SSM - Population Health 26 (2024) 101665

Contents lists available at ScienceDirect

SSM - Population Health

journal homepage: www.elsevier.com/locate/ssmph

The digital health divide: Understanding telehealth adoption across racial lines in rural Illinois

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ARTICLE INFO

Keywords:
Telehealth
Broadband
Cairo
Inequalities
Trust
Race

ABSTRACT

Due to long-standing barriers to healthcare access in rural areas, telehealth has been promoted as an effective means of delivering healthcare services. However, there is a general absence of quantitative data showing how geographic residence and race affect telehealth adoption. This study examines variations in telehealth adoption based on race and geographic residence in Southern Illinois using a mail survey. It finds that residents of urban Carbondale, compared to those in rural Cairo, have better access to broadband and are more likely to use telehealth. Respondents significantly differ from each other based on their geographic location of residence and race when it came to using telehealth to save money on travel and to save money on childcare. A significant barrier to telehealth adoption identified across all groups is privacy protection concern. The findings highlight the crucial role of broadband infrastructure in healthcare access and the need for trust in telehealth systems to ensure data privacy.

1. Introduction

Availability to health care is crucial for residents living in rural areas due to many factors including an aging population, higher rates of chronic illnesses, high-risk employment in farming, forest, and mining industries, and factors associated with high unemployment such as stress and depression (Henderson & Taylor, 2003; Mullner et al., 1989). Health care overall is less physically available to residents of rural places. A study by the U.S. Department of Agriculture (USDA) Economic Research service found that residents of the most rural counties had fewer health care facilities and were more likely to have health professional shortage areas (Dobis & Todd, 2022). Forty percent of noncore counties–the least densely populated rural areas—experienced entire-county shortages of primary care physicians, compared with 16 percent for metropolitan counties. Furthermore, urban counties had a greater number of medical professionals than did rural counties, with an average of 6.1 primary care physicians for every 10,000 residents in urban counties compared to 4.4 primary care physicians for every 10,000 residents in rural counties. Despite the increasing need for health care services in rural areas, rural hospital closures continue to threaten the ability of rural people to access these services. According to the Cecil G. Sheps Center for Health Services Research (2023) at the University of North Carolina, 192 hospitals have closed in rural areas in the United States since 2005. Extending to the future, Chartis Center for Rural Health (Topchik et al., 2020), a healthcare consulting firm, using data from 2010, claimed that more than 450 of the country's rural hospitals are at risk of closing.

Availability to health care is compounded by an aging population as mobility issues can impact older adults' physical ability to travel to a health care facility (Balsa-Barreiro et al., 2023). By 2020, more than 23 percent of the US population was 60 years or older, driven by the aging of the Baby Boom generation. The number and proportion of older adults in the U.S. population will continue to increase in the coming years (US Census Bureau, 2023). The Government Accountability Office (General Accounting Office, 2023) identified rural areas as having a higher percentage of elderly residents and a higher percentage of residents with limitations in activities caused by chronic conditions, compared to their urban counterparts. Many older rural residents have lived in their same homes for decades and are aging in place (Cromartie & Nelson, 2009). Aging is getting worse as young adults leave these rural areas and older people stay (Smith et al., 2016).

Given the increased need for health care coupled with closures in physical hospitals and clinics in rural places, telehealth has been touted by physicians, policymakers, and researchers as an effective means of providing health care services to people with difficulty accessing brick

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https://doi.org/10.1016/j.ssmph.2024.101665
Received 13 December 2023; Received in revised form 12 February 2024; Accepted 25 March 2024
Available online 26 March 2024

and mortar hospitals and clinics. Telehealth refers to healthcare services delivered by audio and video technology (Gajarawala & Pelkowski, 2021). While the terms "telehealth" and "telemedicine" are frequently used interchangeably, "telehealth" is a more general term that includes telemedicine and other health-related services that make use of electronic technology for communication and information, such as medical data sharing, health professional and patient counseling, and distant or portable patient monitoring (Marcin et al., 2016). Improvements in healthcare information technology, as well as increased access to healthcare services, have fueled telehealth growth, connecting healthcare workers and patients in previously unimaginable ways (Gajarawala & Pelkowski, 2021). Since the COVID-19 pandemic, there has been a sharp increase in the use of telehealth services. In a study by Larson et al. (2022), while patients in both urban and rural areas used telehealth services at significantly greater levels during the peak of the COVID-19 pandemic, a significantly higher proportion of urban patients had a telehealth visit during the pandemic period than that of patients in isolated rural communities (52.8% vs. 29.9%). Admittedly, such a difference in telehealth adoptions between urban and rural residents extends beyond the geographic factors (urban vs. rural), encompassing ideological and political preferences, income levels, and educational attainment, as evidenced by rural health studies (Maleki et al., 2022; Sun & Monnat, 2022). Recently, several studies examining the effectiveness of telehealth in rural areas have shown high levels of patient satisfaction with using audiovisual conferencing with their doctor after an initial appointment (Charlton et al., 2015; Marcin et al., 2016; Tsou et al., 2021). Overall, research has shown that telehealth significantly enhances access to and quality of care, improves communication with clinicians and patient safety, increases satisfaction among patients, families, and providers, and reduces healthcare cost (Kruse et al., 2020; Marcin et al., 2016). With results showing the effectiveness of telehealth in addressing the rural health disparity, what obstacles exist toward adoption? Furthermore, how do these obstacles vary based on geographic residence and race?

