	6.9%	6.5%	4.9%	6.1%
Low-Inc. Talk to Dr.	8.0%	8.5%	9.1%	8.5%
High-Inc. Buy Online	9.0%	15.7%	17.5%	13.8%
High-Inc. Support Grp	4.2%	4.8%	3.7%	4.2%
High-Inc. Talk to Dr.	6.7%	8.9%	16.3%	10.8%
<i>Race/Ethnicity</i>				
Hispanic Buy Online	5.0%	9.3%	20.3%	11.7%
Hispanic Support Gp.	2.5%	3.7%	3.1%	3.0%
Hispanic Talk to Dr.	6.3%	3.7%	15.6%	9.0%
Black Buy Online	5.8%	9.9%	16.7%	10.8%
Black Support Group	5.4%	6.9%	6.8%	6.3%
Black Talk to Doctor	7.7%	9.9%	13.6%	10.4%
White Buy Online	8.9%	15.2%	16.8%	13.4%
White Support Group	5.0%	5.0%	3.6%	4.5%
White Talk to Doctor	6.9%	8.8%	16.0%	10.7%
<i>Education</i>				
Low-Ed. Buy Online	6.5%	12.7%	13.1%	10.5%
Low-Ed. Support Grp.	4.0%	3.7%	2.1%	3.2%
Low-Ed. Talk to Dr.	4.3%	4.5%	6.7%	5.2%
High-Ed. Buy Online	9.2%	15.3%	17.9%	13.9%
High-Ed. Support Grp.	5.3%	5.8%	4.2%	5.0%
High-Ed. Talk to Dr.	8.3%	10.6%	18.2%	12.5%

4.5. Race/Ethnicity

Race/ethnicity trends relating to research question 5 involve only access to online support groups, which is significantly influenced by race/ethnicity both as a main effect and through interaction with year. The main effect arises from Blacks using online support groups at a higher rate than either Whites or Hispanics (Scheffé test, Black vs. White $p = .003$, Black vs. Hispanic $p = .011$). The interactive effect arises from decreasing use of support groups over time by Whites vs. relatively steady use by Blacks and Hispanics.

4.6. Education

Research question 6 addresses effects of education on adoption trends. The results indicate education has main effects on all e-health services we studied and has no interactive effects. Individuals with some college or higher educational background bought medicines or vitamins online, participated in online support groups, and communicated electronically with their doctor at an average rate of nearly two-thirds higher than individuals with high school or lower education (average rate for all services across all years = 6.4% for the lower-educated group and 10.5% for the higher-educated group). This finding is especially pronounced in use of the Talk to Doctor e-health service, which is more than twice as high among highly-educated than lower-educated individuals.

5. Discussion

The results contain a mix of implications, some that might be expected and others that are quite surprising. In this section we discuss what we consider to be the major implications of the study.

5.1. General E-Health vs. Specific Services

Overall, adoption of advanced e-health services is increasing but the rate of increase is remarkably uneven among the services we studied. Where Buy Online and Talk to Doctor services have experienced rapid growth in usage, use of Online Support services actually dropped numerically between 2003 and 2007. These results imply that it is hazardous to study only overall adoption of e-health services, such as general use of e-health portals, as the overall results likely will be inapplicable to at least some of the specific services that are contained. This observation corresponds with the view proposed by Jaspersen et al. [22], who suggest that adoption decisions are often made toward the features offered by technology rather than the

overall technology product. Our findings illustrate the extent to which patients distinguish among services when evaluating their use. We advise researchers as well as e-health designers and administrators who assess e-health products to incorporate metrics that can address adoption at the feature or service level rather than relying exclusively on aggregated measures.

5.2. Age and E-Health

The elderly use health care services at a disproportionately high rate relative to the rest of the U.S. population [5]. Thus, it is troubling that the 2003 HINTS figures showed average use of the three studied e-health services to be higher for younger individuals (6.7%) than for the elderly (6.0%). More recently, however, the elderly have been adopting advanced e-health services, especially Buy Online, at a high rate. By 2007, average use of the three services had increased to 12.8% among the elderly vs. 12% for younger individuals. These findings imply that the elderly are sensitive to benefits offered by e-health services and sufficiently flexible to go online to gain those benefits. An interesting topic for future research will be identifying the degree to which changes in e-health adoption among the elderly are driven by changes in attitudes toward computers vs. generational shifts.

5.3. Gender and E-Health

Women are the primary participants in health care. They utilize personal health care services at a rate approximately 30% higher than men and also frequently support health care for others, e.g., children [32]. This would suggest that women stand to benefit more than men by adopting advanced e-health services as a way to reduce effort involved in managing health care needs. Instead we find that only use of online support groups is higher for women than men (see Table 2) and the trend in use of this service is flat among women as well as men. One interpretation of this finding is that women may have more motivation toward communicating with peers than other aspects of health care, e.g., transactions. Yet men communicate with their physicians at a higher rate than women (18.9% vs. 13.7% in 2007), suggesting that e-health services may provide an opportunity for men to become more involved in health care. These findings are troubling, as they suggest some e-health services have a lower attraction to women. Identifying how to remove obstacles and effectively promote use of advanced e-health services by women and will be an important topic for future research.

5.4 Disadvantaged Populations

Several demographic factors in the present study — income, race/ethnicity, and education—have been applied previously in the study of disadvantaged populations. Of these factors, race and ethnicity played only a minor role in adoption. In 2003, Whites used the three studied e-health services at approximately 25% higher average rate than Blacks and Hispanics, but this difference decreased to near-parity by 2007.

Income and education are important and pervasive contributors to adoption. In 2003 an average 6.6% of high-income individuals used the e-health services vs. 7% for low-income. Yet by 2007 the average rate of use for high-income individuals had nearly doubled to 12.5% vs. 7.7% for low-income individuals. Education shows a similar pattern in which average rate of use for highly-educated individuals had grown to 13.4% by 2007 vs. 7.3% for less-educated individuals.

These findings indicate the digital divide remains an important obstacle to achieving potential benefits of e-health across the broad population. Clearly, research needs to address how to better support the poorer and less educated portions of the U.S. population in gaining online access that is sufficiently comprehensible that and usable to support at least basic online services. At the same time it is reassuring that race and ethnicity are not an important part of this equation.

5.5 Limitations

The use of secondary data in the present study substantially constrains the domain of the research. The most important limitation, from the authors' perspective, is that only three advanced e-health services (Buy Online, Support Group, and Talk to Doctor) were included in the HINTS design in each of the three survey years. Data were not available concerning use of other common advanced e-health services, such as appointment scheduling, prescription refilling, and online viewing of test results. Finer-grained measures of frequency, duration, or intensity of use could also have improved the analytical options and statistical power of the research design.

In addition, it must be considered that adoption of at least some e-health services by patients may be artificially constrained by their availability. HINTS does not ask whether the services we studied are available to respondents, so it will be necessary to conduct additional research to inform this issue.

5.6 Conclusion

The purpose of our research was to study two aspects of e-health adoption that have not received much prior

attention—conducting longitudinal analysis of trends in adoption of advanced e-health services, including trends based on demographic factors, and investigating adoption of distinct e-health services rather than an integrated e-health portal or other aggregation of e-health services. While our findings are reassuring in some aspects, such as the positive growth in overall use of e-health services across all demographic groups, they suggest a need to rethink research practices in this area. As illustrated by Support Group use figures, which are flat across the years we studied, adoption of distinct e-health services may not be predicted well by overall use of an e-health portal. Implementing fine-grained research designs that address e-health at the level of specific services or features can help improve predictiveness and validity of future e-health research.

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