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COMMUNICATION

Reassessing the disability divide: unequal access as the world is pushed online

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Abstract
In a time when a global pandemic has forced people to use technology for almost every aspect of their day-to-day lives, it is important to determine if specific disadvantaged groups are appropriately connected to the digital world. This paper attempts to assess whether people with disabilities (PWD) own computers, connect to the Internet, and participate in online activities at the same rates as the general population. Using comprehensive data from the 2017 Current Population Survey we find that PWD still lag behind in computer ownership and Internet access. This result is driven by those with physical, mental, and emotional impairments along with those with multiple disabilities. We also find that the online activities of PWD are similar to the general population for half of the activities studied, while falling behind in areas such as online communication and finances. Our results also indicate relatively high confidentiality concerns related to online activities among specific disabled groups. We do find PWD are moderately more likely than others to use the Internet for health-related activities in general. Overall, our results indicate the disability divide has been partially bridged, but that given the state of the world more can be done to ensure this already disadvantaged group is not left further behind.

Keywords Digital divide · Disability · ICT

1 Introduction

The spread of coronavirus (COVID-19) pushed society into increased technology use across all facets of life. With stay-at-home orders and self-quarantines people were forced to use the Internet for school, work, shopping, and basic social interactions. For some individuals this was an easy transition that was achieved relatively effortlessly. For others, however, this transition was overwhelming in terms of costs and the technical knowledge required. Households with no Internet access, or with unreliable Internet access, were at a clear disadvantage relative to their connected peers at school and work. Without reliable access to the Internet, people have difficulty staying connected with friends and family, and with getting the most recent news on the growing pandemic. COVID-19 has highlighted the digital divides in Internet access and usage and has shown that in a world suddenly pushed online entire segments of the population could be left behind.

This paper focuses on a group of individuals that often lag behind in access to technology but who could arguably benefit the most from its use. Specifically, we focus on people with disabilities (PWD) in the USA and examine their access and use of technology. PWD face barriers starting at the very basic level of being able to obtain and install appropriate equipment or being physically or mentally able to use standard computers, tablets, or smartphones. Someone with a cognitive delay may not understand what type of equipment they need in order to connect to the Internet or how to get it, while someone with a physical disability may be unable to use a standard mouse or keyboard. These often-overlooked barriers can be daunting even for those who have the desire, and the means, to connect to the Internet. During a pandemic this hurdle is even higher since it is difficult to find someone to come inside the home to determine what is needed and to install equipment.

The difficulty in getting access to technology is compounded for some PWD since they may require expensive assistive technologies (AT) to effectively utilize their devices and navigate online. Paying for, and becoming proficient

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with, the necessary assistive technologies serve as an additional barrier to being connected that others do not face. Hoppestad [9] provides a summary of the literature on the challenges of matching assistive technologies with severely disabled individuals. He finds that while there is a wide range of assistive technologies available, they are widely underutilized due to their complexity of use.

Once connected, PWD may find that many websites are not optimized for their specific disability. Someone with vision impairment may find sites that do not work well with screen readers, or a hard of hearing user may try to watch videos with no closed captioning or descriptive text. Harris (2010) found that even when the disabled could afford specialty assistive technologies, they often found them difficult to use or to be ineffective resulting in widescale abandonment of these devices. Wentz et al. [21] and Jaegar (2012) paint a grim picture where many sites are designed without consideration for PWD and later try to retrofit the site to be compliant. These technology lags can be frustrating for disabled users and "given the rapid pace of technological change and introduction of new Web–enabled technologies, as online technologies are often obsolete before they are made accessible" [21].

Our study uses detailed regression analysis to determine if these barriers are stifling PWD when it comes to owning computers and accessing the Internet. Next, we look deeper into the issue by focusing on people's online habits by comparing the online activities of PWD that have access to the Internet to the online activities of the general population. Our results show that while PWD have become more active in many online activities, a meaningful gap does persist. These results should help shape important policy decisions that will insure everyone is able to take advantage of modern communication technologies. It will also ensure that future crises that force people online will not disproportionately harm specific at-risk groups.