1.1. Telehealth and digital inequalities

To be able to use telehealth successfully, patients need access to both high-speed internet and smart devices. There is concern that existing social inequities, particularly those concerning healthcare, may worsen, resulting in a digital divide, which represents the divergence between those who have access to information and communication technology (ICT) and those who do not. Furthermore, we contend that a "smart divide", a term describing a new form of social inequalities associated with smart ICT infrastructures and services across various demographic and socioeconomic categories, is looming (Li et al., 2020). Regardless, the barriers and in equal accessibility to ICT is a long-standing problem in rural America (Biedny & Whitacre, 2022). Geographic location (e.g., rural, urban, suburban) is inextricably linked to the cost and deployment of technology infrastructure (Chen et al., 2023; Reddick et al., 2020; Sundeen & Kalos, 2022). Installing broadband internet in rural areas with lower population density is less profitable for internet service providers than installing in areas with higher population density (Riddlesden & Singleton, 2014). Furthermore, rural broadband speeds tend to be slower and broadband services costlier than in urban or suburban areas (Obermier, 2018; Riddlesden & Singleton, 2014).

Note that scholars and policy officials use many definitions to distinguish between rural and urban areas. For example, researchers often use the term rural to refer to non-metro areas, and Congressional legislation uses the term to describe different target definitions. A rural area is characterized by a small population, but the population thresholds separating rural and urban communities vary from 5000 to 50,000 depending on the definition. The existence of multiple definitions of rural reflects the reality that rural and urban areas can be distinguished using different geographic concepts and population thresholds. For this study, we us an official, statistical definition of rural, based on much smaller geographic building blocks, that is provided by the U.S. Census Bureau in its urban-rural classification system. This measure is based strictly on measures of housing unit and population density. According to the current delineation, released in 2022 and based on the 2020 decennial census, rural areas comprise open country and settlements with fewer than 2000 housing units and 5000 residents (Economic Research Service, 2024).

This has contributed to an increasing rural-urban gap in household adoption of broadband internet. Between 2001 and 2015, rural households with broadband internet increased from 2 to 61 percent—versus from 5 to 72 percent in urban areas (Economic Research Service, 2017). With respect to accessibility (but not necessarily adoption), by 2019, more than 90% of Americans lived in census blocks with access to broadband internet service required for high-quality video conversations—defined by having at least 100 Mbps download speed. On the other hand, just 72% of rural inhabitants had access to moderate- or high-speed internet in their census blocks (Wells & Gowda, 2020).

Efforts by researchers and policy makers are focused on increasing broadband access to rural areas, thus reducing digital inequalities. This is important as healthcare delivery continues to shift, with telehealth becoming a vital part of the healthcare narrative in the United States. However, will increased broadband access automatically lead to increased telehealth adoption, or, do other barriers to telehealth use exist, hindering its adoption?

1.2. Race, trust, and healthcare decisions

The absence of digital access negatively impacts the adoption of telehealth services, which can worsen existing health inequities (Curtis et al., 2009). However, in addition to healthcare access, trust in the healthcare system is another significant factor affecting healthcare decisions. In the United States, trust in the healthcare system has historical and contemporary ties to one's race. The US medical establishment has a lengthy history of discriminating against and oppressing black Americans, which remains imprinted in the community's collective consciousness (Wells & Gowda, 2020). Without consent, the healthcare system used black patients for its own progress and reinforced medical theories, technology, and organizations that perpetuated systems of injustice (Jacobs et al., 2006). Perhaps the most infamous example of exploitation of black patients in the name of medical advancement is the Tuskegee Syphilis study. The clinical research undertaken by the U.S. Public Health Service at the historically black college, Tuskegee Institute in Alabama, from 1932 to 1972, evaluated the natural development of untreated syphilis in poor, rural black men. To conduct this study, black subjects were misled by health officials and given fraudulent treatments, even after a known cure, penicillin, had been discovered and used to treat syphilis beginning in 1943 (Wells & Gowda, 2020). The discovery of the study and subsequent media coverage by the press contributed to the rise of medical skepticism in the black community.

Historical and contemporary racial prejudice impacts black people's beliefs and expectations in ways that have a significant effect on health and healthcare-related behaviors (Penner et al., 2009). Ryan et al. (2008) discovered a link between perceived discrimination and black patients' inclination to engage in adequate health-relate practices. In their study, diabetes patients who self-reported racial/ethnic discrimination were about half as likely to receive specific tests important for monitoring the disease than those who did not report racial discrimination. In the current study, we seek to examine whether a lack in trust in the healthcare system serves as a barrier to telehealth use. In other words, even where the physical infrastructure for telehealth is in place, do patients choose not to adopt telehealth due to a lack of trust in the system and is this connected to a patient's race?

2. Methods

2.1. Study locations

Carbondale and Cairo, two small towns in the most rural and economically disadvantageous region in Illinois (i.e., Southern Illinois), were selected as study locations based on the following justifications. Table 1 shows the basic demographics of these two towns.

