



Original Article/Research

The impact of digital competence on telehealth utilization

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ABSTRACT

Objectives: Telehealth use has increased steadily since the mid-2000's when technology shifted from voice-only systems to live video-conferencing and other technologies supported by broadband Internet. More recently, the COVID-19 pandemic has resulted in exponential growth in telehealth use. As telehealth systems become increasingly complex and gain widespread adoption, this study explores how users' digital competences affect telehealth use.

Methods: We apply a series of multivariate logit models to a representative sample of California adults with Internet access surveyed in early 2021. We estimate the impact of self-reported digital competence—using items from the digital skills assessment scale—on a participant's likelihood of telehealth use during the COVID-19 pandemic as well as the likelihood to continue using telehealth beyond the pandemic.

Results: The findings show that a one-unit increase in digital competence is associated with 72.8% greater odds of telehealth use ($p < 0.001$) and 71.6% greater odds of willingness to continue using telehealth services beyond the pandemic ($p < .01$). We also found that greater social and economic capital generally were associated with increased odds of telehealth use.

Conclusions: Improving access to telehealth will require solutions addressing both the first level (i.e., access to broadband and devices) and the second level (i.e., skills and attitudes towards the internet) of digital inequality. Policies and programs seeking to expand internet access must be coupled with investments in digital upskilling and training. Those with limited digital competence will face continued barriers in navigating telehealth systems, further exacerbating disparities in healthcare access and outcomes.

Public Interest Summary: Digital competence is the ability and confidence to apply one's knowledge and skills to perform tasks through information technology, including computing devices and the internet. This study explores the relationship between digital competence and telehealth use among those with broadband internet access at home. Telehealth has become increasingly common due to its cost-effectiveness and accessibility for patients unable to visit healthcare facilities. Though the COVID-19 pandemic has contributed to a significant increase in telehealth use, it is expected that telehealth services will continue to expand after the pandemic subsides. In our analysis of California adults, a year into the pandemic, we find those with greater digital competence are more likely to have used telehealth during the pandemic. Further, among telehealth users, those with greater digital competence are more likely to continue using telehealth beyond the pandemic. Addressing disparities in healthcare access and outcomes will require improving potential users' digital competence.

Introduction

Telehealth use has increased steadily since the mid-2000's when technology shifted from voice-only systems to live video-conferencing and other technologies supported by broadband Internet. More recently, the COVID-19 pandemic has resulted in exponential growth in the availability and adoption of telehealth services, offering both

providers and patients a safer and more convenient alternative to traditional in-person care. Pre-pandemic, telehealth was by and large promoted either as a cost-saving alternative for non-emergency and non-surgical medical appointments, or as an alternative for patients who either faced mobility barriers—either bodily or transportation—or that lived in areas with limited healthcare infrastructure [1]. Much like in the case of remote work and remote learning, the pandemic demonstrated

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that the benefits of telehealth go well beyond cost savings or increased access for patients located far from healthcare facilities. The mainstreaming of telehealth holds the potential to significantly improve healthcare delivery even after the pandemic subsides.

The digital divide has been identified in previous studies as an important social determinant of health [2]. While telehealth has been shown to have comparable health outcomes in terms of patient-physician communication and patient satisfaction and engagement, differences in digital access and use exacerbate the socioeconomic factors that create barriers to healthcare. Such issues as unreliable internet connectivity and a lack of video chat/webcam capabilities can hinder the effectiveness of telehealth to its full capability, especially among communities of color, the poor, and medically underserved [3].

The benefits of telehealth are premised on a number of factors, including access to computing devices capable of supporting remote delivery of health services as well as access to the connectivity infrastructure capable of supporting the increasing data requirements of telehealth applications. Though computer and broadband access have grown in recent years, the evidence underscores how the digital divide continues to limit the availability of telehealth to those most in need [4]. The extant literature examining the relationships between the digital divide and telehealth focuses on computer and Internet access, however less attention has been paid to the digital competence required for effective telehealth use, which range from basic computer skills to more complex tasks such as uploading results from self-monitoring devices or protecting personal health data. Existing empirical work on digital competence and telehealth primarily looks at populations in Europe [5, 6]. Of the studies in North America, a primary focus has been on health providers' digital competence [7,8], and of those exploring patients and the wider population, the vast majority rely on anecdotal evidence, case studies, and meta-analyses of eHealth interventions without measures of users' digital competence in their design [9]. As the U.S. invests more resources in bridging the digital divide and improving access to telehealth programs, more work is needed to understand how digital competence moderates telehealth use in the country. We argue that without proper skills training and development, providing access to computing devices and the Internet may be ineffective in promoting telehealth use, particularly among vulnerable populations with low levels of digital competence.

In this study, we explore the link between digital competence and telehealth use among a representative sample of California adults during the COVID-19 pandemic. To disentangle the effect of digital competence from other factors, we limit the sample to respondents who have residential (fixed) internet access, and thus can potentially access telehealth services. Our analysis excludes those with mobile broadband access because of the limited capabilities offered by existing mobile services and devices [10]. This study explicitly addresses the co-occurring challenges of broadband access and digital literacy. Addressing the complex interplay between broadband access and the skills to utilize broadband telehealth services is vital to support policy development that can support the deployment of telehealth on an equitable basis.

The critical role of telehealth during the COVID-19 pandemic

The World Health Organization (WHO) defines telehealth as “the delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities” [11]. Telehealth has the capability to incorporate several organizations and situations of health care into one virtual network. This network can bridge physical distances as well as different modes of practice (e.g., prevention centers, private clinics, private offices of physicians, and hospitals) [12].

