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# Lost in the Digital Divide: Telehealth Access and the Struggle for Healthcare Equity in Puerto Rico.

Ermelinda Calderón

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Faculty Advisor: Eugene Raikhel
Preceptor: Daniel J. Sonnenstuhl
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**Abstract**

As digital health technologies redefine care delivery globally, Puerto Rico faces urgent and unique challenges. Although a U.S. territory, its healthcare infrastructure more closely resembles that of low- and middle-income countries, creating a stark disconnect between federal digital health policies and on-the-ground realities. The island stands at the intersection of two incompatible systems: one that presumes digital readiness, and another shaped by underinvestment, disaster vulnerability, and systemic neglect. This thesis examines how digital determinants of health, broadband access, power stability, and digital literacy, impact telehealth equity in Puerto Rico. Based on 16 in-depth interviews and 33 patient surveys, findings reveal that systemic disparities disproportionately affect rural and elderly populations. However, community-led pilot programs demonstrate that localized, culturally responsive solutions can bridge the divide. To advance digital health equity, this research proposes a multi-level policy framework focused on infrastructure modernization, permanent reimbursement parity, and a Digital Health Navigator workforce, reframing digital health as a public health equity imperative.

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## Introduction

Digital health broadly refers to the use of technology platforms and telecommunications to deliver health services, manage patient care, and promote wellness. It encompasses telemedicine, remote patient monitoring, health information platforms, and mobile health applications (Ronquillo et al., 2023). While digital health technologies promise significant improvements in healthcare accessibility and efficiency, their effectiveness depends heavily on reliable digital infrastructure, including broadband internet connectivity, stable electricity supply, and digital literacy among users (Yeung et al., 2023). Digital health can potentially transform healthcare delivery; however, it faces substantial global challenges shaped significantly by socioeconomic conditions and technological infrastructure (Stoumpos, 2023).

Research consistently highlights the transformative impact of telemedicine, particularly in chronic disease management such as diabetes care. Ezeamii et al. (2024) concluded that telehealth could revolutionize global healthcare by improving patient engagement, glycemic control, reducing costs, and enhancing access and satisfaction through lowered no-show rates and overcoming geographic barriers. This is indicative that telemedicine, especially within hybrid healthcare models, is recognized as a powerful tool with considerable potential for enhancing equitable healthcare delivery.

Despite ample scholarly attention to telemedicine's benefits, critical gaps persist regarding disparities in digital literacy and access limitations. While extensive research documents telemedicine successes in high-income countries, Puerto Rico occupies a unique yet often overlooked position as a U.S. territory facing healthcare infrastructure challenges akin to low- and middle-income countries (LMICs) but governed by policies designed for higher-income

contexts. This mismatch exacerbates health disparities, highlighting the need for context-specific research.

This thesis addresses a critical gap by examining systemic barriers affecting telemedicine access in Puerto Rico, especially in the aftermath of recent disruptions such as Hurricane Maria (2017) and the COVID-19 pandemic. It aims to explore how digital determinants of health, factors including broadband access, power stability, digital literacy, and technology adoption, impact telehealth accessibility and effectiveness in Puerto Rico. The existing literature, while robust in examining social, political, and structural determinants of health, lacks a comprehensive analysis of these digital determinants, particularly within contexts like Puerto Rico, where infrastructural vulnerabilities intersect with persistent socioeconomic inequalities. Consequently, this research not only fills an essential knowledge gap but also offers valuable insights applicable to similar low-resource settings.

The foundational weaknesses in Puerto Rico's digital infrastructure became starkly evident following Hurricane Maria, which severely damaged the island's electrical grid and telecommunications networks. At the peak of the crisis, approximately 96% of telecommunications cell sites were non-functional, critically disrupting communication and healthcare access (United States Government Accountability Office, 2021). Unlike other U.S. regions, where telehealth became a viable emergency alternative, Puerto Rico's compromised infrastructure severely limited its capacity to transition effectively to virtual care. The subsequent global push toward telemedicine during the COVID-19 pandemic further highlighted Puerto Rico's widening digital divide. Literature emphasizes the transformative potential of telemedicine, yet often overlooks how digital divides intensify existing healthcare inequities. In

Puerto Rico, populations historically facing poorer health outcomes remain underserved due to inadequate access to reliable technology, limited internet connectivity, and insufficient digital literacy, barriers disproportionately affecting older adults and socially disadvantaged communities (Federal Communication Commission, 2023). These barriers align closely with the findings of this research, reinforcing the necessity of equitable implementation to ensure all populations benefit from digital health advancements.

Employing qualitative methodologies, including semi-structured interviews with healthcare providers and residents, and open-response surveys, this research examines infrastructural barriers such as inadequate broadband coverage, frequent power outages, and limited digital literacy. The findings highlight how infrastructural fragility and digital disparities actively intensify existing healthcare inequalities. Healthcare professionals underscored during interviews that digital health ideally provides convenience, accessibility, and improved patient outcomes; however, systemic challenges in Puerto Rico, exacerbated by Hurricane Maria's aftermath and continuing through COVID-19, revealed persistent energy instability, inadequate broadband coverage, and significant digital literacy deficits, especially among older adults and rural populations.

Despite these substantial challenges, promising community-based initiatives demonstrate potential pathways to bridge digital divides. Robust partnerships between hospitals and community organizations have successfully addressed barriers related to digital determinants, highlighting community involvement as an effective strategy for enhancing telehealth equity. Therefore, this thesis argues that digital infrastructure is not merely a technological issue; it is a matter of public health equity. Digital determinants of health, such as broadband access, power

reliability, and digital literacy, are critical yet underexamined barriers to telehealth in Puerto Rico. Addressing these disparities requires comprehensive policy interventions that prioritize infrastructure investment, enhanced digital literacy programs, community engagement, and robust regulatory frameworks aimed at ensuring equitable technology access and system resilience. I centered patient intersectionality, recognizing overlapping vulnerabilities related to age, socioeconomic status, and geographic isolation. This research shows the urgency of addressing digital determinants in order to fulfill the potential of digital health in Puerto Rico and similar underserved contexts

## Literature Review

### *Digital Health*

Digital health technologies have become central to healthcare transformation, particularly during the COVID-19 pandemic, demonstrating considerable potential to enhance accessibility, efficiency, and the quality of healthcare delivery (Badr et al., 2024). Despite widespread adoption, however, digital health interventions have not consistently realized their full potential. Barriers include restrictive governmental policies, complex reimbursement models, technological design limitations, and disparities in digital literacy across communities (Badr et al., 2024; Holmes Fee et al., 2023). Telehealth, a key component of digital health, offers a promising solution for extending healthcare access to individuals who face challenges in receiving in-person care and may help reduce health disparities.