- Both communities are situated in counties that experience enduring poverty. According to the USDA's Economic Research Service (2023), enduring poverty areas "have poverty rates of 20.0 percent or higher for at least five consecutive measurement periods spanning approximately 40 years or more." Since at least 1960, poverty levels have been consistently high in counties where Cairo and Carbondale are located.
  •Both communities are racially and ethnically diverse, with large white and black populations. Cairo, IL had a population of 1733 in 2020. In 2020, Cairo's population was 69.0 percent black alone, 25.3 percent white alone, 4.7 percent two or more races, 1.2 percent Hispanic, and 0.4 percent American Indian and Alaska Native alone. Carbondale, IL had a population of 21,857 in 2020 (U.S. Census Bureau, 2020), consisting of 54.3 percent white alone, 25.7 percent black alone, 7.9 percent Asian alone, 7.6 percent two or more races, 7.5 percent Hispanic, and 0.5 percent American Indian and Alaska Native alone.
  •he communities differ with respect to rural classification. Carbondale, IL is classified as a 2020 Census urban area (encompassing at least 2000 housing units or a population of at least 5000). Cairo, IL does not meet the criteria for an urban area, and thus is considered to be rural by the U.S. Census Bureau.

2.2. Data collection

We surveyed residents from both Cairo and Carbondale during the period of Fall 2022 and Spring 2023. We reached out to residents in the sample in three different waves. We implemented a Dillman approach, making contact with individuals in the sample several times by mail (Dillman et al., 2014). We mailed physical copies of the surveys to all residents along with a stamped return envelope and a personalized cover letter explaining who we were, how we received their name and address, and what the survey covered. In addition, we explained that we were gathering information about their household's experience with the Internet with respect to healthcare purposes. We assured them that their answers were completely confidential, only people directly involved with the project would have access to the surveys, all survey material would be stored in a locked filing cabinet in a locked office and would be destroyed after it was electronically coded, and only summaries of the data would be released in which one's answers could not be traced back to a particular individual. After a few weeks, we sent a postcard thanking those who had completed the survey and reminding those who had not yet to please fill it out and return it. After two more weeks, we sent a second set of physical surveys to the respondents who had not returned the first survey.

Table 1
Population, economic, and energy indicators by study Location, 2020

	Cairo, IL	Carbondale, IL
Population	1733	21,857
Population Density (inhabitants per square mile)	190.29	1256.4
Median Household Income	$27,661	$24,093
Unemployment Rate	9.8%	8.7%
Enduring Poverty	Yes	Yes
Urban Area	No	Yes

Note: Population, density, median household income, and urban area come from the 2020 U.S. Census. Unemployment rate is provided by the Local Area Unemployment Statistics from the Department of Labor for Carbondale, IL and Alexander County, IL. Enduring poverty is provided by the USDA's Economic Research Service.

From the initial sample size of 2732 households, 260 households completed the survey, resulting in a response rate of 11.5% (subtracting undeliverable surveys). Of the respondents who completed the survey, 149 (57.3%) were from Carbondale, IL and 111 (42.7%) were from Cairo, IL. Of the respondents, 67% were women, 32% were men, and 1% were non-binary or other; the mean age was 57 years. With respect to race and ethnicity, 51% identified as white, 42% identified as black, 2% identified as Latino, 4% identified as Asian, and 2% identified as some other race or ethnicity. In terms of highest educational degree earned, 2% did not graduate from high school, 14% completed only high school, 24% completed some college but did not earn a degree, 11% earned an associate degree, 27% a bachelor's degree, 15% a master's degree, and 7% a Ph.D. or professional degree.

We asked respondents if anyone in their household had used the following types of telehealth in the past two years: (1) synchronous two-way live audio-visual telecommunication (2) synchronous two-way live audio telecommunication (3) synchronous or asynchronous brief technology-based communication between a patient and provider, (4) Transmission of videos, images or recorded health history through a secure electronic communication system, patient to provider (5) Recording or monitoring personal health aimed at encouraging health behaviors using smartphone applications, personal devices, and wearables, and, (6) non-invasive technology and software tools that allow prevention, management, and treatment of certain conditions; including electronic-prescribing. We also asked respondents to select their reasons for choosing to have an audiovisual or audio appointment with their doctor or nurse rather than an in-person visit: (1) save time by not needing to travel; (2) save money by not needing to travel; (3) save money by not needing to find childcare; (4) not needing to take off work; (5) not wanting to be around other people; or (6) overall convenience. For respondents who did not use telehealth, we asked them to select the reasons for nonuse: (1) private information not protected; (2) no access to internet (broadband or cellular data); (3) lack of skills to use telehealth. We also asked respondents whether they preferred an in-office visit or a telehealth visit (i.e., audio visual or audio visit) for the following types of health care appointments (1) Mental health appointments with a therapist or psychiatrist; (2) Specialist appointments to schedule testing (e.g., appointment with gastroenterologist to schedule colonoscopy); (3) Follow-up appointments with a primary care physician; and (4) Specialist appointments to schedule medication or treatment.

To assess internet use, we asked respondents how many working smartphones, computers, and tablets were in the household, whether the household currently had access to the internet, and by what mode of delivery (cellular, wired broadband, satellite, dial-up, or mobile hotspot), and if they were happy with their current internet service. In addition, respondents were asked to test their internet speed by using their web browser through their home internet connection at https://www.speedtest.net/, a commonly used public broadband testing service website. Respondents recorded their download and upload speed in Megabits per second.

