



Telemedicine In Developing Countries: A Cross-Disciplinary Evaluation

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Abstract

Telemedicine has emerged as a revolutionary tool in healthcare delivery, particularly in developing countries, where access to quality medical services is often limited. This article provides a cross-disciplinary evaluation of telemedicine, exploring its technological, healthcare, and policy aspects. By integrating perspectives from public health, health informatics, and socio-economic development, we examine the potential of telemedicine to address the challenges of healthcare access, resource constraints, and rural health disparities in developing countries. The article also highlights the importance of policy support, infrastructure development, and cultural considerations in successfully implementing telemedicine systems.

Keywords: *Telemedicine, Healthcare access, Developing countries, Technology adoption.*

INTRODUCTION:

In the face of limited healthcare resources and infrastructure in many developing countries, telemedicine has emerged as a promising solution for enhancing healthcare access, especially for rural populations. Telemedicine leverages telecommunications technology to provide remote clinical services, health monitoring, and consultation, making healthcare more accessible and affordable. Despite its potential, challenges such as lack of infrastructure, regulatory issues, and resistance to technology adoption hinder the widespread implementation of telemedicine in these regions. This article examines the current state of telemedicine in developing countries, evaluating its technological feasibility, socio-economic impact, and policy framework. We also propose solutions to overcome the barriers to its adoption, drawing insights from multiple disciplines to guide future telemedicine development.

Technological Advancements in Telemedicine

Telemedicine has revolutionized the healthcare industry by enabling remote consultations, monitoring, and management of patient health. Over the years, advancements in technology have enhanced the scope and efficacy of telemedicine, making it a viable healthcare solution, especially for underserved and rural areas in developing countries. This section provides an overview of key telemedicine technologies, discusses the infrastructure requirements for telemedicine in developing countries, and explores the challenges faced in terms of internet

connectivity, hardware, and software availability.

1. Overview of Telemedicine Technologies and Tools

Telemedicine technologies encompass a variety of tools designed to provide healthcare services remotely. The main categories of these technologies include:

Video Consultations: One of the most widely used tools in telemedicine, video consultations enable real-time communication between patients and healthcare providers. Platforms such as Zoom Health, Doxy.me, and Telehealth apps integrate secure video conferencing to facilitate medical advice, diagnosis, and follow-up care. These systems have become particularly important in the wake of the COVID-19 pandemic, reducing the need for in-person visits while ensuring continued access to healthcare.

Remote Monitoring Devices: Remote patient monitoring (RPM) devices are used to track and transmit a patient's vital signs, such as heart rate, blood pressure, oxygen saturation, and glucose levels. These devices, including wearable sensors and diagnostic tools, enable continuous monitoring of chronic conditions, facilitating early intervention. Examples of RPM devices include Fitbit, Apple Watch, and specialized medical devices like blood glucose meters and ECG monitors.

Mobile Health Apps: Mobile health (mHealth) apps are widely used in telemedicine for managing patient care, collecting health data, and offering virtual consultations. Apps like MyChart, Medisafe, and Doctor on Demand enable patients to access healthcare services directly through their smartphones, track medication schedules, and book appointments. These apps also allow for easy sharing of health data between patients and doctors, improving communication and treatment outcomes.

2. Infrastructure Requirements for Telemedicine in Developing Countries

To successfully implement telemedicine in developing countries, certain infrastructural elements must be in place:

Reliable Internet Connectivity: High-speed internet is essential for seamless video consultations and data transmission in telemedicine. In many developing countries, especially rural regions, internet access can be intermittent or slow. Therefore, efforts need to focus on expanding internet infrastructure, improving broadband penetration, and ensuring stable connections for telemedicine services to function effectively.

Telecommunication Networks: A robust telecommunication network is required to support telemedicine tools. This includes mobile networks, which are vital in countries where mobile phones are more prevalent than landlines. In rural or remote areas, extending mobile network coverage can enable greater access to telemedicine, where patients can consult doctors via mobile phones.

Healthcare Infrastructure and Equipment: Developing countries often face challenges related to insufficient healthcare infrastructure, such as a lack of hospitals, clinics, and qualified healthcare providers. Telemedicine can be a solution to these gaps, but it requires investments in medical devices, telemedicine platforms, and IT infrastructure. This includes telemedicine

workstations equipped with computers, cameras, and secure communication software.