2 Background and related studies

The concept of a digital divide has been used since the beginning of the computer age to describe the gap between those with access to transformative new technologies and those that were being left behind. The divide has been measured across numerous important dimensions leading to new policies aimed at narrowing them. For example, early work by the National Telecommunications and Information Administration (NTIA (1998, [13], 14) along with Hoffman and Novak (1998) and Lenhart et al. (2005) found that there was a divide based on race and ethnicity. They found that Black and Hispanic individuals were less likely to use computers and access the Internet than their White cohorts. As a result of these findings programs such as the Universal Service Fund for Schools and Libraries, commonly called "E-Rate" was developed. It focused on expanding broadband access along with technical education to more urban areas and large schools. Local governments also rolled out programs like Chicago's Digital Excellence Initiative which created special programs to bridge the racial divide. Fairlie [5] asked in the title of his paper "Have we finally bridged the digital divide? Smart phone and internet use patterns by race and ethnicity." He found that while some progress had been made a gap still persists.

There were numerous early studies that were also able to identify a digital divide between people with various disabilities and those with no disability. These studies include Kaye [11], NTIA (2000), Lenhart et al. [12], and Dobransky and Hargittai [3]. Kaye [11] noted "People with disabilities are perhaps the single segment of society with the most to gain from new technologies of the electronic age. Yet they have among the lowest rates of use of these technologies." The focus of these early empirical studies was on differences in access to Information and Communication Technology (ICT) with little discussion of the differences in usage among groups once online. The next wave of the literature confirmed the continued divide in access and found that PWD were often doing fewer activities online than those without disabilities (Dobransky and Hsieh 2013; Vincente and Lopez [20]; and [17]).

A recent study by Raja [15] has become increasingly relevant given what the world has experienced with COVID-19. She explores the disability divide across many countries and shows that this divide is a global phenomenon. She also discusses how PWD are at an additional disadvantage during a disaster given their lack of access to ICTs. She outlines three important areas that need to be addressed for PWD during a crisis, which include: Mitigation and Preparedness, Alerts and Response, and Recovery and Reconstruction. Arnold et al. [1] expand on the importance of specifically focusing on PWD both before and after a disaster. They encourage governments to include a voice from the disabled community in disaster planning, to collect accurate data on PWD during the disaster, and then to use the recovery period as an opportunity to improve connectivity for the disabled.

Two studies, Goggin [6] and Dobransky and Hargittai (2016), have attempted to re-measure and expand our understanding of the digital divide today and serve as the main catalysts for this paper. Goggin [6] provides a comprehensive literature review of disability divide research along with providing a discussion on whether it should be considered a digital divide or thought of as digital inequality. Dobransky and Hargittai (2016) provide one of the most detailed analyses of the disability divide to date by using a novel dataset from the "U.S. Federal Communication Commission's 2009 National Consumer Broadband Service Capabilities Survey." While the survey has a small sample size,

less than 4000 observations, it asks detailed questions about online activities, Internet skills, and online experiences that make it valuable for the study. They find that PWD are significantly less likely to connect to the Internet than those without a disability but find that their online activities are very similar to others. They conclude "although not every disability was positively related to engaging in each type of activity, a number of disabilities are associated with each, and in no case is a disability negatively associated with an activity." Our study hopes to expand on their findings by using a large and updated dataset, and by considering the role of security concerns when explaining the persistent gap in online activity.

Van Deursen and Helsper [19] and Scheerder et al. [18] provide an overview of the three levels of digital divide research. The first-level focuses on the gaps in access to ICTs among groups, the second-level looks into differences in skills and uses of technologies, and the third-level addresses how access to the Internet and technology impact peoples' offline outcomes. The goal of this paper is to search for any current first-level divides among PWD and those without disabilities, then to provide a detailed list of second-level divides that will help provide the focus for upcoming research on third-level digital divides.

3 Data and Methodology

The data for this study come from the 2017 Current Population Survey (CPS) conducted jointly by the US Census Bureau and the Bureau of Labor Statistics. Specifically, data from the Computer and Internet Use Supplement survey from November 2017 is used, which was sponsored by the National Telecommunications and Information Administration (NTIA). This supplemental survey has been added to the CPS survey periodically for over 20 years in an effort to measure the connectedness of households in the USA along with attempting to understand peoples' online habits. The survey is conducted on over 52,000 households and receives responses from over 123,000 people in those households.

