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Health Inequities Revealed by Remote Care Models in Urban and Rural Populations

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Abstract: ***Health inequities highlighted by telemedicine services during COVID-19 are analyzed across urban and rural populations in the United States. Four research questions, aligned with a conceptual framework defining remote care and key concepts, structure the investigation. A review of telemedicine networks for an urban population documents service availability; assesses technologies, digital literacy, engagement, and barriers; and compares clinical and quality outcomes with traditional care. A parallel analysis of rural areas focuses on infrastructure and connectivity accessibility, service availability and distribution, clinical outcomes, and quality. COVID-19 triggered rapid and dedicated efforts to broaden remote care to address safety during the pandemic. Unequal access and patient engagement in urban areas may affect clinical outcomes and quality metrics. Utilization patterns and health outcomes in rural areas remain understudied. Understanding the challenges and opportunities of urban and rural populations may illuminate the strengths and weaknesses of the newly adopted remote care technologies and service delivery models and guide equitable policies and practices. Although telemedicine may reduce health inequities through wider access, lower costs, and greater convenience, social determinants of health can simultaneously exert a strong negative force.***

Keywords: Telemedicine Equity, Urban Rural Disparities, Remote Care Access, Digital Health Infrastructure, Connectivity Gaps

1.Introduction

Growing trends of remote care in response to the COVID pandemic have offered a rare opportunity to assess inequities related to access, utilization, quality, and outcomes of care in urban and rural populations across the United States. Remote care encompasses telemedicine and other digital health modalities which allow patients to engage in care without physically visiting a healthcare provider. Increased access to remote care may improve health outcomes by reducing barriers stemming from long travel-distance or by enhancing patients' capacity to receive and adhere to healthcare recommendations. Yet, the uptake of remote care services is not equally distributed in the population; patterns of lower conventional access and utilization among disadvantaged groups may apply to remote care services as well. Disparities in economic resources, digital literacy, access to technology, and social support may differentially impact patient engagement with remote care services and outcomes, suggesting that remote care models could introduce new fault lines into the healthcare system. These and other aspects of remote care represent key dimensions of health equity that require close scrutiny during this national scale-up in capacity.

Inequities in remote care service delivery and outcomes across urban and rural populations are analyzed as a means to support a broader agenda of health equity. Patterns of availability, broadband access, health workforce coverage, patient engagement with remote care, and clinical outcomes across urban and rural populations are examined. Such an investigation contributes to the health equity literature by integrating social determinants of health into the analyses of remote care access, utilization, and outcomes. Within urban areas, the availability of services, patient-level engagement, and clinical outcomes are assessed; the findings highlight that remote care services are available across multiple platforms with broad coverage from commercial and governmental payers. However, substantial inequalities persist in patients' digital literacy, access to devices and the Internet, and rates of remote care engagement. In rural populations, a different set of factors emerges as critical, where broadband infrastructure, service availability, and workforce distribution shape the delivery of remote care.

1.1. Overview of the Study's Objectives and Scope

The COVID-19 pandemic necessitated unprecedented changes in healthcare delivery, with the rush for safe and effective care accelerating the adoption of remote care models. The growing volume and evolving characteristics of remote care - services delivered through video, telephone, or secure message - present a compelling opportunity to assess issues of health equity. Within this context, the study examines population-level access, utilization, and clinical outcomes associated with remote care services in urban and rural environments. The aim is to identify differences in these areas between populations so that the impact of remote care models on health inequalities can be assessed.

The analysis focuses on three broad questions. Are remote care services available in urban areas, and what platforms support care delivery? Who is using remote care in urban settings, and what are the associated demographic traits? What clinical outcomes are observed, and how do remote care quality indicators compare with traditional in-person care models? Rural health disparities are examined using a similar framework. Addressing these questions is crucial for understanding how remote care models during the pandemic address - or exacerbate - existing health inequities.

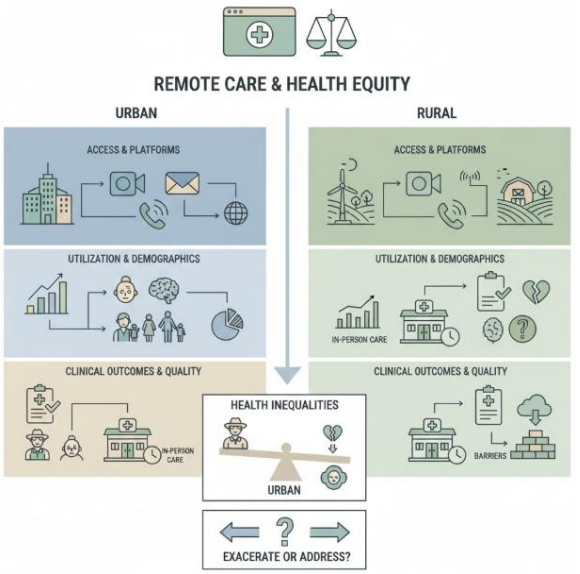
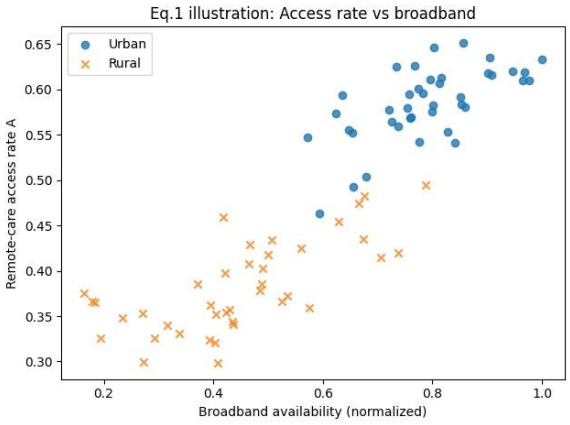