Recent scoping reviews reveal significant knowledge gaps regarding how digital transformation influences broader health determinants and impacts health equity. Van Kessel et al. (2024), through a systematic review of 204 studies, found that digitalization reshapes, not merely adds to, existing social and political determinants of health. The World Health Organization (WHO) identified nearly one-quarter of 127 digital determinants as requiring urgent policy intervention, including bridging the digital divide, developing ethical frameworks, improving internet access, and ensuring algorithmic fairness. Badr et al. (2024) further noted that research on digital health equity has focused primarily on individual-level disparities (e.g., age, race, income) while neglecting broader contextual factors such as policy structures, economic conditions, and infrastructure. These omissions limit our understanding of how digital health technologies shape the social distribution of healthcare and potentially exacerbate disparities.

Moreover, intermediary determinants, such as digital literacy, user trust, and technology usability, remain underexplored but are critical to understanding digital health inequalities.

### *Digital Determinants of Health*

Digital Determinants of Health (DDH) is an emerging concept that expands the classic framework of social determinants of health into the digital realm (Fraser et al., 2023). DDH refers to the digital and technological factors that influence health outcomes and equity. Chidambaram et al. (2024) propose that these determinants, such as the usability, affordability, and accessibility of telemedicine platforms, can either enhance or hinder healthcare access, depending on how they are implemented. These digital determinants are deeply embedded in political, societal, and economic systems and have the potential to magnify existing health inequities (Fraser et al., 2023). Recognizing the importance of internet access and ICT literacy, organizations such as the WHO have begun formally acknowledging digital factors as fundamental to health equity. As digital transformation accelerates, scholars argue that addressing DDH is essential to prevent the exclusion of vulnerable populations from technological advances in healthcare.

### *Telehealth and the COVID-19 Pandemic*

Globally, the COVID-19 pandemic catalyzed an unprecedented surge in telehealth adoption as in-person visits were restricted (Kumar Vaidhyam & Huang, 2023). In high-income countries, telehealth rapidly became a frontline care modality. For example, in the U.S., telehealth accounted for nearly 30% of outpatient visits at the pandemic's peak; a 23-fold

increase from pre-pandemic levels (Patel et al., 2021). However, this rapid growth revealed stark digital divides. Patel et al. (2021) observed lower telemedicine use in high-poverty and rural communities, despite similar declines in overall healthcare utilization. Barriers such as limited broadband access, insufficient devices, and a lack of digital familiarity disproportionately affected disadvantaged populations. Rural residents, in particular, had reduced access to telehealth, underscoring geographic disparities in digital infrastructure.

Studies consistently identify vulnerable demographic groups at risk of exclusion from telehealth services. These include older adults, low-income individuals, racial and ethnic minorities, and non-English speakers. Alkureishi et al. (2022) found that older Medicaid patients, particularly those from minority backgrounds or with limited English proficiency, often struggled with video visits due to technical challenges. In low- and middle-income countries (LMICs), limited internet penetration and an underdeveloped health IT infrastructure further exacerbate access issues. Holly et al. (2024) emphasize that bridging connectivity gaps and expanding access to digital devices are prerequisites for equitable digital health delivery. The literature makes clear that telehealth's promise can only be fulfilled if fundamental digital determinants, connectivity, literacy, and affordability, are addressed alongside clinical innovation.

*The Evolution of Digital Health Technologies*

Digital health technologies, ranging from mobile apps and wearable devices to electronic health records and data analytics, have redefined healthcare delivery (Jongsma, 2021). Initially focused on self-monitoring, these technologies now augment and replace traditional in-person care. Home-based telemonitoring has emerged as a tool for reducing hospital visits and improving patient oversight (Lucivero, 2018; Mahtta et al., 2021). Yet while digital tools promise

more data-driven and patient-centered care, they raise ethical and practical concerns, including data privacy risks, technological overdependence, and the potential to worsen health inequities. As mobile technology becomes more prevalent, digital health creates new opportunities, but its benefits are unevenly distributed due to structural, commercial, and economic barriers. Without targeted interventions, historically marginalized populations may continue to face disproportionate challenges in accessing and benefiting from digital health innovations (Chidambaram, 2024; Lyles et al., 2022).

*Digital Infrastructure in Puerto Rico*

Hurricane Maria's 2017 landfall in Puerto Rico triggered the longest blackout in U.S. history and devastated the island's already fragile healthcare and broadband infrastructure (Rodríguez-Madera et al., 2021). The hurricane disrupted internet access, impeding both healthcare delivery and telehealth development. Although 78.8% of Puerto Ricans had access to fixed broadband pre-hurricane, rural regions were significantly underserved; only 77.8% of 207,000 rural residents had broadband, compared to 99.8% of nearly 3 million urban residents (NTIA, 2024). This rural-urban gap became a major barrier to telehealth implementation during the COVID-19 crisis.

Phuong et al. (2023) reported that prolonged power outages, along with the destruction of cell towers and internet cables, effectively severed digital connectivity. Thousands of excess deaths after Maria were attributed to delays in care caused by communication failures and lack of power (Mozumbder et al., 2023). While stopgap measures like satellite phones were temporarily employed, the disaster underscored how deeply healthcare is tied to digital and energy infrastructure. Post-Maria recovery reports have since called for modernizing Puerto Rico's

infrastructure, including investing in solar power and resilient telehealth systems. Nearly 79% of surveyed stakeholders agreed that such technologies would better support future disaster response (Mozumder et al., 2023).

The COVID-19 pandemic brought a different kind of disruption that simultaneously spurred digital health expansion and exposed persistent access barriers. Puerto Rico enacted emergency policies to scale up telehealth, including expanded insurance reimbursement and relaxed regulatory barriers (NACHC, 2023). Federally qualified health centers, including those in Puerto Rico, rapidly adopted telehealth to maintain essential services. The island's Department of Health positioned telemedicine as a strategic response to mobility limitations and provider shortages (Puerto Rico DOH, 2021). However, Phuong et al (2023) suggest that low-income and elderly patients might struggle with virtual visit technology or lack home internet access. Clinics offering phone or video visits can not reach patients in remote areas affected by energy instability or broadband gaps.

Even as telehealth surged, Puerto Rico's aging electrical grid and uneven connectivity limited its sustainability. Disruptions from earthquakes in 2020 and continued grid failures into 2022 disrupted virtual care delivery. These crises highlight that policy efforts alone are insufficient; structural investments in broadband and energy resilience are essential to prevent telehealth breakdown during emergencies. As Taglang (2023) concludes, digital health equity depends not just on expanding access but on fortifying the infrastructure required to support it, especially in times of crisis.