Training and Capacity Building: Healthcare providers in developing countries may need training to effectively use telemedicine tools. The healthcare workforce must be educated in operating remote monitoring devices, using video conferencing software, and managing electronic health records (EHR). Similarly, patients must be trained to use mobile health apps or devices for remote monitoring.

3. Challenges Related to Internet Connectivity, Hardware, and Software Availability

While telemedicine holds great promise, several challenges hinder its implementation in developing countries:

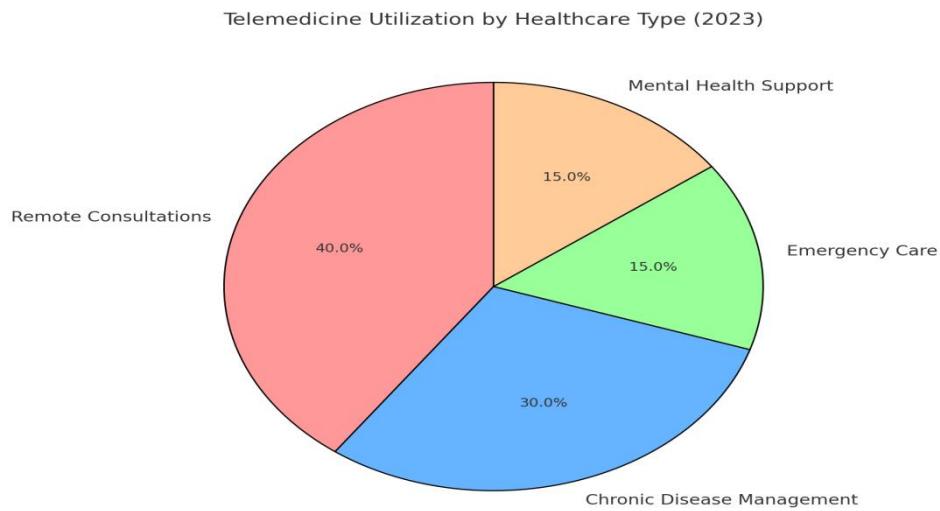
Limited Internet Access: One of the most significant barriers to telemedicine adoption in developing countries is limited or unreliable internet connectivity. In rural areas, access to high-speed internet is often unavailable, making video consultations and real-time monitoring difficult. Without stable internet connections, telemedicine platforms face delays, low-quality video, or complete failures, ultimately impacting the quality of healthcare delivery.

High Cost of Technology: The cost of telemedicine equipment, such as remote monitoring devices, video conferencing tools, and health apps, can be prohibitively high in developing countries. Many healthcare facilities lack the financial resources to invest in advanced technology, hindering the scalability of telemedicine. Additionally, the cost of internet data and mobile plans for both healthcare providers and patients may limit access to telemedicine services.

Software Compatibility and Integration: Another challenge is the compatibility and integration of telemedicine software with existing healthcare systems, such as electronic health records (EHR) and hospital information systems (HIS). Many developing countries still rely on paper-based records, and transitioning to digital systems can be a significant barrier. Moreover, healthcare software solutions may not always be tailored to local needs, requiring further customization and localization.

Data Security and Privacy Concerns: The use of telemedicine tools raises concerns about data security and patient privacy, especially in countries with weak data protection laws. Securing patient health information during remote consultations, storage, and transmission is critical to building trust in telemedicine services. Developing countries may lack the necessary cybersecurity infrastructure, making healthcare data vulnerable to breaches.

Digital Literacy: Both healthcare providers and patients in developing countries may have limited digital literacy. Without proper training in using telemedicine tools, such as mobile health apps and remote monitoring devices, individuals may be unable to take full advantage of these technologies. There is a need for initiatives to improve digital literacy to ensure the successful adoption of telemedicine.



Graph 2: Telemedicine Utilization by Healthcare Type (2023)

Description: A pie chart representing the distribution of telemedicine use across different healthcare services (e.g., remote consultations, chronic disease management, emergency care, mental health support) in developing countries.

Healthcare Access and Equity in Telemedicine

Telemedicine plays a critical role in improving healthcare access and promoting equity, particularly in rural and underserved regions of developing countries. By leveraging technology, telemedicine reduces barriers related to distance, cost, and availability of healthcare professionals, ensuring that more people can receive timely and effective medical care. This section explores how telemedicine improves access, enhances healthcare delivery, and examines successful case studies from developing countries.

