Disparities in Telemedicine Literacy and Access in the United States

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Video DISCUSSION

Background: Because of the expansion of telehealth services through the 2020 Coronavirus Aid, Relief, and Economic Security (CARES) Act, the potential of telemedicine in plastic surgery has gained visibility. This study aims to identify populations who may have limited access to telemedicine.
Methods: The authors created a telemedicine literacy index (TLI) using a multivariate regression model and data from the US Census and Pew Research Institute survey. A multivariate regression model was created using backwards elimination, with TLI as the dependent variable and demographics as independent variables. The resulting regression coefficients were applied to data from the 2018 US Census at the county level to create a county-specific technological literacy index (cTLI). Significance was set at $P < 0.05$.
Results: On multivariable analysis, the following factors were found to be significantly associated with telemedicine literacy: age, sex, race, employment status, income level, marital status, educational attainment, and urban or rural classification. Counties in the lowest tertile had significantly lower median annual income levels ($43,613 versus $60,418; $P < 0.001$) and lower proportion of the population with at least a bachelor's degree (16.7% versus 26%; $P < 0.001$). Rural areas were approximately three times more likely to be in the lowest cTLI compared with urban areas ($P < 0.001$). Additional associations with low cTLI were Black race ($P = 0.045$), widowed marital status ($P < 0.001$), less than high school education ($P = 0.005$), and presence of a disability ($P = 0.01$).
Conclusions: These results highlight disadvantaged groups at risk of being underserved with telehealth. Using these findings, key stakeholders may be able to target these communities for interventions to increase telemedicine literacy and access. *(Plast. Reconstr. Surg.* 151: 677, 2023.)

Despite the widespread adoption of novel technologies in health care, the implementation of telemedicine in plastic surgery has been limited until recently, with only 8% of Americans using telemedicine services in 2019.[1] As a result of the expansion of telehealth services through the 2020 Coronavirus Aid, Relief, and Economic Security (CARES) Act, however, the immense potential of telemedicine has gained visibility.[2–4] For example, during the COVID-19 pandemic, many health systems experienced a dramatic decline in in-person visits, with a large migration toward telemedicine visits, particularly for preoperative and postoperative follow-up.[5–7]

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In plastic surgery, telemedicine has been shown to improve postoperative care[8] while maintaining patient satisfaction.[9] Since the COVID-19 pandemic began, telemedicine use has increased dramatically within plastic surgery, with many institutions and practices transitioning from little to no telemedicine prepandemic to mostly telemedicine consultation and follow-up visits during the pandemic.[10,11] Because social distancing is one of the most effective ways to prevent the spread of communicable disease, telemedicine increases safety and reduces exposure during the COVID-19

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A Video Discussion by Lisa Gfrerer, MD, PhD, accompanies this article. Go to PRSJournal.com and click on "Video Discussions" in the "Digital Media" tab to watch.

pandemic, especially as new variants continue to arise. In addition, telemedicine decreases health care costs for both patients and institutions though reductions in travel time and costs.[12,13] As such, telemedicine will undoubtedly continue to play a large role in plastic surgery and the health care system more broadly moving forward.[14]

Although there are many benefits in the shift toward telemedicine, there also are unique challenges. One of the major difficulties centers around access, such as reliable internet connection, access to a smartphone or computer, and knowledge of technology, which are all required to conduct health care appointments successfully using telemedicine. These requirements may exacerbate the health care access disparities already present in disadvantaged groups, especially as the number of patients using telemedicine continues to increase.[15] Data regarding disparities in telemedicine access among commercially insured populations exist, but the extent of access among other populations including those without insurance remains unclear.[16,17] In addition, there is a dearth of literature linking telemedicine disparities to geographic region, which prevents local policymakers from identifying and addressing vulnerable populations within their jurisdiction.

In this study, we define the sociodemographic and geographic factors that signal disparities in access to telemedicine across the United States. We identify factors that define populations at risk for being disadvantaged in telemedicine access and use. Our hypothesis was that people with lower socioeconomic status and in rural areas would be most limited in terms of their ability to use telemedicine. As we work toward developing and sustaining telemedicine services in plastic surgery both during and after the pandemic, identifying these limitations is the first step in defining targeted solutions. This is particularly important because disparities in access to care have been magnified during the COVID-19 pandemic and our ability to reach vulnerable populations may be limited.[18] Illuminating these disparities allows plastic surgeons to identify populations at risk for low telemedicine literacy so that these patients can be preemptively provided with technological education and assistance that will ensure successful subsequent virtual visits.

