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Trends in U.S. Consumers' Use of E-Health Services: Fine-Grained Results from a Longitudinal, Demographic Survey

Vance Wilson
Worcester Polytechnic Institute, vancewilson@gmail.com

Sule Balkan
National Chiao Tung University, Taiwan

Nancy K. Lankton
Marshall University, USA

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E. Vance Wilson

Worcester Polytechnic Institute, USA

vancewilson@gmail.com

Sule Balkan

National Chiao Tung University, Taiwan

Nancy K. Lankton

Marshall University, USA

Abstract:

Although growth in U.S. consumers' overall use of e-health is strong, it is being driven by only a portion of the e-health services that are offered through online health portals. Fine-grained, longitudinal analysis of three representative e-health services shows that, while online communication with medical personnel has grown consistently between 2003 and 2012, the purchase of health supplies online plateaued by 2007, and participation in online support groups has been flat since 2003. Socio-economic factors of income and education level continue to have an impact on consumers' use of e-health; however, differences based on age, sex, and race/ethnicity are trending lower during this period. The findings caution against the common practice of studying e-health adoption principally at the level of online health portals, which can mask substantial variation in adoption trends among the underlying e-health services, and suggest that it is important to update trend studies on a regular basis to maintain currency.

Keywords: consumer health information; health communication; longitudinal survey

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I. INTRODUCTION

There is broad consensus that e-health, defined as "cost-effective and secure use of information and communications technologies in support of health and health-related fields" [WHO, 2005], has enormous potential to benefit health care consumers [Wilson and Strong, 2014]. These benefits include enhanced communication and collaboration with health care providers, improved quality of care at lower cost, and improved personal health management through use of online resources [Westat, 2012]. Consumer e-health services are a central part of efforts to increase consumer health engagement in the U.S. [Ricciardi, Mostashari, Murphy, Daniel, and Siminerio, 2013] and enhance citizen empowerment in Europe [European Commission, 2012]. Even in developing nations where Internet infrastructure is limited, e-health shows promise to benefit consumers through improvements in medication management and patient monitoring [Blaya, Fraser, and Holt, 2010].

Moreover, the concept of e-health is popular with consumers. In the U.S., the focus of this article, consumers consider the Internet to be their most important resource for health information, and the majority of these consumers desire access to e-health services, including test results, medical records, appointment scheduling, and communication with their health care provider [Deloitte, 2008]. However, the overall popularity of consumer e-health resources masks the reality that consumers sometimes resist using specific e-health services. Consumer resistance has been reported for a range of e-health services, including diabetes decision support [Nijland, van Gemert-Pijnen, Kelders, Brandenburg, and Seydel, 2011], asthma self-management [Sassene and Hertzum, 2009], spinal cord injury follow-up [Mea, Marin, Rosin, and Zampa, 2012], and personal health records [Greenhalgh, Hinder, Stramer, Bratan, and Russell, 2010]. In these cases, consumer resistance resulted in underutilization or outright failure of the service.

To avoid similar adverse outcomes in the future, we propose that it is important to study consumers' adoption and use of e-health through research designs that focus on *fine-grained services* and measure *longitudinal trends*. To date, the plurality of consumer e-health studies have implemented cross-sectional research designs in which adoption and use of e-health services are aggregated into coarse-grained units of analysis. These units include e-health web portals that aggregate informational e-health (typically providing encyclopedic health-related content) with a variety of other e-health services [e.g., Klein, 2007; Sarkar et al., 2011, Wilson and Lankton, 2004b] or personal health records (PHR) that aggregate consumer health data resources with other e-health services [e.g., Bundorf, Wagner, Singer, and Baker, 2006; Roblin et al., 2009; Yamin et al., 2011]. Representative scholarly studies of e-health adoption and use are presented in Table 1 to illustrate these distinctions of coarse- versus fine-grained services and cross-sectional versus longitudinal research designs. We propose that fine-grained, longitudinal analysis of distinct e-health services offers significant benefits over alternative approaches, as described in the following sections.

A Fine-Grained Approach to E-Health Use

Fine-grained analysis can distinguish differences among major categories of e-health services, as observed by Sue, Griffin, and Allen [2011] in their study of two key questions regarding PHR software:

- Which PHR services are being used most by patients registered for the PHR?
- How does use of PHR services vary by patients' demographic characteristics?

By focusing on features and user demographic characteristics, these authors were able to identify several noteworthy patterns:

- Women were more likely than men to view test results, to send emails to their provider, or to order prescription refills.
- Elderly used more PHR services than did young-adult participants.
- Hispanics were least likely among racial/ethnic groups to send emails to their providers.
- Overall, participants used the PHR to view lab tests much more frequently than to send emails to their providers or to order prescription refills, yet level of usage varied markedly across PHR services when contrasted among demographic groupings.