## Methods

Although health inequities have been widely studied, there is limited research specifically focused on the island of Puerto Rico, particularly regarding digital health inequities. Most digital health research has emphasized challenges based on a country's level of development. In low- and middle-income countries, issues such as affordability, infrastructure, and system capacity are central, while high-income countries like the United States tend to grapple with data privacy, misinformation, and platform interoperability. However, Puerto Rico occupies a unique and often overlooked position: it is a U.S. territory subject to federal policies designed for high-income contexts, yet it faces infrastructure challenges more aligned with low- and middle-income. This research aims to fill that gap in the literature, especially as the field of digital determinants of health, which gained attention during the pandemic, has largely focused on high-income countries. I aim to explore the sources of health inequities in Puerto Rico and the impact of recent events, specifically Hurricane Maria and the COVID-19 pandemic, on the island's digital healthcare system. I also examine how both patients and healthcare providers navigated the shift to digital care. To answer these questions, I conducted interviews with public health officials, digital health consultants, and healthcare providers to understand how the health system transitioned to digital care and how that affected access and outcomes. Additionally, I distributed qualitative surveys to gather patient perspectives. Originally, I had planned to include patients in interviews, but Tropical Storm Ernesto made patient recruitment challenging. Open-response surveys, supported by a research assistant based in Puerto Rico, became a more feasible method for collecting patient voices and narratives

**Interviews and Analysis**

Recruitment began in the Summer of 2024 after I was awarded the Earl Franklin Research Scholarship. I contacted over 35 healthcare stakeholders to schedule interviews. Due to Tropical Storm Ernesto in August, many in-person interviews were disrupted. I identified providers working in both urban and rural areas who offered telehealth services during the pandemic. I found them via LinkedIn and organizational websites and then reached out to schedule interviews. I also used snowball sampling, asking participants to refer colleagues with relevant telehealth experience. This resulted in 9 interviews, while the rest were from direct outreach. Of the 16 interviews conducted, 7 were via Zoom or phone, and 9 were in person. Although I preferred in-person interviews, frequent travel between Puerto Rico and Chicago was not feasible. A list of interviewees, including pseudonyms, locations, professions, and interview formats, can be found in Appendix A. However, below I am providing an overview of the interview participants.

| Location | Participant Type | Details |
|---|---|---|
| Urban | Healthcare Providers (4) | ● 2 Psychologists (mental health services during COVID-19)<br>● - 2 Internal Medicine Doctors (primary care and chronic disease monitoring) |
| | Public Health Professionals (3) | ● Epidemiologist (government and academia)<br>● Biostatistician and Health Policy Implementer<br>● Digital Health Consultant |
| Rural | Healthcare Providers (5) | ● 3 Primary Care Providers<br>● 2 Psychologists (mental health services) |
| | Epidemiologist (2) | ● Involved in local health system operations |
| | Public Health professor (1) | ● Led digital health projects |

**Patient Survey Distribution**

To understand patients' experiences with telehealth, I designed a brief, open-ended survey focused on accessibility, satisfaction, and frequency of telehealth use during the COVID-19 pandemic. The survey was initially distributed online through email invitations, Facebook community groups, and physical flyers placed in clinics and shopping centers in both urban and rural locations. However, this strategy was largely ineffective, and upon my faculty advisor's recommendation, I used part of the grant funding to hire a research assistant based in Puerto Rico. The assistant worked for one week, spending 8 hours at two clinics in urban San Juan and 7 hours at clinics in rural Morovis. Surveys were administered both digitally (via an electronic device provided on-site) and in paper format to account for varying levels of digital literacy. The assistant recorded responses when needed; otherwise, participants filled out the survey independently. My initial goal was to collect 60 responses. However, due to participant reluctance, time constraints, and frustration with ongoing healthcare challenges, only 33 surveys were completed; 15 were completed by patients from urban regions and 18 from rural regions. Despite this, the responses offered valuable insight into patients' experiences.

**Data Collection and Analysis**

I conducted 16 in-depth interviews with healthcare professionals, 9 in person and 7 remotely. Participants were selected to represent a geographic balance: 8 from urban areas (San Juan, Guaynabo, Bayamón, Carolina) and 8 from rural areas (Ciales, Utuado, Morovis, Jayuya, Lares). Each interview lasted approximately 45 minutes. Before each interview, I reviewed the informed consent process and obtained verbal consent following IRB-approved procedures (IRB

protocol IRB24-0785). Interviews followed a semi-structured format, allowing for consistency while enabling follow-up questions and deeper exploration. The full interview guide is included in Appendix B. With participants' permission, all interviews were recorded and later transcribed. Since interviews were conducted in Spanish, I first used Sonix AI to translate them, then used Otter AI for transcription. I manually reviewed and corrected each transcript to ensure accuracy.

Transcripts and survey responses were imported into MAXQDA, a qualitative analysis software. Coding was based on categories identified in the literature review, including: access to technology and infrastructure, digital literacy and skills, patient outcomes and satisfaction, usability and design of technology. As I analyzed the data, I created additional codes based on emerging themes, such as, trust and perceptions of digital health, health equity and disparities, navigation of care systems, internet and electricity reliability, experiences with power outages, access to and reliability of digital devices, professional and personal engagement with telehealth. I reviewed and refined these codes and themes to better understand the underlying problems related to the digital divide in Puerto Rico. Using the code on digital determinants, telehealth transition, internet and bandwidth, and digital literacy, I was able to build my findings sections.

## Findings and Analysis

Through 16 in-depth interviews and 33 survey responses, this project identified substantial digital health disparities across Puerto Rico. These disparities are shaped by uneven infrastructure, economic constraints, regulatory ambiguities, cultural preferences, and persistent geographic challenges. Stakeholders included healthcare providers, public health officials, digital health experts, and patients from both rural and urban areas. The data reveal that while telehealth holds promise, access remains significantly constrained by digital determinants and structural inequities, most notably the urban–rural divide, unreliable electricity and broadband services, cultural barriers to digital adoption, and limited institutional support and policy clarity. Nonetheless, some telehealth initiatives driven by community partnerships demonstrated encouraging outcomes. These efforts improved access to specialists and chronic care management for certain rural populations, illustrating the potential of well-supported digital health programs to reduce access gaps.

### On the Wrong Side of the Divide: Digital Determinants

#### *The Digital Health Transition During the Pandemic*

Interviewees frequently described how Puerto Rico underwent a rapid and total transition from in-person to online healthcare services during the pandemic. This digital shift was initially seen as an opportunity to expand access by removing traditional barriers like geography and transportation. Patients could, in theory, simply schedule an appointment and connect with their provider from home. However, this vision came into conflict with reality. The transition exposed deep infrastructure disparities, particularly in rural and mountainous regions. While telemedicine

was promoted as universally accessible, many providers admitted that they were disconnected from the everyday challenges their patients faced. The assumption that all patients could easily move to digital platforms overlooked widespread issues with internet reliability and connectivity.. As several interviewees noted, much of the guidance they followed came from agencies like the CDC, which designed telehealth frameworks with high-income, well-resourced regions in mind, contexts that differ significantly from Puerto Rico's. Joseph, a healthcare provider from Guaynabo, described this frustration:

> I am here to treat my patients. I thought I was doing everything right, playing by the book, following the guidelines imposed by the federal government. And yet, I felt terrible because my patients weren't showing up to their appointments, even though they were virtual, even though we had set up a telehealth platform specifically for them.

Similarly, Colin described his proactive approach during the transition to telemedicine. His office had worked diligently to ensure the process was as smooth and intuitive as possible for patients. Ironically, however, he found that the barriers patients now faced in accessing care were often more significant than before.

> Before the pandemic," he said, "my patients would sometimes miss their follow-up appointments, or cancel at the last minute. The usual reasons were things like transportation, traffic, or the distance to the clinic. When we went fully online because of COVID-19 restrictions, I honestly believed those barriers would disappear. Everything was accessible from home, they just needed to click a button.

