2016
THE JOURNAL ON TECHNOLOGY AND PERSONS WITH DISABILITIES

Wireless Technology Use by People with Disabilities: A National Survey

John T. Morris, PhD, Michael L. Jones, Ph.D., W. Mark Sweatman, Ph.D.
Rehabilitation Engineering Research Center for Wireless Technologies
Shepherd Center
john_morris@shepherd.org, mike_jones@shepherd.org, mark_sweatman@shepherd.org

Abstract

Access to and use of mobile wireless consumer technology (i.e., mobile devices like cellphones and tablets, software and services) has become critical to social and economic participation, especially for people with disabilities who already face additional barriers. This article presents data from the Survey of User Needs (SUN) conducted by the Rehabilitation Engineering Research Center for Wireless Technologies (Wireless RERC) from June 21, 2015 through April 14, 2016. The SUN focuses on patterns of use, preferences and unmet needs for wireless technology among people with disabilities. Data are presented on the overall adoption rates, preferred platforms (cellphone, smartphone, and tablet), wireline (landline) use, and wireless use by disability type. Comparative analysis of adoption rates between people with disabilities and the general population is presented. Additionally, data from the 2012-2013 SUN are presented for comparison with the 2015-2016 data. The potential impact of demographic variables (age, income and education) and type of disability on wireless technology use is also analyzed. Response data show that people with disabilities own and use wireless technology at rates similar to the general population, but substantial variation exists in ownership of various types of wireless devices depending on disability type and other demographic variables.

Keywords

Technology, disability, cellphone, smartphone, tablet, accessibility.

Introduction

Access and use of mobile consumer information and communication technology (ICT) has become essential to independent living, employment and social participation. The ubiquity of technology in society and its increasing power and sophistication – especially the mobile kind – has made it ever more critical for communications, information access, entertainment, navigation/wayfinding, shopping, banking, and health monitoring. Data from the CTIA-The Wireless Association show over 355 million wireless service subscriptions in the United States (2015). The Pew Research Center's survey data show a steadily rising rate of cellphone ownership among the general population of American adults in recent years, from 73% in 2006 to 92% in 2015, with current smartphone ownership at 68%, and tablet computer ownership at 45% of American adults (2015).

Advances in consumer technology have created new opportunities for people with disabilities: to augment or assist communication, aid vision, aid memory, guide navigation outside the home, automate and monitor events inside of the home, monitor health, support emergency communications and location finding, provide information on the go, and socialize. Despite these new opportunities, the rapid rate of technological innovation risks leaving people with disabilities behind, or undoing hard-won advances in accessibility as new generations of technology are introduced (Wentz and Lazar 2016; Schroeder and Burton, 2010).

This article presents findings from the Survey of User Needs (SUN), a large, multi-year survey on use and usability of mainstream consumer wireless technology by people with disabilities conducted by the Rehabilitation Engineering Research Center for Wireless Technologies (Wireless RERC). Established in 2001, the Wireless RERC is funded by the National Institute on Disability, Independent Living and Rehabilitation Research (NIDILRR) within the U.S. Department of Health and Human Services. Now in its third cycle of funding, the RERC is a partnership between the Georgia Institute of Technology and Shepherd Center, a rehabilitation hospital in Atlanta specializing in rehabilitation for spinal cord and brain injury.

Most of the data presented here were collected for the 2015-2016 version of the survey. Some comparisons will be made to data collected for the 2012-2013 survey in order to uncover possible trends in technology ownership in recent years. This article is a follow-up to the article published in this journal based on the authors' presentation at the 2013 International Conference on Technology and Persons with Disability (Morris et al. 2014). Additional survey data from the

Pew Research Center is presented for comparison with the general population. This article is intended as a broad review of a considerable body of survey data that addresses some core issues and questions (listed below) related to disability and technology access:

1. Disability or digital divide (Kessler Foundation/NOD 2010; Horrigan 2010) – Do people with disabilities use wireless technologies at lower rates than the general population?
2. Functional divide (Morris and Mueller 2016; Morris and Mueller 2014) – Do people with specific disabilities own or use more sophisticated types of wireless devices more than people with different disabilities?
3. Wireless substitution (Blumberg and Luke 2015) – Do income and age of people with disabilities affect the use of wireline technology in the home? Do people with disabilities have wireline service in the more at the same rate as the general population?
4. Income divide (Morris et al. 2014) – Among people with disabilities, do those with higher incomes use more advanced wireless technology than those with lower incomes?
5. Age divide (Morris, Mueller, and Jones 2010) – Do younger adults with disabilities use more advanced technology than older individuals with disabilities?