Table 1: Representative E-Health Adoption and Use Studies		
	Course-Grained E-Health Service Focus	**Fine-Grained E-Health Service Focus**
Cross-Sectional Research Design	• Bundorf et al. [2006] assess use of the Internet by U.S. consumers to access health information based on sex, age, income level, and education level, using a survey conducted at the end of 2001. • Klein [2007] studies how U.S. patients' perceptions of usefulness and ease of use, computer self-efficacy, health care need, and personal innovativeness influence their intention to use a health web portal. • Roblin, Houston, Allison, Joski, and Becker [2009] assess effects of U.S. patients' age, sex, race/ethnicity, and level of education on registration for access to a personal health record during 2005-2007. • Sarkar et al. [2011] investigate use of a health web portal by U.S. patients based on age, sex, employment status, race/ethnicity, and education level. • Wilson and Lankton [2004b] study how satisfaction with overall medical care, health care knowledge, information-seeking preference, health care need, and Internet dependence influence U.S. patients' intention to use a health web portal. • Yamin et al [2011] investigate U.S. patients' adoption and use of a personal health record website during the 2007-2009 period based on sex, age, race/ethnicity, and age characteristics.	• Sue et al. [2011] study personal health record services use by U.S. patients in 2009 based on sex, age, and race. • Weingart, Rind, Tofias, and Sands [2006] track e-health services used by U.S. patients in 2003, including appointment request, prescription refill, referral request, and clinical email messages. • Santana et al. [2010] study effects of age, sex, and employment status on consumers' use of the Internet for prescription requests, appointment scheduling, and asking health questions using data from the 2007 WHO eHealth consumer trends survey.
Longitudinal Research Design	• Kummervold and Wynn [2012] aggregate data from four European studies to assess differences among nations in use of the Internet for accessing health information. • Wangberg, Andreassen, Kummervold, Wynn, and Sørenson [2009] investigate effects of age on Internet use for health purposes using surveys conducted in Norway during 2000, 2001, 2003, 2005, and 2007. • Wilson and Lankton [2009] study how prior intention, offline service utilization, and structural need affect use of an e-health portal by U.S. patients over a six-month period during 2003.	• Andreassen et al. [2007] and Kummervold et al. [2008] assess impacts of age, sex, and employment status on consumers' use of the Internet for self-help, ordering medication or other health products, and interacting with health professionals using data from the 2005 and 2007 WHO eHealth consumer trends survey. • Wilson, Balkan, and Lankton [2010] study effects of age, sex, income level, race/ethnicity, and educational level on consumers' use of the Internet for buying medications or other health products, communicating with health professionals, and accessing peer support using data from 2003–2007 administrations of the U.S. Health Information National Trends Survey.

These patterns could not have been observed had the authors applied a course-grained approach in which only overall access to the PHR was measured. The ability to identify and test fine-grained distinctions in technology adoption and use research can help guide modifications to software functionality and design elements to better support needs of specific user subgroups [Johnson, Johnson, and Zhang, 2005].

Longitudinal Trends in E-Health Use

Longitudinal research designs provide an ability to accurately assess historical trends in e-health use that is superior to what can be achieved by "snapshots-in-time" offered by cross-sectional research studies. Even where several heterogeneous cross-sectional studies are aggregated longitudinally—as exemplified by Kummervold and Wynn's [2012] review study of e-health access in five European countries—the scope of research findings is greatly limited by variations in methodology and focus of the underlying studies. In addition to documenting historical trends, longitudinal research provides a basis for confidently predicting the trajectory of future trends—for example, prediction of slowing Internet uptake accompanied by increasing use of the Internet for overall health purposes among Norwegian consumers [Wangberg et al., 2009].

Currency of Research in Consumers' Use of E-Health

Along with the distinctions we have noted above of coarse- versus fine-grained e-health focus and cross-sectional versus longitudinal research design, there is a further consideration that is inherent to the e-health context: the issue of *currency*. Of the articles presented in Table 1 that apply longitudinal designs to study fine-grained e-health services, all use data was collected prior to 2008. Yet Internet use patterns and service capabilities have changed dramatically since that time. We note, for example, that between 2008 and 2012 Internet users grew from 1.5 billion to 2.4 billion worldwide, and websites increased from 187 million to 634 million [Pingdom, 2009, 2013]. In order to effectively guide development of e-health services in the fast-evolving Internet environment, it is important to maintain research currency as well as topic coverage.

Research Questions

The central questions addressed by the research presented in this article are:

- What are the recent trends in U.S. consumers' use of e-health
  - overall?
  - by distinct e-health service?
  - by demographic characteristics?
- How do these trends relate to prior research findings?

Information systems (IS) practitioners often are tasked with development of e-health services [Wilson and Tulu, 2010]. With this consideration in mind, we argue that studies concerning adoption and use of e-health services are relevant to IS researchers who study health topics, especially those whose goal is to guide e-health practice. We consider this article to be an example of the research strategy recommended by Wilson and Lankton [2004a] of drawing from the health informatics reference discipline to inform IS audiences, and we propose that it fulfills one of the key purposes of the Information Systems and Healthcare Department at *Communications of the Association for Information Systems:* "To support the efforts of researchers who conduct studies crossing IS and healthcare disciplines" [Wilson, 2004, p. 456].

II. LITERATURE REVIEW

In this article we present a fine-grained, longitudinal analysis of recent trends in U.S. consumers' use of three representative e-health services, assessed both as overall use by the study population and broken out by demographic subpopulations. We studied demographic factors of sex, age, race/ethnicity, income level, and education level, based upon prior empirical work that has examined the relationship of these factors to adoption and use of e-health [Andreassen et al., 2007; Hardiker and Grant, 2011; Kummervold et al., 2008; Sarkar et al., 2011; Sue et al., 2011; Wilson, Balkan, and Lankton, 2010; Yamin et al., 2011]. These demographic factors are also known to predict use of a wide array of other online services, including shopping [Adapa, 2008], Internet search [Fallows, 2008], and financial applications [Sciglimpaglia and Ely, 2006]. In addition, several of these factors characterize traditionally underserved populations [Sun, Wang, and Rodriguez, 2013; Woolf and Braveman, 2011] for whom e-health services potentially offer exceptional benefits [Calvillo, Roman, and Roa, 2013; Chang et al., 2004; Gustafson et al., 2001; Kreps, 2005]. In the following sections we briefly describe the background relating to each factor and the significance of including the factor in our research design.