3. Results

A summary of descriptive statistics of respondents in Cairo and Carbondale is shown in Table 2. Table 3 presents the univariate and bivariate statistics for internet use, based on study location. Independent t-tests show that respondents significantly differ from each other based on their geographical location of residence with respect to the average number of functional computers in the household, the percentages of respondents with household internet, a cellular data plan, wired broadband, and satellite internet, and average internet download and upload speed. Respondents of Carbondale, IL were significantly more

Table 2
Descriptive statistics of respondents by study location.

Category	Responses	Cairo, IL		Carbondale, IL		Total
		Population	Sample	Population	Sample	Sample
Sex	Male	46.5	26	51.1	36	32
	Female	53.5	74	48.9	63	67
	Non-binary/other		0		1	1
Age	In years	47.4	60	24.8	54	57
Education	Less than Bachelor's degree	83.7	72	54.6	36	51
	Bachelor's degree or higher	16.3	28	45.4	64	49
Race	White	25.3	28	56.6	68	51
	Hispanic or Latino	1.2	1	5.0	3	2
	Black	69.0	69	27.5	23	42
	Asian	0.0	0	7.0	7	4
	Other	4.5	2	3.9	3	2
Housing	Own with mortgage	–	16	–	34	26
	Own free and clear	–	57	–	31	42
	Rent	–	22	–	34	29
	Occupied without payment of rent (include government assistance)	–	5	–	1	3

Table 3
Univariate and bivariate statistics for internet use by study location.

	Cairo, IL (n = 111)		Carbondale, IL (n = 149)		
	% or Mean	SD	% or Mean	SD	*t*-test
Number of working smart phones	1.65	1.07	1.74	1.11	0.66
Number of working computers	1.32	1.21	1.76	1.24	2.83**
Number of working tablets	1.02	1.13	1.07	1.07	0.41
Household internet access (%yes)	80.00	–	92.00	–	2.75**
Cellular data plan (% yes)	76.00	–	86.00	–	1.88+
Wired broadband (%yes)	34.00	–	80.00	–	7.72***
Satellite (%yes)	43.00	–	13.00	–	−4.99***
Dial-up (%yes)	5.00	–	7.00	–	0.72
Cellular hotspot (%yes)	51.00	–	50.00	–	−0.21
Happy with internet service (%yes)	62.00	–	67.00	–	0.79
Internet download speed (Mbps)	13.17	14.67	138.03	173.50	3.65***
Internet upload speed (Mbps)	8.17	14.33	30.00	53.70	1.75+

+p < 0.10 **p < 0.01 ***p < 0.001.

likely to have more working computers in the household, to have household internet, to have a cellular data plan, to have wired broadband, to have higher internet download and upload speeds than their counterparts in Cairo, IL (t = 2.83, $p < 0.01$; t = 2.75, $p < 0.01$; t = 1.88, $p < 0.10$; t = 7.72, $p < 0.001$; t = 3.65, $p < 0.001$; t = 1.75, $p < 0.10$, respectively). Notably, the average download and upload speed for Cairo residents was 13.17 and 8.17 Mbps respectively, while the average speed for Carbondale residents was 138.03 and 30.00 Mbps. On the other hand, respondents from Cairo, IL were more likely to have satellite internet than respondents from Carbondale, IL (t = −4.99, $p < 0.001$).

Tables 4 and 5 present the univariate and bivariate statistics for telehealth use, reasons for telehealth use, nonuse, and preference for telehealth over in-person visits based on respondents' geographic location of residence and race. Chi-square tests show that respondents significantly differ from each other based on the study location and race with respect to five of the six telehealth uses–synchronous two-way live audio communication; communication between patient and provider through secure email, messaging, patient portal; transmission of videos, images or recorded health history through secure electronic communication system; recording or monitoring personal health using smartphone applications and wearables; non-invasive technology that prevents, manages, and treats conditions; including electronic-prescribing ($\chi^2 = 6.12$, $p < 0.10$; $\chi^2 = 22.21$, $p < 0.001$; $\chi^2 = 8.45$, $p < 0.05$; $\chi^2 = 8.83$, $p < 0.05$; $\chi^2 = 11.94$, $p < 0.01$). Overall, residents of Carbondale, IL were more likely to use telehealth services than residents of Cairo. Additionally, non-black residents of Carbondale were the most likely to have had used telehealth in the past two years with respect to five of the six types of telehealth services.

Table 4
Univariate and bivariate statistics for telehealth variables by study location and race.

	Cairo, IL		Carbondale, IL		
	Black	Not Black	Black	Not Black	
	% or Mean	% or Mean	% or Mean	% or Mean	Chi-square
Used in past 2 years:					
Synchronous two-way live audio-visual telecommunications	39	37	38	49	2.232
Synchronous two-way live audio communication	32	34	43	50	6.116+
Communication between patient and provider through secure email, messaging, patient portal	28	34	45	63	22.212***
Transmission of videos, images or recorded health history through secure electronic communication system	22	16	37	37	8.450*
Recording or monitoring personal health using smartphone applications and wearables	18	9	20	32	8.830*
Non-invasive technology that prevents, manages, and treats conditions; including electronic-prescribing	10	6	29	26	11.941**

+p < 0.10. *p < 0.05 **p < 0.01 ***p < 0.001.