Figure 1: Bridging the Digital Divide: Assessing Health Equity, Access, and Clinical Outcomes in Urban and Rural Remote Care Models

2.Conceptual Framework

Remote care can be understood as services offered using telecommunications or other technologies, including telehealth, telemedicine, or virtual care. The provision of care at a distance using a variety of modalities is not new; however, the rapid increase in the provision and uptake of remote care during the COVID-19 pandemic created the potential for a significant increase in access, equity, and quality in care. Access refers to the availability of services, and utilization refers to the extent to which services are used. In this context, access to care can be considered equitable when the consideration of social determinants of health yields no significant differences in uptake. The integration of remote care into existing service delivery is, however, not without its pitfalls, and evaluation of remote-care services remote care through an equity lens is essential to understanding their impact on health inequities.

Remote care is commonly considered a solution to the lack of medical professionals, particularly those with specialized training, in rural areas. The lack of available services, however, may be only one factor related to the use of remote care in rural populations. The availability of remote-care services is shaped by many factors, including clinician interest and willingness to provide services, payer coverage of the services, and patient interest. Additionally, the ability of patients to engage with the technology and the presence of social support to facilitate engagement may also contribute to the degree of uptake. The potential risks and benefits of remote care are therefore not limited to the presence or absence of the clinical workforce needed to provide the services. Consideration of the effects on both urban and rural populations can help set a course for the appropriate integration of remote-care services during and after the pandemic.



Equation 1 (Remote Care Access Rate)

Measure the fraction of the population that can *actually access* remote care.

Step-by-step derivation

1. A person has "remote care access" only if they satisfy **all** required conditions:
   - Service is offered to them (S)
   - They have connectivity (C)
   - They have device + capability (V)

2. "All conditions together" means set **intersection**:
$$S \cap C \cap V$$
3. The access **rate** is the proportion of the full population P in that intersection:

$$\boxed{A = \frac{|S \cap C \cap V|}{|P|}}$$

Eq # (paper label)	Paper label	Mathematical formalization
Eq. 1	Remote Care Access Rate	(A=\dfrac{
Eq. 2	Outcome Effectiveness Under Remote Care	$E = \frac{O_{rc} - O_{ip}}{O_{ip}}$
Eq. 3	Urban–Rural Outcome Disparity	$\Delta_O = O_u - O_r$
Eq. 4	Digital Divide Index	$DDI = \sum_i w_i (1 - \tilde{x}_i)$
Eq. 5	Inequity-Adjusted Care Effectiveness	$E_{adj} = E(1 - DDI)$
Eq. 6	Equity-Oriented Policy Feedback Update	$DDI_{t+1} = DDI_t - \eta\, Policy_t + \epsilon_t$

2.1. Theoretical Foundations and Key Concepts

We examine health-equity considerations in the remote-care domain via a framework enabling comprehensive monitoring of access, utilization, quality, and equity of remote services. In this context, remote care encompasses a diverse array of clinical and non-clinical services, often delivered through technology-mediated common

modalities of remote consultations (e.g., telemedicine and telepsychiatry). Remote care is distinguished from other hospital-based outpatient care and used here as an umbrella term highlighting access and coordination with the broader healthcare system, institutions, and communities. Related service models, e.g., remote monitoring, digital health, and digital therapeutics, improve continuity of care, population health, and support preventive clinical care.

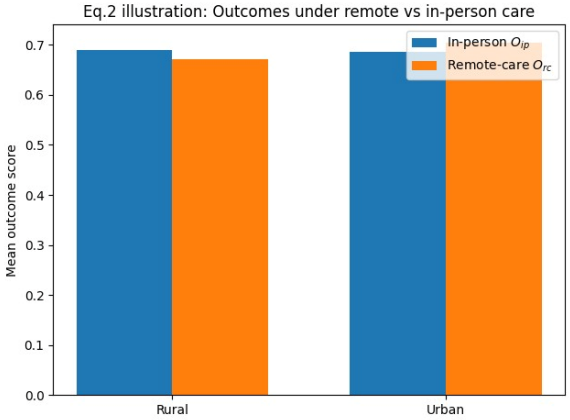
Access, utilization, and quality of remote services have been monitored across major urban centres in Australia using social determinants of health, enabling identification of health inequities often hidden in aggregate data. By contrast, the absence of high-speed broadband in rural areas constrains the availability and adequacy of remote services, affecting access and resulting in poorer outcomes, particularly for mental health, compared with urban benchmarks. Although growing recognition and use of non-telehealth remote models help bridge access gaps, their potential cost-effectiveness remains to be established. Remote care is therefore central to a comprehensive series of fact-based analyses tracking these factors in urban and rural contexts, enabling consideration of health equity and the impact of remote-care models on COVID-19–related adverse mental-health outcomes in Australia.