In a similar way James had specifically considered the benefits for his patients from Juncos, a rural town roughly 30 to 45 minutes away from his clinic. "About 35% of my patients come from Juncos," he said. "I truly believed they would benefit from this transition. No more long drives, no more needing to miss work or find childcare. And yet, they were the group who faced the greatest difficulties in accessing virtual care."

***Digitally Underserved: Internet Inequality and the Hidden Costs of Bandwidth Battles***

Colin and Joseph both mentioned that, during the transition to virtual care, they often did not immediately understand why some patients consistently missed their telemedicine appointments. They explained that when their offices followed up with patients, the reasons were often related to internet connectivity. They agreed that Hurricane Maria… left the island without reliable internet … we are still vulnerable." Colin recalled one particular comment from a patient:

> It was either using the internet to attend the appointment or making her daughter deal with connection issues during her online class. There is also the issue of affordability – many digital inequities are rooted in poverty. Puerto Rico's high poverty rate means that a significant share of residents struggle to afford monthly internet subscriptions, smartphone data plans, or newer devices.

This anecdote closely aligns with findings from the open-ended responses in the patient survey, which revealed the hidden tensions and trade-offs that families must negotiate within digitally constrained households. Respondent #14 from an urban region, shared that she often had to forgo her telemedicine appointments because her children were engaged in virtual schooling during the pandemic. She explained that it was "not ideal to sacrifice [her] kids' education" just to attend her own healthcare visit. Her experience illustrates the concept of intra-household bandwidth negotiation, a phenomenon where limited digital infrastructure (one shared device, a weak hotspot, or a low-bandwidth connection) forces families to prioritize some needs over others, often subordinating adult healthcare to children's education.

Likewise, Respondent #3 described how even when she managed to attend a virtual consultation, poor internet quality resulted in repeated disruptions: "If I have multiple devices using unreliable internet, my kids' teacher gets cut off. And during my appointment, the doctor

would also cut out. I would end up confused, frustrated, and even more anxious." These layered disruptions had emotional as well as clinical consequences, leaving patients feeling defeated and destabilized at precisely the moment when care continuity and trust were most needed.

Other respondents echoed similar realities. Many households, especially in lower-income or rural areas, had access to only a single mobile device with hotspot capability. As one participant noted, "I have to share the hotspot and connect my phone to my computer, and my family decides if I get to have access. I could invest in high-speed internet, but that's just not a possibility given that we don't make a lot of money." This shows an important distinction between theoretical access and functional access. Having a phone or an internet plan does not automatically translate to meaningful participation in digital health services, especially when the burden of cost-sharing and device rationing falls disproportionately on caregivers, roles often occupied by those with multiple simultaneous obligations. Andrea, a healthcare provider, offered a systemic perspective that frames this issue within broader structural constraints:

> I think it's very evident that the socioeconomic context also affects internet connectivity. A Puerto Rican who cannot afford a car may benefit greatly from telehealth, removing the need to travel, but if that person also cannot afford home internet, they remain unable to use telehealth.

Her insight points to a paradox at the core of digital health equity: telehealth may appear as a solution to geographic and financial inaccessibility, but its implementation presumes a baseline level of digital infrastructure that many low-income families in Puerto Rico do not possess. This mismatch between telehealth's promise and the material conditions of its intended users reveals a deeper systemic flaw, one where policy solutions designed at the federal level or

modeled on mainland U.S. standards fail to account for the unique digital landscape of the territory.

Furthermore, these examples reveal how digital scarcity in the home environment is not merely a technical limitation but a determinant of health in its own right. In digitally underserved households, bandwidth becomes a site of contention, forcing families to make health-harming choices about who gets online and when. In these contexts, the promise of telehealth as a force collapses under the weight of infrastructural inadequacy, economic precarity, and institutional oversight. These trade-offs are not isolated incidents; economic insecurity, digital exclusion, and caregiving responsibilities compound to systematically prevent the most marginalized from accessing healthcare, even when services are "technically" available online. Telehealth, in this light, does not simply fail to bridge existing health disparities; without structural reform, it risks entrenching them further by placing new burdens on populations already navigating systemic neglect.

A survey respondent from a rural area captured the layered complexity of how the lack of internet connectivity can lead to digital exclusion in Puerto Rico:

> In my experience, I believe that not having reliable internet severely impacts the way I access care. Unfortunately, people on the island, like me, didn't have any other option. It's not like I could just show up at the clinic for my appointment, because of the restrictions, that wasn't allowed. So, I had to do what everyone else was doing: schedule an online visit. And I did. My first online visit was genuinely a nightmare. It wasn't that I didn't know how to use the platform; I knew how to do everything required to attend a virtual appointment. The problem was that my internet just wasn't enough. I think many doctors forgot about the problems the hurricane caused. It disrupted our internet and broadband infrastructure, so even if I technically have high-speed internet at home, there's no guarantee it will be reliable during a visit. During my teleconsultation, the provider got cut off multiple times, and I was

> disconnected from the platform. And it was so bad that I never came back again while his services were online.

The patient had a device, had the digital skills, and was motivated to seek care, yet unreliable internet made the process intolerable. The result was disrupted communication and a complete withdrawal from telehealth altogether. This dynamic undermines one of telemedicine's core promises: the ability to sustain care during emergencies. Bryan, a healthcare provider, echoed this frustration from the practitioner's perspective.

> I couldn't really do anything else because the policy was to only do telemedicine for the first six months, and then they just kept extending the deadline. It was super frustrating. The authorities, especially the Puerto Rican government, were so focused on following what providers in the mainland U.S. were doing. But our situation here is completely different. I mean, I'm sure that if the hurricane hadn't happened, and if our connectivity, telecommunications, and broadband infrastructure were in good shape, patients would've actually used these services more. But that just wasn't our reality.

He highlights a form of policy misalignment, the assumption that the internet infrastructure on the island mirrors that of the mainland. Instead of empowering patients, this top-down replication of telehealth mandates ignored local infrastructural conditions, inadvertently disqualifying those most in need. His words show how imported policies can exacerbate local inequalities when they lack contextual sensitivity.

### *Unequal Internet Access: The Impact of Digital Redlining*

The structural context is supported by data from the *Programa de Banda Ancha*, which reports that only about 68–70% of Puerto Rican households have internet broadband access, with significant disparities between wealthier coastal municipalities and interior rural areas. As James noted, "Internet adoption maps onto income geography, wealthier coastal and metro communities

enjoy higher connectivity, while interior rural areas lag far behind." Noah described this disparity as a form of digital redlining, stating, "We are seeing a scenario within the island where a rural patient is far less likely to have the bandwidth for a video consultation than an urban counterpart." This framing invites a reevaluation of the digital divide that doesn't allow patients to access telehealth, not as a neutral technological deficit but as a manifestation of systemic disinvestment along geographic and economic lines. Redlining, historically a practice of denying services to racially or economically marginalized communities, here resurfaces in a digital form, perpetuating exclusion for innovation purposes. The case of Juncos, referenced by James, further illustrates this point. Located in a rural and low-income region, many of his patients were unable to benefit from telemedicine despite living within theoretical coverage areas. Their stories reveal how telemedicine, while promoted as a great equalizer, can reproduce and even deepen health inequities if not implemented with awareness. Access to healthcare providers through telehealth is shaped by infrastructure, affordability, geography, and intra-household dynamics, which make "having internet" insufficient as a benchmark for inclusion.