This dataset was chosen based on the NTIA's description of the supplement: "With its large sample size and more than 50 questions about internet usage, it is the most comprehensive national survey of how Americans connect to the internet and what they do when they're online. NTIA asked dozens of questions about devices, technologies, and locations of internet use, as well as online activities, privacy and security concerns, and reasons why some Americans still are not online" (Reidl [16]). The breadth of questions provided by the Computer and Internet Use Supplement along with the descriptive demographic and socioeconomic data provided by the CPS data make this an ideal dataset for this study. Its large sample size also helps in the identification issues in the regression analysis.

We employ empirical analysis to address digital access and usage concerns since there are many factors other than an individual's disability that impacts the probability that they will have access to information and communications technology (ICT). For example, the socioeconomic status data for PWD indicate that on average they have lower education levels, lower levels of employment, and lower incomes. Studies by Houtenville and Boege [10] and Erickson and Schrader [4] show that PWD are less likely to graduate high school and are significantly less likely to graduate college than those without a disability. They further find that the employment-to-population ratio for PWD is between 35 and 37% while those without any disability have an employment-to-population ratio between 77 and 79%. This has led to a poverty rate that is twice as large for PWD relative to those without a disability. According to the Center for Economic and Policy Research, these employment numbers are significantly worse during a health crisis when competition within the labor market is at its greatest (Brown [2]). The result of this is less exposure to technology at school and work along with less ability to afford technology at home.

Questions asked in the CPS survey regarding ownership and use of ICTs are almost exclusively "Yes" or "No" questions. To deal with the dichotomous nature of the dependent variables we employ a probit regression model. The results presented in the tables represent the marginal effects of the estimates since they are easier to interpret than the changes in the z-scores. The first model investigated in this paper includes whether or not someone owns a computer as the dependent variable. The explanatory variables will include each specific disability along with a variety of demographic and socioeconomic variables. The model will be defined as follows:

$$Y_i^* = X_i\beta + u_i \tag{1}$$

where X_i is a vector of explanatory variables, β is their corresponding coefficient estimates, and u_i is the error term. The observable outcome is defined as:

$$\begin{aligned} Y_i &= 1 \; if \; X_i\beta + u_i > 0 \\ &0 \; if \; X_i\beta + u_i \leq 0 \end{aligned} \tag{2}$$

A similar process will be used for each dependent variable that is estimated using probit analysis.

The CPS survey asks whether anyone in the household owns a computer and whether anyone connects to the Internet. However, they only ask about online activities for those who said "Yes" to connecting to the Internet. To deal with hierarchical nature of this data we employ the Heckman two-step process Heckman [8]. This is done by including an inverse Mills ratio, lambda, into each regression regarding online activities. Lambda is defined as:

$$\text{Lambda} = \frac{f(z)}{F(-z)} \tag{3}$$

where z is the estimated value from the probit selection equation, f is the standard normal probability density function, and F is the cumulative density function for a standard normal variable.

4 Results

The results are split into three sections. The first section will focus on the connectivity of people with disabilities (PWD) along with their basic Internet usage patterns. The second section will investigate whether PWD use the Internet to acquire health-related information more or less than those without disabilities. The final section will address whether PWD exhibit greater than normal concerns about privacy and security when it comes to participating in activities online.

4.1 Access

The earliest measures of the disability divide found that PWD were significantly less likely to own a computer or access the Internet than those with no disability. This was an important finding since these technologies have the potential to greatly enhance the lives of the disabled. To assess if there is still a gap in computer ownership we run a probit regression with the dependent variable being whether an individual owns a computer and with independent variables relating to disability, demographics, and socioeconomic factors. In this case computer ownership includes both desktop and laptop computers. The initial regression includes disability as a single dummy variable that equals 1 if a person has any disability and 0 if they do not. Next we divide PWD by disability type to determine if people with specific types of disabilities are more or less likely to use technology. The disability categories include:

- Deaf/Hard of Hearing—whether a person is deaf or has serious difficulty hearing
- Blind/Visually Impaired—whether a person is blind or has serious difficulty seeing even when wearing glasses
- Physical Disability—whether a person has difficulty walking, climbing stairs, dressing, or bathing
- Physical–Mental–Emotional (PME) Disability—whether a person has serious difficulty; concentrating, remembering, making decisions, or doing errands alone as the result of a physical, mental or emotional condition[1];
- Multiple Disabilities—whether a person has more than one of the disabilities listed above

These are modeled as dummy variables with 1 indicating the disability and 0 if there is no disability. To be counted as Deaf/Hard of Hearing, Blind/Visually Impaired, Physical Disability, or PME Disability the individual must have listed that as their only disability. If more than one disability is provided, then the individual is counted in the Multiple Disabilities variable. This avoids overlap and correlation among the independent variables. An aggregated dummy variable, "Disabled" was also created that equals 1 if any disability is listed and is equal to 0 if the person has no disability. Each empirical analysis was attempted separately using this variable as the main independent variable instead of the individual disabilities listed above.