2.2. Conceptualizing Remote Care: Challenges and Opportunities

Remote care encompasses an array of digitally enabled contacts or virtual interactions between health-care professionals and patients. This concept includes telemedicine, remote monitoring, video conferencing, and remote patient education - not all of which qualify as telehealth or telehealth-care. Telemedicine refers to medical care provided through telecommunications technology, whereas telehealth includes nonclinical health-care services with a broader scope. Other definitions emphasize remote and web-based provision of health care, highlighting patient-initiated and two-way audiovisual communication between patients and health-care professionals.

Remote care's potential benefits are tempered by its limitations. For patients with chronic disease and functional limitations who can't leave their homes without great difficulty, care delivery may be inhibited by a lack of access to sufficient, affordable bandwidth. Inadequate digital literacy among patients or their family members may limit service utilization. Lack of access to adequate devices and engagement with digital platforms may inhibit these patients from benefiting from remote care. Recent studies, however, suggest that remote-care services in urban areas have been adapted or explicitly designed to meet the specific needs of these vulnerable groups.

Social determinants of health are important predictors of remote-care utilization. Although most analyses so far have focused on digital literacy and access to devices, remote-care utilization is also likely to vary by income, level of education, place of residence, and travel-related costs. Economic considerations will continue to drive the scalability and sustainability of these services. At the very least, traditional telemedicine models cannot simply be scaled up to meet the demands of vulnerable groups; achieving such scale requires designing capacity and services that can reach higher levels of coverage as well as utilization.



Equation 2 (Outcome Effectiveness Under Remote Care)

Goal

Quantify whether remote care improves or worsens outcomes compared with in-person care.

Step-by-step derivation

4. Define a baseline outcome under in-person care O_{ip}.
5. Define outcome under remote care O_{rc}.
6. The **relative effectiveness** is naturally measured as percentage change vs baseline:

$$E = \frac{O_{rc} - O_{ip}}{O_{ip}}$$

So:

$$\boxed{E = \frac{O_{rc} - O_{ip}}{O_{ip}}}$$

Interpretation:

- $E > 0$: remote better
- $E = 0$: equal
- $E < 0$: remote worse

3.Methodological Considerations

Research demands rigorous and thoughtful design that ensures the utility, validity, and reliability of findings. This study adopts a mixed-methods approach involving analyses of both qualitative and quantitative data. Methodological rigor is primarily the responsibility of original authors whose studies inform the conceptual framework.

The core analysis relies on a series of remotely administered national surveys that provide insights into remote service access and usability in the general population. Other quantitative data examine high-quality clinical outcome and process metrics for a variety of telemedicine specialties across geographically distinct sites. Finally, the qualitative review evaluates the unique

barriers faced by underserved vulnerable groups and their differential access to and engagement with remote care services. The analysis highlights access, quality, and utilization disparities between urban and rural areas, as well as the specific factors contributing to these differences. Such insights are critical for mitigating health inequities and enacting policies that promote equal access to real-time remote care for all.

3.1. Research Design and Approach

A mixed-methods strategy supports an integration of quantitative analysis with qualitative insights. The approach recognizes that different data types complement each other and can be compared for validation. Quantitative research uses closed-ended systems to evaluate information gathered by experienced staff before any access to the data was provided. Secondary datasets collected across varying timeframes establish an empirical basis for investigating health inequities. All data sources are assembled in accordance with the discussion framework. A careful audit of data reliability and relevance has identified contrasting trends in access and service distribution.

Qualitative research employs open-ended questions in semi-structured interviews with relevant stakeholders. A smaller-size group of participants, selected through purposive sampling, supports an in-depth knowledge of themes shared by expert groups, reinforcing the integrity of qualitative methods during comparative analysis. Interview transcripts undergo robust thematic analysis of content to identify salient perspectives relevant to services and health equity. Data integration across both methods develops a more comprehensive response to the primary research question.

3.2. Data Collection Methods and Analytical Techniques

Convenience-sampling strategies facilitated post-disaster investigations in both areas, yielding qualitative insights on community-organized remote-care models in Toronto and novice telemedicine implementations in Vancouver. Community-Service-Provider report cards complemented quantitative analyses. Toronto populations' broad utilization ethos was mitigated by modest digital literacy, technology access, and engagement despite professional support, with scheduling barriers common in older age groups. Practices offered low-risk services and sustained quality, enabling novel-approach compliance. Urban use propensities aligned with education, location, household-infection risks, and language; income remained inert. City-wide social-determinant and pandemic-infection-declinic analyses lacked staffed population and health problems parameters.