METHODS

This study used publicly available data and thus was not subject to institutional review board approval.

Data Sources

Pew Research Center Core Trends Survey on Internet and Technology

The Pew Research Center Core Trends Survey on internet and technology was used to determine sociodemographic factors associated with variation in technological use. This survey was conducted from January 8 to February 7, 2019.[19] The Pew Research Center is a nonpartisan, nonprofit organization that seeks to inform the public about trends and issues affecting the world. The center conducts surveys on a wide range of topics, including the internet, science and technology, religion and public life, Hispanic trends, global attitudes and trends, and US social and demographic trends. One of the main missions of the Pew Research Center is to structure data collection and distribution in a manner that ensures inclusive, diverse, and equitable sampling.[20] The Core Trends Survey is conducted by telephone and is weighted to reflect both the demographic distribution and the proportion owning landlines compared with mobile phones in the broader US population. In addition, certain racial subgroups are oversampled to ensure representative data are collected.[21] There is no national database of patients undergoing plastic surgery; the Core Trends Survey was used because it captures the breadth of the general US population who might potentially seek plastic surgery.

US Census American Community Survey

Demographic predictors of low telemedicine literacy were extrapolated to the United States using the 2018 American Community Survey (ACS), a publicly available product of the US Census Bureau that aims to help community leaders and businesses understand how changes may be taking place in communities across the country. The ACS is the premier source for specific housing and population data in the United States. Data were obtained and analyzed at the county level using Federal Information Processing System codes.[22]

Telemedicine Literacy Index

Definition

Using the Pew Research Center Core Trends Survey, we created a telemedicine literacy index (TLI). The TLI was a summation of three domains: access to internet, access to a smartphone, and comfort with technology. Answers to the following questions were categorized as yes or no answers: "Do you use the internet or email, at least occasionally?" "Is your cell phone a smartphone, or not?" and "Do you currently subscribe to internet service at home?" The question "About how often do you use the internet?" was answered on an ordinal scale from 1 to 5, with possible responses ranging from "almost constantly" to "less often."

Predictive Modeling of Demographic Predictors

Multivariate linear regression analysis with backwards elimination was performed for all sociodemographic factors available in the Pew Research Center data. Variables with the highest *P* values were sequentially removed from the multivariate model until the R^2 value was maximized. Sociodemographic factors were used as the independent variables and the TLI was used as the dependent variable. These variables included age, sex, race, ethnicity, employment status, income level, marital status, highest educational attainment, and urban/suburban/rural status of the household.

Extrapolation to US Population

After creating the multivariate model of the TLI, the resulting β coefficients for each independent variable were applied to county-level data in the 2018 ACS to create a county-specific telemedicine literacy index (cTLI), representing the TLI score for each individual county, parish, or organized borough in the United States. Our aim was that the cTLI would reflect access to the critical computer and internet services required to implement telemedicine services among all 3,090 counties, parishes, and organized boroughs across the country. The ACS has county-specific demographic data, which were used as the independent variables in the multivariate model, and these county-specific data were used to calculate the cTLI for each county. For variables that were reported as binary in the ACS data, the percentage was first multiplied by the β coefficient for that variable. For example, the % female population was multiplied by the β coefficient for female sex. The resultant number was then multiplied by the TLI score. Variables such as income level were reported as means for each area. In this case, the β coefficient for the applicable income bracket in the multivariate model was used. A diagram of this process using an example variable is available in Fig. 1. This process was repeated sequentially for each variable among all counties, parishes, and organized boroughs to create the final cTLI score for each county. The final cTLI scores were then separated into tertiles based on the most even distribution among the three categories of high, medium, and low cTLI. Significance throughout our study was considered at $P < 0.05$. Data were analyzed using STATA, release 15, 2017 (StataCorp; College Station, TX).