The summary statistics for the explanatory variables in the model are provided in Table 1. Column (1) gives information on the total population of people surveyed, column (2) provides the summary statistics for those who own a computer, column (3) for those who access the Internet, and column (4) for cellphone owners. As predicted by previous research Black and Hispanic individuals are on average less likely to own a computer and access the Internet than their white counterparts. Similarly, those with higher education levels and higher incomes are more likely to own computers and access the Internet. Surprisingly, the summary statistics do not show that older individuals are less likely to use modern technology as expected, though the results of regression analysis in subsequent tables do confirm this expectation.

Column 1 of Table 2 shows that after controlling for socioeconomic and demographic variables PWD as a group are still significantly less likely to own a computer than those with no disability. Column 2, however, shows that this result is driven mostly by those with a physical disability, PME disability, or multiple disabilities with the deaf/hard of hearing and the visually impaired being just as likely to own a computer as those with no disability. The rest of the variables from columns 1 and 2 are as expected with minorities and older individuals being less likely to own a computer and females, the more educated, and those with higher incomes being more likely.

The next two columns in Table 2 focus on whether an individual accesses the Internet from where they live.

[1] This variable is the combination of two variables in the data one specifically about whether a physical, mental, or emotional condition limits errands and a second on whether these conditions make concentrating and decision making difficult. All results were also checked with these variables included separately and are available upon request.

Table 1 Summary statistics

	(1) Population	(2) Computer owners	(3) Internet access	(4) Own a cellphone
N	127.907	74.910	91.568	80.s690
Deaf/hard of hearing	0.0158	0.015	0.014	0.013
	(0.125)	(0.121)	(0.119)	(0.115)
Blind/visually impaired	0.005	0.004	0.004	0.005
	(0.068)	(0.065)	(0.065)	(0.067)
Physical disability	0.025	0.021	0.022	0.021
	(0.158)	(0.144)	(0.146)	(0.144)
PME disability	0.0163	0.013	0.014	0.014
	(0.127)	(0.113)	(0.118)	(0.120)
Multiple disabilities	0.205	0.128	0.160	0.085
	(0.404)	(0.334)	(0.367)	(0.279)
Black	0.107	0.087	0.094	0.100
	(0.309)	(0.282)	(0.292)	(0.300)
Hispanic	0.146	0.108	0.131	0.135
	(0.353)	(0.310)	(0.337)	(0.342)
Native American	0.014	0.009	0.01	0.011
	(0.118)	(0.094)	(0.101)	(0.106)
Asian	0.053	0.056	0.055	0.057
	(0.224)	(0.230)	(0.227)	(0.231)
Age	40.803	41.789	40.214	41.836
	(22.596)	(20.376)	(20.855)	(18.695)
Female	0.516	0.524	0.520	0.524
	(0.500)	(0.499)	(0.500)	(0.500)
Married	0.051	0.544	0.531	0.525
	(0.500)	(0.498)	(0.500)	(0.500)
Household income	78,166.84	89,580.98	85,447.95	85,577.41
	(54,654.39)	(54,329.54)	(54,379.64)	(54,609.72)
Education	13.383	14.074	13.784	13.760
	(2.735)	(2.426)	(2.525)	(2.555)

Standard errors in parentheses

Column 3 indicates that PWD are less likely than others to access the Internet from home. Column 4 looks at each specific disability type and finds that only those with a PME disability and those with multiple disabilities are significantly less likely to access the Internet at home, while the other disability types are just as likely as the general population to access the Internet from home. These results indicate that PWD still lag behind others in terms of online access at the aggregated level but that this outcome is mainly driven by two groups within the disabled community.