1. Improving Healthcare Access in Rural and Underserved Regions

In many developing countries, rural areas often lack adequate healthcare infrastructure, with hospitals, clinics, and qualified medical professionals concentrated in urban centers. Telemedicine addresses this disparity by providing remote access to healthcare services. Patients in remote villages can consult specialists without traveling long distances, which is particularly valuable for those with mobility issues, chronic illnesses, or limited financial resources.

Remote Consultations: Video consultations and telephonic consultations allow patients to speak with doctors in urban centers or even internationally. This reduces the need for travel and associated costs.

Mobile Health Services: mHealth apps and mobile clinics equipped with telemedicine tools can reach isolated communities, offering preventive care, diagnostic support, and follow-up services.

By making healthcare services accessible in geographically isolated regions, telemedicine directly contributes to reducing health inequities.

2. Enhancing Healthcare Delivery and Reducing Wait Times

Telemedicine can streamline healthcare delivery, improve patient outcomes, and reduce wait times in overburdened healthcare systems:

Efficient Resource Allocation: Hospitals and clinics can prioritize in-person appointments for patients requiring urgent or complex care, while routine consultations and follow-ups are conducted via telemedicine.

Reduced Patient Load: By managing non-critical cases remotely, telemedicine decreases overcrowding in healthcare facilities, allowing providers to focus on critical patients.

Continuity of Care: Patients with chronic illnesses benefit from remote monitoring, regular virtual check-ins, and timely interventions, reducing complications and hospitalizations.

This efficiency improves the overall quality of healthcare services and enhances equity by ensuring that underserved populations are not left behind.

3. Bridging the Gap in Healthcare Disparities

Telemedicine reduces disparities in healthcare by addressing socioeconomic and geographical barriers:

Cost Reduction: Remote consultations reduce travel and accommodation costs, making healthcare more affordable for low-income populations.

Access to Specialists: Patients in rural or remote areas can access specialists who would otherwise be unavailable locally, bridging the expertise gap.

Cultural and Language Adaptations: Telemedicine platforms can offer services in local languages and culturally sensitive care, improving patient engagement and adherence.

By integrating technology into healthcare systems, telemedicine promotes a more equitable distribution of healthcare resources.

4. Case Studies from Developing Countries

India – eSanjeevani Telemedicine Platform

Launched by the Ministry of Health, this platform provides free teleconsultations to rural populations. It has facilitated millions of online consultations, especially during the COVID-19 pandemic, reducing patient travel and improving access to specialists.

Bangladesh – Telehealth for Rural Communities

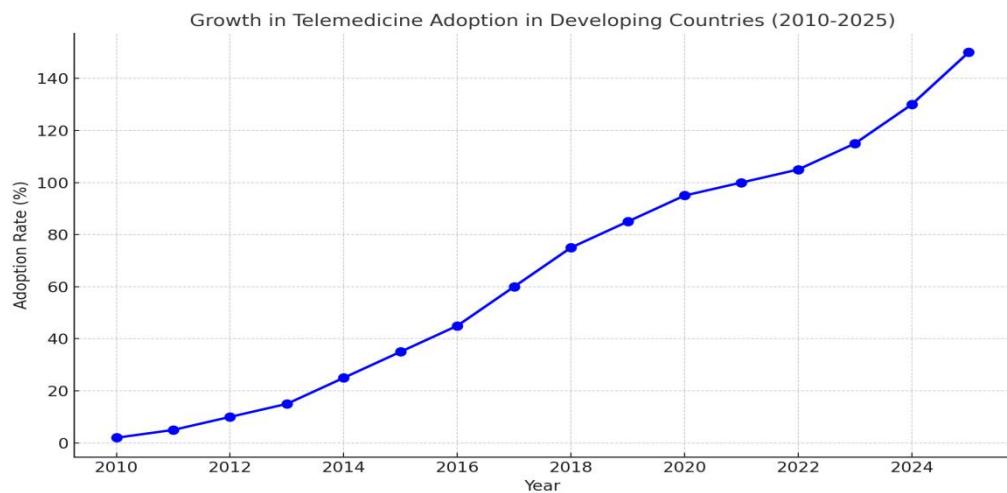
Telemedicine initiatives in Bangladesh have connected rural health centers to urban hospitals, enabling remote consultations for maternal and child health, infectious diseases, and chronic conditions. This model has significantly improved healthcare reach in isolated communities.