Prior to the COVID-19 pandemic, telehealth services were projected

to grow on the basis of: continued innovation in the consumer technology market; advancements in electronic health records and clinical decision making; projected shortages in the healthcare workforce; reorganization in the delivery and financing of medical care; and the growth of consumerism in health care [13].

Due to the unprecedented need for healthcare and challenges in delivering in-person care, the use of telehealth services had an exponential surge during the COVID-19 pandemic. A 2021 report by the Office of Health Policy under the Assistant Secretary for Planning and Evaluation (ASPE) found a 63-fold increase in telehealth visits among Medicare patients, from about 840,000 in 2019 to nearly 52.7 million in 2020 [14]. Telehealth has been used broadly in the context of the COVID-19 pandemic as an aid to the active management of patients with COVID-19; for surveillance, triage, and diagnosis, treatment including e-prescriptions, follow-up care, and rehabilitation [15]. Additionally, through telehealth, healthcare workers and clinicians with mild symptoms could safely work with patients, facilitate quick access to medical decision making, seek second opinion for severe medical cases, exchange cross-border experiences, and offer teleradiology and online training for healthcare workers [12].

Telehealth use has proven vital for reducing morbidity and mortality during the pandemic. In a cross-sectional study of US counties, Lin et al. [16] found that COVID-19 mortality rates were higher in counties with lower levels of broadband adoption even after controlling for other social determinants of health. The authors estimate that a 1% increase in the share of residents without Internet in a county is associated with an increase of between 2.4 and 6 COVID deaths per 100,000.

Differential levels of the digital divide

Access to telehealth and other online services, such as remote learning, is part of a broader discussion about the “digital divide” that can be assessed on multiple levels. Initially, studies about the digital divide revolved mainly around issues of access to the internet and computing devices [17]. There is a vast literature on the determinants of access to broadband and devices, which is commonly referred to as the first level of the digital divide. The findings point to income, age, employment, language, and other individual factors that determine opportunities and incentives for adoption [18]. There is also a vast literature that emphasizes differences in broadband availability, and the persistence of race as a critical determinant of investments in basic public infrastructure, including transportation, health facilities, and now broadband networks [19,20].

Scholars later turned attention to the second level of the digital divide, which emphasizes differences in skills and attitudes toward the internet. In critique of a singular and binary focus on internet access, Hargittai [21] noted that a distinction should be made between an internet access divide and a skills divide, the latter indicating differences between groups of people in terms of the skills necessary to effectively use the internet. This critique also departed from the idea that access to technology would automatically result in benefits to users. Further, van Deursen et al. [22] distinguish between different types of digital skills such as ‘operational skills’ (the basic skills needed to use the internet), ‘information navigation skills’ (the ability to find, select, and evaluate sources of information on the internet), ‘social skills’ (the ability to use online communication and interactions to understand and exchange meaning and acquire social capital), and ‘creative skills’ (needed to create different types of quality content and to publish or share this with others).

The third level of the digital divide investigates variations in outcomes related to internet access and use [23]. Literature on the third level of digital inequality expands beyond internet access and digital skills to explore measurable changes in wellbeing—such as better employment, increased educational opportunities, and better health outcomes—that trace back to internet-related activities. Overall, research points to complex interconnections between the three levels of the

Table 1
Digital competency survey items: Eigenvalue and factor loading scores.

Survey prompt: "Now I will read a list of things that people sometimes use the Internet for. For each item, please tell me whether you would be very comfortable, somewhat comfortable, or not comfortable at all doing this task, or whether you just do not understand what the task is about:"	Eigenvalue	Factor Loading Score
1. Connecting a computer or smartphone to a Wi-Fi network	5.065	0.817
2. Sending an email with an attached image or document		0.862
3. Finding information online about jobs or healthcare		0.840
4. Paying bills online		0.799
5. Making an appointment, for example, with the DMV		0.746
6. Downloading and installing a new app on your smartphone or tablet		0.832
7. Deleting cookies on a web browser		0.758
8. Setting up safeguards against phishing and spam email		0.700

Note: In measuring scale reliability, this factor score has a Cronbach alpha coefficient of 0.9266; the factor score has a minimum value of -2.934 and maximum value of .7624.

digital divide [24], suggesting that digital competence is critical to realize the potential benefits of digital access [25].

As previously noted, telehealth became a vital public health tool during the COVID-19 pandemic. Although the potential benefits of telehealth are clear, much less is known about potential disparities arising from its rapid expansion. With pre-pandemic telehealth use, there were disparities along several dimensions of socioeconomic status and human capital [26]. With the exponential increase in telehealth services and growing access to broadband, there is a need to evaluate the impact of digital competence on telehealth utilization. This study seeks to fill that gap by exploring the impact of second-level digital divide constructs on the utilization of telehealth during the COVID-19-driven telehealth expansion.

Methods

Population of study

Our data comes from a telephone survey representative of California adults (ages 18 and older) administered in February and March of 2021. Participants were asked a series of questions about their digital connectivity and experiences with telework, telehealth, and remote learning. Participants were sampled through random-digit dialing (RDD) of cellphones (94%) and landlines (6%) listed in California. Surveys were conducted in either English, Spanish, Mandarin, or Vietnamese. The full sample consisted of 1650 participants, 86.9% of whom are digitally connected, 7.7% unconnected, and 5.4% underconnected (mobile access only). We narrowed the sample to 1130 participants based on those who have residential (fixed) Internet access and responded fully to our digital competence survey items and other indicators included in our multivariate statistical models. Among the connected (*i.e.*, our population of interest), 6.5% did not respond to all survey items measuring digital competence. In examining these non-responders, nearly half are men (49.4%), a slight majority do not live in low-income households (51.8%), more than a third are Latinx (39.0%), nearly a third are non-Hispanic white (30.5%), and a plurality have less than some college education (48.8%).