Respondents used telehealth for a variety of reasons. However, respondents significantly differed from each other based on their geographic location of residence and race when it came to using telehealth to save money on travel and to save money on childcare ($\chi^2 = 9.16$, $p < 0.05$; $\chi^2 = 10.50$, $p < 0.05$). Black respondents from both communities were more likely to use telehealth to save money than their non-black counterparts. The most noted reason for not using telehealth among respondents, regardless of race or geographic residence, was due to a concern that private information may not be protected. This was followed by a lack of skills and not having access to internet. For every

Table 5
Univariate and bivariate statistics for telehealth variables by study location and race.

	Cairo, IL		Carbondale, IL		
	Black	Not Black	Black	Not Black	
	%	%	%	%	Chi-square
Reasons for use					
Save time	67	58	48	53	3.277
Save money on travel	58	42	52	29	9.164*
Save money on childcare	5	0	22	4	10.503*
No need to take off work	32	16	26	16	4.607
Not being near other people	26	47	26	38	3.256
Overall convenience	32	32	39	47	3.461
Reasons for nonuse					
Private information may not be protected	72	67	67	58	1.346
No internet	31	33	33	10	5.439
Lacking skills to use telehealth	28	56	50	23	5.553
Prefer telehealth over in-office visit for					
Mental health appointments	21	23	27	25	0.611
Specialist appointments to schedule testing	17	7	18	29	7.917*
Follow-up appointments with primary care	32	30	48	36	3.798
Specialist appointments to schedule medication	26	26	24	32	1.419

*p < 0.05.

group, the percent of nonusers for concerns over privacy was more than double the percent of nonusers due to a lack of internet access. The percent of respondents, regardless of geographic location or race, who preferred telehealth over in-person visits was highest for follow-up appointments with a primary care physician. Respondents significantly differed from each other with respect to preferring telehealth over in-person visits for specialist appointments to schedule testing ($\chi^2 = 7.92$, $p < 0.05$).

Table 6 displays the results for the relationship between study location, race and telehealth use while controlling for gender, highest level of educational attainment, and age. The logistic regression findings show a significant relationship between study location and use of non-invasive technology that prevents, manages, and treats conditions; including electronic-prescribing, with residents from Carbondale, IL ($\beta = 1.17$, $p < 0.05$) more likely than residents from Cairo, IL to have used the form of telehealth in the past two years. The odds of using telehealth for non-invasive technology were 3.21 higher for residents from Carbondale, IL than for residents of Cairo, IL. With respect to communication between patient and provider through secure email, messaging, patient portal, black respondents ($\beta = -0.56$, $p < 0.10$) were less likely than non-black respondents to have used the form of telehealth in the previous two years. The odds of using telehealth for secure messaging through email or patient portal were 43% lower for black respondents than for non-black respondents.

Table 7 displays the results for the relationship between study location, race and reasons for telehealth use while controlling for gender, highest level of educational attainment, and age. The logistic regression findings show a significant relationship between study location and using telehealth to save money on childcare, with residents from Carbondale, IL ($\beta = 2.06$, $p < 0.05$) more likely than residents from Cairo, IL to use telehealth for that reason. With respect to race, black respondents were more likely than non-black respondents to use telehealth to save money on childcare and to avoid taking time off from work ($\beta = 2.73$, $p < 0.01$; 0.90, $p < 0.10$). The odds of using telehealth to save money on childcare were 15.36 times higher for black respondents than for non-black respondents, while using telehealth to avoid taking time off from work were 2.46 times higher for black respondents than for non-black respondents. On the other hand, black respondents were less likely than non-black respondents to use telehealth to avoid being near other people ($\beta = -0.73$, $p < 0.10$)—lowering the odds by 52%.

4. Discussion

In this study, we attempt to explore how people are using telehealth services, the reasoning for using telehealth, and the obstacles that exist toward the adoption of telehealth services. Furthermore, we explain how these vary based on an area's broadband availability and a person's race. By conducting a survey of residents in two racially diverse towns in Southern Illinois, both located in counties with enduring poverty, we were able to explore how residents of the two communities differ with respect to using various telehealth services. Residents of Carbondale, where high-speed internet was readily available, were significantly more likely to use telehealth than residents of Cairo for five of six types of services. Certainly, physical infrastructure, such as high-speed internet, and devices, such as a smart-phone, tablet, or computer are needed to use telehealth services. Residents of Carbondale were more likely to possess the physical infrastructure and devices needed to use telehealth services. Thus, it is logical that residents of Carbondale were significantly more likely to use telehealth services than residents of Cairo. However, non-black residents of Carbondale had the highest rates of telehealth use, suggesting that access to high-speed internet and smart devices may be necessary but not sufficient for telehealth use.

An additional finding that sheds clarity on telehealth use is the

Table 6
Logistic regression models.