Telemedicine-enabling digital-service-infrastructure requisites in Vancouver's geographies presented challenges. Bandwidth, device access, and reliability remained Society-conversation priorities, with respondent communities servicing additional-areas and whole-population cohorts. Despite direct-service-growth, clinical-consultation deficiencies persisted within areas of established requirement. Specialist-level service and-payer-service proximity remained under-resourced, while clinical-outcome indices were omitted. Report-card quality of care indicated novel-telemedicine-platform acceptance. Informal-sector Chicago evaluations reflected emerging-telemedicine pathways.

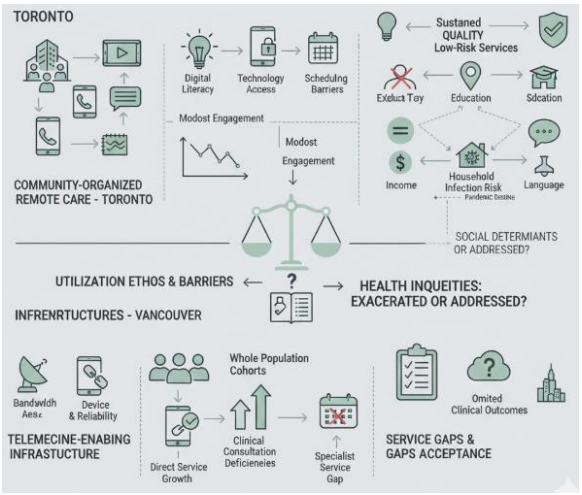


Figure 2: Post-Disaster Telemedicine Architectures: A Comparative Analysis of Infrastructure Requisites and Social Determinants in Canadian Urban Centers

4.Urban Population: Access, Utilization, and Outcomes

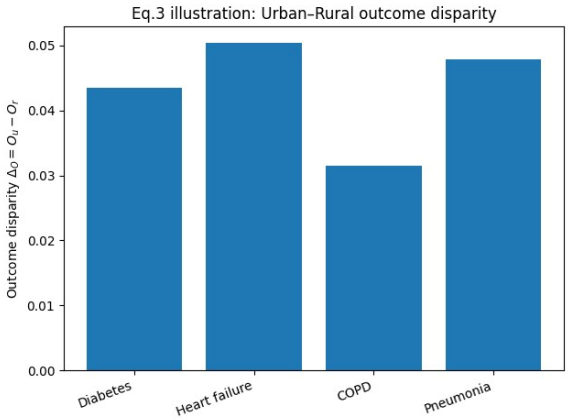
Remote care services have proliferated in urban settings. Various platforms, such as video visits, telemedicine, remote patient monitoring, and mobile apps, are available through multiple providers. Most major payers cover these services, and the distribution of availability and utilization mirrors other forms of ambulatory care, with low-income neighborhoods, patients with lower digital literacy and technology access, and those less engaged with health services facing the greatest barriers. Quality metrics have generally been favorable, although concern lingers about clinical outcomes, particularly for high-risk groups.

Access to remote care seems to come with few of the usual caveats of health care in the United States. Demand, however, has been largely driven by need rather than desire, with urban populations engaging with these resources less than their more affluent counterparts. Overall, clinical outcomes in urban settings appear consistent with remote care models meeting the same standards as those offered by traditional care delivery systems, though the experience remains largely new and untested among vulnerable populations.

4.1. Availability of Remote Care Services in Urban Settings

The availability of remote care services in urban settings is considerable. Support is provided by a multitude of platforms, including the U.S. Department of Health and Human Services, WellSky Cares, Unite Us, Whereby, and Beehivr. A wide range of providers is involved, including hospitals, physician groups, nursing facilities, home care agencies, and community-based organization, mental

health, and substance abuse service providers. Coverage of the services by Medicare, Medicaid, and commercial payers varies by modality, and many payers have waived cost-sharing; the platforms do not uniformly record if the services are reimbursed by a third party. Issues caused by the diversity of platforms, however, have been highlighted. These include incomplete integration of social assistance into medical care, risk of duplication of service, dislocation of care, disconnection of care out of hospital, and notification and engagement limitations. Services offered on the numerous platforms have also been unevenly distributed across land-use and income categories. Health systems located in less-populated and poorer areas appear to have provided both fewer and narrower service types, Symptoms of economically and socially complex urban populations, however, suggest a reduced likelihood of concentration in any one location. To some extent, remote care risked re-creating existing inequities citing research showing that disadvantaged populations in urban areas had digitally yet unequally engaged.