The final two columns of Table 2 address cellphone ownership by individuals. Owning a cellphone can expand an individual's independence and make it easier to connect with others. The findings show that PWD are significantly less likely to own a cellphone than those without a disability. These results hold true for each disability group except for the blind/visually impaired who are equally as likely as the general population to own a cellphone. This is an important new aspect of the digital divide that needs to be tracked and addressed as cellphone usage has become as ubiquitous as computer ownership. This is especially important since specialized apps on smartphones designed for those with disabilities have the potential to improve the everyday lives of PWD.

4.2 Online Activity

This section will look at the online activities of PWD relative to others after controlling for socioeconomic variables such as education and income. Since the CPS survey only asks the online activity questions to those that have access

Table 2 Probit regressions for computer ownership, Internet access, and cellphone ownership

	(1) Own a computer	(2) Own a computer	(3) Connect to Internet	(4) Connect to Internet	(5) Own a cellphone	(6) Own a cellphone
Disabled	− 0.060***		− 0.044***		− 0.079***	
	(0.01)		(0.004)		(0.01)	
Deaf/hard of hearing		− 0.02		− 0.004		− 0.054***
		(0.01)		(0.01)		(0.01)
Blind/visually impaired		0.02		0.01		0.01
		(0.02)		(0.02)		(0.02)
Physical disability		− 0.031***		(0.01)		− 0.037***
		(0.01)		(0.01)		(0.01)
PME disability		− 0.076***		− 0.051***		− 0.091***
		(0.01)		(0.01)		(0.01)
Multiple disabilities		− 0.138***		− 0.135***		− 0.172***
		(0.01)		(0.01)		(0.01)
Black	− 0.092***	− 0.092***	− 0.067***	− 0.067***	− 0.023***	− 0.024***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Hispanic	− 0.117***	− 0.117***	− 0.046***	− 0.047***	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Native American	− 0.136***	− 0.136***	− 0.153***	− 0.154***	− 0.081***	− 0.082***
	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Asian	− 0.054***	− 0.053***	− 0.043***	− 0.041***	− 0.018**	− 0.017*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age	− 0.005***	− 0.004***	− 0.005***	− 0.005***	− 0.007***	− 0.007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0003)
Female	0.026***	0.029***	0.020***	0.024***	0.025***	0.028***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.009)
Married	0.049***	0.043***	0.056***	0.049***	0.060***	0.054***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)	(0.01)
Household income	0.084***	0.083***	0.058***	0.057***	0.054***	0.054***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.01)
Education	0.050***	0.049***	0.030***	0.030***	0.030***	0.029***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
N	105,596	105,822	105,596	105,822	105,596	105,822
LR chi2(16)	19,431	19,457	14,329	14,387	16,503	16,560

Categorical variables for household size, being in a metro area, and owning your own business, and regional dummies are included in the regression but not shown

Standard errors are in parentheses

** indicates significance at the 5% level and *** indicates significance at the 1% level or smaller

to the Internet, the results will better represent differences in Internet activity instead of recapturing the fact that PWD are less likely to have a computer or have access to the Internet. One drawback of the 2017 survey is that no questions were asked that would directly determine someone's experience or familiarity with computers and the Internet. To proxy for this important variable we include whether the individual uses a computer at school or work as a measure of their comfort with ICTs.

Given the broad range of activities covered by the CPS survey we split the results into two tables, Table 3 and Table 4. Table 3 looks at whether people use the Internet to (1) listen to music or watch videos, (2) E-mail, (3) text or instant message, (4) access social networks such as Facebook, Twitter, or Instagram, (5) telecommute for work, and (6) create online content such as blogs or original videos. The results indicate that the deaf/hard of hearing, the physically disabled, the PME disabled, and those with multiple disabilities are all less likely to E-mail or use text and instant messaging than those without disability. Column 1 also shows that those with physical disabilities and those with multiple disabilities are less likely to use the Internet for