RESULTS

Patient Population

The Pew Research Center Core Trends Survey comprised 1,067 patients with complete data. This included 278 patients (26%) who were older than 65 and 473 patients (44%) who were female. The racial composition of the sample was primarily White (82%), followed by Black or African American (11%), Asian or Asian American (3.6%), and mixed-race participants (3.1%). A total of 82 participants (7.7%) were of Hispanic ethnicity. A total of 528 patients (49%) were employed full time, 99 (9.3%) were employed part time, and 266 (25%) were retired. A full description of the demographic information for this population is shown in Table 1.

Factors Associated with Telemedicine Literacy

Sociodemographic Factors

Because of our large sample size, many sociodemographic factors were significantly associated with TLI. In creating the multivariate regression model using backwards elimination, factors that were not independently associated with TLI were Hispanic ethnicity and rural/urban/suburban classification of residence.

In descending order of importance, factors independently associated with decreased TLI on multivariate analysis included widowed marital status (β, −18.5; 95% CI, −22.62, −14.42; $P < 0.001$), less than high school education (β, −14.74; 95% CI, −25.01, −4.47; $P = 0.005$), age over 65 (β, −8.52; 95% CI, −11.7, −5.4; $P < 0.001$), employment classified as disabled (β, −7.94; 95% CI, −14.07, −1.81; $P = 0.011$), some college, no degree (β, −6.60; 95% CI, −11.53, −1.68; $P = 0.009$), and Black or African American race (β, −3.09; 95% CI, −6.22, 0.043; $P = 0.045$) (Table 2).

Annual income >$150,000 was the strongest predictor of increased TLI (β, 13.5; 95% CI, 8.46, 18.59; $P < 0.001$) and each income bracket above $40,000 per year was associated with significantly increased TLI. Having a postgraduate or professional degree was similarly highly associated with increased TLI (β, 13.3; 95% CI, 9.706, 16.894; $P < 0.001$), in addition to each educational level above some college, no degree. Additional factors associated with significantly increased TLI included