Sex

Although men dominated use of the Internet in its early days, the proportion of women and men now online is roughly equal [Fallows, 2005]. However, use of online services varies between the sexes due to contextual factors [Dholakia, 2006]; for example, higher proportions of men than women use the Internet to find news, weather, and sports information [Fallows, 2005]. Kim and Forsythe [2008] report no difference between sexes in use of shopping websites; however, several studies find that women participate more extensively in online health services. Lemire, Paré, Sicotte, and Harvey [2008] report that women are more likely than men to search online for health-related information; Roblin et al. [2009] find that women account for nearly 60% of registrants to access an online PHR; and Wilson and Lankton [2004b] report that women comprise nearly 80% of users who volunteered to participate in their study of e-health adoption. We note that Andreassen et al. [2007] find a higher proportion of men than women use the Internet for health-related purposes; however, this effect was reversed when the differential rate of overall Internet usage between men and women in the study was controlled. Wilson et al. [2010] report from analysis of 2003–2007 data that women are more likely than men to access online peer support groups, but are less likely to communicate online with doctors. In addition, use of the e-health services they studied increased faster among men than women during that period. These findings suggest that sex is an important antecedent to use of specific e-health services; however, we find no studies since that time that address sex-related trends in use of distinct e-health services.

Age

Younger individuals tend to have more positive attitudes towards computers [Venkatesh and Agarwal, 2006] and higher rates of Internet use [Jones and Fox, 2009] than older individuals do. This situation is compounded among the elderly by lack of Internet access and low awareness of services that are available via the Internet [Hill, Beynon-Davies, and Williams, 2008]. As a group, older adults have heightened needs that the Internet can fulfill for health information [Wicks, 2004], health services [CDC, 2005], and specialized health infrastructure [Toshio, Ishmatova, and Iwasaki, 2013]. In addition, using e-health services in place of more expensive alternatives such as office visits could provide some relief from health care costs for the elderly, which are forecast to approximately double between 2000 and 2030 [Goldman et al., 2005].

Over time, it is predictable that Internet use by older adults will increase through generational shifts, as suggested by a Kaiser survey reporting that the proportion of 50- to 64-year-olds who have gone online is more than twice as high as among those 65 and older [Kaiser, 2005]. Wilson et al. [2010] provide support for this idea, finding that use of e-health services increased faster overall among elderly consumers (65 or greater in age) than among younger consumers between 2003 and 2007. It is not known to what extent this shift has continued in recent years, however, suggesting there is a need for new research to address age-related trends in use of distinct e-health services.

Race/Ethnicity

Minority groups currently represent over one third of the U.S. population and could cumulatively account for more than half the population by 2050 [US Census, 2004]. In the early 2000s, Blacks and Hispanics used home computers, broadband technology, and the Internet at lower rates than Whites [Dupagne and Salwen, 2005; Horrigan, 2008; Peña-Purcell, 2008], but this gap is lessening as familiarity with the Internet increases and costs fall [Horrigan, 2009]. It also has been reported that Blacks and Hispanics are less likely than Whites to use routine health care such as colorectal screening [Stimpson, Pagán, and Chen, 2012] or to complete certain treatment programs [Saloner and Lê Cook, 2013]. A study of U.S. consumer trends during the 2003–2007 period finds that higher use of e-health by Whites in 2003 had reduced to near-parity with Blacks and Hispanics by 2007 [Wilson et al., 2010]. We were unable to find more recent studies of e-health usage trends by racial/ethnic groups, however, suggesting there is need for new research to determine whether racial/ethnicity characteristics continue to contribute to the digital divide that is described by Norris [2001].

Income Level

Income level, a key indicator of socioeconomic status, is generally correlated with Internet use as individuals with higher income levels have increased ability to pay for computer hardware, software, and Internet access [DiMaggio, Hargittai, Celeste, and Shafer, 2004]. Frequency of e-health access is lower for low-income groups than for mid-to-upper income groups [Dart, 2008], and those with lower incomes are less likely to adopt broadband access, shop online, or use search engines [Adapa, 2008; Fallows, 2008; Horrigan, 2008]. Yet income level does not reduce individuals' intentions to adopt online services such as financial services [He and Mykytyn, 2007]. Wilson et al. [2010] report that significant changes associated with income level in U.S. consumers' use of e-services occurred in the 2003–2007 period. They write:

> 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. [Wilson et al., 2010, p. 7]

Potentially, effects of income level on e-health use will be mitigated as costs of equipment and Internet access fall over time. However, new longitudinal research will be required to evaluate this idea under current conditions.

Education

Educational achievement is another important component of socioeconomic status [Hseih, Rai, and Keil, 2008]. Highly educated computer users have less anxiety and better attitudes toward microcomputers than less-educated users do [Igbaria and Parasuraman, 1989]. In addition, highly educated individuals access the Internet more and are more likely to use search engines and shop online [Fallows, 2008; Horrigan, 2008]. Wilson et al. [2010] and Andreassen et al. [2007] found that education is associated with use of a range of e-health services in the U.S. and Europe; however, the data used for these studies was collected prior to 2008. The overall findings suggest that education is a key factor underlying e-health use. Since we did not find recent empirical studies that address trends in the relationship of education to use of e-health services, this suggests a need for new research in this area.

