# Equitable Healthcare Access During the Pandemic: The Impact of Digital Divide and Other SocioDemographic and Systemic Factors 

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#### Abstract

Access to healthcare is a fundamental right for all individuals, and it has become more crucial than ever during the ongoing COVID-19 pandemic. Unfortunately, many people have faced barriers to accessing healthcare services due to the digital divide. The COVID-19 pandemic has brought into sharp focus the urgent need for access to healthcare services. The impact of the pandemic on healthcare access has been a matter of concern for policymakers, healthcare providers, and the public alike. This study aimed to empirically examine the determinants of healthcare access during the pandemic, with a specific focus on the impact of the digital divide. The sample size consisted of 312 individuals, and the study applied a multivariable regression model with HAC estimator to analyze the data. Healthcare access was the dependent variable, while the independent variables included Digital divide, Demographic factors, Sociocultural factors, and Systemic factors. The findings revealed that demographic factors, sociocultural factors, and systemic factors significantly impacted healthcare access during the pandemic. However, the most significant finding was the impact of the digital divide on healthcare access. This finding underscores the critical need to address the digital divide to ensure equitable healthcare access during the pandemic and beyond. This study highlights the urgent need for policymakers and healthcare providers to focus on addressing the digital divide to ensure equitable access to healthcare services. By doing so, it will be possible to ensure that vulnerable populations are not left behind during this critical time. The findings of our study have important implications for healthcare policy and practice and can guide future research in this area. This study provides valuable insights into the determinants of healthcare access during the pandemic, which can inform efforts to improve healthcare delivery and promote health equity.


Keywords: Dizital divide, Healthcare, Re8ression, Demographic, Sociocultural, Systemic

## Introduction

The COVID-19 pandemic has placed an unprecedented strain on healthcare systems and resources worldwide. With the rapid spread of the virus, hospitals and healthcare facilities have been overwhelmed by the surge in patients requiring treatment. The pandemic has also resulted in shortages of essential medical supplies and equipment, such as personal protective equipment (PPE) and ventilators, which are crucial for the care of COVID-19 patients. The virus is primarily transmitted through respiratory droplets when an infected individual coughs, sneezes, or talks. The symptoms of COVID-19 can range from mild to severe and can include fever, cough, fatigue, shortness of breath, and loss of taste or smell. In severe cases, the virus can cause pneumonia, acute respiratory distress syndrome, and even death.

Access to healthcare services is crucial for individuals who experience symptoms, require testing, or need treatment. Early diagnosis and treatment of COVID-19 can help reduce the severity of the disease and prevent complications. Testing is also important for identifying and isolating infected individuals to prevent further transmission of the virus. Healthcare professionals play a critical role in providing care to COVID-19 patients, but they also face significant challenges, including shortages of personal protective equipment and limited hospital capacity. As such, it is essential to prioritize access to healthcare services for those who need it most, including frontline healthcare workers and individuals who are most vulnerable to severe illness from COVID-

19 , such as the elderly and those with underlying medical conditions.

It is essential for patients to have access to healthcare services in order to guarantee that they will get the care that they need and that healthcare practitioners will have the resources they require to offer treatment. Without access to healthcare services, patients with COVID-19 may not receive timely medical attention, which could result in severe illness and even death. Furthermore, healthcare providers may be forced to work without adequate PPE and other essential medical supplies, putting their own health and safety at risk. It is therefore essential to prioritize access to healthcare services and to provide the necessary resources to healthcare providers to ensure that they can provide care safely and effectively.

The COVID-19 pandemic has brought to light the importance of preventative care and chronic disease management. With the focus on treating COVID-19 patients, there has been a significant disruption in the delivery of routine medical care, leading to delayed or missed diagnoses and treatments for chronic conditions. However, it is important to recognize that individuals with chronic conditions, such as diabetes, heart disease, and asthma, are at a higher risk of severe illness from COVID-19. Access to healthcare services is crucial for managing these chronic conditions and reducing the risk of severe illness from COVID-19.

Access to healthcare services also allows individuals to receive preventative care, such as vaccinations, cancer screenings, and regular check-ups. Preventative care is essential for detecting and treating illnesses
early, reducing the burden on healthcare systems and improving health outcomes. Moreover, preventative care can help individuals maintain their health and wellbeing, which is especially important during the pandemic when mental health concerns are on the rise.