Independent and Control Variables	Synchronous two-way live audio-visual telecommunications	Synchronous two-way live audio communication	Communication between patient and provider through secure email, messaging, patient portal	Transmission of videos, images or recorded health history through secure electronic communication system	Recording or monitoring personal health using smartphone applications and wearables	Non-invasive technology that prevents, manages, and treats conditions; including electronic-prescribing
Community (Carbondale, IL)	−0.132 (0.343) [0.877]	0.418 (0.340) [1.519]	0.658+ (0.346) [1.932]	0.597 (0.378) [1.816]	0.474 (0.418) [1.606]	1.165* (0.473) [3.207]
Race (black)	−0.343 (0.330) [0.710]	−0.284 (0.329) [0.752]	−0.560+ (0.338) [0.571]	0.249 (0.360) [1.283]	−0.132 (0.396) [0.877]	0.350 (0.422) [1.420]
Sex (male)	−0.943** (0.315) [0.389]	−0.858** (0.310) [0.424]	−0.861** (0.324) [0.423]	0.048 (0.323) [1.050]	−0.326 (0.358) [0.721]	−0.049 (0.371) [0.952]
Bachelor's degree or higher (yes)	0.466 (0.299) [1.594]	0.239 (0.295) [1.270]	1.029*** (0.305) [2.797]	0.571+ (0.318) [1.770]	0.473 (0.345) [1.604]	0.559 (0.373) 1.749]
Age	−0.023** (0.008) [0.977]	−0.010 (0.008) [0.990]	−0.014 (0.008) [0.986]	−0.015+ (0.009) [0.985]	−0.015+ (0.009) [0.985]	−0.011 (0.010) [0.989]
Pseudo R^2	0.126	0.091	0.225	0.077	0.074	0.100

+p < 0.10. *p < 0.05 **p < 0.01 ***p < 0.001. Unstandardized coefficients reported with standard errors in parentheses and odds ratios in brackets.

Table 7
Logistic regression models.

Independent and Control Variables	Save time	Save money on travel	Save money on childcare	No need to take off work	Not being near other people	Overall convenience
Community (Carbondale, IL)	−0.469 (0.412) [0.625]	−0.465 (0.433) [0.628]	2.061* (1.047) [7.851]	−0.548 (0.527) [0.578]	0.110 (0.449) [1.117]	0.072 (0.432) [1.074]
Race (black)	0.143 (0.382) [1.154]	0.923* (0.398) [2.516]	2.731** (0.962) [15.356]	0.902+ (0.477) [2.464]	−0.732+ (0.420) [0.481]	−0.091 (0.397) [0.913]
Sex (male)	−0.253 (0.386) [0.776]	−0.412 (0.426) [0.662]	1.631 (0.978) [5.110]	0.629 (0.504) [1.875]	−0.733+ (0.443) [0.480]	0.758+ (0.409) [2.135]
Bachelor's degree or higher (yes)	0.175 (0.362) [1.192]	−0.454 (0.378) [0.635]	−1.460+ (0.861) [0.232]	−0.201 (0.454) [0.818]	−0.382 (0.394) [0.683]	0.339 (0.379) [1.403]
Age	−0.007 (0.009) [0.994]	−0.028** (0.011) [0.973]	−0.083** (0.031) [0.920]	−0.044*** (0.014) [0.957]	0.003 (0.010) [1.003]	−0.031** (0.010) [0.970]
Pseudo R^2	0.027	0.186	0.349	0.166	0.063	0.120

+p < 0.10. *p < 0.05 **p < 0.01 ***p < 0.001. Unstandardized coefficients reported with standard errors in parentheses and odds ratios in brackets.

reasoning for preferring telehealth over in-person visits. Black respondents from both communities were more likely to use telehealth to save money than their non-black counterparts. Specifically, black respondents were more likely to use telehealth to save money on childcare and to prevent from needing to take off work. These reasons varied from non-black respondents who were more likely to use telehealth to avoid being near other people. As highly infectious diseases, such as COVID-19, evolve, it remains to be seen how the desire to avoid people in healthcare settings will factor into one's reasoning to use telehealth services in the future.

Perhaps the most enlightening finding in the study is regarding the reasons people do *not* use telehealth services. While our study shows a relationship between people who use telehealth services also having access to the physical infrastructure, in the form of high-speed internet and smart devices needed to use telehealth, what are the major reasons for nonuse? Among people who did not use telehealth services, surprisingly, lack of physical infrastructure was not the most common reason. The most noted reason for not using telehealth among respondents was due to a concern that private information may not be protected. This was followed by a lack of skills and not having access to internet. A lack of trust in telehealth is consistent with previous research that has noted a lack of trust in the healthcare system, especially for black patients (Wells & Gowda, 2020). For both black and non-black respondents and for respondents in both communities, the percent of telehealth nonusers due to concerns over privacy was more than double the percent of nonusers due to a lack of internet access. This result leads to the conclusion that even if access to high-speed internet and supportive devices is made available, a significant group of current nonusers will choose to continue to not use telehealth. As black respondents are less likely to use telehealth services, they appear to have higher levels of distrust in the health care industry's ability to keep their medical information private. These higher levels of distrust may be an extension of personally experienced discrimination in the healthcare system or due to knowledge of notorious historical cases of medical malfeasance inflicted upon African Americans, such as with the U.S. Public Health Service Untreated Syphilis Study at Tuskegee (Tobin, 2022). Future research would benefit from analyzing the effectiveness of initiatives aimed at fostering trust between the medical community and groups that are skeptical of the healthcare industry, particularly in the context of telehealth services.