III. STUDY DATA AND METHODS

This study uses data primarily from administrations of the Health Information National Trends Survey (HINTS) conducted in 2007 and 2012 by the U.S. National Cancer Institute. HINTS is intended to document changing patterns in use of health information, identify health communication trends, and test theories related to health communication by surveying representative samples of the U.S. adult population [Cantor et al., 2007]. The HINTS [2013] website describes the program in this way:

> The HINTS data collection program was created to monitor changes in the rapidly evolving field of health communication. Survey researchers are using the data to understand how adults 18 years and older use different communication channels, including the Internet, to obtain vital health information for themselves and their loved ones.

Our study uses a subset of HINTS data limited to respondents' demographic data and use of the Internet for access to e-health services. HINTS data that are provided for scientific analysis exclude identifying information on individual respondents. The HINTS data files we used have been assigned exempt status by the Institutional Review Board (IRB) of the National Cancer Institute and have received additional clearance from the US Office of Management and Budget. Thus, no additional IRB approvals were required by our institutions.

The 2007 and 2012 HINTS data used in this analysis were collected using mail surveys sent to recipients selected through stratified random sampling from the Marketing Systems Group Database [Westat, 2012]. HINTS 2007 data were collected between January and April of 2008, and 2012 data were collected between October 2011 and February 2012. Only respondents age 18 and above were recruited to participate in the surveys.

Demographic Factors

Five demographic factors were included as independent variables in our research design: sex, age, race/ethnicity, income, and education. All measures were categorized prior to analysis in the following manner:

- **Sex** is measured as male vs. female.
- **Age** is grouped at two levels—18 through 64 vs. 65 or over.
- **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 our analyses.
- **Income** is grouped at two levels—less than $20,000 income per year vs. $20,000 and higher per year.
- **Education** was grouped into two levels—completion of high school equivalency or less vs. completion of some college or a college degree.

E-Health Services

Where prior studies have included e-health services, these frequently have been aggregated within an e-health portal. However, technology researchers argue that studies of adoption and use should encompass a fine-grained, feature-centric view of technology in recognition that users' perceptions of the technology are based on specific affordances of the implemented features rather than on overall functionality [Jasperson, Carter, and Zmud, 2005] and that changing situational factors and user needs often cause variation over time in the features that are used

[Kay and Thomas, 1995]. We apply this approach by studying three representative e-health services that have been surveyed consistently across administrations of the HINTS questionnaire. The following survey question was posed to HINTS participants in each survey regarding use of the e-health services: “In the past 12 months have you done the following things while using the Internet?” The survey then presented these descriptions:

- “Bought medicine or vitamins online?” (Hereafter referenced as *Buy Online*.)
- “Participated in an on-line support group for people with a similar health or medical issue?” (Hereafter referenced as *Support Group*.)
- “Used e-mail or the Internet to communicate with a doctor or a doctor's office?” (Hereafter referenced as *Talk to Doctor*.)

In addition, we used two other forms of HINTS data. We included data indicating whether respondents had used the Internet for any purpose during the prior year (hereafter referenced as *Go Online*). We also calculated which subjects had used any of the three e-health services just described during the prior year (hereafter referenced as *Use Any Service)*. All responses were coded in Yes/No format.

Prior to analysis, we filtered the overall dataset from HINTS 2007 and 2012 to remove records where respondents did not complete the measures under study, including demographic survey items and use of the Internet. In addition, we removed records from race/ethnicity categories other than Hispanic, White, and Black, as these other categories did not include sufficient numbers of respondents to support analysis. The resulting dataset of 2912 respondents from 2007 and 3046 respondents from 2012 was used in the descriptive and statistical analyses we present in the following sections.

III. STUDY RESULTS

Overall U.S. population trends in use of e-health services are shown in Figure 1, including data points from HINTS 2003 and 2007 administrations, as reported by Wilson et al. [2010]. HINTS 2003 was administered using a telephone interview method. This approach was augmented by mail surveys during HINTS 2007 and discontinued thereafter in favor of mail surveys. Results from the telephone method vary in systematic ways from results of HINTS mail surveys, most notably in differing response rates between phone and mail administrations. In recognition of this limitation, we include the HINTS 2003 and 2007 telephone survey results for informational purposes in our presentation of overall U.S. population trends in Figure 1 but not in our detailed presentation of demographic trends data (see Table 2) or statistical analysis (see Table 3).

Results shown in Figure 1 indicate that use of both Internet and overall e-health services trended upward between 2007 and 2012. However, growth in overall e-health use (Use Any Service) in this period was driven primarily by increased online communication with physicians and office personnel (Talk to Doctor). Use of the Internet for health-related purchases (Buy Online) showed no increase between 2007 and 2012, and access to peer support (Support Group) decreased by a small extent across the 2007-2012 period. Table 2 presents a detailed breakout of use contrasting demographic subpopulations across e-health services from 2003-2007 and 2007 – 2012.

In order to assess the significance of the descriptive data reported in Table 2, we conducted a multivariate analysis of variance (MANOVA) statistical test. This approach allows simultaneous testing of the joint effects of demographic factors in overall use of e-health services (multivariate results) as well as use of each distinct e-health service (univariate results). MANOVA was conducted using SAS GLM with Type III sum of squares. Using this method allowed us to incorporate replicate weights as recommended for conducting multi-year analysis with HINTS data [Rizzo, Moser, Waldron, Wang, and Davis, 2008]. MANOVA is robust to effects of unbalanced cell sizes [Tabachnick and Fidel, 2001] and dichotomous dependent variables [Mandeville, 1969, 1972] in situations where sample populations are large, as in this study, and where correlations among dependent variables are not excessive (Pearson’s *r* was found to be less than 0.13 among dependent variables in this study) [Maxwell, 2001].