Table 3 Probit regressions for online activities

	(1) Music or videos	(2) Email	(3) Text	(4) Social media	(5) Telecommute	(6) Create content
Deaf/hard of hearing	− 0.033	− 0.036***	− 0.034***	− 0.028	− 0.051	− 0.027*
	(0.017)	(0.01)	(0.01)	(0.016)	(0.027)	(0.014)
Blind/visually impaired	− 0.025	− 0.023	− 0.026	− 0.017	0.002	0.046
	(0.03)	(0.02)	(0.02)	(0.03)	(0.05)	(0.03)
Physical disability	− 0.052***	− 0.039***	− 0.029***	− 0.002	− 0.047	0.006
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)
PME disability	− 0.02	− 0.054***	− 0.064***	− 0.045*	− 0.041	0.016
	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)	(0.01)
Multiple disabilities	− 0.045***	− 0.064***	− 0.062***	− 0.008	− 0.041	− 0.011
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)
Black	− 0.065***	− 0.033***	− 0.006	− 0.080***	− 0.067***	0.011
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Hispanic	− 0.040***	− 0.041***	− 0.008	− 0.052***	− 0.033**	0.006
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Native American	− 0.127***	− 0.115***	− 0.02	− 0.096***	− 0.129***	− 0.019
	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)
Asian	− 0.052***	− 0.033***	− 0.016*	− 0.087***	− 0.031*	0.0001
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Age	− 0.012***	− 0.003***	− 0.005***	− 0.010***	− 0.004***	− 0.004***
	(0.0004)	(0.0002)	(0.0002)	(0.0004)	(0.001)	(0.0003)
Female	− 0.011*	0.025***	0.023***	0.103***	− 0.008	0.007*
	(0.01)	(0.002)	(0.003)	(0.01)	(0.01)	(0.003)
Married	0.025***	0.027***	0.012***	0.023***	0.065***	− 0.005
	(0.01)	(0.003)	(0.004)	(0.01)	(0.01)	(0.01)
Household income	0.067***	0.036***	0.031***	0.045***	0.117***	0.010**
	(0.01)	(0.002)	(0.003)	(0.01)	(0.01)	(0.004)
Education	0.038***	0.026***	0.013***	0.024***	0.070***	0.009***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.004)	(0.002)
Comp. at school/work	0.175***	0.055***	0.057***	0.075***	0.201***	0.098***
	(0.01)	(0.002)	(0.003)	(0.01)	(0.01)	(0.01)
N	43,902	43,902	43,902	43,902	28,394	43,902
LR chi2(22)	9,000	4,315	5,600	5,285	4,371	2,454

Categorical variables for household size, being in a metro area, and owning your own business, regional dummies, and lambda are included in the regression but not shown

Standard errors are in parentheses

** indicates significance at the 5% level and *** indicates significance at the 1% level or smaller

music and videos. Columns 4, 5, and 6 indicate that PWD have very similar likelihoods of using the Internet for social media, to telecommute for work and for creating online content as those without disabilities.

Additional online activities are presented in Table 4 and address whether people use the Internet to (1) shop or make travel reservations, (2) request services such as Uber, Airbnb, or request home repair through sites like Angie's List, (3) offer services such as Uber or sell homemade items, (4) bank, invest, or pay bills, and (5) search for or apply for a job. The results indicate that the blind/visually impaired are as likely as those with no disability to participate in each of these online activities. People with all other types of disabilities are found to lag behind in shopping online, hiring services over the Internet, and using the Internet for banking or finances. Surprisingly, every category of disability is as likely as those without a disability to use the Internet to sell items or services and to search for job information online. Those with physical–mental–emotional impairment

Table 4 Probit regressions for online activities

	(1) Shop online	(2) Hire services	(3) Sell online	(4) Banking or finance	(5) Search job info
Deaf/hard of hearing	− 0.080***	− 0.061***	0.011	− 0.116***	0.006
	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Blind/visually impaired	0.004	− 0.025	0.023	− 0.034	0.055
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Physical disability	− 0.042**	− 0.066***	− 0.003	− 0.098***	− 0.003
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
PME disability	− 0.072***	− 0.060***	0.001	− 0.151***	0.051**
	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Multiple disabilities	− 0.083***	− 0.077***	− 0.01	− 0.132***	− 0.035**
	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
N	43,902	43,902	43,902	43,902	43,902
LR chi2(22)	7,618	7,547	2,044	6,843	4,710

A full set of demographic and socioeconomic variables were included in each regression but are not shown
Standard errors are in parentheses
** indicates significance at the 5% level and *** indicates significance at the 1% level or smaller