The COVID-19 pandemic has had a profound impact on mental health, with many individuals experiencing stress, anxiety, and depression related to the pandemic's social and economic impacts. The pandemic has brought about isolation, financial stress, and uncertainty, resulting in a significant increase in mental health concerns. Access to mental healthcare services is critical for individuals to cope with these challenges and receive the support they need to maintain their mental well-being.

The pandemic has also highlighted the importance of integrating mental healthcare services into overall healthcare services. Mental health and physical health are intertwined, and individuals with chronic conditions or COVID-19 may also experience mental health concerns. Access to mental healthcare services can improve overall health outcomes, reduce healthcare costs, and improve the quality of life for individuals. Moreover, it is essential to reduce the stigma associated with mental illness and promote mental health awareness to encourage individuals to seek help when they need it.

## Digital divide and healthcare access

The digital divide, defined as the gap between those who have access to digital technology and those who do not, can have a significant impact on healthcare access. In
this context, there are various ways in which the digital divide can impact healthcare access, from limited access to health information to reduced access to medical records. Understanding these impacts is crucial for addressing healthcare disparities and ensuring equitable access to healthcare for all individuals.

## Limited access to health information

Access to health information is a critical aspect of health literacy. Health literacy refers to the ability to obtain, process, and understand basic health information and services to make informed decisions about one's health. In today's world, where technology has become an integral part of our daily lives, digital technology plays a significant role in providing access to health information. However, not everyone has equal access to technology, and this can be a barrier to accessing reliable health information. People who lack digital literacy skills or do not have access to digital devices may have difficulty finding and accessing reliable health information online, which can limit their ability to make informed decisions about their health.

For individuals without access to digital technology, accessing health information can be a daunting task. Many healthcare providers now offer patient portals where patients can access their medical records, make appointments, and communicate with their providers. However, not everyone has access to these portals, particularly in underserved communities where the digital divide is more significant. This lack of access can limit their ability to track their health conditions, access information about medications, and monitor their health progress. Additionally, with the rise of
misinformation and fake news on the internet, individuals without access to reliable sources of health information may be at a greater risk of making poor health decisions based on inaccurate information.

Limited access to health information can have significant implications for public health. People with limited access to health information are less likely to receive preventive care and more likely to experience poor health outcomes. This can lead to increased healthcare costs, a greater burden on healthcare providers, and decreased quality of life for individuals and communities. Therefore, efforts to increase access to digital technology and promote digital literacy can have a significant impact on improving health outcomes and reducing health disparities. Public health officials and healthcare providers can play a vital role in bridging the digital divide by promoting access to reliable health information and providing education on how to use digital technology to access health information.

## Difficulty accessing telehealth services

Telehealth services have become increasingly popular in recent years, offering patients the convenience of receiving medical care from the comfort of their own homes. Virtual doctor appointments and remote monitoring of health conditions are just a few examples of the many telehealth services available to patients. However, accessing these services can be challenging for people without reliable internet access and digital devices. This can limit their ability to take advantage of these services and receive the medical care they need.

In rural areas and underserved communities, where the digital divide is more significant, accessing telehealth services can be especially challenging. Many individuals in these areas lack access to high-speed internet and may not have the digital devices necessary to use telehealth services. This can be a significant barrier to receiving medical care, particularly for individuals with chronic health conditions who require ongoing monitoring and care. Without access to these services, these individuals may be forced to travel long distances to receive medical care, which can be costly and time-consuming.

Difficulty accessing telehealth services can have significant implications for public health. The COVID-19 pandemic has highlighted the importance of telehealth services in providing medical care while minimizing the risk of spreading infectious diseases. Without access to these services, individuals may be less likely to seek medical care, leading to delayed diagnoses and poorer health outcomes. This can result in increased healthcare costs and a greater burden on healthcare providers, particularly in areas where access to medical care is already limited.

## Reduced access to medical records

Access to medical records is crucial for healthcare providers to provide quality care to patients. Digital medical records have made it easier for healthcare providers to access patient information quickly, even in emergency situations. However, not all patients have access to digital medical records, which can lead to delays in care or reduced quality of care.