Pakistan – Sehat Kahani

Sehat Kahani is a telemedicine platform connecting women doctors with underserved patients in rural Pakistan. By leveraging mobile technology, it provides remote consultations, follow-up care, and health education, improving access and reducing health disparities in remote regions.

Kenya – AMPATH Telemedicine Program

AMPATH's telemedicine initiative links rural clinics with specialists in urban hospitals, enabling real-time consultation and remote patient monitoring. This program has reduced delays in diagnosis and treatment, improving healthcare equity across rural populations.



Graph 1: Growth in Telemedicine Adoption in Developing Countries (2010-2025)

Description: This line graph shows the increase in telemedicine adoption across various developing countries from 2010 to 2025. The graph highlights the rapid growth of telemedicine due to advancements in mobile technology and internet penetration.

Policy and Regulatory Framework for Telemedicine

Telemedicine has emerged as a crucial tool for expanding healthcare access, particularly in developing countries. However, its successful implementation requires a robust policy and regulatory framework that addresses the technological, legal, and ethical concerns associated with remote healthcare delivery. This section discusses existing telemedicine policies in developing countries, the role of governments and international organizations, and the regulatory and legal challenges related to telemedicine.

1. Existing Telemedicine Policies in Developing Countries and Their Effectiveness

Many developing countries have started implementing telemedicine policies to address the gap in healthcare services, particularly in remote and underserved regions. These policies vary in scope and effectiveness based on the country's healthcare infrastructure, technological capabilities, and regulatory environment.

India: The Indian government launched the **National Telemedicine Service (eSanjeevani)** to provide remote consultations and healthcare services to rural populations. This initiative was successful during the COVID-19 pandemic, providing over 30 million consultations. However, challenges remain, including the integration of telemedicine services into existing healthcare frameworks and ensuring broad coverage in remote areas.

Bangladesh: The **Telemedicine Policy** in Bangladesh was introduced to improve healthcare delivery in rural areas. It aims to reduce health disparities by offering virtual consultations with specialists. While the policy has enhanced access to healthcare in underserved regions, it still faces obstacles in scaling up services and addressing the quality control of telemedicine practices.

South Africa: South Africa has implemented the **eHealth Strategy**, which includes telemedicine as a key component. It has focused on integrating telemedicine with the national healthcare system, providing remote monitoring and consultation services to marginalized communities. However, the policy's implementation has been hampered by financial constraints and limited technological infrastructure in rural areas.

The effectiveness of telemedicine policies in these countries has been mixed, with successes in expanding access but ongoing challenges in infrastructure development, regulatory oversight, and equitable access.

2. The Role of Governments and International Organizations in Promoting Telemedicine

Governments and international organizations play a pivotal role in the promotion and regulation of telemedicine. Their support is essential for establishing sustainable and effective telemedicine services.

Government Support: Governments are responsible for creating policies that facilitate telemedicine adoption, providing funding for infrastructure, and ensuring healthcare professionals are trained to use telemedicine technologies. Some key roles governments play include:

Policy and Regulatory Frameworks: Governments create national telemedicine policies that ensure quality care while addressing privacy concerns and ethical considerations.

Infrastructure Development: Governments invest in technological infrastructure such as broadband internet, mobile networks, and healthcare facilities to support telemedicine services in underserved areas.

Telemedicine Reimbursement: Governments can create reimbursement policies that encourage healthcare providers to adopt telemedicine by reimbursing virtual consultations at similar rates to in-person visits.

International Organizations: International bodies like the **World Health Organization (WHO)**, **International Telecommunication Union (ITU)**, and the **World Bank** play a significant role in advocating for telemedicine globally. They:

Provide Technical Assistance: They assist countries in developing and implementing telemedicine systems by providing technical expertise and funding.

Create Global Standards: WHO and other organizations are working to create global standards and guidelines for telemedicine, ensuring that services are provided with the highest quality and adhere to ethical standards.

Support Capacity Building: These organizations also support the training of healthcare providers and administrators on the use of telemedicine tools and systems.