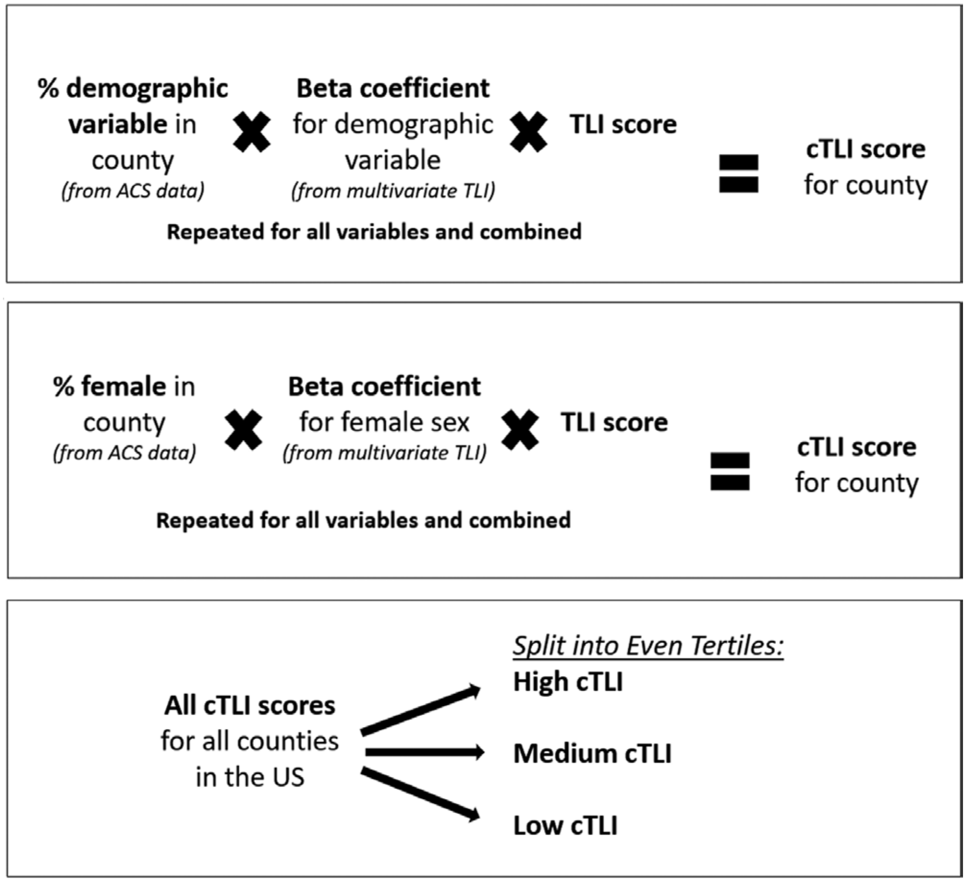

Fig. 1. Extrapolation of the telemedicine literacy index (*TLI*) to the US population. (*Above*) Extrapolation of TLI to a single county. For each demographic variable, the county-level data for the variable [derived from the American Community Survey (*ACS*)] were multiplied by the β coefficient for that variable (derived from our multivariate TLI) and then multiplied by the county-specific technological literacy index (*cTLI*) score. This was repeated for each variable and then combined to create a final cTLI score for that county. (*Center*) Example of extrapolation for a single demographic variable (sex). (*Below*) Categorization of cTLI scores. Final cTLI scores for each county, parish, or organized borough in the United States were divided into even tertiles to categorize counties as high, medium, or low cTLI.

being a student (β, 10.03; 95% CI, 0.35, 19.70; $P = 0.042$), having never been married (β, 5.69; 95% CI, 2.93, 8.46; $P < 0.001$), being employed part time (β, 3.49; 95% CI, 0.07, 7.06; $P = 0.055$), and female sex (β, 3.00; 95% CI, 1.20, 5.01; $P = 0.004$) (Table 2).

Geographic Variation

There was variation across the United States in telemedicine literacy (Fig. 2). Counties in the lowest tertile had significantly lower median annual income levels ($43,613 versus $60,418; $P < 0.001$) and lower proportion of the population with at least a bachelor degree (16.7% versus 26%; $P < 0.001$). Rural areas were approximately three times more likely to be in the lowest cTLI tertile compared with urban areas ($P < 0.001$). In the 100 areas with the highest proportion of Black or African American residents, 78% of areas were in the lowest cTLI tertile; in the 100 areas with the lowest proportion of Black or African American residents, 49% of areas were in the lowest cTLI tertile ($P = 0.021$).

DISCUSSION

Telemedicine has been a valuable tool for health care delivery during the COVID-19 pandemic as plastic surgeons have increasingly adopted telemedicine as part of their practice; as many as 76.9% of facial plastic surgeons are now using telemedicine.[23] Rapid increases in

Table 1. Characteristics of Respondents to the Pew Research Survey on Technological Utilization (*n* = 1,067)

Characteristics	*n* (%)
Age >65 yr	278 (26)
Female	473 (44)
Race	
White	875 (82)
Black or African American	121 (11)
Asian or Asian American	38 (3.6)
Mixed race	33 (3.1)
Hispanic ethnicity	82 (7.7)
Employment status	
Full time	528 (49)
Part time	99 (9.3)
Retired	266 (25)
Not employed for pay	98 (9.2)
Has own business/self-employed	28 (2.6)
Disabled	30 (2.8)
Student	18 (1.7)
Annual income	
<$10,000	79 (7.4)
$10,000 to $20,000	83 (7.8)
$20,000 to $30,000	99 (9.3)
$30,000 to $40,000	91 (8.5)
$40,000 to $50,000	88 (8.3)
$50,000 to $75,000	163 (15)
$75,000 to $100,000	143 (13)
$100,000 to $150,000	129 (12)
>$150,000	192 (18)
Marital status	
Married	537 (50)
Living with a partner	67 (6.3)
Divorced	127 (12)
Separated	31 (2.9)
Widowed	83 (7.8)
Never married	222 (21)
Education level	
Less than high school	10 (0.9)
High school graduate	51 (4.8)
Some college, no degree	227 (21)
Associate degree	164 (15)
Four-year college or university degree	111 (10)
Postgraduate or professional degree	136 (13)
Population classification	
Urban	386 (36)
Rural	190 (18)
Suburban	491 (46)