This analysis is critical to understanding the state of mobile wireless accessibility for people with disabilities in general and for those with specific disability types. It provides the beginnings of a nuanced view of technology access by analyzing the impact of demographic and other factors. Additionally, it provides important detail on the accessibility of mobile wireless technology, which is increasingly essential to independent living and social participation.

Originally launched in 2002, the SUN has been updated over the years to keep up with the rapid pace of technological change. Over 7000 people with all types of disabilities have completed the SUN since 2002. Now in its 5th version (SUN 5) this unique nationwide survey on wireless technology use by people with all types of disabilities has come to be an important reference for the wireless industry, government regulators, people with disabilities and advocates, and other researchers. The results presented in this paper focus on the most recent

version of the SUN updated and launched in June 2015. Participants were recruited across the eight general disability categories listed in Table 1. These are based on the categories used by the American Community Survey (ACS), augmented with categories adapted from the National Health Interview Survey (NHIS) for a more robust listing of functional limitations (Ruggles, et al., 2015; CDC/National Center on Health Statistics, 2014). The SUN 5 questionnaire permits finer segmentation of respondents by disability sub-types (e.g., blindness as a subtype of difficulty seeing, using a wheelchair as a subtype of difficulty walking). A total of 1008 people responded to the survey, with 845 reporting having at least one of the eight general functional disability types listed in Table 1. Females constituted 56% of the respondents. The relatively high mean age of 53 years is partly attributable to the exclusion of minors under the age of 18 due to the greater challenges of conducting research with vulnerable populations.

Table 1. Survey of User Needs Sample by Disability Type (%)*

Disability Type	**2012-2013 Respondents**	**2015-2016 Respondents**
Difficulty walking or climbing stairs	39%	43%
Difficulty hearing**	36%	48%
Difficulty seeing**	29%	22%
Difficulty using hands or fingers	26%	25%
Difficulty concentrating, remembering, deciding	24%	21%
Frequent worry, nervousness, or anxiety	20%	22%
Difficulty using arms	17%	21%
Difficulty speaking so people can understand me	14%	17%

*Respondents were asked to indicate all disability types that apply to them. Many respondents noted more than one disability type.

**Respondents were asked separately to indicate level of impairment with difficulty hearing, including hard of hearing (26% in 2012-2013 and 32% in 2015-2016) and deaf (10% in 2012-2013 and 11% in 2015-2016); or seeing, including low vision (15% in 2012-2013 and 12% in 2015-2016) and blind (11% in 2012-2013 and 6% in 2015-2016). However, some did not answer the subsequent question, causing the percentages of level of impairment to add to a sum lower than for the general functional difficulty (seeing or hearing).

Recruitment of participants relied on convenience sampling. Participants completed the survey via web, phone and in-person interviews, and on paper. For analyses that included all respondents with disabilities the sample was weighted, an established technique for correcting potential sampling biases (Yansaneh, 2003). The SUN sample was weighted by annual household income in order to minimize possible sampling biases in favor of wealthier, more educated respondents. Target household income distribution was calculated for respondents with disabilities in the 2014 ACS, the most recent available. Weights were calculated to make the income distribution in the SUN sample match that of the much larger ACS sample. The same procedure was conducted for analysis of the 2012-2013 SUN data, using the 2011 ACS sample.

Discussion

This article comprises two main areas of analysis: 1) analysis of responses for all eight disability categories taken together to assess the impact of demographic variables on mobile wireless technology ownership and use; and 2) analysis of responses by each disability category to identify differences in ownership and use between and among disability types. General trends related to overall ownership rates and ownership of specific types of devices (basic or "feature" phone, smartphone, tablet) are examined. Additionally, response data on wireless substitution (discontinuing wireline service, or "cutting the cord", in favor of wireless-only communications) are examined as a way of understanding the degree to which people with disabilities rely on mobile wireless technology and how that compares to the general population.

Table 2 shows aggregate ownership rates of three types of devices (basic cellphone, smartphone and tablet) for all SUN respondents with a disability and the general population in surveyed by the Pew Research Center. Overall, recent SUN respondents with disabilities own or use cellphones (basic cellphones and smartphones) at a substantially lower rate (82%) than the general population (92%) as measured by the Pew Research Center. Adding SUN respondents who own a tablet raises the ownership rate to 92%. The Pew data do not show the percentage owning any of the three types of devices. Ownership rates for cellphones and tablets for SUN respondents with disabilities have been relatively flat since the 2012-2013 survey; changes in ownership and use rates likely reflect in part sample variation. Over the same period there seems to be a moderate increase of ownership/use by the general population.