Six independent variables were entered as between-subject measures representing survey year and the five demographic variables. Sex, age, income, and education were assessed at two levels, and race/ethnicity was assessed at three levels (Hispanic, White, and Black), as described previously. Survey year was assessed at two levels (2007 and 2012). The MANOVA analytical model was set to test main effects of all independent variables. In addition, the model tested two-way interactions of each demographic variable with survey year in order to identify changing patterns of e-health use that may have occurred within each demographic group during the 2007–2012 time period.

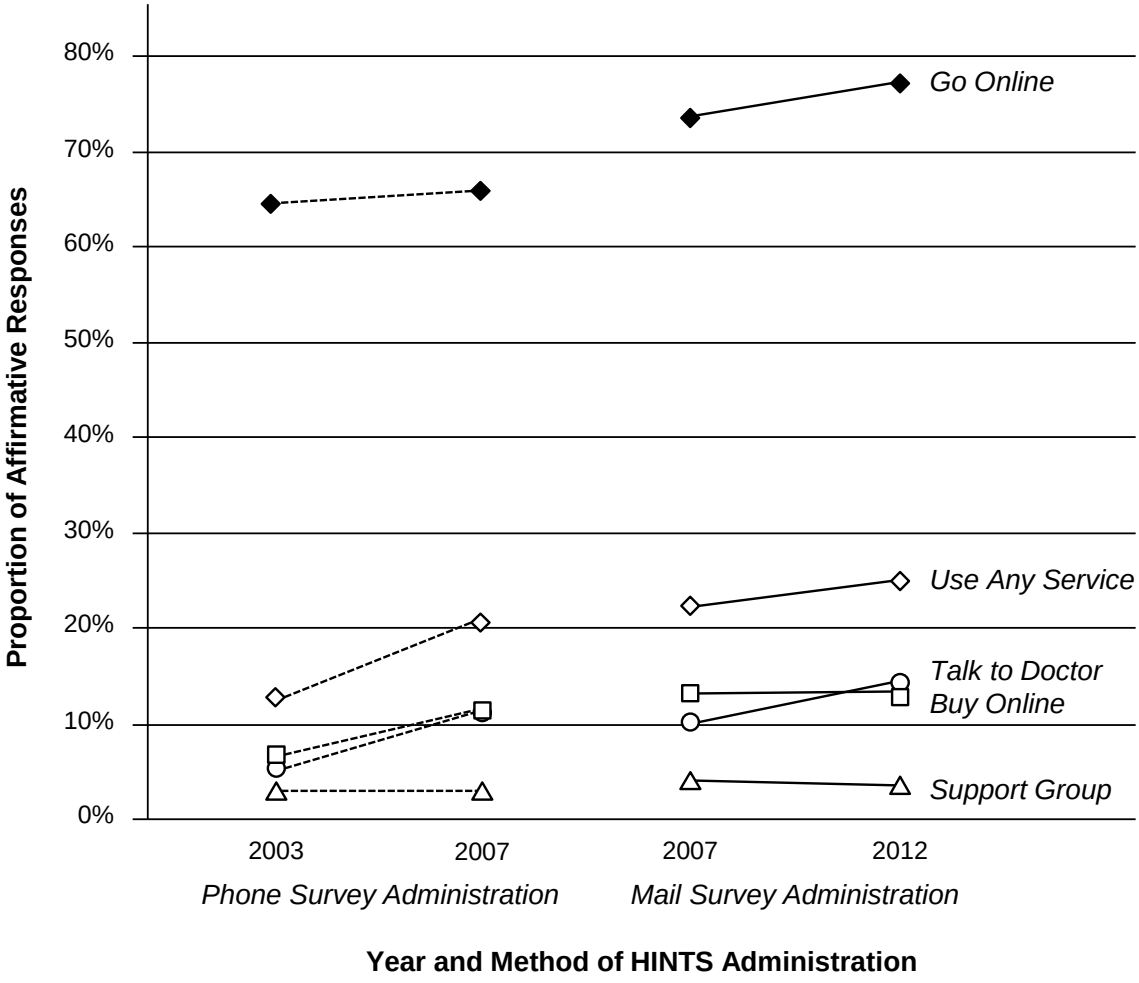

Figure 1. Overall Population Trends in Internet and E-Health Usage, 2003–2012

Results of MANOVA are reported in Table 3. The multivariate results indicate that all the demographic factors we tested except race/ethnicity have significant main effects on overall use of e-health services. In addition, univariate main effects reveal that usage patterns vary substantially among the e-health services. Between 2007 and 2012, change in Buy Online e-health use was significantly driven by income and education, Support Group by age, and Talk to Doctor by sex and education. Interaction effects were noted between race/ethnicity and survey year in both the multivariate results and univariate results for Buy Online e-health use.

IV. DISCUSSION

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

Recent Trends in Use of Overall E-Health and Distinct E-Health Services

Measured across the U.S. population, use of e-health is increasing, yet the rate of increase is remarkably uneven among the services we studied. Although Talk to Doctor e-health has experienced rapid growth in use between 2007 and 2012, use of Buy Online e-health showed little growth during that period, and use of Support Group e-health declined numerically. These results imply that it can be misleading to study use of aggregated e-health services within portals, as results are likely to mask true usage patterns of the distinct services. This observation reinforces the argument that usage decisions are often made toward the features offered by technology rather than the overall technology product. In addition, the transition HINTS undertook between telephone and mail administration indirectly highlights the important of longitudinal designs in which identical research methods can be applied. Despite careful controls, certain findings of the 2007 HINTS vary substantially between telephone and mail survey versions (see Figure 1). Similar differences between cross-sectional designs could easily lead to spurious interpretations.