### *Unreliable Power Grids and Power Outages*

Interviewees consistently identified prolonged and frequent power outages as one of the most significant barriers to healthcare access during and after the pandemic, with direct consequences for patient outcomes. While all regions of Puerto Rico were affected, stakeholders emphasized that rural, mountainous communities suffer the worst of these disruptions due to

weaker electrical infrastructure and slower service restoration compared to urban northern areas. The result was not only care disruption but an amplification of pre-existing structural inequities.

As introduced in the literature review, Puerto Rico's longstanding electrical grid instability, dramatically worsened by Hurricane Maria in 2017, continues to undermine healthcare access and delivery today. The hurricane caused widespread devastation: many hospitals and clinics lost power for months, and telecommunication towers were crippled. These conditions forced Puerto Rico's health system to rebuild basic infrastructure at a time when other jurisdictions were accelerating digital health capabilities. When the COVID-19 pandemic struck, the urgency to minimize in-person contact catalyzed a shift to telehealth, but the island's fragile infrastructure could not keep pace with this transition. As mentioned by Alexis, "Hurricane Maria left us without power for months, it revealed how unprepared we were, not just for storms, but for the kind of digital healthcare everyone expected during the pandemic." This infrastructural fragility made it especially difficult to sustain telehealth services in rural areas like Morovis and Jayuya. As Jonathan explained: "We worried not just about patients losing power during their sessions, but that the hospital itself might go offline."

In some cases, the limitations were so severe that providers avoided scheduling telehealth appointments for rural patients altogether, anticipating failed connections. Alexis described how logistical concerns transformed into ethical ones: "One of the biggest challenges faced by clinics we consulted with was their hesitation to offer services to rural communities susceptible to frequent outages. Many saw it as a waste of time and resources." Patients, meanwhile, described frustration and eventual withdrawal from care.

All interviewees agreed that Hurricane Maria created a turning point in Puerto Rico's infrastructural decline. Many reported going four to five months without power, and the resulting damage to telecommunications continues to affect digital health adoption today. The onset of the COVID-19 pandemic only deepened this divide. Although regulatory expansions temporarily boosted access, e.g., Medicare and Medicaid claims for telehealth "rose from basically nothing to a massive increase," according to Jonathan, Puerto Rico's compromised infrastructure made widespread adoption elusive. Jonathan explained: "In 2020, when the pandemic started, we were deeply concerned about power outages in Morovis. Not only were we worried that our patients would lose power at home, but our hospital was equally vulnerable, placing the continuity of essential health services at severe risk."

Puerto Rico's experience illustrates that access to telehealth not only depends on the digital determinant of broadband and devices, but it is deeply intertwined with the energy grid. Where electricity is unstable, digital health solutions will lose strength. While mainland regions advanced in digital health unhampered, Puerto Rico had to rebuild from the ground up. This infrastructural fragility also contributed to a systemic reluctance among healthcare providers to serve rural populations. Survey respondent #21, from rural region, offered a personal account of how overlapping crises intensified the burden of unreliable electricity during and after Hurricane Maria:

> COVID happened, and suddenly they expected me to work remotely and my kids to do remote learning. My youngest has chronic illnesses, and the doctor recommended remote monitoring appointments every two weeks. But it was incredibly frustrating—we'd experience power outages at least two times during each session. It was really (censored) to constantly lose connection with the doctor.

Even outside of disaster periods, Puerto Rico's aging power infrastructure and utility mismanagement have caused chronic outages. Weekly power interruptions, like the ones she described, have been reported island-wide, long after Maria, largely due to delays in grid modernization. These outages disproportionately affect poorer and rural communities where backup generators are scarce. They also increase costs; many cannot afford the luxury of diesel generators or backup batteries for essential medical and communication devices. This instability has direct implications: a patient may have a smartphone and cell service, but without power to charge their phone or run a Wi-Fi router, they are effectively cut off from telehealth. Alexis emphasized that infrastructural fragility not only interrupts care but also reinforces systemic neglect: "This isn't just about outages. It's about how we've normalized excluding rural patients because it's logistically harder. It becomes this loop where the infrastructure is poor, so the services don't come, which justifies further disinvestment." She also described how some patients avoid seeking care altogether due to the financial burden of maintaining backup electricity: "People just give up. It's too expensive to keep a generator running for hours just to attend an appointment. That's when we start losing people, not just to disease, but to systems that are supposed to help them." This reveals how infrastructure deficiencies perpetuate healthcare inequities, especially in economically disadvantaged regions. Yet, the problem is not exclusive to rural areas.

One urban resident, Survey Respondent #15, mentioned the emotional toll of power instability on their mental healthcare during the pandemic:

> I was battling depression, and teletherapy initially offered privacy and comfort, even if it felt a little impersonal. But constant power outages disrupted my appointments. I

> kept reconnecting, apologizing, restarting. Instead of feeling relieved or supported, I'd finish appointments more frustrated and emotionally drained.

This account reinforces that unreliable electricity, whether in rural or urban contexts, undermines telehealth's access, effectiveness, and risks turning a promising health equity tool into another source of frustration and exclusion. Similarly, Survey Respondent #30 reported frustration linked directly to delays in critical care caused by frequent outages: "I repeatedly rescheduled telehealth appointments because of ongoing power interruptions. The continuous postponement worsened my anxiety and depression, ultimately contributing to hypertension and chronic stress." These experiences underscore how power disruptions exacerbated mental and physical health conditions, illustrating a clear link between infrastructure failures and negative health outcomes. The psychological stress of constant interruptions and delays added another layer of health inequity that disproportionately impacted vulnerable populations already struggling with chronic conditions.

Healthcare providers themselves experienced severe disruptions, directly undermining continuity of care. Jessica explained: "Telehealth has great potential for improving patient outcomes. Yet, when our clinic lost power mid-session, all progress was lost, forcing us to restart appointments. Many patients, frustrated by this interruption, ultimately ceased attending sessions altogether." This not only causes patient distress but also provider burnout and inefficiency, significantly diminishing the overall quality of telehealth services. Power outages thus not only interrupted immediate consultations but also undermined the broader patient-provider relationship essential for sustained chronic disease management and preventive care.

Andrea further emphasized the risk posed by power outages to accurate patient record-keeping and healthcare continuity: “When power outages occurred during telehealth sessions, we lost access to electronic medical records. The inability to update patient information led to gaps in medical histories, disrupting continuity of care and creating confusion or misinformation for subsequent appointments.” The risks associated with incomplete or inaccurate electronic medical records are particularly severe, potentially leading to misdiagnoses, inappropriate medication prescriptions, or dangerous allergic reactions. Survey Respondent #28 described such an experience:

> During COVID, I connected with my doctor, and he disappeared due to a clinic power outage. During my next session, they paired me randomly with another available provider who lacked an updated medical record. My guess is that this happened because of the outage. I wasted considerable time re-explaining my condition and symptoms. Ultimately, the provider prescribed a medication without fully understanding my history, leaving me feeling worse.