Table 2. Do you own or use a wireless device? (All respondents with a disability, % yes)

	SUN 2012-13	Pew 2012	SUN 2015-16	Pew 2014
Cellphone, smartphone or tablet ownership	91%	--	92%	--
Cellphone or smartphone ownership	84%	87%	82%	92%

Source: Pew Research Center (n.d.). Device Ownership over Time. Accessed online, http://www.pewinternet.org/data-trend/mobile/device-ownership/, May 9, 2016.

Table 3 shows the disaggregated ownership rates for each of the three types of devices for the SUN and Pew samples since 2012. In this period ownership of smart devices has grown considerably for both samples, with corresponding declines in the ownership of basic cellphones. For the earlier period, SUN respondents reported a substantially higher rate of smartphone ownership than the Pew sample (54% versus 45%). This gap narrowed to a small difference (71% and 68%) in the recent period as adoption rates for both groups grew to high levels. Tablet ownership rates are the same or similar for both samples in both periods, with SUN respondents reporting slightly higher adoption rates than the Pew sample in the recent period (50% and 45%).

Table 3. What type of device(s) do you own or use? (All respondents with a disability, %)

	SUN 2012-13	Pew 2012	SUN 2015-16	Pew 2015
Basic cellphone (e.g., Motorola Razr, Pantech Breeze, Nokia 6350)	31%	42%	13%	24%
Smartphone (e.g., iPhone, Android phone, BlackBerry, Windows phone)	54%	45%	71%	68%
Tablet (e.g., iPad, Kindle Fire, Galaxy Tab, Google Nexus)	31%	31%	50%	45%

Source: Pew Research Center (n.d.). Device Ownership over Time. Accessed online, http://www.pewinternet.org/data-trend/mobile/device-ownership/, May 9, 2016.

The 2015-2016 SUN data show strong evidence of an income divide in wireless device ownership among people with disabilities. It is expected that people with higher incomes are more likely to own more expensive devices, which are used with correspondingly more

expensive service plans (for cellphones and smartphones). Table 4 shows a strong relationship between income and *not owning* a wireless device (first data column) or *owning* a basic cellphone (second data column). Lower-income respondents with disabilities are more likely to either not own a wireless device at all, or own a basic cellphone. Consistent with this pattern, respondents with lower incomes are much less likely to own smartphones and tablets.

Table 4 also shows the percentage of SUN respondents with a disability who own a wireline phone in the home – an indicator of the degree to which people depend on wireless phone communications. According to data from the National Health Interview Survey conducted by the U.S. Centers for Disease Control and Prevention (CDC) individuals in the general population with lower incomes are less likely to own a wireline phone. This pattern is evident among SUN respondents with disabilities. However, the effect is strongest among the lowest and highest income ranges shown in Table 4. Overall, approximately 48% of adults in the general population did not have a working wireline phone in the home in 2015, a figure that has climbed steadily since 2003 (Blumberg and Luke, 2016). Among SUN respondents with disabilities that figure is approximately 36%. These lower rates of wireless substitution among people with disabilities might reflect specific accessibility needs, perhaps for people who are deaf or hard of hearing who might need a landline for teletype or captioning services, or who prefer the sound quality of a wireline phone. Also, people with severe motor limitations or speech limitations might find landline phones more durability or accessibility.

Table 4. Wireless and Wireline Use by Income (All respondents with a disability, %)

Annual household income	No wireless device	Basic cellphone	Smartphone	Tablet	Wireline
Less than $10,000	8%	22%	47%	33%	53%
$10,000-$14,999	3%	15%	65%	51%	66%
$15,000-$24,999	3%	18%	59%	43%	58%
$25,000-$34,999	1%	12%	67%	46%	67%
$35,000-$49,999	1%	14%	71%	52%	68%
$50,000-$74,999	1%	7%	82%	51%	65%
$75,000 or more	1%	8%	86%	63%	74%

Table 5 shows the same wireless and wireline options in the column headings as table 4, but here the row labels contain age ranges beginning with 18-30 years and ending with over-70 years. It is expected that there would be an age divide by which younger respondents with disabilities would be less likely *not* to have a wireless device and less likely to have a basic cellphone than older respondents. Instead, younger respondents as earlier adopters would be more likely to own sophisticated devices like smartphones and tablets. The data in Table 5 generally support these aspects of an age divide, with the exception of not owning a wireless device. There is little difference between age cohorts in *non-ownership* of wireless devices. As expected, younger respondents are less likely to own a basic cellphone. The pattern of smartphone ownership is generally flat across all age groups (between 71% and 77%) with the exception of the oldest age group over 70 years of age, which reports much lower smartphone ownership. This flattening of smartphone ownership likely reflects the broad adoption of smartphone technology among people with disabilities and society in general. Tablet ownership skews somewhat toward younger age cohorts, with the exception of the youngest group of 18-30 years, who may have financial constraints limiting the ability to purchase a tablet. Finally, consistent with the CDC's data, wireline ownership is much lower among younger respondents.