Table 2: Percentage Use of E-Health Services by Demographic Groupings, 2007–2012						
Factor		**2007 N**	**2007 Use %**	**2012 N**	**2012 Use %**	**Change in Use %**
Overall	Use Any Service	2912	22.2%	3046	25.1%	13.2%*
	Buy Online	2912	13.1%	3046	13.3%	1.6%
	Support Group	2912	3.9%	3046	3.3%	-17.7%
	Talk to Doctor	2912	10.0%	3046	14.4%	44.7%*
Sex	Male - Use Any Service	1151	20.2%	1245	23.7%	17.1%*
	Male - Buy Online	1151	13.0%	1245	13.7%	13.4%*
	Male - Support Group	1151	2.8%	1245	1.4%	-50.9%
	Male - Talk to Doctor	1151	8.2%	1245	13.2%	61.3%
	Female - Use Any Service	1761	23.5%	1801	26.2%	11.2%
	Female - Buy Online	1761	13.2%	1801	13.0%	-1.0%
	Female - Support Group	1761	4.7%	1801	4.6%	-3.4%
	Female - Talk to Doctor	1761	11.1%	1801	15.3%	37.2%*
Age	Younger - Use Any Service	2297	25.0%	2327	27.0%	8.1%
	Younger - Buy Online	2297	14.3%	2327	14.0%	-2.4%
	Younger - Support Group	2297	4.9%	2327	3.9%	-19.7%
	Younger - Talk to Doctor	2297	11.2%	2327	15.5%	38.1%*
	Older - Use Any Service	633	12.3%	719	19.2%	55.8%*
	Older - Buy Online	633	8.7%	719	11.1%	28.1%
	Older - Support Group	633	0.6%	719	1.1%	76.1%
	Older - Talk to Doctor	633	5.4%	719	10.8%	102.0%*
Race/ Ethnicity	Hispanic - Use Any Service	297	15.8%	411	17.5%	10.7%
	Hispanic - Buy Online	297	7.7%	411	9.7%	25.7%
	Hispanic - Support Group	297	2.4%	411	3.4%	44.5%
	Hispanic - Talk to Doctor	297	9.8%	411	9.5%	-2.8%
	White - Use Any Service	2218	24.5%	2137	28.2%	15.0%*
	White - Buy Online	2218	15.1%	2137	14.8%	-1.5%
	White - Support Group	2218	4.4%	2137	3.2%	-26.2%*
	White - Talk to Doctor	2218	10.3%	2137	16.5%	60.0%*
	Black - Use Any Service	397	15.8%	498	17.5%	10.7%
	Black - Buy Online	397	6.3%	498	9.8%	56.2%
	Black - Support Group	397	2.8%	498	3.2%	16.0%
	Black - Talk to Doctor	397	8.1%	498	9.4%	17.1%
Income	Lower-Income - Use Any Service	521	11.1%	688	12.9%	16.2%
	Lower-Income - Buy Online	521	5.2%	688	6.7%	29.0%
	Lower-Income - Support Group	521	2.9%	688	2.3%	-19.2%
	Lower-Income - Talk to Doctor	521	5.2%	688	6.7%	29.0%
	Higher-Income - Use Any Service	2391	24.6%	2358	28.7%	16.5%*
	Higher-Income - Buy Online	2391	14.8%	2358	15.3%	2.8%
	Higher-Income - Support Group	2391	4.2%	2358	3.5%	-15.8%
	Higher-Income - Talk to Doctor	2391	11.0%	2358	16.7%	51.5%*
Education	Lower-Education - Use Any Service	883	11.1%	878	10.9%	-1.5%
	Lower-Education - Buy Online	883	7.1%	878	6.0%	-15.4%
	Lower-Education - Support Group	883	1.5%	878	1.5%	0.6%
	Lower-Education - Talk to Doctor	883	4.3%	878	5.6%	29.7%
	Higher-Education - Use Any Service	2029	27.1%	2168	30.9%	14.2%*
	Higher-Education - Buy Online	2029	15.7%	2168	16.3%	3.6%
	Higher-Education - Support Group	2029	5.0%	2168	4.0%	-21.1%
	Higher-Education - Talk to Doctor	2029	12.4%	2168	18.0%	44.8%*

* Indicates significant difference (alpha ≤ .05) in use percentages between 2007–2012 (two-tailed independent samples Z-test)

Table 3: MANOVA Results: Changes in Interactive E-Health Usage Rates, 2007–2012								
Factor	Multivariate Results*		Univariate Results					
	Overall Use		Buy Online		Support Group		Talk to Doctor	
	F	Sig.**	F	Sig.**	F	Sig.**	F	Sig.**
Year	0.44	ns	0.59	ns	0.06	ns	0.70	ns
Sex	16.94	<0.001	0.56	ns	19.64	<0.001	31.05	<0.001
Age	5.12	0.002	3.04	ns	9.58	0.002	1.48	ns
Race/Ethnicity	0.64	ns	0.39	ns	0.76	ns	0.60	ns
Income	7.29	<0.001	21.73	<0.001	0.18	ns	0.01	ns
Education	11.94	<0.001	15.38	<0.001	3.12	ns	22.93	<0.001
Year * Income	2.42	ns	2.29	ns	5.04	ns	1.05	ns
Year * Age	0.80	ns	0.00	.ns	0.52	ns	1.95	ns
Year * Sex	0.94	ns	0.46	ns	0.93	ns	1.23	ns
Year * Race/Ethnicity	3.40	0.002	4.86	0.008	3.00	ns	1.91	ns
Year * Education	2.51	ns	0.57	ns	3.25	ns	3.29	ns