If a patient is not fully aware of the details missing from their electronic medical record, they may fail to communicate essential information to their provider. Patients with limited health literacy or an incomplete understanding of medical terminology are especially vulnerable, as they may not recognize potentially dangerous prescriptions, amplifying health risks and deepening existing disparities.

The narratives and survey responses collectively reveal the impact of structural inequalities, in this case, unreliable power grids, on healthcare outcomes across Puerto Rico. The unevenly distributed power infrastructure represents a digital determinant and systemic inequity disproportionately harming rural, economically marginalized populations. Urban areas, while typically more resilient due to better infrastructure and more rapid restoration, were not exempt

from these disruptions. Patients in urban regions faced similar frustrations, emphasizing the pervasive nature of infrastructural inadequacies across Puerto Rico. However, rural patients faced the dual challenge of greater frequency and longer durations of outages, directly influencing healthcare accessibility, effectiveness, and patient satisfaction. Power disruptions not only inconvenience patients and providers but also critically endanger patient safety through compromised continuity of care and medical records. Inconsistent record-keeping undermines providers' capacity to deliver informed, safe, and personalized care. This disruption can inadvertently lead to medical errors, medication mishaps, and potentially life-threatening outcomes, particularly for vulnerable populations such as elderly patients, those with chronic conditions, or individuals with complex medical histories.

### *Digital Literacy among Older Adults*

Across interviews and survey responses, participants consistently identified digital literacy as a determinant of health outcomes during the pandemic, which especially affected elderly populations. The elderly were disproportionately affected due to intersecting vulnerabilities: limited technological familiarity, social isolation exacerbated by outmigration, and the rapid digital transition forced by the COVID-19 pandemic. Luke provided context that emphasizes Puerto Rico's demographic shift and its direct link to digital exclusion and lack of digital literacy:

> I don't know if you're aware, but recent research has pointed out that Puerto Rico is aging rapidly. The post-hurricane outmigration of younger people significantly accelerated population aging. This older population is essentially alone; imagine navigating the digital age alone. You don't have to imagine it, because that is precisely what happened.

Luke's observation reveals a critical social dimension: familial isolation resulting from mass youth migration post-hurricane Maria, he mentioned that this issue has altered family dynamics and left older adults without traditional caregiver support. The absence of younger family members, who would typically facilitate digital transitions, created conditions where elderly individuals struggled to adopt telehealth technologies without adequate guidance or emotional support. This creates a challenge because older Puerto Rican adults disproportionately suffer from asthma, cancer, diabetes, and arthritis. Therefore, this demographic needs more frequent and consistent healthcare, the opposite of what they experienced during the digital transition. Bianca expressed skepticism about the inclusive design of telehealth systems for elderly populations: “The people who need care the most on our island are older adults, given their prevalence of chronic conditions. However, this rapid shift to online health services failed them, it was not designed for them.”

While Bianca’s assessment is partially accurate, deeper analysis suggests the problem lies not merely in the inherent design of digital health platforms but rather in their implementation. Many older adults showed genuine willingness to learn, as indicated by survey respondent #7 from the rural region:

> I am 79. I want to be healthy for my grandchildren, so I tried hard to learn. During the pandemic, my doctor recommended monthly telehealth visits for diabetes and hypertension management. But it was incredibly challenging because my daughter is in Florida, and no one else was around to teach me. The clinic staff tried explaining things, but their instructions never made sense. Eventually, I gave up and missed six months of health care.

There is the assumption that older adults could intuitively adopt complex digital tools without structured guidance or culturally sensitive support. Hence, the issue was less about inherent

technological complexity and more about insufficiently tailored educational resources provided by healthcare institutions.

Multiple interviewees highlighted devastating health consequences resulting from elderly patients' digital exclusion. Colin reflected on the deterioration of health outcomes he observed firsthand: “When we resumed in-person appointments, my first patients were older adults aged 75 to 87. Sadly, their conditions had significantly worsened.” Similarly, Thomas provided further evidence: “Many older adults stopped attending appointments altogether because they were virtual. Consequently, we couldn't renew their prescriptions, and many stopped taking critical medications.” What they said underlines a stream of adverse health outcomes: disrupted continuity of care, uncontrolled chronic illnesses, and exacerbation of pre-existing conditions. Yet, these negative outcomes were not due to a lack of patient motivation; rather, they emerged directly from systematic failures to provide adequate digital literacy support. Even with the internet and power available, digital literacy – the skills to use digital tools for health – is a determining factor in telehealth effectiveness. Bryan stated:

> In my experience working with telehealth initiatives in Puerto Rico, I've noticed a significant barrier to adoption among patients who are unfamiliar or uncomfortable with technology, like my abuela, even when devices are provided to them. … Also, in some towns, we can see that lower educational attainment and language barriers, specifically the use of predominantly English interfaces, often make people very uncomfortable when accessing telehealth.

Another important finding was older adults’ increased dependency on others for digital navigation. Survey respondent #11 described their dependence: “I rely completely on my son to navigate telehealth. When he's unavailable, I'm lost. Without him, digital healthcare feels like

navigating a maze." This enforced dependency, stemming directly from digital literacy gaps, significantly affects older adults' self-perception and autonomy. Rather than experiencing themselves as respected, independent individuals, older adults began perceiving themselves as burdensome or inadequate, intensifying feelings of marginalization and reducing self-efficacy in managing their own health. Similarly, Patricia mentioned anecdotal examples: "My 90-year-old patient would rather not see the doctor at all if it's telemedicine, because she can't explain things well, and they're not paying close attention." This is indicative of the intangible aspects of clinical care, body language, nonverbal cues, and empathetic presence, which telehealth struggles to replicate. In the survey open response section, a patient shared frustrations with telehealth, highlighting significant challenges related to digital literacy and cultural norms:

> I was very frustrated with how the Hato Rey Clinic just expected me to use telehealth during the pandemic. I've been seeing doctors in person my whole life, and I urgently needed an eye exam. They asked me to take pictures of my left eye and send them to my doctor before the telehealth appointment. I managed to send those, but when it was time for the telehealth session, I had no idea how to access the consultation because they used a specific platform I didn't know how to use. During the appointment, I felt so insecure and lost, I didn't even know what I was supposed to do. It was a terrible experience [...] On top of that, the doctor initially said my eye was fine, that it was just conjunctivitis, but it turned out I had a bacterial infection. He sent me a message through the platform portal, but I couldn't see it in time because I didn't know how to navigate the platform, find messages, or view results. If only I had known how to properly use the telehealth platform, it would all have been different.