Table 5 Probit regressions for online health-related activities

	(1) Contact Dr. Online	(2) Access health records	(3) Health research online	(4) Any health activities
Deaf/hard of hearing	0.063***	0.042*	0.022	0.044*
	(0.02)	(0.02)	(0.02)	(0.02)
Blind/visually impaired	0.014	− 0.006	− 0.001	0.008
	(0.03)	(0.03)	(0.03)	(0.03)
Physical disability	0.052***	0.019	0.031*	0.048**
	(0.02)	(0.02)	(0.02)	(0.02)
PME disability	0.124***	0.076***	0.074***	0.094***
	(0.02)	(0.02)	(0.02)	(0.02)
Multiple disabilities	0.044**	0.039**	0.063***	0.060***
	(0.01)	(0.02)	(0.02)	(0.01)
N	43.902	43.902	43902	43902
LR chi2(22)	3301	5013	4311	5516

A full set of demographic and socioeconomic variables were included in each regression but are not shown
Standard errors are in parentheses
** indicates significance at the 5% level and *** indicates significance at the 1% level or smaller

are found to be more likely than others to use the Internet to search for job information.

On a positive note, these results show that there are many online activities that people with disabilities are now just as likely to participate in as those without disabilities. However, these results also indicate that PWD still lag behind others in about half of the online activities that people participate in on a regular basis. These include lagging behind in activities that help connect people connect such as through texting, instant messaging, and E-mailing. It also includes activities such as shopping and banking online that would provide relief to many with disabilities.

4.3 Health

The Internet has become a resource where many individuals find health-related information or connect with their medical providers. This can help people get their health questions answered quickly and educate them on treatments or new assistive devices without the need to physically visit

Table 6 Probit regressions for privacy concerns online

	(1) Shopping	(2) Banking	(3) Social media	(4) Opinion	(5) ID theft	(6) CC fraud
Deaf/hard of hearing	− 0.003	0.014	− 0.005	− 0.01	− 0.005	0.009
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Blind/visually impaired	0.054*	0.01	0.04	0.04	0.02	0.05
	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
Physical disability	0.042***	0.043**	0.001	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
PME disability	0.031*	0.01	0.048**	0.034*	0.02	0.02
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
Multiple disabilities	0.055***	0.049***	0.024*	0.01	− 0.003	0.039**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
N	43.902	43.902	43.902	43.902	43.902	43.902
LR chi2(22)	328	651	519	702	880	733

A full set of demographic and socioeconomic variables were included in each regression but are not shown

Standard errors are in parentheses

** indicates significance at the 5% level and *** indicates significance at the 1% level or smaller

Table 7 Probit regressions for privacy concerns online

	(1) Website tracking	(2) Gov't tracking	(3) Getting hacked	(4) Getting bullying	(5) Been hacked	(6) Been bullied
Deaf/hard of hearing	0.01	(0.01)	(0.01)	0.01	(0.01)	0.01
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Blind/visually impaired	0.088**	0.060*	0.05	0.056*	0.04	0.01
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.01)
Physical disability	0.032*	0.027*	0.02	0.022*	0.033*	0.025***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
PME disability	0.046**	0.058***	0.03	0.042**	0.038*	0.028**
	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)
Multiple disabilities	0.035**	0.031**	0.02	0.025*	0.056***	0.025***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
N	43.902	43.902	43.902	43.902	43.902	43.902
LR chi2(22)	651	365	452	205	2,119	297

A full set of demographic and socioeconomic variables were included in each regression but are not shown

Standard errors are in parentheses

** indicates significance at the 5% level and *** indicates significance at the 1% level or smaller

the doctor's office. The likelihood that someone uses the Internet for these types of activities is presented in Table 5. The dependent variables of interest include whether someone uses the Internet to (1) contact their doctor or health professional, (2) access health records or health insurance records, (3) research health information, or (4) participate in any health-related activities online. Column 1 indicates that people with all types of disability, except the visually impaired, are more likely to use the Internet to contact a health professional than those without a disability. Also, those with a PME disability and those with multiple disabilities are more likely to participate in each of the online health-related activities tested.

The ability to engage in health-related activities online can be especially important for those with a disability since they may find it difficult to visit their doctor's office on a regular basis. It is encouraging to see that PWD do not lag behind others in any of the health-related categories tested and in fact significantly outpaced those with no disability in several areas. This is an area that must continue to evolve to meet the needs of this group since

the benefits to individuals and society would be very large (Table 6).