* Reporting Wilks' Lambda statistic

** Significance is reported at p < .01

Recent Trends in Use of E-Health Services by Demographic Characteristics

Sex and E-Health

Women are the primary participants in health care. They use personal health care services at a rate approximately 30% higher than men do. Women also frequently support health care for others, especially children and adult relatives [Mustard, Kaufert, Kozyrskyj, and Mayer, 1998]. Thus, it may be anticipated that women stand to benefit more than men do by adopting e-health services as a way to reduce effort involved in managing health care needs. Instead we find that only use of the Support Group e-health service is higher for women than men, and this effect is principally due to a steep decline in use of this service by men between 2007 and 2012. This observation suggests it remains important to promote e-health services to women and to consider how to best provide services that support the caregiving roles that women often assume. It also will be important for future researchers to undertake study of roles that consumers take on in their interactions with e-health—for example, acting as caregiver versus self-representation.

Age and E-Health

The elderly use health care services at a disproportionately high rate relative to the rest of the U.S. population. Thus, it is troubling that the 2007 HINTS figures showed Use Any Service responses to be more than twice as high for younger respondents (24.7%) as for the elderly (11.8%). More recently, however, older consumers have dramatically increased their use of e-health overall, especially Talk to Doctor e-health services. These findings suggest that generational transitions are moderating the stereotypical image of the elderly as computer-averse. The findings further imply that older individuals are sensitive to benefits offered by e-health services and are sufficiently flexible to go online to gain those benefits.

E-Health Use by Disadvantaged Populations

Several of the demographic factors included in this study—race/ethnicity, income, and education—have been applied widely in the study of disadvantaged populations. We find income and education to be important and pervasive predictors of e-health use. In 2007 the Use Any Service rate for respondents with at least some college education was 250% that of respondents with high school or less education, and by 2012 that difference had increased to over 280%. Income shows a similar pattern of higher e-health use rates and greater increase in use among higher-income respondents. These findings suggest that a socio-economic digital divide continues to have an impact on disadvantaged populations in the U.S.

On the other hand, we find race/ethnicity plays a decreasing role in the use of e-health services in 2012, especially when comparing Blacks and Hispanics versus Whites. Differences in e-health use by race/ethnicity center on a relative increase in use of Buy Online e-health service from 2007–2012 as Blacks and Hispanics move toward "catching up" with Whites in this area. Other interesting race/ethnicity results involve Hispanics, who increased use of Support Group e-health but not Talk to Doctor e-health from 2007–2012, suggesting that language barriers may underlie the relatively low e-health use found among this demographic group. We note that neither of these effects involving Hispanics was significant in our MANOVA results; however, follow-up analysis of the 2012 race/ethnicity data via one-way ANOVA finds that Talk to Doctor e-health use remains significantly lower for both Hispanics and Blacks than for Whites.

Our interpretation is that the digital divide continues to present an important obstacle to achieving benefits of e-health across the broad U.S. population. It will be important for researchers to address how to better support the poorer and less-educated portions of the population in gaining and using online access to e-health. At the same time, it is reassuring that race/ethnicity is becoming less prominent as a determinant of digital "haves" versus "have-nots."

How These Trends Relate to Prior Research Findings

The present study implements a research design similar to that used by Wilson et al. [2010], who analyzed trends between 2003 and 2007. Both studies use HINTS measures administered to representative samplings of the U.S. population, and both address the same three e-health services, described herein as Buy Online, Support Group, and Talk to Doctor. For this reason, we focus our comparisons of the current findings with those of Wilson et al. [2010] rather than some other fine-grained, longitudinal studies that surveyed non-U.S. populations and applied different measures, e.g., Andreassen et al. [2007] and Kummervold et al. [2008].

The Wilson et al. [2010] study is based on phone surveys, and the present study is based on mail survey administration. Therefore data points from the two studies are not directly comparable. We note, for example, that all three e-health services were reported to be used at different levels in the 2007 phone survey than in the 2007 mail survey (see Figure 1). Despite this numeric inconsistency, we propose that it is appropriate to compare *usage trends* between the studies, as each study measured use in an internally consistent manner. Using this approach, we see two e-health services in which the 2003–2007 trajectories continue and one in which the trajectory changes. Use of Talk to Doctor experienced significant recent growth, and use of Support Group trended non-significantly downward during 2007–2012, both continuing patterns reported for 2003–2007. However, Buy Online transitioned from strong growth during 2003–2007 to a small, non-significant increase during 2007–2012.

Our interpretation of the combined findings of Wilson et al. [2010] and the present research focuses on two major points. First, while overall growth in use of e-health services continues, the rate of growth is diminishing. A calculation from data reported by Wilson et al. [2010] during 2003–2007 shows growth of 69% during that period, averaged across Buy Online, Support Group, and Talk to Doctor e-health services. The same calculation for our 2007–2012 data shows growth of only 10%.

Second, we find that diffusion of distinct e-health services proliferates in distinctive patterns, based on consumers' underlying need for the service and opportunity to use it. We observe, for example, that use of Support Group e-health services has been flat since 2003. Need for Support Group functions such as focused health information, peer counseling, and community support tends to be high, yet need is concentrated in individuals who suffer from specific health conditions, such as breast cancer or diabetes, and their caregivers. Further, opportunity to access Support Group functions emerged early in the build-out of the Internet as many of these e-health services were developed by peer consumers unconstrained by organizational caution, based on their personal needs and interests [Eysenbach, Powell, Englesakis, Rizo, and Stern, 2004]. Thus, it is not surprising that high levels of need combined with ready opportunity to quickly diffuse use of Support Group e-health services, reaching maximum uptake by 2003. However, it is an interesting question why uptake did not increase noticeably with the advent during the 2000 decade of social media, such as Facebook, which increase exposure of Support Group e-health services[1]. An important ramification of this interpretation is that similarly mature e-health services cannot be expected to contribute to overall growth of health portal usage regardless of their importance to population subgroups.