Table 5. Wireless and Wireline Use by Age (All respondents with a disability, %)

	No wireless device	Basic cellphone	Smartphone	Tablet	Wireline
18-30	1%	7%	71%	39%	40%
31-40	3%	8%	77%	58%	57%
41-50	1%	9%	75%	56%	57%
51-60	3%	16%	72%	50%	68%
61-70	3%	16%	72%	48%	77%
Over 70 years old	1%	20%	55%	39%	84%

The analysis above for all respondents with disabilities reveals some important trends, particularly in comparison to the general population. However, a more complete understanding requires analysis of wireless device ownership by disability. Table 6 shows wireless device and

wireline ownership for the eight disability types listed in Table 1. Table 7 shows the same technology options, but with the respondents who reported having visual or hearing loss disaggregated by level of functional loss: low vision and blind, and hard or hearing and deaf.

Table 6. Wireless and Wireline Use by Disability Type (%)

	No device	Basic phone	Smartphone	Tablet	Wireline
Cognitive	0%	13%	72%	50%	58%
Anxiety	3%	14%	67%	52%	56%
Seeing	0%	14%	73%	45%	69%
Hearing	2%	12%	74%	56%	71%
Speaking	4%	11%	59%	49%	61%
Using arms	5%	17%	59%	42%	71%
Using hands and fingers	4%	16%	59%	45%	67%
Walking, climbing stairs	3%	16%	64%	46%	65%

Disability type differs from income and age as a variable in that there is no natural order or progression of the values, except perhaps low vision and blind, and separately hard or hearing and deaf (Table 7). Consequently, it is not possible to analyze trends across the eight general disability categories as in previous tables. Still, some specific values stand out. First, those who reported having difficulty speaking or difficulty using arms, hands and fingers have the highest rates of not having a wireless device, but still at very low levels (4% or 5%). Additionally, those with physical limitations (using arms, hands, fingers, and ambulating) reported the highest rates of basic cellphone ownership (16% or 17%), perhaps because the direct action of physical keys on these devices may provide more control. These interfaces may produce less slippage of fingers for these users and provide physical feedback of key activation. Simple cellphones also may provide greater durability when dropped.

Notably, respondents with hearing and vision, as well as cognitive, limitations were substantially more likely to own smartphones. Those with hearing limitations also were most like to own a tablet and have home wireline service. Those with limited sight were among the least

likely to own tablets, but reported among the highest rate of home wireline service. Overall, these results likely reflect in part the ownership patterns of blind and deaf respondents, who are regarded as most enthusiastic technology adopters. There are also notable distinctions between the two vision loss groups and the two hearing loss groups (Table 7). Deaf respondents show much higher rates of smartphone (80% versus 71%) and tablet ownership (63% versus 53%) than hard of hearing respondents, and much lower rates of basic phone (6% and 15%) and wireline ownership (58% and 74%). This is understandable since people who are deaf have more complex communication needs which often cannot be satisfied by basic cellphones or wireline phones.

Table 7. Wireless and Wireline Use by Disability Type (Vision or hearing limitations)

	No wireless device	Basic phone	Smart phone	Tablet	Wireline
Low vision	2%	17%	68%	47%	68%
Blind	0%	9%	82%	39%	77%
Hard of hearing	2%	15%	71%	53%	74%
Deaf	2%	6%	80%	63%	58%

Similar differences are noted for blind and low vision respondents, with blind respondents much more likely than low vision respondents to own a smartphone (82% versus 68%) and wireline phone service (77% versus 68%), and less likely to own a basic phone (9% and 17%). Low vision respondents, however, are more likely to own a tablet (47% versus 39% for blind respondents, probably because tablets are more visually engaging than smartphones.

Conclusions

The survey results presented here lead to two general conclusions. First, as a group, people with all types of disabilities use wireless devices (basic phones, smartphones and tablets) at a high rate, although at a lower rate than the general population. They use cellphones overall at a substantially lower rate (82% versus 92%). But, they use smartphones and tablets at somewhat higher rates. Additionally, they are "cutting the cord" of wireline phone service at a slower rate than the general population. These results indicate that the notion of a disability divide between

people with disabilities and the general population overlooks important details. Technology access for people with disabilities is more complicated and variable, and it involves the complex interplay of age and income (just as for the general population) and, perhaps most importantly, type of disability or functional limitation. Among people with disabilities there is evidence of an income divide (higher incomes are associated with use of more sophisticated technology) and an age divide (higher age is associated with use of less sophisticated technology). These divides also characterize the general population.