For patients without access to digital medical records, accessing their medical information can be a time-consuming process. They may need to request their records from their healthcare providers or wait for their providers to send their records to another healthcare facility. These delays can be particularly challenging in emergency situations, where quick access to medical information can be critical. Additionally, patients without access to digital medical records may be at a greater risk of medical errors, as their providers may not have access to complete or up-todate medical information.

Reduced access to medical records can have significant implications for public health. Without access to complete medical records, healthcare providers may be unable to provide quality care to their patients, leading to poorer health outcomes and increased healthcare costs. Additionally, patients without access to medical records may be less likely to seek medical care, leading to delayed diagnoses and the progression of illnesses.

Limited access to health apps and wearables
In recent years, mobile health apps and wearables have become increasingly popular as tools for managing chronic conditions and promoting wellness. These tools can provide patients with valuable insights into their health and allow them to monitor their progress towards their health goals. However, people without access to digital devices may be unable to take advantage of these tools, limiting their ability to manage their health effectively.

Access to health apps and wearables requires digital devices such as smartphones or tablets. For individuals who cannot afford or do not have access to these devices, using health apps and wearables may be challenging or impossible. This can limit their ability to track their health and wellness, potentially leading to undiagnosed conditions or unmanaged chronic illnesses.

Limited access to health apps and wearables can also exacerbate existing health disparities. People living in poverty or in rural areas may have limited access to digital devices and may be unable to afford expensive wearables or healthcare apps. This can make it difficult for them to manage their health effectively and may lead to poorer health outcomes.

## Inequitable distribution of healthcare

 resourcesInequitable distribution of healthcare resources is a significant issue that can exacerbate existing healthcare disparities. Healthcare providers may be more likely to offer digital health services and resources to patients who live in areas with high-speed internet and have access to digital devices. This can lead to an uneven distribution of resources, with some patients having access to advanced digital health tools while others do not.

The unequal distribution of healthcare resources can have significant implications for patient outcomes. Patients without access to digital health resources may be at a greater risk of undiagnosed conditions or unmanaged chronic illnesses, leading to poorer health outcomes. Additionally, the unequal distribution of healthcare resources
can contribute to healthcare disparities, with certain groups having less access to healthcare than others.

Addressing the issue of inequitable distribution of healthcare resources requires a multifaceted approach. Healthcare providers can work to improve access to digital health resources in underserved communities by partnering with community organizations and providing education on how to use digital health tools effectively. Additionally, policymakers can work to ensure that all patients have access to reliable internet and digital devices, regardless of socioeconomic status or geographic location.

Efforts to address the issue of inequitable distribution of healthcare resources are critical to improving health outcomes and reducing healthcare disparities. By ensuring that all patients have access to the resources they need to manage their health effectively, it is possible to work towards a more equitable and just healthcare system.

In conclusion, the unequal distribution of healthcare resources is a significant issue that can contribute to healthcare disparities and lead to poorer health outcomes. Addressing this issue requires a multifaceted approach, including efforts to improve access to digital health resources in underserved communities and policies to ensure that all patients have access to reliable internet and digital devices. Healthcare providers and policymakers must work together to ensure that all patients have access to the resources they need to manage their health effectively.

## Methodology

We calculated the indexes of all the variables using logarithmic summation of the questionnaire items provided in table 1.

$$
Z_{i}=\sum_{n}^{i} x_{i}
$$

For instance, the digital divide index was calculated as follows:


The variables are then employed in the following multiple OLS model:

$$
\begin{gathered}
\text { haccess }_{i}=\alpha+\beta_{1} \text { divide }_{i}+\beta_{2} \text { demo }_{i} \\
+\beta_{3} \text { socio }_{i}+\beta_{4} \text { syst }_{i}+\vartheta_{i}
\end{gathered}
$$

Multiple regression is a statistical technique used to analyze the relationship between a dependent variable and two or more independent variables. It allows researchers to investigate the effects of multiple predictors on the outcome variable while controlling for other variables. We may describe the model as follows if $x_{n j}$ is the $j^{t h}$ predictor for observation n :

$$
y_{n}=\beta_{0}+\beta_{1} x_{n 1}+\cdots+\beta_{D} x_{n D}+\epsilon_{n} .
$$

This may be expressed as:

$$
y_{n}=\boldsymbol{\beta}^{\top} \mathbf{x}_{n}+\epsilon_{n} .
$$

The minimization of this loss function is easier when dealing with matrices as opposed to sums. Define y and X with.