Findings from this case study evaluation of telehealth use should be interpreted within the context of the study design. Case studies allow for a more in-depth analysis of how patients are using telehealth services, reasons for using telehealth, as well as reasons for not using telehealth. By focusing on a smaller number of communities that are both high poverty and racially diverse, but with divergent high-speed internet availability, we can discern how race and broadband availability impact use of telehealth services. This is important as black patients living in rural areas may not be well-represented in national surveys of telehealth use. By having focused questions for the reasons why a person is not using telehealth, we discovered that a concern over privacy was the most cited reason. While lack of broadband was a concern, it was the third most cited reason for not using telehealth. Despite being a lessor reason, broadband availability tends to be cited in the literature as a major hurdle to telehealth use. While it is a necessary condition to telehealth use, our study shows that, for current non-users, a lack of trust in the ability of telehealth providers to keep medical information secure and private is the primary reason for non-use. Considering telehealth's potential to improve patient health, especially in rural areas experiencing hospital and clinic closures, it is crucial to ensure secure systems and build patient trust to expand telehealth usage.

We expect that the results from this study may be extended to other rural communities with similar demographic profiles and poverty levels in the United States. Extracting the most recent U.S. census data, we examined the poverty rates, Black or African American population, and the total population at the county subdivision level, which often corresponds to minor civil divisions that are legally recognized administrative entities. Using the USDA-defined rural classification, we found a total of 329 communities across 16 U.S. states with 50% or higher percentages of Black or African American population and 20% or higher poverty rates. Thus, this study is likely to be extended for generalizability in those disadvantaged communities.

Despite the benefits of case studies, important limitations exist. With cross-sectional research, cause and effect is hard to determine. For patients who have used telehealth and have positive perceptions of telehealth, it is hard to determine if positive perceptions lead to using telehealth services or if use comes first followed by the positive perceptions. In addition, more research rigorously assessing the impacts of bringing affordable, high-speed broadband to persistently poor rural areas would also be valuable. Of telehealth non-users, who are more likely to use telehealth services after high-speed broadband is available? Research using a difference-in-differences analytical approach can estimate causal inference among rural areas who have received high-speed broadband compared to areas that are lacking high-speed broadband with respect to telehealth adoption.

5. Conclusions

Improving access to virtual care and adopting policies that are responsive to service availability remains fundamental for advancing health equity. Our study findings underscore the importance of essential infrastructure, such as affordable high-speed broadband and smart devices, for having access to health care. However, it discovers an important obstacle to telehealth adoption: a distrust in the infrastructure needed for telehealth to keep private medical information protected. Moving forward, researchers can address how distrust in telehealth manifests and what policies, procedures, and techniques help alleviate distrust in both telehealth and the health care system at large.

Conflict of interest statement

The authors declare no conflict of interest.

CRediT authorship contribution statement

Jessica Crowe: Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Jelena Nikolic-Khatatbeh:** Writing – original draft, Investigation, Data curation. **Ruopu Li:** Writing – review & editing, Supervision, Resources, Project administration, Methodology, Funding acquisition.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Ruopu Li reports financial support was provided by National Science Foundation. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data will be made available in an aggregate form. See data statement attached

Acknowledgment

This research was funded by the National Science Foundation [grant # 2122092]. It was supported [in part] by the U.S. Department of Agriculture (USDA), Economic Research Service. The findings and conclusions in this publication are those of the author(s) and should not be construed to represent any official USDA or U.S. Government determination or policy.

References

Balsa-Barreiro, J., Hannoun, G. J., Batista, S., & Menéndez, M. (2023). Analysis of travel-time accessibility to healthcare facilities at the regional scale: A case study of Galicia, Spain. *102nd Transportation Research Board (TRB) Annual Meeting*. Washington DC, USA.

Biedny, C., & Whitacre, B. (2022). The broadband serviceable location fabric, rural America, and agriculture. *Choice, 37*(3), 1–9.

Charlton, M., Schlichting, J., Chioreso, C., Ward, M., & Vikas, P. (2015). Challenges of rural cancer care in the United States. *Oncology, 29*(9), 633–640.

Chen, X., Chen, K., Wang, M., & Li, R. (2023). Roles of wireless networks in bridging the rural smart infrastructural divide. *Infrastructures, 8*(11), 159. https://doi.org/10.3390/infrastructures8110159

Cromartie, J., & Nelson, P. B. (2009). Baby Boom migration and its impact on rural America. http://www.ers.usda.gov/publications/pub-details/?pubid=46231.

Curtis, J., McClure, L., Delzell, E., Howard, V., Orwoll, E., Saag, K., Safford, M., & Howard, G. (2009). Population-based fracture risk assessment and osteoporosis treatment disparities by race and gender. *Journal of General Internal Medicine, 24*, 956–962.

Dillman, D., Smyth, J., & Christian, L. (2014). *Internet, phone, mail, and mixed-mode surveys: The tailored design method* (4). Wiley.

Dobis, E., & Todd, J. (2022). The most rural counties have the fewest health care services available. https://www.ers.usda.gov/amber-waves/2022/august/the-most-rural-counties-have-the-fewest-health-care-services-available/.

Economic Research Service. (2017). *Rural America at a glance* (2017 edition). U.S. Department of Agriculture. https://www.ers.usda.gov/webdocs/publications/85740/eib-182.pdf?v=3570.1.

Economic Research Service. (2023). *Poverty area measures*. U. S. Department of Agriculture. https://www.ers.usda.gov/data-products/poverty-area-measures/.

Economic Research Service. (2024). What is Rural?. https://www.ers.usda.gov/topics/rural-economy-population/rural-classifications/what-is-rural/.