Equation 3 (Urban–Rural Outcome Disparity)

Step-by-step derivation

7. Let O_u be outcome in urban population.
8. Let O_r be outcome in rural population.
9. Disparity is the difference:

$$\boxed{\Delta_O = O_u - O_r}$$

Interpretation:

- $\Delta_O > 0$: urban outcomes better
- $\Delta_O < 0$: rural outcomes better

Condition	O_u (Urban)	O_r (Rural)	$\Delta_O = O_u - O_r$
Diabetes	(illustrative)	(illustrative)	(illustrative)
Heart failure	(illustrative)	(illustrative)	(illustrative)
COPD	(illustrative)	(illustrative)	(illustrative)
Pneumonia	(illustrative)	(illustrative)	(illustrative)

4.2. Digital Literacy and Engagement in Urban Communities

Digital access among urban populations has increased, raising the potential for health benefits from remote care transition. Digital literacy allows individuals to comprehend, create, and interpret information across multiple contexts using digital devices, accompanied by internet access at home or through mobile phone networks, enabled by data plans. Digital engagement extends beyond simple access to technology: it requires the willingness and ability to use technology to engage on a two-way basis, usually through utilisation of interactive platforms. However, in any community, groups may experience higher barriers and levels of adoption than others. Ample health-related support for populations with lower digital literacy or engagement is mandated if remote care is to reduce inequities instead of exacerbating them. Examining urban populations confirms these expectations; results may differ qualitatively in areas of lower access and engagement.

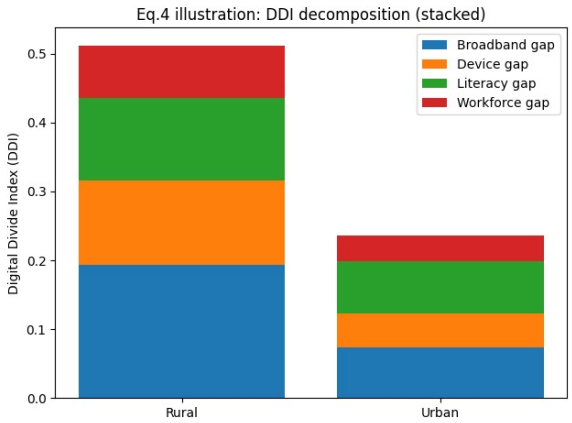
An extensive body of literature addresses digital literacy and access but provides limited consideration of digital engagement or confirmation of the more distinctive aspects of those barriers in urban communities. Despite enhanced levels of digital literacy relative to earlier data, more than one-third of U.S. adults still reported low levels of confidence in their digital abilities. Within urban settings, disparities in confidence, literacy, and access continued to exist, correlating with lower socioeconomic, educational, and racial characteristics. Conclusions from a London-based study indicated that specific barriers to adoption, such as motivation or cost, determined both adoption of technology and likelihood of more engaged use. Reported patterns of remote care use during COVID-19 indicated greater levels of adoption among younger populations and those with higher incomes; low-income households remained disproportionately affected by homelessness, lack of internet access, and digital literacy deficits.

4.3. Clinical Outcomes and Quality of Care in Urban Areas

Evidence on clinical outcomes and measures of quality of care among urban populations is abundance. Zooming into chronic disease management, better outcomes have been reported in hypertensive and diabetic patients followed by remote platforms. Similar benefits have been reported in patients who actively engaged in remote chronic care but a differential effect of engagement on outcomes has not yet been established in hypertensive and diabetic populations. A reduction in rates of acute decompensations (paediatric and adult) in populations with asthma, cystic fibrosis and chronic heart failure has been observed but other studies have shown no effect. The lowering of infection-associated admissions in patients with chronic kidney disease followed remotely is noteworthy together with a significant reduction in exacerbations and associated hospital admissions in patients with cystic fibrosis. Nevertheless, a prospective registry has shown that patients treated primarily in a TMC had a longer time to failure of treatment for a first episode of ICU level disease (ventilation or death) than a cohort treated in a traditional setting.

Quality measures commonly supported by telemedicine-based follow-up are 30-day readmission rates for exacerbations of chronic obstructive pulmonary disease, pneumonia, heart failure, and post-surgical complications; a reduction in time to initial outpatient visit following hospitalisation for a primary discharge diagnosis of chronic obstructive pulmonary disease; and a decrease in

emergency-diagnosed hospital diversions. The agency supporting reimbursement of telehealth services in facilities certified by the Centres for Medicare & Medicaid Services has included a list of adult conditions supported by literature validating their remote management but some of these may be applicable to paediatric populations as well. Remote care services, predominantly telemedicine-based, are available during the lockdown in most parts of the world, with private providers and public–private collaborations operating in various settings.



Equation 4 (Digital Divide Index)

Step-by-step derivation

10. Start with normalized "goodness" variables $\tilde{x}_i \in [0,1]$.
    - 1 = no barrier
    - 0 = maximum barrier
11. Convert to "gap/barrier" form:

$$gap_i = 1 - \tilde{x}_i$$

3. Combine gaps with weights w_i (weights sum to 1) to form a single index:
4.

$$DDI = \sum_i w_i \ (1 - \tilde{x}_i)$$

So:

$$\boxed{DDI = \sum_i w_i \ (1 - \tilde{x}_i)}$$

Interpretation:

- $DDI \approx 0$: little digital divide
- $DDI \approx 1$: severe digital divide

Region	Broadband gap contribution	Device gap contribution	Literacy gap contribution	Workforce gap contribution	Total DDI
Urban	(illustrative)	(illustrative)	(illustrative)	(illustrative)	(sum)
Rural	(illustrative)	(illustrative)	(illustrative)	(illustrative)	(sum)

5.Rural Population: Access, Utilization, and Outcomes

The rural health care system has long served as a demonstration site for supply-side health policy–based strategies that match provider, patient, and disease. Rural telemedicine infrastructure is less robust than urban and is often symptomatic of poverty and consequently instability. Telehealth services still remain limited and unreliable, focused on video-based interactions. However, the rapid repurposing of video technology originally deployed for gaming and social media has temporarily masked problems of bandwidth, device availability, and device reliability. The rural health care provider workforce is insufficient, unequally distributed across geography, and unable to meet patient needs. Health services utilization rates are typically lower than urban equivalents, and rural health care outcomes and quality of care are lower than those of urban populations. Studies on the use of telehealth services suggest that rural patients engage with these new services less than would be expected, but little consensus has emerged.