telemedicine use have been seen across multiple surgical subspecialties and institutions worldwide since the COVID-19 crisis began.[24–26] Given increased patient satisfaction, decreased cost, and widespread adoption by clinicians, telehealth is likely to play a role in care beyond the pandemic. However, there are important limitations of telehealth that must be overcome through institutional, state, and national-level policies. We hypothesized that certain communities may be disadvantaged because of lack of the basic computer, smartphone, or internet services that are required to participate in telemedicine. Our investigation revealed a number of demographic factors associated with poor telemedicine literacy and access, including widowed or divorced marital status, age older than 65, disability, and Black or African American race. Of the 100 counties with the highest proportion of Black or African American residents, 78% fell in the lowest tertile for telemedicine access in the United States. These disparities are even more concerning in light of the known disparities in access to reconstructive plastic surgery among racial minority groups, people with public insurance, and individuals who live in geographic areas with a low density of plastic surgeons.[27–29] Care must be taken to avoid compounding disparities among vulnerable patient populations as telemedicine continues to be used in plastic surgery practices. Our analysis can educate insurers, policymakers, health care providers, and the technology industry for designing appropriate demographically and geographically targeted outreach and mitigation efforts to improve telemedicine access and prevent worsening of existing health disparities in plastic surgery.[30]

The trends we observed are important, because the largest barriers to wider adoption of telemedicine are social, with one of them being inadequate digital literacy. It has been shown that adults older than 65 and individuals with a lower income or education are more likely to have lower digital health literacy.[31] In addition, unemployed people, individuals with disabilities, people from nonfamily households, and minority groups lag behind other groups in digital literacy.[32] This issue of a divide in digital literacy is important; studies have found a decrease in physician visits among populations with low digital literacy since the COVID-19 pandemic began.[18]

Digital literacy is important, but it is not the only factor limiting the widespread adoption of telemedicine. Other difficulties center around access to the internet and a reliable smartphone.[33] The digital divide describes how difficulties in access to the internet are affected by a wide variety of geosocial factors.[34] These factors include having a lower income, having less education, being older than 65, being widowed, being Black, and living in a rural area.[35–39] Demographics of populations at risk of not having a smartphone are similar, with older adults, Black individuals, and people with lower education and income being less likely to have access to a smartphone compared with their counterparts.[39,40] Our data add to these findings by incorporating access to the internet, access to a smartphone, and comfort with technology into one combined measure (TLI) and show that these groups remain disadvantaged. The significance of this measure is clear, as past studies have found that Black individuals access telemedicine and high-quality

Table 2. Beta Coefficients of Variables Included in the Multivariate Model Predicting the Telemedicine Literacy Index using Pew Research Center Data

Variable	β Coefficient	95% CI (lower, upper)	*P* Value
Sex			
Male	Referent	NA	NA
Female	3.00	1.20, 5.01	0.004
Age >65 yr	–8.52	–11.7, –5.4	<0.001
Race			
White	Referent	NA	NA
Black or African American	–3.09	–6.22, 0.043	0.045
Asian or Asian American	–0.91	–6.15, 4.32	0.732
Mixed race	–1.64	–7.30, 4.03	0.571
Employment			
Full time	Referent	NA	NA
Part time	3.49	0.07, 7.06	0.055
Retired	–1.71	–4.98, 1.56	0.304
Not employed for pay	–2.69	–6.46, 1.08	0.162
Has own business/self-employed	–1.68	–7.73, 4.36	0.585
Disabled	–7.94	–14.07, –1.81	0.011
Student	10.03	0.35, 19.70	0.042
Annual income			
<$10,000	Referent	NA	NA
$10,000 to $20,000	0.587	–4.43, 5.60	0.818
$20,000 to $30,000	3.044	1.88, 7.97	0.226
$30,000 to $40,000	7.065	1.94, 12.19	0.007
$40,000 to $50,000	9.328	4.11, 14.55	<0.001
$50,000 to $75,000	11.140	6.32, 15.96	<0.001
$75,000 to $100,000	10.581	5.61, 15.56	<0.001
$100,000 to $150,000	12.667	7.41, 17.93	<0.001
>$150,000	13.523	8.46, 18.59	<0.001
Marital status			
Married	Referent	NA	NA
Living with a partner	0.890	–3.23, 5.02	0.672
Divorced	–4.906	–8.15, –1.67	0.003
Separated	0.498	–5.45, 6.45	0.870
Widowed	–18.522	–22.62, –14.42	<0.001
Never married	5.693	2.93, 8.46	<0.001
Education level			
Less than high school	–14.741	–25.01, –4.47	0.005
High school graduate	Referent	NA	NA
Some college, no degree	–6.603	–11.53, –1.68	0.009
Associate degree	6.843	3.64, 10.04	<0.001
Four-year college or university degree	11.705	8.798, 14.612	<0.001
Postgraduate or professional degree	13.299	9.706, 16.894	<0.001