The loss function may be written similarly as:

$$
\mathcal{L}(\hat{\boldsymbol{\beta}})=\frac{1}{2}(\mathbf{y}-\mathbf{X} \hat{\boldsymbol{\beta}})^{\top}(\mathbf{y}-\mathbf{X} \hat{\boldsymbol{\beta}}) .
$$

| Table 2 |  |
| :--- | :--- |
| Healthcare Access Metric | Measurement |
| Healthcare coverage | Percentage of population with health <br> insurance coverage: private insurance, <br> public insurance (Medicare or Medicaid), <br> or uninsured |
| Healthcare utilization | Number of doctor visits, hospitalizations, <br> and emergency room visits among <br> different populations |
| Distance to healthcare <br> facilities | Distance that people have to travel to reach <br> healthcare facilities such as hospitals and <br> clinics |
| Availability of healthcare <br> services | Number and distribution of healthcare <br> providers and services, such as primary <br> care providers, specialists, and mental <br> health services, in different regions |


| Table 1. |  |
| :--- | :--- |
| Digital Divide Metric | Description |
| Internet access | The percentage of households with internet access |
| Broadband access | The percentage of households with high-speed broadband internet access |
| Device ownership | The percentage of households with computers, laptops, or smartphones |
| Digital skills | The percentage of individuals who have basic digital skills, such as using email or social media |
| Online activities | The frequency with which individuals engage in online activities, such as online shopping or social media use |
| Digital literacy | The ability of individuals to critically evaluate and use digital information |


| Table 3. |  |  |  |
| :--- | :--- | :---: | :---: |
| Factor | Description |  |  |
| Demographic factors | Individuals in remote or rural areas may have limited access to medical facilities <br> and healthcare providers, which can make it difficult to receive timely care. |  |  |
| Geographic location | Older adults and individuals with disabilities may face additional challenges in <br> accessing healthcare services due to physical or cognitive limitations. |  |  |
| Age and disability | People with lower income or financial resources may have limited access to <br> healthcare due to lack of health insurance or inability to pay for healthcare <br> services. |  |  |
| Socioeconomic status | Lack of education or understanding of health-related information can lead to poor <br> health decisions and may prevent individuals from seeking appropriate healthcare. |  |  |
| Sociocultural factors | Language barriers or cultural differences may make it challenging for people from <br> minority groups or non-dominant language speakers to access healthcare services. |  |  |
| Education and health literacy | Stigmatization or discrimination based on factors such as race, ethnicity, sexual <br> orientation, or health status can prevent people from seeking healthcare services. |  |  |
| Cultural and linguistic barriers |  |  |  |
| Stigma and discrimination | Shortages of healthcare providers can make it difficult for individuals to access <br> timely care. |  |  |
| Systemic factors | Lack of reliable transportation can make it difficult for individuals to travel to <br> medical facilities to receive healthcare services. |  |  |
| Availability of healthcare providers | Lack of health insurance coverage can make it difficult for individuals to afford <br> necessary healthcare services. |  |  |
| Transportation | Government policies and regulations can affect access to healthcare services, such <br> as restrictions on certain medical procedures or limitations on insurance coverage. |  |  |
| Health insurance coverage |  |  |  |

## Results and discussion

Figure 1 shows that there are negative correlations between healthcare access and Digital divide, Demographic factors, Sociocultural factors, Systemic factors.

The first correlation to consider is the negative relationship between healthcare access and the digital divide. Those who lack access to technology may also lack access to healthcare services, as healthcare providers are increasingly using technology to deliver care. This means that those who are already marginalized or disadvantaged in terms of access to technology are likely to be further disadvantaged in terms of access to healthcare. This correlation highlights the importance of addressing the
digital divide in order to improve healthcare access and reduce health disparities.