3. Regulatory and Legal Challenges Related to Telemedicine

While telemedicine offers numerous benefits, its widespread implementation raises several regulatory and legal challenges that need to be addressed:

Patient Privacy and Data Security: One of the most critical concerns in telemedicine is safeguarding patient privacy and ensuring the security of health data. Since telemedicine relies heavily on the internet and electronic health records (EHRs), there is an increased risk of data breaches and unauthorized access to sensitive health information.

Data Protection Regulations: Many countries lack comprehensive data protection regulations for telemedicine. Some have adopted frameworks similar to the **General Data Protection Regulation (GDPR)** in the European Union, but compliance with these laws remains a challenge in many developing nations.

Cybersecurity: Telemedicine systems must be protected from cyberattacks, hacking, and malware, which require robust encryption technologies, secure networks, and continuous monitoring.

Cross-Border Healthcare Delivery: Telemedicine often involves healthcare providers and patients from different countries, which raises issues related to jurisdiction, liability, and regulatory compliance. For instance:

Licensing and Professional Standards: In cross-border telemedicine, healthcare providers may be required to hold licenses in the patient's home country. The absence of international agreements on medical licensing creates a barrier to providing telemedicine services across borders.

Regulatory Variance: Different countries have different standards for telemedicine practice, which can create confusion and legal complexities when services cross borders.

Reimbursement and Legal Liability: In many countries, telemedicine services are not reimbursed at the same rate as in-person consultations. Legal liability also becomes a concern in case of misdiagnosis or improper treatment delivered through telemedicine, as the responsibility for such incidents may be unclear.

Telemedicine Reimbursement Policies: In some developing countries, telemedicine services are not reimbursed by national health systems, limiting the financial viability of telemedicine for healthcare providers.

Medical Malpractice: Without clear legal frameworks, healthcare providers may be hesitant to engage in telemedicine services due to concerns about malpractice suits arising from remote

consultations.

Regulatory Gaps in Telemedicine Standards: Some countries lack specific regulations regarding the quality of telemedicine services, such as guidelines on the use of medical equipment, telemedicine ethics, and the scope of remote consultations. Standardization of these practices is essential to ensure the safety and efficacy of telemedicine services.

Economic and Social Impacts of Telemedicine

Telemedicine has emerged as a transformative tool in healthcare, not only improving access but also reducing costs and providing economic benefits. It can reshape healthcare delivery by optimizing resources, enhancing efficiency, and generating new job opportunities. Additionally, social factors such as cultural acceptance and patient trust significantly influence the successful adoption of telemedicine. This section explores the cost-effectiveness of telemedicine, its economic benefits, and the social factors that impact its widespread use.

1. The Cost-Effectiveness of Telemedicine in Reducing Healthcare Costs for Both Providers and Patients

Telemedicine offers significant potential to reduce healthcare costs for both providers and patients. By leveraging technology to provide remote consultations, continuous monitoring, and reduced need for physical infrastructure, telemedicine has proven to be a cost-effective alternative to traditional healthcare delivery.

Reduced Patient Costs: Telemedicine eliminates the need for patients to travel long distances to see specialists, particularly in rural or underserved areas. This reduces transportation costs, travel time, and accommodation expenses. For patients with chronic conditions or ongoing health needs, telemedicine helps to minimize outpatient visits and hospitalizations, reducing overall treatment costs.

Lower Infrastructure and Operational Costs for Providers: Healthcare providers can reduce costs associated with building and maintaining physical infrastructure. Virtual consultations allow providers to serve more patients without needing additional space, staff, or equipment. By using telemedicine, healthcare facilities can increase the number of consultations and improve resource utilization.

Improved Resource Allocation: Telemedicine enables more efficient use of healthcare professionals' time. Routine follow-up consultations, minor health issues, or administrative tasks can be managed remotely, freeing up time for healthcare providers to focus on critical cases. This leads to better allocation of healthcare resources and reduces unnecessary in-person visits that would otherwise increase operational costs.

Cost-Effectiveness in Chronic Disease Management: Remote monitoring of patients with chronic conditions like diabetes, hypertension, or heart disease can prevent hospitalizations by identifying issues early. This early intervention is generally less expensive than treating an acute event at the hospital, making telemedicine a cost-effective option for managing long-term health conditions.