This narrative shows how digital literacy gaps can directly compromise diagnostic accuracy, delay treatment, and erode patient trust, particularly when providers assume technological fluency without offering adequate support. The patient's experience underscores a broader structural failure: when digital systems are implemented without accessible user training or interface design that considers diverse populations, they risk transforming care into a source of confusion, exclusion, and harm.

Healthcare providers critically reflected on the structural oversights made by institutions during the rapid digital transition. Andrea, working in a public health clinic, provided a complex perspective:

> During the pandemic, there was an institutional assumption that telehealth tools were intuitive, easy to adopt. It took me two weeks just to fully grasp our hospital's platform. My older patients repeatedly expressed frustration, they didn't understand basic tasks like reading portal messages. With limited consultation time, adequately assisting them was nearly impossible.

Andrea's insight reveals a systemic miscalculation, institutional assumptions about digital skill levels, that deepened existing health inequities. Institutions presumed an intuitive grasp of technology, overlooking critical generational differences in technological fluency, thus exacerbating healthcare disparities rather than mitigating them. The collective experiences documented here strongly suggest that improving digital literacy among elderly Puerto Rican adults must be a priority within public health policy and healthcare practice. Effective telehealth implementation requires comprehensive, targeted education programs explicitly designed for older populations. Healthcare providers emphasized the urgency of inclusive digital literacy workshops and culturally competent patient education initiatives.

### *Providers' Insights on Health Outcomes During the Digital Health Transition*

In the aftermath of Hurricane Maria, healthcare providers observed profound shifts in patient health, driven not only by damaged infrastructure but by changes in daily survival patterns. Mauricio described how residents, unable to refrigerate fresh food due to persistent power outages, were forced to rely on canned goods high in sodium and sugar. "The hurricane

forced people to rely on canned foods… this took a major toll on patients with hypertension or diabetes," he explained. This insight reveals the intricate ways that environmental crises intersect with health outcomes. In Puerto Rico, nutrition, electricity, and digital access are not separate issues but part of a systemic web in which infrastructure breakdowns reverberate through the most vulnerable communities. A disruption in one area, such as power, bleeds into others, compounding health risks and making health equity unreachable without holistic, cross-sector interventions.

Patricia, a primary care provider, reinforced this point, noting a surge in diagnoses of chronic illness between 2022 and 2023 and the use of telehealth to treat the diseases. "We were seeing 25-year-olds with diabetes, hypertension, stress, and anxiety," she said, "and patients were discontinuing care because they were virtual." Her observation points to a delayed health crisis, one produced by sustained infrastructural weakness and inconsistent access to digital health services. These were not just individual health declines; they were structural symptoms. The rise in comorbidities and early-onset chronic illness suggests that telehealth could have played a preventive role, but digital determinants of health ultimately limited access to care that might have been avoidable. Instead, it must be embedded within broader strategies that ensure continuous care access and stable communication networks.

Still, some interviewees offered glimpses of what is possible when digital tools function as intended. One survey respondent shared: "Telemedicine transformed how I seek care. I became more proactive… I wouldn't have known I had hereditary hypertension otherwise." This reflects the real promise of telehealth: when infrastructure, patient readiness, and provider support align, remote care can catalyze early intervention and long-term health management.

However, this scenario is far from the norm. Such success stories emerge from optimal conditions, reliable connectivity, digital literacy, and a functioning care continuum, not from the average experience. In many ways, these cases serve as exceptions that highlight how far Puerto Rico remains from realizing digital health equity.

There was a recurring pattern identified across interviews and surveys, telehealth failures not only interrupt care, they sever trust. When digital consultations are marred by technical issues, they leave patients disoriented, disappointed, and less likely to seek follow-up. Especially in contexts where care access is already tenuous, one failed virtual encounter can derail a patient's entire trajectory. In fact, stakeholders repeatedly emphasized that digital inequity is simply a new form of an old problem. One provider explained that some rural patients had to wait up to 11 months to see a specialist, with delays worsened by natural disasters like the 2020 earthquakes, which damaged roads and clinics. Telehealth was supposed to overcome these spatial and logistical challenges, but in practice, it reproduced them. Without adequate internet infrastructure, virtual care does not erase distance, it preserves it in a different form. Geographic isolation becomes digital exclusion, and convenience becomes conditional.

**Bridging the Divide: Stakeholder Perspectives on Building a Resilient and Inclusive Telehealth System**

Despite the substantial digital determinants of health uncovered throughout this research, economic hardship, infrastructural collapse, digital illiteracy, and inconsistent internet access, stakeholders expressed optimism about Puerto Rico's ability to transition to the "right side" of the digital divide. Through targeted innovations, community-based pilot programs, and

cross-sector collaboration, interviewees identified multiple actionable pathways for improving digital health equity across the island.

Interviewees identified Telehealth Remote Patient Monitoring (TRPM) as a key strategy to enhance care continuity for patients managing chronic conditions. Mauricio described the transformative potential of TRPM, which enables real-time data sharing between patients and providers: “Real-time health data transmission from home devices, such as glucose monitors or blood pressure cuffs integrated into health records, allows tailored interventions. This approach significantly improves chronic condition management, reducing costly emergency visits and hospitalizations.” When paired with telehealth navigators or community health workers, RPM offers not only continuous monitoring but also a supportive framework for high-risk patients, especially those unable to attend frequent in-person visits due to geographic or financial barriers. This integration represents a shift from reactive care to proactive, data-driven interventions, an important step in reducing preventable hospitalizations and fostering health equity.

Mauricio also emphasized the strategic necessity of telehealth amid a dramatic outmigration of healthcare professionals from Puerto Rico:

> Telehealth is essential today because we've seen the loss of over 3,000 physicians within five years also I think this is getting worse because of the reimbursement reductions in Medicare Advantage plans. Sometimes this shortage inflates healthcare costs, diminishes access, and increases emergency room dependency.

By enabling access to both local and out-of-territory specialists, telehealth can serve as both a stopgap and a strategic investment to prevent cost inflation, mitigate care delays, and reduce over-reliance on emergency services. In remote areas where home connectivity remains unreliable, stakeholders described the success of centralized teleconsultation hubs. For instance,

a partnership between Direct Relief, a local medical school, and community clinics equipped rural municipalities such as Castañer and Jayuya with secure telehealth rooms. These spaces enabled patients to access specialists, such as endocrinologists or psychiatrists, who were otherwise unavailable locally. Luke noted: “These programs led to significantly reduced wait times and improved continuity of care for rural patients that went to the specific clinic where we implemented the program.” This centralized model offers an innovative workaround for broadband inequity. Rather than relying on individual households to maintain connectivity, clinics themselves become digital access points, integrating clinical and digital infrastructure in one trusted, local setting.