surgical care significantly less frequently than their White counterparts.[41,42] It is important to address this disparity to avoid adding to the systematic disadvantages that Black communities already face. In addition, the telemedicine access disparities among older people are significant, because they are more likely to have chronic conditions that need to be monitored regularly and are at risk of being neglected during the COVID-19 pandemic.[43] Widowed individuals tend to have lower telemedicine literacy, likely because being widowed is correlated with being older and having fewer social supports or resources; thus, being widowed may further compound other sociodemographic factors that put individuals at high risk for low telemedicine literacy. Within the field of plastic surgery, these disparities highlight specific at-risk populations. Whereas cosmetic surgery patients tend to be employed, married, and educated,[44] subgroups of reconstructive surgery patients are more likely to have sociodemographic factors that put them at greater risk of telemedicine-related health disparities. For instance, patients seeking cancer-related reconstruction are likely to be older and thus at greater risk for having reduced telemedicine literacy or access.[45] It has also been shown that patients who are members of racial minority groups are less likely to have access to procedures such as reconstruction for breast cancer or treatment for craniosynostosis at baseline.[27,28] Plastic surgeons must be vigilant when working with these populations to ensure that telemedicine does not constitute another barrier to their care. Although previous studies on telemedicine use in plastic surgery have discussed clinical and technological barriers such as inaccuracy of diagnosis by using video or photographs alone, poor video quality or connection, and legal or privacy concerns,[8,46] our findings provide insight about the element