The second conclusion is that substantial differences in technology ownership and use are evident between and among people with different disabilities. The various platforms – basic cellphones, smartphones, tablets (and even wireline phones) – offer different interfaces and capabilities that are utilized at varying rates by people with differing levels and types of abilities, whether it is seeing, hearing, using hands, etc. Each of these platforms offers access and barriers depending on the specific functional loss of potential users with disabilities. Challenges and barriers to access and use persist, and hard won gains can be quickly lost with successive versions and generations of technology (Wentz and Lazar 2016). Furthermore, emerging mobile technologies such as wearables will pose new challenges to access and usability.

Acknowledgement

The Rehabilitation Engineering Research Center for Wireless Technologies is funded by the National Institute on Disability, Independent Living and Rehabilitation Research of the U.S. Department of Health and Human Services, grant # 90RE5007-01-00. The opinions contained in this document are those of the grantee and do not necessarily reflect those of the U.S. Department of Health and Human Services.

Works Cited

Blumberg, Stephen J., and Julian V. Luke. "Wireless Substitution: Early Release of Estimates From the National Health Interview Survey, July–December 2015." Centers for Disease Control and Prevention, 2015. Web. 17 May 2016.

CDC/National Center on Health Statistics, National Health Interview Survey, 2015. Web. 12 May 2016.

CTIA-The Wireless Association. "Wireless Industry Summary Report, Year-End 2014." CTIA, 2015. Web. 12 May 2016.

Horrigan, John B. "Broadband Adoption and Use in America." U.S. Federal Communications Commission, 2010. Web. 19 May 2016.

Kessler Foundation and National Organization on Disability. "The ADA, 20 Years Later." 2010. Web. 19 May 2016.

Morris, John and James L. Mueller and Mike Jones. Tomorrow's Elders with Disabilities: What the Wireless Industry Needs to Know. *Journal of Engineering Design*. 2010; 21(2-3):131-146. Print

Morris, John T. and James L. Mueller. "Assets, Actions, Attitudes: Hearing and Vision Impaired Mobile Technology Personas." *Designing Around People*. Ed. Pat Langdon, et al. London: Springer, 2016. 249-258. Print.

Morris, John T. and James L. Mueller. "Blind and Deaf Consumer Preferences for Android and iOS Smartphones." *Inclusive Designing: Joining Usability, Accessibility, and Inclusion*. Ed. Pat Langdon, et al. London: Springer, 2014. 69-79. Print.

Morris, John, James Mueller, Michael L. Jones, and Ben Lippincott. Wireless Technology Use and Disability: Results from a National Survey, *Journal on Technology and Persons with Disabilities*, Issue 1: 67-77. Web. 20 May 2016.

Pew Research Center. "Pew Internet Surveys, 2006-2012." n.d. Web. 7 May 2016.

Pew Research Center. "Device Ownership over Time." n.d. Web. 18 May 2016.

Steven Ruggles, Katie Genadek, Ronald Goeken, Josiah Grover, and Matthew Sobek. "Integrated Public Use Microdata Series: Version 6.0 [Machine-readable database]." Minneapolis: University of Minnesota, 2015. Web. 9 May 2016.

Schroeder, P. and Burton, D. "Microsoft Backtracks on Accessibility in New Mobile Operating System, Commits to Accessibility in Future Windows Phone Platform." *Access World*, 11, 8, 2010. Web. 27 April 2016.

Wentz, Brian, Lazar, Jonathan. (2016). "Exploring the Impact of Inaccessible Redesign and Updates." *Designing Around People*. Ed. Pat Langdon, et al. London: Springer, 2016. 3-12. Print.

Wireless RERC. "SUNspot –People with Disabilities, Income, and Wireless Access." March 30, 2011. Web. 19 May 2016.

Yansaneh, Ibrahim S. "Construction and Use of Sample Weights." United Nations Statistics Division, 2003. Web. 19 May 2016.

Journal on Technology and Persons with Disabilities

ISSN 2330-4216

LIBRARY OF CONGRESS * U.S. ISSN CENTER
ISSN Publisher Liaison Section
Library of Congress
101 Independence Avenue SE
Washington, DC 20540-4284
(202) 707-6452 (voice); (202) 707-6333 (fax)
issn@loc.gov (email); www.loc.gov/issn (web page)