Secondly, there is a is a negative relationship between healthcare access and demographic factors. Demographic factors such as age, race, ethnicity, income, and education level can all impact access to healthcare. For example, older adults may face barriers to accessing healthcare due to mobility or transportation issues, while individuals with lower income may struggle to afford healthcare services. Addressing these demographic factors is important for improving healthcare access and reducing health disparities. This may involve providing targeted healthcare services to specific populations, increasing access to healthcare insurance, or implementing
policies to address social determinants of health.
to healthcare. Addressing these factors is important for improving healthcare access

Figure 1. correlation results and relation between healthcare access and digital divide


and reducing health disparities. This may involve increasing cultural competency among healthcare providers, implementing policies to address systemic barriers to healthcare access, and addressing social determinants of health that impact healthcare access.

The output in table 4 presents the results of a linear regression model, where the dependent variable is HACCESS and the independent variables are DIVIDE, DEMO, SOCIO, SYST, and C. The model was estimated using the least squares method, which aims to minimize the sum of squared residuals between the predicted values and the actual values. The coefficients for each of the independent variables represent the expected change in the dependent variable for a one-unit change in the corresponding independent variable, holding all other independent variables constant. For example, a one-unit increase in DIVIDE is associated with a 0.855971 decrease in HACCESS, all else being equal.

The t -statistic and associated p -value test the null hypothesis that the corresponding coefficient is equal to zero. In this case, all of the $t$-statistics are large in magnitude and statistically significant at the 0.05 level, indicating that all of the independent variables are significantly related to the dependent variable.

The R-squared value of 0.644152 indicates that approximately $64 \%$ of the variation in HACCESS is explained by the independent variables included in the model. The adjusted R-squared value of 0.639516 takes into account the number of independent variables in the model and penalizes for including too many variables that do not contribute to explaining the variation in the dependent variable.

The F-statistic of 138.9321 tests the null hypothesis that all of the coefficients in the model are equal to zero. The associated pvalue is very small ( 0.0000 ), indicating strong evidence against this null hypothesis and providing further support for the model's overall explanatory power.

The remaining statistics provide information about the goodness of fit and various model selection criteria. The mean dependent variable is -1.030924 , and the standard deviation of the dependent variable is 0.675099 . The S.E. of regression is 0.405331 , which is the standard deviation of the residuals. The Akaike information criterion (AIC), Schwarz criterion (SC), and Hannan-Quinn criterion (HQ) are different measures of how well the model fits the data, with lower values indicating a better fit. The Durbin-Watson statistic tests for autocorrelation in the residuals, with values close to 2 indicating no
autocorrelation. In this case, the value of 1.891898 suggests some positive autocorrelation in the residuals.

| Sample: 1312 Included observations: 312 |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
|  |  | 95\% CI |  | 99\% CI |  |
| Variable | Coefficient | Low | High | Low | High |
| DIVIDE | -0.855971 | -1.015092 | -0.696849 | -1.065570 | -0.646372 |
| DEMO | -0.990693 | -1.142753 | -0.838633 | -1.190990 | -0.790396 |
| SOCIO | -1.015827 | -1.173438 | -0.858215 | -1.223437 | -0.808217 |
| SYST | -1.059076 | -1.221145 | -0.897007 | -1.272558 | -0.845594 |
| C | 0.968109 | 0.794117 | 1.142101 | 0.738922 | 1.197296 |

The output in table 5 shows the $95 \%$ and $99 \%$ confidence intervals for the coefficients of the independent variables in the linear regression model. The confidence intervals provide a range of plausible values for the population coefficient, based on the sample data.

Table 6. Variance Inflation Factors
Sample: 1312
Included observations: 312

| Variable | Coefficient <br> Variance | Uncentered <br> VIF | Centered <br> VIF |
| :---: | :---: | :---: | :---: |
| DIVIDE | 0.006539 | 4.432866 | 1.003608 |
| DEMO | 0.005972 | 3.907389 | 1.013868 |
| SOCIO | 0.006416 | 3.990729 | 1.011732 |
| SYST | 0.006784 | 4.433161 | 1.002804 |
| C | 0.007819 | 14.84794 | NA |

For example, for the variable DIVIDE, the estimated coefficient is -0.855971 . The $95 \%$ confidence interval for this coefficient is -1.015092 to -0.696849 , which means we can be $95 \%$ confident that the true population coefficient lies somewhere in
this interval. Similarly, the $99 \%$ confidence interval is -1.065570 to -0.646372 .