Design

Through a series of statistical models, we estimated the impact of digital competence on a participant's likelihood of telehealth use during the COVID-19 pandemic. Our measure of telehealth excludes consultations over the phone using audio only, as we seek to capture the full

potential of telehealth services that use both audio and video over a broadband connection.

To measure digital competence, we adapted the digital skills assessment scale developed by van Deursen et al. [27]. The original scale consists of 32 items that capture operational, information navigation, creative, and social digital skills. Prior work on digital competence have validated shortened versions of this original digital skills scale [28]; given the purposes of the study, we use the eight operational items that are most relevant to effective telehealth use. Each item uses a 4-point Likert scale ranging from "very comfortable" performing this digital task to "not comfortable at all." We further validate the survey items using factor analysis and Cronbach's Alpha to measure reliability. A full list of the items can be found in Table 1.

Statistical analysis

We first applied factor analysis on the full set of digital skills items (see Table 1) to produce a factor score estimating a latent measure of digital competence. This composite variable is subsequently included in a multivariate model that estimates the relationship between digital competence and the propensity for telehealth use. Though factor scores are a more refined and exact method for measuring a latent variable than summing scores [29], we test the relationship between digital competence and telehealth use using the average score across survey items as a robustness check.

Exploratory statistics and relationships are estimated through univariate and bivariate analyses. However, we rely on multivariate logit models as our primary methodological approach to estimate the relationship between digital competence and telehealth use. In our multivariate models, to account for confounding differences in telehealth use and digital competence associated with sociodemographic characteristics, we controlled for educational attainment, age, disability status, household income status, gender, race/ethnicity, and employment status. To broadly control for location-specific characteristics, such as access to hospitals and healthcare centers, we controlled for whether the county that the respondent lives in is considered metropolitan or non-metropolitan by the U.S. Department of Agriculture's (USDA) classification. The USDA's classification is based on population size and proximity. Hospitals, healthcare centers, and primary care providers in more rural areas may be lagging in their infrastructure and integration of telehealth services relative to more urban metropolitan regions [30]; however, differences in telehealth use could also relate to differences in awareness about telehealth options between rural and urban residents [31].

There are other confounding factors that may shape an adult's comfort level in using the internet and their likelihood to engage in telehealth. We controlled for whether at least one child under the age of 18 is present in the household and whether the respondent is working or attending classes virtually/remotely. Children, who typically have greater exposure and learning experiences with digital devices, have been shown to be effective in helping parents without the digital competence to navigate digital platforms like telehealth, particularly in low-income, less educated, and immigrant households [32,33].

Working and taking classes remotely may also expose adults to new digital tools and build their digital competence [34]. During the COVID-19 pandemic, non-essential workers and students were forced to work and learn remotely, increasing their exposure and use of digital technology, particularly communication tools (*e.g.*, video conferencing). Hauret and Martin [34] find that 30% of their sample report digital upskilling during the pandemic-induced lockdown, with teleworkers with "high extensive use" of digital tools reporting the greatest improvement in digital skills. We controlled for whether participants had experience working or learning remotely during the pandemic to account for possible digital upskilling due to teleworking or telelearning that is not captured in their self-reported digital competence.

Survey weights are applied to adjust results for age, gender, race/

Table 2
Descriptive statistics.

	Telehealth Use since Pandemic				Future Telehealth Use			
	Nonuser	User	Total	%	No	Yes	Total	%
Observations	703	427	1130	100%	234	365	599	100%
Digital Competency Factor Score								
Median	0.46	0.57	0.53	-	0.07	0.37	0.25	-
Standard Deviation	0.83	0.55	0.75	-	0.74	0.63	0.69	-
Digital Competency Average Score								
Median	2.75	2.86	2.75	-	2.4	2.64	2.54	-
Standard Deviation	0.68	0.47	0.62	-	0.62	0.53	0.58	-
Remote Work or Class								
No	324	168	492	43.54%	114	138	252	42.07%
Yes	379	259	638	56.46%	120	227	347	57.93%
Educational Attainment								
Less than High School	64	15	79	6.99%	15	21	36	6.01%
High School	152	54	206	18.23%	35	62	97	16.19%
Some College	208	131	339	30.00%	82	97	179	29.88%
Bachelor's Degree	159	128	287	25.40%	62	98	160	26.71%
Post-Graduate Degree	120	99	219	19.38%	40	87	127	21.20%
Gender								
Men	390	177	567	50.18%	97	158	255	42.57%
Women	313	250	563	49.82%	137	207	344	57.43%
Race/Ethnicity								
Non-Hispanic White	287	237	524	46.37%	110	208	318	53.09%
Hispanic/Latinx	233	92	325	28.76%	66	83	149	24.87%
Black	25	24	49	4.34%	18	11	29	4.84%
Asian	107	39	146	12.92%	26	35	61	10.18%
Native Hawaiian or Pacific Islander	7	1	8	0.71%	0	0	0	0.00%
Native American or Alaskan Native	9	5	14	1.24%	4	4	8	1.34%
Other/Mixed	35	29	64	5.66%	10	24	34	5.68%
Age (Years)								
Median	44	49	46	-	51	48	49	-
Standard Deviation	17.17	16.91	17.18	-	16.91	16.92	16.98	-
Low-Income								
No	415	310	725	64.16%	145	262	407	67.95%
Yes	257	98	355	31.42%	75	90	165	27.55%
Refused/Don't Know	31	19	50	4.42%	14	13	27	4.51%
Child(ren) Present in HH								
No	438	264	702	62.12%	142	231	373	62.27%
Yes	265	163	428	37.88%	92	134	226	37.73%
Employed								
No	279	181	460	40.71%	112	158	270	45.08%
Yes	424	246	670	59.29%	122	207	329	54.92%
Disabled								
No	630	362	992	87.79%	192	312	504	84.14%
Yes	73	65	138	12.21%	42	53	95	15.86%
Lives in Metro								
No	52	23	75	6.64%	14	25	39	6.51%
Yes	651	404	1055	93.36%	220	340	560	93.49%

ethnicity, education, and region based on the 2019 American Community Survey data for California.