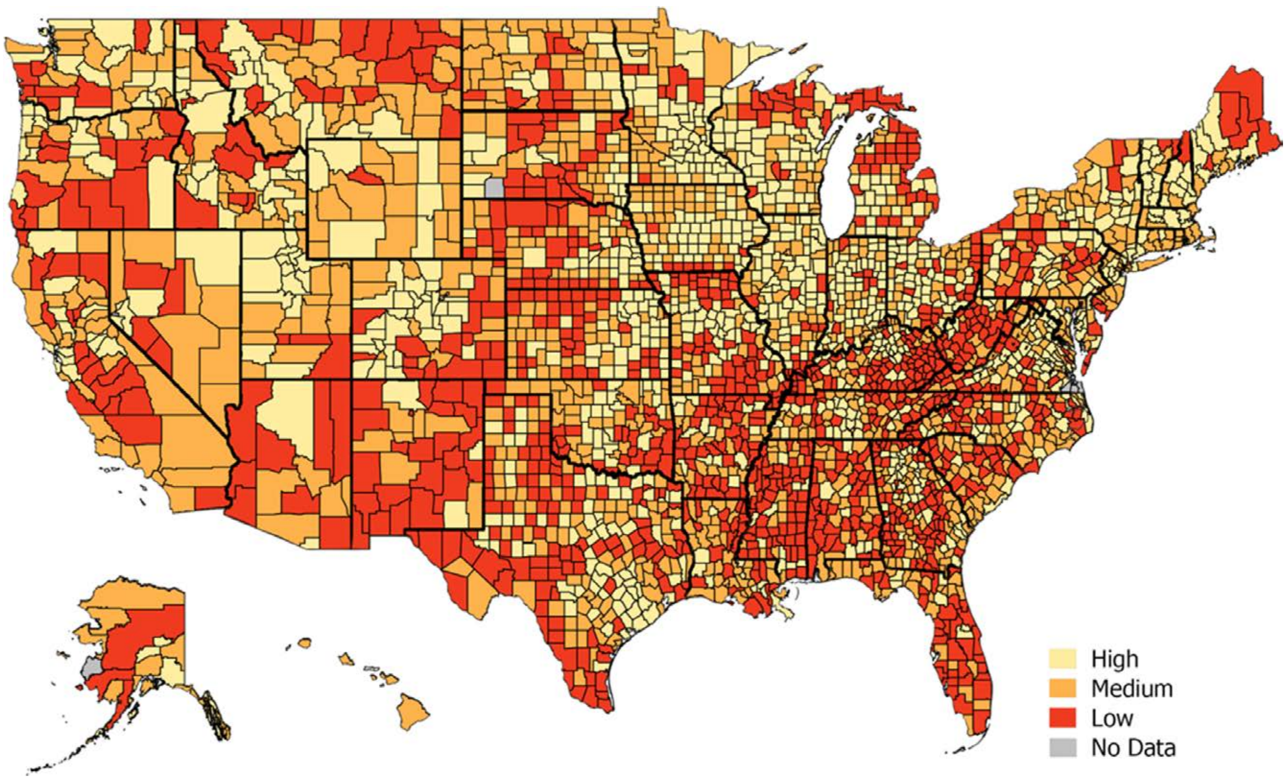

Fig. 2. Variation in the county-specific telemedicine utilization index throughout the United States. County-specific telemedicine utilization index scores were divided into tertiles, with a high score tertile indicating a higher degree of predicted telemedicine utilization (*yellow*) and a lower score tertile indicating a lower degree of predicted telemedicine utilization (*red*). Scores are plotted on a map of individual US counties according to data from the 2018 US Census. Created using STATA.

of sociodemographic and geospatial barriers to telemedicine access faced by patients.

Although there are clear disparities present in telemedicine, there are ways to mitigate them by addressing each metric included in our TLI. Policies such as the National Broadband Plan from the Federal Communications Trade Commission are important to increase reliable internet access and programs to improve smartphone access among vulnerable populations have also been implemented.[47–49] However, having fast internet and a smartphone does not always equal more utilization; good digital literacy is also necessary.[50] Exposure to online health services improves perceptions and can make patients feel empowered, leading to increased frequency of use and better access.[37] It may be beneficial to provide support for vulnerable populations through training services to increase self-efficacy in technology usage.[51,52] The benefits of addressing these metrics are clear; past studies have shown the potential of telehealth to reduce disparities in underserved communities if they have access to internet and smartphones and are comfortable with using technology.[53] For example, when patients present for preoperative consultation, they can also receive training on how to log on to virtual visits and access results remotely to facilitate future telehealth interactions. It is important to address these factors to avoid worsening of existing disparities as surgical consultations shift towards telemedicine in a variety of surgical subspecialties.[24,54]

Although our study highlights specific at-risk populations, it has important limitations. First, our data are derived from the Pew Research Center Core Trends Survey and ACS and are based on participants' self-reported information. Social desirability bias could have skewed participants' answers about their internet usage and comfort level with technology. Furthermore, because the Core Trends Survey was conducted solely by telephone, it is subject to nonresponse bias. However, the magnitude of this nonresponse bias is typically small for lifestyle, health, and demographic questions.[55] Sampling biases must also be considered as the Core Trends Survey respondents are not necessarily representative of the general US population. However, the Pew Research Center uses subgroup sampling and weighting to increase representativeness of the sample along demographic lines as well as by landline versus mobile phone ownership.[21] An even larger nationally representative survey of technology use could have strengthened our ability to ascertain factors associated with a high degree of telemedicine literacy. In addition, plastic surgery–specific databases designed to evaluate health literacy would evaluate the question at hand more directly. Although limitations exist in developing a model that fits the complexities of a service that spans both technology and health care industries, this is an important first step during a critical time when it may be possible to expand services through internet providers and develop skill-based interventions on a county level. Because health care is now highly dependent on the ability to use technology, an acknowledgement of these factors is critical to develop appropriate mitigating strategies. The data we used were collected before the onset of the COVID-19 pandemic and were intended to represent the American population at the start of the pandemic. As new national data are released, future studies can examine trends in cTLI as the pandemic continues.

CONCLUSIONS

Our results highlight that patients at the highest risk of being underserved with telehealth are those who fall in specific socioeconomically disadvantaged groups. Based on these findings, insurers, policymakers, health care providers, and patient advocates may be able to target specific communities for interventions to increase telemedicine literacy and access. As plastic surgery and health care more broadly is becoming increasingly dependent on the ability to use technology, appropriate efforts to mitigate and prevent adding to preexisting health care disparities is critical.

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