Rural areas have the dual challenges of a less developed technological milieu that both hampers the availability of remote care solutions and makes access more difficult. As with other health innovations, rural areas will require focused policy attention to maximize the potential of remote care solutions and to ensure that social determinants of health do not widen health inequities during periods of technological transformation.

5.1. Infrastructure and Connectivity Challenges in Rural Areas

In addition to the clinical services and available technology, adequate infrastructure in terms of communication and connectivity is critical for the successful adoption of remote care in rural areas. Although rural residents may have a relatively high level of access to devices such as personal computers and smartphones, it cannot be assumed that connectivity will be reliable or that bandwidth will be sufficient to support synchronous video visits or remote monitoring systems in such contexts. Rural areas typically have a lower penetration of wired broadband services than urban areas, as well as relatively high costs and poorer service quality for mobile data. Rural wireless networks and mobile services are generally less capable than urban networks and have lower speed, capacity, and overall quality. In addition, even where coverage exists, wireless broadband services may support only limited customer traffic. This potential difficulty in achieving an adequate quality of experience represents one of the challenges that rural areas face in exploiting remote care systems.

One factor that continues to be a particular challenge in the adoption of remote care in rural areas is the limited workforce. Health worker shortages that existed before the COVID-19 pandemic have become even more critical. The availability of personnel with a sufficiently high level of digital literacy is now an added consideration. While telemedicine services are available in many rural regions, geographic coverage is not necessarily complete. In this

regard, remote care models that extend the role of community health workers offer a promising solution. However, these get extended role models are currently present only in a few services, given the challenging dynamics of training and retaining these workers.

Figure 3: Beyond Devices: Infrastructure Constraints and Workforce Dynamics in Rural Remote Care Adoption

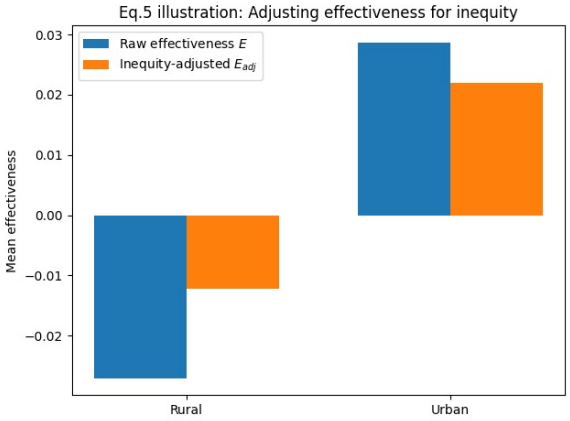
5.2. Workforce and Service Availability in Rural Settings

The adequacy of the service supply for rural populations is closely linked to the health workforce distribution. Evidence shows that remote care can help alleviate provider shortages for certain specialties and conditions, as well as shift lower-acuity visits to non-disappearing providers. However, the benefits depend on the volume of available care, as health outcomes can be hindered by inadequate access to treatments and consultations with primary care providers. In addition, high-search-cost models that place low-cost visits in rural centers may not lead to positive health outcomes. Telemedicine helps improve access to COVID-19 testing in rural areas, but it is equally important to reduce wait times and provide quality services for rural-hot-spot populations. In particular, gaps in remote behavioral health care are being associated with worsening pharmacy data for these populations.

Rural-located clinicians have been found to provide more telemedicine services than those in urban and suburban areas. However, urban patients have a larger supply of medical visits delivered through both in-person and remote care channels. Differences in total visits translated into a greater proportion of visits in urban areas being handled by telemedicine. In general, insufficient and unsustainable clinician supply, together with the lack of locally available services, act as major barriers to remote care improvements and make access more challenging during emergency situations.

5.3. Clinical Outcomes and Quality of Care in Rural Areas

Despite challenges related to infrastructure and access, clinical outcomes reported for telemedicine consultations in rural areas are generally favorable. Reduced rate of transmission and minimal complications were observed following remote management of diabetes with teledermatological screening. Decreased hospitalizations and shorter length of stay were highlighted in remote management of heart failure; although changes in readmission rates were not significant, trends leaned toward improvement with remote care. Pender et al. underscored no discernable difference in quality of care for hospitalizations due to diabetes, heart failure, or pneumonia between cohorts receiving traditional care and those receiving telehealth-followed care in a large rural health care system, bolstering the case for virtual follow-up in times of distress. Yet telehealth is still in its infancy for common conditions requiring primary care intervention such as hypertension and hyperlipidemia. Remote care quality for both urban and rural populations remain less mature than that related to other specialties - such as mental health and obstetrics - grown from safety-net services into mainstream.