Results

As shown in Table 2, approximately 37.8% of our sample report having used telehealth since the start of the COVID-19 pandemic. Those who used telehealth have higher medians and lower standard deviations in their digital competence scores than those who did not use telehealth. Compared to nonusers, telehealth users are more likely to have experience with remote work or classes and to have a college degree. Demographically, telehealth users are also more likely to be women, non-Hispanic white, older, and not low-income. Relative to nonusers, telehealth users are also more likely to be unemployed, to have a disability, and to live in a metro area.

Among telehealth users, 60.9% report that they would likely continue to use telehealth beyond the COVID-19 pandemic. This group of future telehealth users has higher medians and lower standard deviations in their digital competence scores relative to those who indicated that they would not continue to use telehealth. Future users are more likely to have experience with remote work or classes and to have a college degree. They are also more likely to be women, non-Hispanic

white, younger, and not low-income than future nonusers, while also more likely to be employed, not disabled, and to live in a non-metro area.

Table 3 summarizes the bivariate relationships between the variables of interest. The results indicate that greater digital competence, experience with remote work or classes, at least some college education, and having a disability are associated with higher propensity to use telehealth. Further, low-income respondents are less likely to use telehealth than wealthier respondents. Latinx and Asian participants are shown to have lower odds of using telehealth than white participants, whereas other racial/ethnic groups show no statistical relationship with telehealth use. Among telehealth users, greater digital competence and experience with remote work or class are associated with greater odds of self-reporting future telehealth use. As the bivariate analyses overlook confounding factors that may influence telehealth outcomes, we turn to our multivariate models to isolate the relationship between digital competence and telehealth use.

Overall, as shown in Table 4, we found that digital competence was statistically and positively associated with the likelihood of telehealth use since the start of the COVID-19 pandemic. This result holds using either factor scores (Model 1) or average scores (Model 2) to measure digital competence. Model 1 shows that, *ceteris paribus*, a one-unit

Table 3
Univariate analysis of telehealth use and self-reported future telehealth use.

	(1) Telehealth Use during Pandemic			(2) Self-Reported Future Telehealth Use		
	Odds Ratio	Standard Error	95% Interval	Odds Ratio	Standard Error	95% Interval
Digital Competence Factor Score	1.617***	(0.159)	[1.334,1.959]	1.687***	(0.236)	[1.282,2.221]
Digital Competence Average Score	1.720***	(0.196)	[1.375,2.151]	1.915***	(0.318)	[1.382,2.652]
Remote Work or Class (yes=1)	1.313*	(0.171)	[1.016,1.696]	1.542*	(0.274)	[1.087,2.187]
Child(ren) in HH (yes=1)	1.002	(0.131)	[0.775,1.295]	0.811	(0.145)	[0.571,1.153]
<i>Education (reference: less than high school)</i>						
High School Graduate	1.498	(0.499)	[0.779,2.884]	1.360	(0.558)	[0.608,3.044]
Some College	2.165**	(0.817)	[1.417,4.825]	0.930	(0.353)	[0.441,1.958]
Bachelor's Degree	3.379***	(1.065)	[1.821,6.272]	1.166	(0.449)	[0.547,2.483]
Post-Graduate Degree	3.491***	(1.126)	[1.854,6.575]	1.589	(0.634)	[0.726,3.478]
Age	1.037 [†]	(0.022)	[0.995,1.081]	0.980	(0.030)	[0.923,1.041]
Age (Squared)	0.999	(0.000)	[0.999,1.000]	1.000	(0.000)	[0.999,1.001]
Low-Income HH (yes=1)	0.498***	(0.072)	[0.374,0.662]	0.730	(0.142)	[0.498,1.071]
Woman/Female (yes=1)	1.970	(0.252)	[1.533,2.531]	0.817	(0.143)	[0.580,1.151]
<i>Race/Ethnicity (reference: non-Hispanic white)</i>						
Latinx	0.478***	(0.075)	[0.352,0.650]	0.754	(0.159)	[0.499,1.140]
Black	1.037	(0.317)	[0.569,1.889]	0.389*	(0.159)	[0.174,0.866]
Asian	0.431***	(0.091)	[0.284,0.652]	0.792	(0.233)	[0.444,1.410]
Hawaiian or Pacific Islander	0.162 [†]	(0.174)	[0.020,1.330]	1.000	(.)	[1.000,1.000]
American Indian or Alaskan Native	0.927	(0.540)	[0.295,2.907]	0.520	(0.389)	[0.120,2.261]
Other/Mixed	1.031	(0.284)	[0.600,1.772]	1.514	(0.619)	[0.678,3.381]
Employed (yes=1)	0.898	(0.117)	[0.696,1.158]	1.179	(0.207)	[0.835,1.666]
Disabled (yes=1)	1.519**	(0.292)	[1.042,2.214]	0.848	(0.201)	[0.533,1.351]
Lives in Metro Area (yes=1)	1.361	(0.366)	[0.803,2.307]	0.723	(0.263)	[0.353,1.479]
Observations	1130			599		

Coefficient in odds ratio; Standard errors in parentheses; 95% confidence intervals in brackets.