4.4 Privacy concerns

One possible explanation for why the digital divide may persist in certain areas relates to security concerns among the disabled. Previous research has shown that PWD have been late adopters of ICTs. This can lead to greater levels of concerns about the safety of modern technologies compared to those who have used these technologies for longer. This can especially become a barrier if there is a fear that one's health information will become public and lead to bullying, tracking, or targeting by scammers. These concerns are explored in Table 7. The dependent variables of interest here relate to a survey question about what the respondents greatest concerns were when it comes to online privacy and security: (1) data collection or tracking by websites, (2) data collection or tracking by the government, (3) being hacked and losing control over personal data, or (4) online harassment, stalking, or cyberbullying. The final two columns deal with experiences the respondent may have already had over the last year including (5) having been hacked or had their identity stolen and (6) having been harassed, stalked, or cyberbullied.

The results in Table 7 indicate that PWD are not more likely to fear being hacked but that all groups, except for the hearing impaired, are concerned about being tracked by firms and the government and have a fear of being bullied.[2] There is some evidence that those with disabilities have experienced a security breach in the last year, especially among those with multiple disabilities. The most concerning result, however, is found in column 6 where we find that within the last year the physically and PME impaired along with those with multiple disabilities have been significantly more likely than others to have experienced online bullying. This finding can help explain why some PWD may not find it rewarding to engage in too many activities online, especially if it becomes a source of undue stress and anxiety.

5 Discussion

The spread of coronavirus (COVID-19) forced people into a greater reliance on information and communication technologies (ICTs). This has taken the form of an increase in the level of telecommuting, online education, online grocery shopping, and even families and friends communicating by video in order to contain the spread of the virus. This shift to a more online environment forces us to explore what groups may end up being left behind and to consider what can be done to insure everyone can have full access to ICTs. People with disabilities (PWD) have historically been slow to adopt ICTs and therefore have been unable to fully reap the benefits that they offer. Our findings indicate that the technology gap between PWD and those without a disability continues to persist for many people. We find that people with physical and PME disabilities along with those with multiple disabilities are less likely to own a computer than those with no disability. We also find that people with PME disabilities and those with multiple disabilities are less likely to access the Internet from home than those with no disability.

Focusing only on people who have access to the Internet, we find that among this group PWD are less likely than others to participate in many online activities. Areas where PWD lag include using the Internet for E-mail, texting/instant messaging, shopping, hiring services, and banking/finance. Many of these are activities that could benefit the everyday lives of PWD if they fully embraced and participated in them. One potential explanation we find for this gap in usage relates to confidentiality concerns regarding the Internet. We find that PWD have concerns about being tracked online and being bullied and find that many have already experienced cyberbullying within the last year.

We also find many positive results for PWD regarding their use of ICTs. The results indicate that those with hearing and visual impairments are just as likely as others to own a computer and to connect to the Internet. We find that PWD are equally likely as those without a disability to use social media, telecommute for work, create online content, provide goods and services for sales online, and to search for job information. We also find the PWD are often more likely than others to contact their health professionals online, and that those with PME impairments and multiple disabilities are more likely to engage in numerous online health activities than those without a disability. This is a positive sign that there has been progress in closing the disability digital divide, but we see there is still more that can be done.

Further research is still needed on this topic with an emphasis given to creating a dataset that is more tailored to the questions specifically impacting PWD. The CPS dataset used in this study is large, asks numerous questions regarding online activities, and separates people with disability by their disability type. However, this data does not have a good measure for experience using the Internet, does not have any information regarding whether individuals are using assistive technologies to access the Internet, and does not ask how their disability impacts their ability to use ICTs. Including these types of variables in an empirical analysis creates more meaningful results and better guides future policy. There is also a need for continued work on the third-level digital divide that focuses on how access to ICTs and using the Internet impacts life outcomes. This is a difficult

[2] Note that many of these were only significant at the 10% level.

concept to measure and is not possible with the current data within the CPS.

One clear implication of this study is that additional resources dedicated to getting PWD to access computers and connect to the Internet would result in gains for this disadvantaged group. There are already organizations such as PCs for People, Internet Essentials, National Cristina Foundation, and Everyone On that focus on getting people with low-income access to these ICTs. Fiscal support of these types of organizations can help bridge the divide that still exists. The COVID-19 pandemic showed us that lagging behind in the digital world is amplified when people are forced to stay at home and that waiting to enact policies to bridge this divide is not a viable option.

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