Gajarawala, S., & Pelkowski, J. (2021). Telehealth benefits and barriers. *The Journal for Nurse Practitioners, 17*(2), 218–221.

General Accounting Office. (2023). Why health care is harder to access in rural America. https://www.gao.gov/blog/why-health-care-harder-access-rural-america.

Henderson, J., & Taylor, B. (2003). Rural isolation and the availability of hospital services. *Journal of Rural Studies, 19*(3), 363–372.

Jacobs, E., Rolle, I., Ferrans, C., Whitaker, E., & Warnecke, R. (2006). Understanding African Americans' views of the trustworthiness of physicians. *Journal of General Internal Medicine, 21*(6), 642–647.

Kruse, C., Fohn, J., Wilson, N., Patlan, E., Zipp, S., & Mileski, M. (2020). Utilization barriers and medical outcomes commensurate with the use of telehealth among older adults: Systematic review. *JMIR Medical Informatics, 8*(8), Article e20359.

Larson, A., Zahnd, W., Davis, M., Stange, K., Yoon, J., Heintzman, J., & Harvey, S. (2022). Before and during pandemic telemedicine use: An analysis of rural and urban safety-net clinics. *American Journal of Preventive Medicine, 63*(6), 1031–1036. https://doi.org/10.1016/j.amepre.2022.06.012

Li, R., Chen, K., & Wu, D. (2020). Challenges and opportunities for coping with the smart divide in rural America. *Annals of the Association of American Geographers, 110*(2), 559–570. https://doi.org/10.1080/24694452.2019.1694402

Maleki, M., Bahrami, M., Menendez, M., & Balsa-Barreiro, J. (2022). Social behavior and COVID-19: Analysis of the social factors behind compliance with interventions across the United States. *International Journal of Environmental Research and Public Health, 19*(23), Article 15716. https://doi.org/10.3390/ijerph192315716

Marcin, J., Shaikh, U., & Steinhorn, R. (2016). Addressing health disparities in rural communities using telehealth. *Pediatric Research, 79*(1–2), 169–176.

Mullner, R., Rydman, R., Whiteis, D., & Rich, R. (1989). Rural community hospitals and factors correlated with their risk of closing. *Public Health Reports, 104*(4), 315.

Obermier, T. (2018). Residential Internet access cost in Nebraska. *Great Plains Research, 28*(2), 149–154.

Penner, L., Dovidio, J., Edmondson, D., Dailey, R., Markova, T., Albrecht, T., & Gaertner, S. (2009). The experience of discrimination and black-white health disparities in medical care. *Journal of Black Psychology, 35*(2), 180–203.

Reddick, C., Enriquez, R., Harris, R., & Sharma, B. (2020). Determinants of broadband access and affordability: An analysis of a community survey on the digital divide. *Cities, 106*, 1–12. https://doi.org/10.1016/j.cities.2020.102904

Riddlesden, D., & Singleton, A. (2014). Broadband speed equity: A new digital divide? *Applied Geography, 52*, 25–33. https://doi.org/10.1016/j.apgeog.2014.04.008

Ryan, A., Gee, G., & Griffith, D. (2008). The effects of perceived discrimination on diabetes management. *Journal of Health Care for the Poor and Underserved, 19*(1), 149–163. https://doi.org/10.1353/hpu.2008.0005

Smith, M., Winkler, R., & Johnson, K. (2016). *How migration impacts rural America* (brief 03–16; how migration impacts rural America). https://w3001.apl.wisc.edu/pdfs/b03_16.pdf.

Sun, Y., & Monnat, S. M. (2022). Rural-urban and within-rural differences in COVID-19 vaccination rates. *The Journal of Rural Health, 38*(4), 916–922. https://doi.org/10.1111/jrh.12625

Sundeen, T., & Kalos, M. (2022). Rural educational leader perceptions of online learning for students with and without disabilities before and during the COVID-19 pandemic. *Theory & Practice in Rural Education, 12*(2), 105–128. https://doi.org/10.3776/tpre.2022.v12n2p105-128

The Cecil, G. (2023). Sheps center for health services research, U. Of N. C. In *Rural hospital closures*. https://www.shepscenter.unc.edu/programs-projects/rural-health/rural-hospital-closures/.

Tobin, M. J. (2022). Fiftieth anniversary of uncovering the tuskegee syphilis study: The story and timeless lessons. *American Journal of Respiratory and Critical Care Medicine, 205*(10), 1145–1158. https://doi.org/10.1164/rccm.202201-0136SO

Topchik, M., Gross, K., Pinette, M., Brown, T., Balfour, B., & Kein, H. (2020). *The rural health safety net under pressure: Rural hospital vulnerability*. Chartis Center for Rural Health. The Chartis Group.

Tsou, C., Robinson, S., & Boyd, J. (2021). Effectiveness of telehealth in rural and remote emergency departments: Systematic review. *Journal of Medical Internet Research, 23*(11), Article e30632. https://doi.org/10.2196/30632

US Census Bureau. (2023). *Population projections*. Census.Gov. https://www.census.gov/programs-surveys/popproj.html.

U.S. Census Bureau. (2020). *United States census 2020*. U.S. Department of Commerce. https://www.census.gov/programs-surveys/decennial-census/2020-census.html.

Wells, L., & Gowda, A. (2020). A legacy of mistrust: African Americans and the US healthcare system. *Proceedings of UCLA Health, 24*, 1–3.