- [†] $p < .1$
- * $p < .05$
- ** $p < .01$
- *** $p < .001$

Table 4
Telehealth use since the start of the COVID-19 pandemic.

	(Model 1) Digital Competence Factor Score			(Model 2) Digital Competence Average Score		
	Odds Ratio	Standard Error	95% Interval	Odds Ratio	Standard Error	95% Interval
Digital Competence	1.728***	(0.242)	[1.313,2.275]	1.864***	(0.305)	[1.351,2.571]
Remote Work or Class (vs. not remote)	1.356 [†]	(0.236)	[0.964,1.908]	1.357 [†]	(0.237)	[0.964,1.910]
Child(ren) in HH (vs. no children)	1.507**	(0.232)	[1.114,2.037]	1.507**	(0.232)	[1.114,2.039]
<i>Education (compared to less than high school)</i>						
High School Graduate	1.103	(0.398)	[0.544,2.237]	1.134	(0.408)	[0.560,2.296]
Some College	1.450	(0.500)	[0.737,2.853]	1.511	(0.520)	[0.770,2.968]
Bachelor's Degree	1.718	(0.630)	[0.837,3.526]	1.799	(0.658)	[0.878,3.686]
Post-Graduate Degree	1.445	(0.554)	[0.681,3.065]	1.515	(0.579)	[0.716,3.209]
Age	1.039	(0.025)	[0.991,1.090]	1.040	(0.025)	[0.992,1.091]
Age (Squared)	1.000	(0.000)	[0.999,1.000]	1.000	(0.000)	[0.999,1.000]
Low-Income HH (vs. not low-income)	0.644*	(0.122)	[0.444,0.933]	0.642*	(0.121)	[0.443,0.930]
Woman/Female (vs. man/male)	2.099***	(0.288)	[1.603,2.749]	2.120***	(0.292)	[1.618,2.777]
<i>Race/Ethnicity (compared to non-Hispanic white)</i>						
Latinx	0.734 [†]	(0.135)	[0.512,1.053]	0.732 [†]	(0.134)	[0.510,1.050]
Black	1.211	(0.385)	[0.649,2.259]	1.192	(0.380)	[0.638,2.228]
Asian	0.496**	(0.113)	[0.317,0.776]	0.492**	(0.112)	[0.315,0.770]
Hawaiian or Pacific Islander	0.243	(0.295)	[0.023,2.620]	0.245	(0.298)	[0.023,2.659]
American Indian or Alaskan Native	1.226	(0.733)	[0.380,3.961]	1.249	(0.746)	[0.387,4.029]
Other/Mixed	1.260	(0.341)	[0.741,2.142]	1.258	(0.340)	[0.740,2.137]
Employed (vs. not employed)	0.653*	(0.118)	[0.458,0.932]	0.651*	(0.118)	[0.457,0.929]
Disabled (vs. not disabled)	1.813*	(0.430)	[1.138,2.888]	1.800*	(0.426)	[1.131,2.863]
Lives in Metro Area (vs. not in Metro)	1.584	(0.499)	[0.854,2.938]	1.582	(0.498)	[0.853,2.935]
Observations	1130			1130		

Coefficients in odds ratio; Standard errors in parentheses; 95% confidence intervals in brackets.

- [†] $p < .1$
- * $p < .05$
- ** $p < .01$
- *** $p < .001$

increase in the digital competence factor score is associated with 72.8% greater odds of telehealth use. The results from Model 2 are nearly identical: a one-point increase in the digital competence scale is associated with 86.4% greater odds of telehealth use, all else equal. Figs. 1

and 2 show the marginal effects of increasing digital competence and the positive association with increased odds of telehealth use during the pandemic.

As expected, we also found that greater social and economic capital

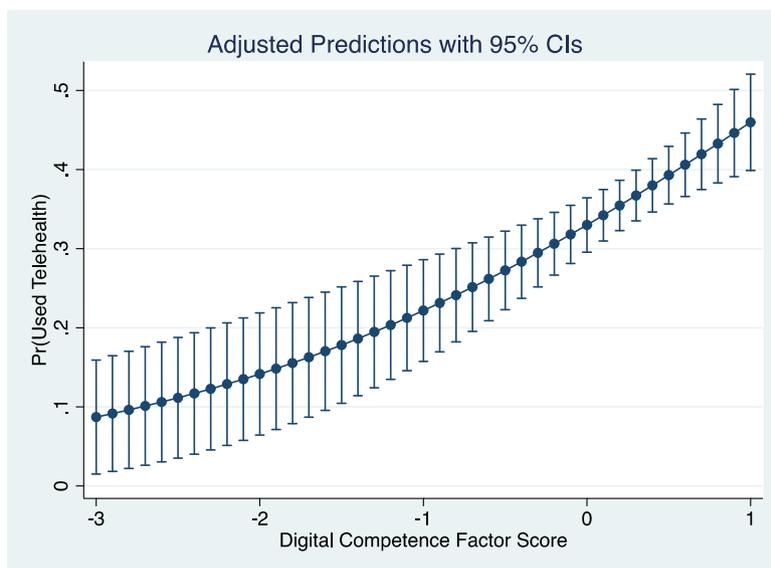


Fig. 1. Marginal effects of digital competence (factor score) on odds of telehealth use during COVID-19 pandemic.