2. The Economic Benefits of Telemedicine in Terms of Job Creation and Resource Optimization

Telemedicine not only saves healthcare costs but also provides significant economic benefits through job creation and resource optimization in the healthcare sector:

Job Creation: Telemedicine platforms require professionals in several fields, including healthcare providers, IT specialists, data analysts, and customer service personnel. By developing and expanding telemedicine infrastructure, new job opportunities emerge, particularly in rural areas where healthcare employment might be scarce. Jobs related to telemedicine technology development (e.g., software engineers, cybersecurity experts) are also on the rise, contributing to the broader tech sector.

Healthcare Workforce Expansion: In regions where there is a shortage of healthcare professionals, telemedicine allows a broader workforce to participate in patient care. For example, general practitioners can remotely consult with patients, while specialists can offer expertise from afar. This expanded workforce helps to reduce the gap in healthcare delivery, improving overall efficiency and access.

Resource Optimization: Telemedicine helps healthcare systems optimize the use of resources, including medical equipment, healthcare staff, and physical space. By enabling remote consultations, fewer resources are needed for in-person visits, such as examination rooms or administrative staff to manage patient flow. Additionally, telemedicine encourages the use of AI and machine learning in diagnostics, further optimizing resource use in healthcare systems.

Economic Growth and Healthcare Industry Growth: As telemedicine grows, it attracts investment, stimulates economic growth in the health-tech sector, and increases demand for telehealth services. The healthcare sector becomes more efficient, and the country's overall health index improves, indirectly contributing to higher productivity levels and economic growth.

3. Social Factors Influencing the Adoption of Telemedicine, Including Cultural Acceptance and Patient Trust

While telemedicine offers substantial economic and healthcare benefits, its success in developing countries depends significantly on social factors, particularly cultural acceptance and patient trust.

Cultural Acceptance: In many cultures, face-to-face interactions with healthcare providers are deeply rooted in traditional healthcare practices. In rural or conservative areas, people may be hesitant to adopt telemedicine, as they might prefer in-person consultations with doctors who are viewed as more trustworthy. Overcoming cultural barriers to telemedicine adoption often requires addressing these concerns through community outreach, education, and cultural sensitivity.

Patient Trust: For telemedicine to succeed, patients need to trust the technology and the healthcare professionals delivering care remotely. Trust is built over time, and its development depends on factors such as:

Quality of Service: Patients are more likely to adopt telemedicine if the quality of care is high, and they receive timely and accurate diagnoses. Providers who offer virtual consultations that are as effective as in-person visits can instill greater trust in telemedicine services.

Data Security and Privacy: One of the major concerns patients have about telemedicine is the privacy and security of their health data. Telemedicine platforms that prioritize strong encryption, secure communication channels, and transparent data policies can help build patient confidence. Patients must be assured that their medical information is safe from cyber threats and breaches.

Digital Literacy and Inclusivity: The level of digital literacy among patients, especially in rural areas, plays a significant role in the adoption of telemedicine. For telemedicine to be effective, patients need basic knowledge of how to use the technology (e.g., smartphones, computers, apps). Providing digital literacy training and making technology accessible to the elderly and low-income groups is crucial for broader adoption.

Government and Institutional Support: Public perception of telemedicine also depends on the role of governments and healthcare institutions in supporting and regulating telemedicine services. Policies that encourage telemedicine adoption, including reimbursement schemes for teleconsultations, can increase public trust in these services.

Summary:

Telemedicine has significant potential to improve healthcare access in developing countries by overcoming geographical and economic barriers. Technologically, the adoption of mobile-based solutions and teleconsultations has become more feasible, with growing internet access and mobile phone penetration. Despite these advancements, challenges such as inadequate infrastructure, lack of regulatory support, and cultural resistance remain substantial barriers to widespread implementation.

From a policy perspective, governments must establish comprehensive frameworks to support telemedicine, ensuring the protection of patient data, promoting digital health literacy, and encouraging private and public sector partnerships. Additionally, the economic impact of telemedicine should be closely examined, as it holds promise not only for improving healthcare outcomes but also for creating economic opportunities through new jobs and services.

Ultimately, telemedicine represents a vital tool for enhancing healthcare delivery in resource-limited settings, but its success depends on overcoming infrastructural, regulatory, and cultural challenges. Through interdisciplinary efforts across technology, policy, and social sciences, telemedicine can become an integral part of the healthcare landscape in developing countries, contributing to a more equitable and efficient healthcare system.

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