We can use these confidence intervals to test hypotheses about the population coefficients. For example, if we want to test whether the population coefficient for DIVIDE is equal to zero, we can check whether the $95 \%$ confidence interval includes zero. In this case, since the entire confidence interval is negative and does not include zero, we can conclude that there is strong evidence that the population coefficient for DIVIDE is negative.

In general, wider confidence intervals reflect greater uncertainty or variability in the estimates, either due to smaller sample sizes or larger variability in the data. In this case, the confidence intervals for all of the coefficients are relatively narrow, indicating relatively precise estimates.

The output shows the Variance Inflation Factors (VIF) for each independent variable in the linear regression model. The VIF is a measure of how much the variance of the estimated coefficient for each independent variable is increased due to the presence of other independent variables in the model. A high VIF indicates that the corresponding independent variable may be collinear with other independent variables in the model, which can lead to unstable or unreliable estimates of the coefficients.

In this case, all of the VIFs are relatively low, indicating that there is little or no collinearity between the independent variables in the model. The VIFs for DIVIDE, DEMO, SOCIO, and SYST are all close to 1 , indicating that the variance of their estimated coefficients is not
significantly increased by the presence of the other independent variables. The VIF for the constant term C is relatively high at 14.84794, but this is expected since the constant term is not correlated with any other independent variable. The low VIF values in table 6 suggest that the model is well-specified and the estimates of the coefficients are reliable.

## Conclusion

The findings of the study highlight that digital divide has significant implications for healthcare access. As more healthcare resources and services are moved online, individuals without access to the internet or technology are at a disadvantage. These individuals are unable to access telemedicine services, which can be critical in remote areas where healthcare resources are scarce. They are also unable to access healthcare information and resources that are available online, such as patient portals, online appointment scheduling, and health education materials. This lack of access to healthcare resources can result in poorer health outcomes and exacerbate existing health disparities.

Infrastructure development is crucial for bridging the digital divide, which refers to the disparity between individuals and communities with access to digital technologies and those without. The availability of infrastructure such as broadband internet and wireless networks is necessary for individuals and businesses to participate in the digital economy, access education and healthcare services, and communicate with others. However, many underserved areas, particularly in rural and low-income communities, lack the necessary infrastructure for digital
connectivity. To address this issue, governments and the private sector can collaborate to develop and expand infrastructure in these areas. The government can provide funding and incentives for private companies to invest in infrastructure development, while private companies can leverage their expertise and resources to design and deploy infrastructure solutions. By bridging the digital divide through infrastructure development, individuals and communities can access the opportunities and benefits of the digital age.

In addition to providing access to digital technologies, infrastructure development can also have a transformative impact on underserved areas. For example, broadband internet can enable remote work and ecommerce, providing new opportunities for economic growth and job creation. Wireless networks can support telemedicine and distance learning, improving access to healthcare and education in remote areas. Infrastructure development can also improve quality of life by enabling access to entertainment and social connectivity, as well as facilitating emergency communication and disaster response. Therefore, infrastructure development is not only a means of bridging the digital divide but also a means of fostering economic and social development in underserved areas.

Policies are needed to address these barriers and increase healthcare access for all.

One of the main reasons why policies are needed to increase healthcare access is to reduce health disparities. Individuals from low-income, rural, and minority
communities are more likely to face barriers to healthcare access, resulting in higher rates of chronic diseases, poor health outcomes, and premature mortality. Policies that address these disparities, such as expanding Medicaid coverage and funding community health centers, can help ensure that all individuals have access to affordable, high-quality healthcare services.

Access to healthcare services is essential for early detection, prevention, and treatment of diseases. By increasing healthcare access, policies can improve health outcomes and reduce healthcare costs by addressing health issues at an early stage. This can lead to a healthier and more productive population, benefiting both individuals and society as a whole. Healthcare access should not be limited to those who can afford it, and policies can help ensure that everyone has access to basic healthcare services. By promoting social justice through healthcare access, policies can help reduce poverty and inequality, improving the overall wellbeing of individuals and communities.

Policies are needed to increase healthcare access for all to reduce health disparities, improve population health, and promote social justice. By working to ensure that all individuals have access to affordable, highquality healthcare services, policymakers can help create a healthier and more equitable society.

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