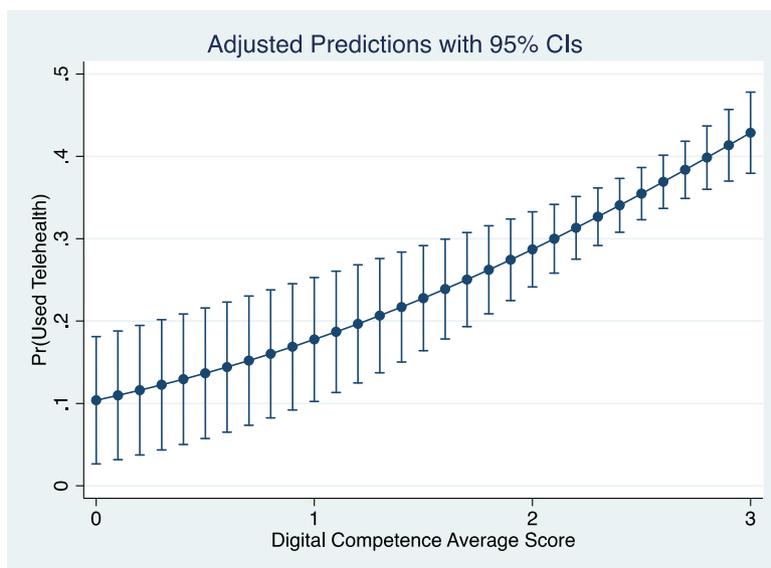


Fig. 2. Marginal effects of digital competence (average score) on odds of telehealth use during COVID-19 pandemic.

generally were associated with increased odds of telehealth use. The results show that adults with at least one child under 18 years old in the household have 50.7% greater odds of having engaged in telehealth, all else equal. Adults in low-income households (adjusted for household size) have 35.6% lower odds of using telehealth during the pandemic relative to wealthier households.

Regarding demographic differences, women have more than twice the odds of engaging in telehealth than men. Compared to white respondents, Asian Americans have 50.4% lower odds of using telehealth, all else equal, while there are no statistical differences for other racial/ethnic groups. Those who reported a disability have 81.3% greater odds of using telehealth than their non-disabled counterparts, all else equal, which likely reflects differences in underlying health conditions requiring medical attention.

We do not find a statistically significant difference between people living in a metropolitan area compared to those living outside metro areas. This may reflect the leveling effect of the restrictions imposed on in-person visits to health facilities during the pandemic. In contrast to results from the bivariate analyses, we do not find a statistical

relationship between telehealth use and education, nor age, which are typical predictors of telehealth use [5,6].

We further explored whether those that used telehealth during the pandemic are likely to continue once in-person health services resume. In effect, this serves as an indirect measure of satisfaction with telehealth services. As shown in Table 5, Model 3 and Model 4 indicate that digital competence is also a significant predictor of future telehealth use. More specifically, drawing from Model 3, a one-unit increase in the digital competence factor score is associated with 71.6% greater odds of future telehealth use, all else equal. Similarly, Model 4 shows that a one-point increase in the average digital skills scale nearly doubles the odds of future telehealth use. Figs. 3 and 4 show the marginal effect of increasing digital competence and the positive association with increased odds of continuing telehealth after the pandemic.

Discussion and policy implications

This study explored how disparities in telehealth use are exacerbated by individual differences in digital competence, with particular

Table 5
Odds ratio of self-reported future telehealth use.

	(Model 3) Digital Competence Factor Score			(Model 4) Digital Competence Average Score		
	Odds Ratio	Standard Error	95% Interval	Odds Ratio	Standard Error	95% Interval
Digital Competence	1.716**	(0.310)	[1.204,2.446]	1.938**	(0.411)	[1.278,2.938]
Remote Work or Class (vs. not remote)	1.280	(0.311)	[0.794,2.062]	1.272	(0.310)	[0.788,2.052]
Child(ren) in HH (vs. no children)	0.694 [†]	(0.146)	[0.460,1.048]	0.696 [†]	(0.146)	[0.460,1.051]
<i>Education (compared to less than high school)</i>						
High School Graduate	0.698	(0.334)	[0.273,1.786]	0.704	(0.336)	[0.275,1.798]
Some College	0.389*	(0.184)	[0.153,0.985]	0.394*	(0.185)	[0.157,0.992]
Bachelor's Degree	0.409 [†]	(0.209)	[0.149,1.117]	0.415 [†]	(0.211)	[0.153,1.127]
Post-Graduate Degree	0.552	(0.291)	[0.196,1.555]	0.560	(0.293)	[0.200,1.566]
Age	1.004	(0.037)	[0.934,1.078]	1.004	(0.037)	[0.935,1.079]
Age (Squared)	1.000	(0.000)	[0.999,1.001]	1.000	(0.000)	[0.999,1.001]
Low-Income HH (vs. not low-income)	0.877	(0.231)	[0.523,1.471]	0.878	(0.231)	[0.523,1.474]
Woman/Female (vs. man/male)	0.877	(0.164)	[0.608,1.266]	0.892	(0.167)	[0.618,1.289]
<i>Race/Ethnicity (compared to non-Hispanic white)</i>						
Latinx	0.798	(0.195)	[0.493,1.290]	0.799	(0.196)	[0.494,1.292]
Black	0.359*	(0.156)	[0.153,0.845]	0.356*	(0.155)	[0.151,0.839]
Asian	0.858	(0.289)	[0.443,1.662]	0.861	(0.291)	[0.443,1.672]
Hawaiian or Pacific Islander	1.000	(.)	[1.000,1.000]	1.000	(.)	[1.000,1.000]
American Indian or Alaskan Native	0.447	(0.370)	[0.088,2.270]	0.454	(0.370)	[0.091,2.254]
Other/Mixed	1.414	(0.555)	[0.654,3.058]	1.393	(0.549)	[0.643,3.019]
Employed (vs. not employed)	0.769	(0.176)	[0.490,1.206]	0.767	(0.176)	[0.489,1.203]
Disabled (vs. not disabled)	1.074	(0.297)	[0.624,1.849]	1.074	(0.297)	[0.625,1.848]
Lives in Metro Area (vs. not in Metro)	0.771	(0.281)	[0.376,1.578]	0.771	(0.282)	[0.376,1.580]
Observations	599			599		

Coefficients in odds ratio; Standard errors in parentheses; 95% confidence intervals in brackets.