In the case of Talk to Doctor e-health services, we observe that need for online communication with doctors and clinical personal has been documented in numerous studies (e.g., Wilson [2003]; Deloitte [2008]). However, health care provider organizations have been cautious in deploying online communication services, especially in connecting consumers with physicians [Lazarus, 2001; Wilson, Wang, and Sheetz, 2014], and this circumstance continues to obstruct many consumers' opportunities to use these services. We anticipate from analysis of the combined 2003–2012 trends that Talk to Doctor e-health services still have strong growth potential, especially given current levels of email use, which is calculated in 2012 to have an average volume of 144 billion messages per day worldwide (Pingdom, 2013).

The change in the trajectory of Buy Online e-health services from strong growth during 2003–2007 to slight numeric growth during 2007–2012 suggests that uptake of these services has been maximized. In contrast to the similar observation for Support Group e-health services, however, we anticipate that this equilibrium could change if new conditions emerge in the areas of economics (e.g., additional discounting by major retailers for online prescription

[1] For example, the SupportGroups.com site on Facebook lists more than 220 online support groups.

orders) or politics (e.g., a governmental mandate that online prescription ordering be used in order to receive insurance reimbursement).

Limitations

The use of secondary data in this study necessarily constrains the domain of this research. The most important limitation from the authors' perspective is that only three interactive e-health services (Buy Online, Support Group, and Talk to Doctor) were included in the HINTS design in each of the studied survey years. While these are broadly representative of services included in health portals, data were not available concerning use of other common services such as appointment scheduling, prescription refilling, and online viewing of test results. We note also that each of these services could be further refined to provide better clarity. For example, Buy Online confounds online purchases of medicines and vitamins, Talk to Doctor confounds online communication with office personnel as well as doctors, and Support Group does not distinguish whether the accessed resources are moderated by health professionals or not. Finer-grained measures of frequency, duration, or intensity of use may also have improved the analytical options and statistical power of the research design, had these measurements been available.

In addition, self-reported data as collected by HINTS is prone to inaccuracy due to errors of recollection and social biases. We anticipate that effects of inaccuracy do not have major impacts on the trend results we report here, as there is no reason to theorize that the source of errors changed in any systematic way between 2007 and 2012 survey administrations.

Finally, it must be considered that use of at least some e-health services by consumers may be artificially constrained by lack of availability, and that this could be especially pronounced for disadvantaged populations. HINTS does not ask whether the services we studied are actually available to respondents, thus it will be necessary to inform this issue through further research.

V. CONCLUSION

The purpose of our research was to investigate demographic trends in use of distinct e-health services rather than in aggregated services within portals. This approach allowed us to identify important differences in usage trends of three representative e-health services, two of which appear to have achieved maximum uptake across the U.S. population. While our findings are reassuring in several aspects, such as the positive growth in overall use of e-health services across all demographic groups between 2007 and 2012, the results are uneven and suggest that a socio-economic digital divide continues to have an impact on e-health adoption and use. The findings also suggest a need to rethink research practices in this area. Focusing on fine-grained research designs that address e-health at the level of distinct services or features is recommended as a mechanism to improve the predictiveness and validity of future studies in this area. Finally, our findings demonstrate the importance of maintaining currency in e-health adoption and use research in order to capture evolving patterns of Internet use.

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Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor, or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that:

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ABOUT THE AUTHORS

Vance Wilson is an Associate Teaching Professor in the School of Business at Worcester Polytechnic Institute. He received his B.A. in Psychology from Reed College, M.S.B.A. in Information and Decision Systems from San Diego State University, and Ph.D. in Information Systems from the University of Colorado at Boulder. His research focuses on organizational aspects of human-computer interaction with special emphasis on patient-centered e-health, computer-mediated communication, and online persuasion. He is Supervising Editor of the Information Systems and Healthcare Department of *Communications of the Association for Information Systems.*

Sule Balkan is an Associate Professor at the National Chiao Tung University, Institute of Business and Management in Taiwan. Her research and teaching interests include Predictive Modeling, Business Intelligence and Analytics, and Application Development. Sule has presented her research at a number of conferences, including AMCIS, ICIS, and HICSS. She has more than ten years of professional experience in the information management, predictive modeling, and campaign execution fields. Prior to joining NCTU, she was a Clinical Associate Professor at Arizona State University for four years. She also worked as a Director of Information Management at Ameriprise Financial, and was Senior Manager/Econometrician at American Express International as well as Research Associate for the National Bureau of Economic Research. She earned a PhD in Economics from the University of Arizona Eller College of Business.

Nancy Lankton is an Associate Professor in the College of Business at Marshall University. She received her B.S. in Accounting, M.B.A., M.S. in Computer Information Systems, and Ph.D. in Business Administration from Arizona State University. She teaches accounting information systems and information systems auditing. Nancy's main research interests include trust's impacts on individual and organizational use of information technology, e-health, and privacy. She has published in journals such as *Contemporary Accounting Research, IEEE Transactions on Engineering Management, Journal of Management Information Systems,* and the *Journal of the American Medical Informatics Association.* She is a member of the Association for Information Systems, and the Information Systems Audit and Control Association, and currently serves as an Associate Editor for *Communications of the Association for Information Systems.*

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