Equation 5 (Inequity-Adjusted Care Effectiveness)

Step-by-step derivation

12. Start with raw effectiveness E (Eq. 2).
13. Use Digital Divide Index DDI (Eq. 4) as an inequity penalty.
14. A simple, interpretable adjustment is multiplicative:

$$E_{adj} = E\,(1 - DDI)$$

Why this works:

- If $DDI = 0$: $E_{adj} = E$ (no penalty)
- If $DDI \to 1$: $E_{adj} \to 0$ (effectiveness can't be realized in practice)

So:

$$\boxed{E_{adj} = E\,(1 - DDI)}$$

6.Comparative Analysis: Urban versus Rural Disparities

Integration of social determinants of health with remote care utilization reveals differences across urban–rural

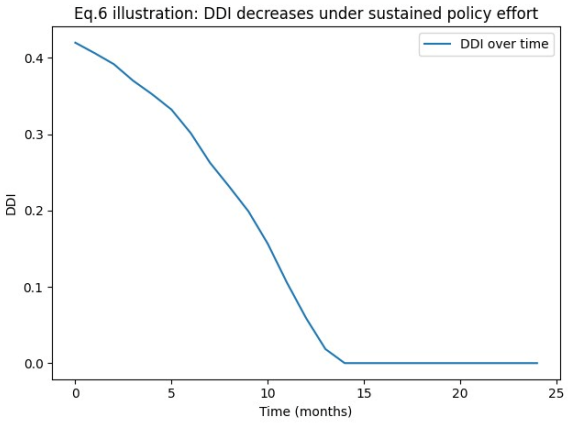
contexts. Greater support for disadvantaged groups can enhance engagement for populations at risk of severe outcomes, while expansion of remote-care access may benefit lower-income individuals and Medicare-eligible patients. Economic considerations further compound inequities: healthier populations, greater amounts of private insurance, and increased income correlate with reduced remote-care utilization expenses. Scale-up of reimbursements across all services and allow permanent reimbursement for care provided by non-physicians may enhance sustainability of remote care in urban areas; on the other hand, when scarce resources are allocated, consideration of whether expanded utilization leads to better health outcomes should guide support for temporal channeling.

Social determinants of health must be a key consideration when implementing remote care. Although health issues are the most important factor for individuals initiating remote care, populations with lower digital literacy, lower household income, and migration minorities are less likely to initiate - -members of these groups might benefit from more support and targeted communication to boost use of remote-care opportunities. In these communicational efforts, it is crucial to consider differences in the characteristics of the available channels. Enabling remote-care accesses for COVID-19 surges may be especially important for preventing its negative health consequences in lower-income populations and in regions with populations at relatively higher risks, such as those on Medicare. Providing additional support to increase remote-care access among those of lower income may also be considered.

6.1. Social Determinants of Health and Remote Care Utilization

The complexity of the social determinants of health model supports the multifactorial nature of health outcomes. Remote care utilization can be viewed through a similar lens, and while the benefits across the remote education and remote business sectors suggest improved access and equity, the evidence is nuanced and points to potentially deleterious impacts on a subsegment of at-risk patient cohorts. Low socioeconomic status is a consistently recognized barrier limiting health-seeking behavior, and the impact of the COVID-19 pandemic demonstrates the stark inverse relationships for some demographic cohorts within the large urban population of the United States. Several social determinants of health variables have been shown to impact digital literacy, capacity to access digital devices, level of engagement with remote technologies, and ability to self-manage complex health conditions such as diabetes, heart failure, and chronic obstructive pulmonary disease.

Accumulated socioeconomic disadvantages are linked to reduced digital health engagement and reduced health literacy. Current literature on home telemonitoring of patients with heart failure suggests that this mode of delivery may be safe and effective in a highly selected population but may not translate to wider health disparities, particularly among disadvantaged subgroups. Other studies indicate poorer uptake of remote health services, such as teleconsultations and telepsychotherapy, by vulnerable populations, risking widening access inequities. Current economic considerations lend weight to particular attention on adaptation and access by disadvantaged groups. While telemedicine services have proliferated rapidly, COVID-19-related reimbursement policies have primarily endorsed their short-term scalability rather than long-term sustainability.



Equation 6 (Equity-Oriented Policy Feedback Update)

Model how policy investment reduces inequity over time.

Step-by-step derivation (discrete-time feedback)

15. Let DDI_t be digital divide at time t.
16. Let $Policy_t$ be policy strength at time t (investment, subsidies, training, broadband expansion).
17. A standard feedback update says: *next state = current state − improvement + noise*

$$DDI_{t+1} = DDI_t - \eta\, Policy_t + \epsilon_t$$

Where:

- $\eta > 0$: how effective policy is per unit effort
- ϵ_t: random disturbances (implementation issues, market shifts, etc.)