*** $p < .001$
[†] $p < .1$
 * $p < .05$
 ** $p < .01$

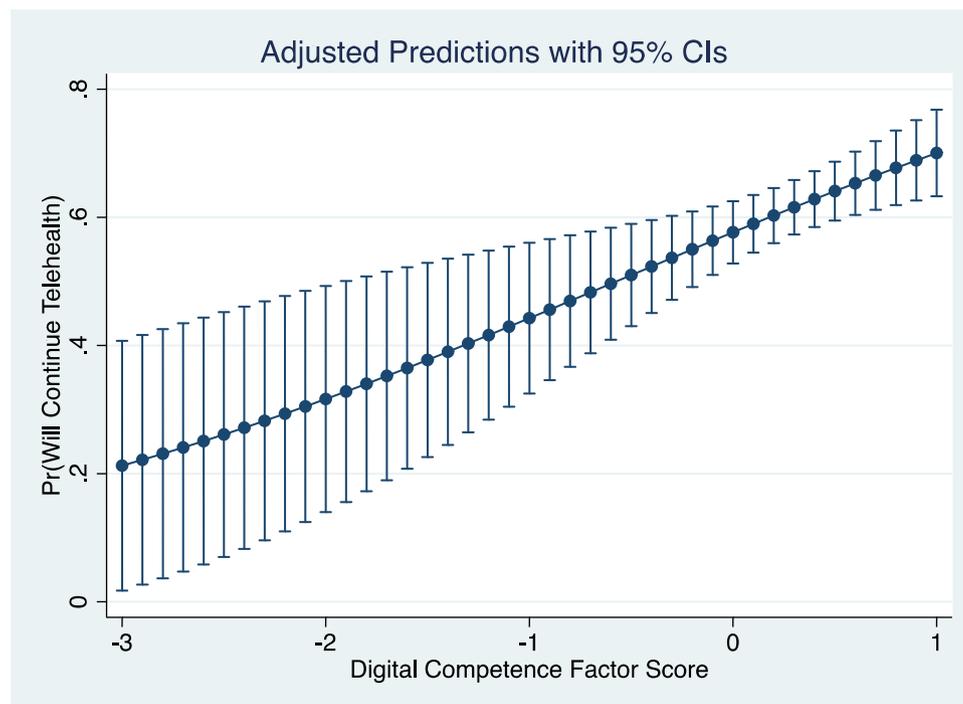


Fig. 3. Marginal effects of digital competence (factor score) on odds of future telehealth use after COVID-19 pandemic.

attention to the operational skills necessary for effective telehealth use. Our findings indicate that digital competence is statistically and positively associated with telehealth use during the COVID-19 pandemic. Further, we probe for satisfaction with and the likelihood of continuing telehealth services beyond the pandemic. Similarly, our findings suggest that those with higher levels of digital competence are more likely to continue to take advantage of telehealth, all else equal. By narrowing the

sample to those with residential (fixed) Internet access (e.g., high-speed broadband), our study shows that addressing the digital divide involves more than just expanding Internet access.

Previous studies find education to be a significant predictor of telehealth use, however, our analyses show that education is insignificant when controlling for digital competence. This is likely because those who have higher educational attainment are also more likely to have

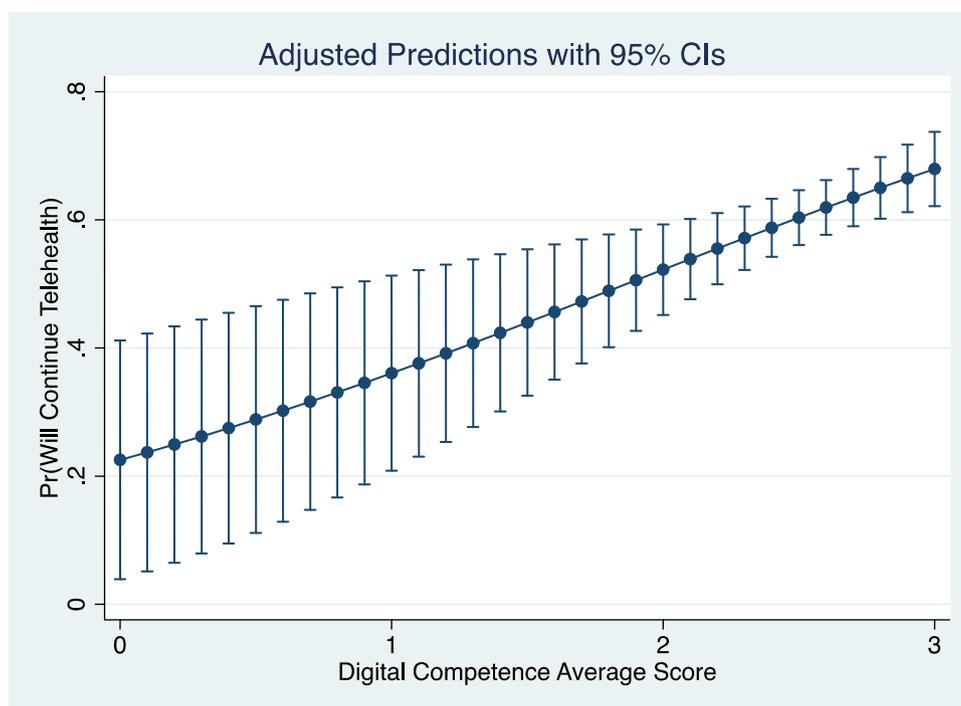


Fig. 4. Marginal effects of digital competence (average score) on odds of future telehealth use after COVID-19 pandemic.