So:

$$\boxed{DDI_{t+1} = DDI_t - \eta\, Policy_t + \epsilon_t}$$

6.2. Economic Considerations and Policy Implications

The interplay of social determinants of health and usage of remote care services reveals divergent influences for urban and rural populations. Economic stress emerges as a barrier for individuals living in cities, while implementing remote care is associated with greater economic resources for rural inhabitants. Payment mechanisms supporting traditional care services remain dominant - especially Medicare fee-for-service plans - while many urban centers have established wider payer coverage of these services. The levels of charging patients and organizations in charge of covering these expenses have a key role in their utilization. Despite evidence and guidelines supporting the clinical efficiency of remote care, the historic disparity between evidence generation and clinical practice utilization endures. The challenges in scaling remote care to the rural-population level are not so much due to a lack of willingness or recognition, but rather to fundamental

elements of health systems that do not yet favor its implementation.

From an economic standpoint, remote care does not appear to be a more cost-effective model, at least under the conditions in which it has been developed. Nevertheless, it remains a useful alternative and tool for supporting face-to-face care and managing a health crisis. Looking ahead, remote care needs solid, long-term analysis and to be embedded in routine practice supported by robust quality indicators. The economic rigor developed for face-to-face care also needs to be applied to remote care models, not only to consider cost-effectiveness but also to evaluate potential savings at the population level that allow for scaling and expansion of the range of services that can be delivered. Adopting such a systematic approach could help guide the reallocation of resources to a level more aligned with the epidemiological profile of rural communities and thus reduce the long-maintained urban-rural divide in health-level equity, not just in service access.

7.Conclusion

Growing numbers of remote care appointments were precipitated by the COVID -19 pandemic. Research to date indicates that COVID -19-related remote care models exhibited unequal access and utilization in urban and rural populations. In urban centres, where remote care services were abundant, telemedicine appeared a viable alternative for some patients but not for others; inequities related to digital literacy and technology access, along with low engagement and uptake among certain subgroups, could lead to worsening health outcomes. In rural communities, the utilisation of remote care services was curtailed by a lack of bandwidth, inadequate infrastructure, physician shortages, limited-service delivery models, and diminished reimbursement by payers. The available literature thus poses a challenge to the use of remote care via telemedicine during pandemics and for broader applications across the medical field. Despite its promise, differential access, utilization, and outcomes raise questions about the fairness and equity of remote care.

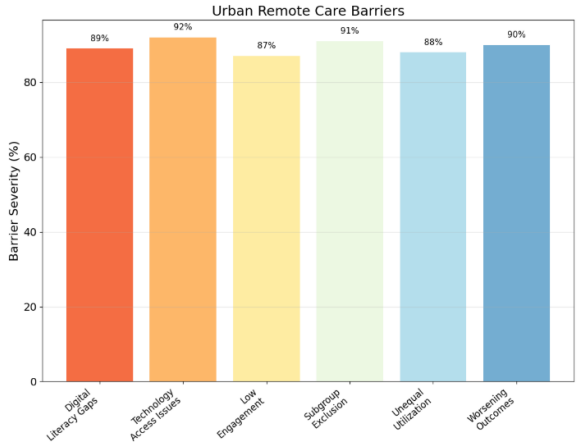


Figure 4: Urban Remote Care Barriers

Health-related social determinants helped reveal the impact of access considerations for urban and rural patients, particularly within the context of the COVID -19 pandemic. Never-before-seemingly-simple aspects of digital literacy and technology access became serious issues that need to be addressed, whereas in rural settings, existing problems with access, infrastructure, and workforce were cast into sharp relief. Dewan et al. provide further evidence that remote care service models have become successful only where scarce resources have been tailored to unique challenges, such as delivering care for both urban and rural populations living a distance from advanced services like critical care. For remote care services to be cost-effective and sustainable in the longer term, particularly after a pandemic, demands will need to be managed, and service reimbursement rates should reflect complexity rather than just time-based considerations.

7.1. Key Insights and Future Directions

Growing evidence indicates that specific segments of the urban population are benefiting from remote care, utilizing a wide range of platforms and services, agreeing with their application for a variety of use cases, and reporting positive therapy outcomes that meet or exceed traditional models on some quality indicators. However, within the urban area, the challenge lies in engaging those with lower engagement levels and addressing the barriers currently impeding utilization. In contrast, inequalities with respect to rural populations could hardly be greater. Access to technology and infrastructure telemedicine, far from offering an alternative for underserved communities, has simply introduced another barrier for those without quality internet access, devices suitable for the application, or sufficient digital literacy. Furthermore, in some areas, the limited presence of a healthcare workforce or specific tele- or e-service diminishes rather than expands access.

Only by considering remote care in combination with its social determinants can the disparity in participation, and consequently the outcomes of care, be clearly visualized. Financially, the question arises as to whether the adoption of remote care is creating a new health system that is potentially more efficient but can still respond appropriately during a public health emergency. In many instances, a lack of payer reimbursement, or an unclear future in relation to this aspect, remains a major barrier to a more widespread adoption of the technology.

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