greater digital competence. We tested this by running additional regressions with digital competence, rather than telehealth use, as our outcome of interest. We found that, as expected, digital competence was positively associated with education (see Appendix for results). This suggests that, even among the educated, lower digital competence is associated with lower odds of telehealth use. Thus, strategies to improve access to telehealth should not be predicated on lack of education, but rather be focused on those with lower digital competence and limited exposure to computing devices and the Internet, such as older adults.

The mainstreaming of telehealth services holds the potential to significantly facilitate access to healthcare, particularly to residents of areas with limited access to in-person healthcare options. However, as our study suggests, without complementary investments in digital upskilling and training, those with more limited digital competence will face barriers in navigating telehealth services, resulting in the exacerbation of current disparities in healthcare access and outcomes. This is especially concerning for low-income households and the aging population who may have more underlying health conditions [35,36], but also are more likely to lack access to reliable Internet as well as the necessary digital skills to effectively engage with telehealth [16,37,38]. Thus, policies addressing the healthcare gap must also consider strategies to improve digital competence among vulnerable populations—a component largely overlooked in current initiatives.

Combining telehealth with broadband expansion and digital upskilling programs is critical to ensure that equity is built into the continued mainstreaming of telehealth post-pandemic [39]. For example, the city of Long Beach in California committed \$1 million of federal funding from the CARES Act to ensure its residents have “equitable access to and use of digital literacy training, the Internet, technology and other resources” [40]. This will complement Senior Links, an initiative that provides nursing and social work services to older adults in need of support through a combination of telehealth and in-person visits.

A limitation to this study is the lack of data about respondents’ overall health condition. However, given our goal of understanding how digital competence shapes telehealth use, the inclusion of individual and group-level control variables, as well as the fact that our fieldwork took

place when in-person services were severely limited, we are confident that our results shed light on important issues facing healthcare practitioners and policymakers. Though our analysis provides a snapshot into telehealth use in California during the COVID-19 pandemic, our results and recommendations bear relevance to other states facing similar disparities in healthcare access. As the delivery of healthcare services increasingly relies on digital platforms, creating opportunities for digital upskilling is more necessary than ever to help close existing gaps in health outcomes.

Funding

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Ethical approval

Data collection and research approved by University of Southern California’s Institutional Review Board (Protocol #: UP-21-00037). Participants were informed of research objectives and were asked of their consent.

CRediT authorship contribution statement

T. Le: Led data analysis and writing. Collaborated on study design and data collections.

H. Galperin: Contributed to data analysis and writing. Collaborated on study design and data collections.

D. Traube: Contributed to data analysis and writing. Collaborated on study design.

Author statements

We believe our research contributes to the health policy and technology literature by empirically exploring how second level digital inequality, as measured by digital competence, worsens disparities in telehealth use. Our study offers novel evidence further supporting the

Table A1
Regression results predicting digital competence score.

	(1) Digital Competency Coefficient	Standard Errors	95% Confidence Interval
Remote Work or Class (vs. not remote)	0.130**	(0.043)	[0.045,0.216]
Child(ren) in HH (vs. no children)	-0.025	(0.039)	[-0.102,0.052]
<i>Education (compared to less than high school)</i>			
High School Graduate	0.807***	(0.130)	[0.551,1.063]
Some College	1.045***	(0.120)	[0.810,1.281]
Bachelor's Degree	1.133***	(0.124)	[0.889,1.377]
Post-Graduate Degree	1.169***	(0.125)	[0.923,1.414]
Age	-0.014***	(0.001)	[-0.017,-0.011]
Low-Income HH (vs. not low-income)	-0.301***	(0.051)	[-0.402,-0.200]
Woman/Female (vs. man/male)	-0.081*	(0.039)	[-0.158,-0.004]
<i>Race/Ethnicity (compared to non-Hispanic white)</i>			
Latinx	-0.157**	(0.051)	[-0.258,-0.057]
Black	-0.125	(0.091)	[-0.303,0.053]
Asian	-0.269***	(0.053)	[-0.372,-0.165]
Hawaiian or Pacific Islander	-0.237*	(0.097)	[-0.427,-0.047]
American Indian or Alaskan Native	-0.167	(0.148)	[-0.457,0.124]
Other/Mixed	-0.093	(0.072)	[-0.234,0.048]
Employed (vs. not employed)	0.010	(0.045)	[-0.078,0.098]
Disabled (vs. not disabled)	-0.121	(0.075)	[-0.268,0.027]
Lives in Metro Area (vs. not in Metro)	0.073	(0.096)	[-0.115,0.261]
Observations	1130		

Standard errors in parentheses; 95% confidence intervals in brackets.

* $p < .05$
** $p < .01$
*** $p < .001$

need for policies that expand access to information technology and programs for digital upskilling.

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Declaration of Competing Interest

None declared.

Appendix

Table A1

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