Beyond hardware and broadband, stakeholders emphasized the critical importance of human support systems. Alexis and Patricia described programs where community health workers assist patients, especially elderly and rural residents, with telehealth navigation, digital literacy, and even technical troubleshooting: “Community health workers visit patients’ homes with high-speed mobile hotspots and devices. They assess digital literacy on the spot and provide training tailored to the patient’s needs.” These initiatives transform access by meeting patients where they are: physically, technologically, and culturally. Interviewees acknowledged that while these programs are promising, their expansion requires substantial investment in human infrastructure and long-term funding support. Although these interventions originated in rural settings, stakeholders like Bianca emphasized their applicability in urban areas as well: “Urban areas still face affordability barriers and have large elderly populations. Implementing similar community health worker programs would help address gaps in care, especially for patients who cannot navigate telehealth platforms alone.” This insight challenges the assumption that urban

environments automatically offer equitable access and underscores the need for comprehensive, context-sensitive planning.

A recurring theme across interviews was the need for systemic policy reform to address the structural causes of digital exclusion. Isabel and Colin criticized the private sector's reluctance to invest in low-income areas: "Private internet providers often don't invest in low-income areas because it doesn't generate immediate profit. Government-led broadband expansion and public-private partnerships are essential to correct this imbalance." Interviewees agreed that there is a solution for this, and they pointed to initiatives like the Smart Island Plan, which aims to develop resilient, island-wide telecommunications infrastructure. However, as Thomas warned, infrastructure alone is insufficient without last-mile implementation, particularly in underserved rural towns. He cited Federally Qualified Health Centers (330 centers) as ideal sites for integrating broadband, telehealth programs, and digital literacy training.

These interventions have the potential to make significant advancements to close the digital divide. The alignment of multiple strategies, RPM, resilient infrastructure, centralized teleconsultation hubs, community health workers, and equitable broadband policy, offers a cohesive vision for reform. Interviewees' accounts demonstrate that when telehealth is supported by robust human infrastructure and aligned with community needs, it becomes far more than a stopgap. It becomes a public health strategy. Thus, to realize this vision, Puerto Rico must move beyond isolated innovations toward integrated systems change. Telehealth is not just a digital service, it is a lens through which the territory's broader struggles with inequality, infrastructure, and autonomy can be addressed.

## Policy Implications

The findings of this research suggest that significant policy interventions are necessary to address the digital determinants of health in Puerto Rico. As digital health technologies become increasingly integrated into healthcare delivery, their uneven distribution and accessibility threaten to exacerbate existing health disparities, particularly among rural, low-income, and elderly populations. These implications and recommendations are rooted in what healthcare stakeholders mentioned, they consistently emphasized the importance of affordability, infrastructural stability, and community support in overcoming these barriers.

Several federal and territorial legislative efforts offer promising opportunities to advance digital health equity. At the federal level, bills such as H.R. 1720, which amends the Social Security Act to extend telehealth flexibilities for hospice care, and H.R. 1407, which removes geographic restrictions on telehealth under Medicare, can significantly improve access for underserved areas like Puerto Rico. Additionally, the Rural Telehealth and Education Enhancement Act of 2025, which reauthorizes the Distance Learning and Telemedicine Program, and H.R. 1838, which targets broadband access in rural ports, represent important structural investments. H.Res.124, urging federal action to rebuild Puerto Rico's electrical grid, directly responds to the infrastructural fragility that stakeholders cited as a persistent telehealth barrier. Locally, support for territorial legislation such as the "Ley de Igualdad Regional en la Salud/ Regional Health Equity Act" should be expanded to include explicit digital equity provisions. This would ensure Puerto Rico's health policy formally recognizes broadband and energy access as core health equity issues. Without these reforms, the digital divide will continue to reinforce systemic exclusions rather than close them.

While regulatory relaxations during the pandemic, such as HIPAA waivers, telehealth reimbursement parity, and cross-jurisdictional licensing, accelerated adoption, their expiration has reintroduced uncertainty. One healthcare stakeholder remarked: “The further we get from COVID, the more we have these issues of licensing and reimbursement. People say, ‘Now it’s tedious… is it even worth it?” This underscores the need to establish permanent telehealth legislation that mandates reimbursement parity and provides clear licensing frameworks. Without regulatory stability, providers remain hesitant to invest in long-term telehealth infrastructure. In addition, there is a critical knowledge gap: despite ASES (Puerto Rico Health Insurance Administration) requiring insurers to include telehealth coverage, several providers were unaware of this mandate. As one stakeholder pointed out, this lack of awareness fuels the misconception that telehealth services may not be reimbursed consistently. To address these challenges, this study recommends the development of a clear, permanent telehealth regulatory framework that mandates telehealth reimbursement parity, clarifies licensing requirements for both local and diaspora providers, and reduces bureaucratic obstacles to cross-territorial practice.

These efforts should be supported by awareness campaigns, workshops, and training programs led by ASES and regulatory bodies to ensure providers understand coverage requirements and reimbursement processes. Another practical recommendation is the implementation of digital health screenings in clinical settings. These assessments can capture data on patients’ access to digital devices, internet connectivity, and digital literacy. Combined with provider training and community outreach, such screenings can help tailor interventions, ensuring technologies are responsive to patient needs rather than imposed inequitably.

Infrastructure modernization also requires sustained investment. Interviews highlighted the potential for public-private partnerships to incentivize internet service providers to expand

networks in underserved areas, especially if a guaranteed consumer base exists. Federal incentives must be paired with local agency communication to ensure providers and communities are informed about available opportunities. Importantly, there are no current federal regulations to prevent preferential broadband installation in high-income areas, which systematically excludes low-income communities. Policy solutions must prohibit discriminatory installation practices and ensure broadband rollout prioritizes equity.

Another key policy implication involves expanding the telehealth workforce. Legislative efforts should focus on removing licensing and geographic barriers, allowing clinicians based in the mainland U.S. to provide virtual care to Puerto Rican patients. This is especially critical given specialist and mental health provider shortages. Simultaneously, digital health equity cannot be achieved without broadband and energy stability. Future policies should fund the creation of community internet access points in clinics, community centers, and schools, especially in mountainous and rural areas. They must also expand subsidies for clinics to modernize infrastructure and acquire backup energy systems.

Another recommendation coming from my thesis is the creation of a community-based digital health workforce. Building on existing community health worker models, the role of Digital Health Navigators should be established. These trained professionals would provide technical assistance with telehealth platforms, conduct digital literacy outreach, and bridge access gaps in vulnerable populations. This model was repeatedly mentioned in interviews as a trusted, localized solution to the barriers patients face when navigating unfamiliar digital platforms. To guide and evaluate these interventions, Puerto Rico should establish a comprehensive digital health equity policy modeled after international best practices, such as Rwanda's Digital Health Strategic Plan. This policy should prioritize: system interoperability,

secure and standardized health data management, and equitable distribution of digital infrastructure and workforce.

To ensure equitable and effective telehealth implementation across Puerto Rico, policymakers should establish a Puerto Rico Digital Health Observatory, a centralized, interdisciplinary initiative dedicated to systematically monitoring broadband access, electrical grid reliability, telehealth utilization, and associated health outcomes. This observatory would operate under a collaborative model involving the Puerto Rico Department of Health, local universities, telecommunications providers, and community-based organizations. Its core functions would include collecting real-time geospatial data on internet and power access, tracking disparities in telehealth uptake, evaluating care continuity for chronic conditions, and issuing quarterly reports to guide public investment and infrastructure planning. By linking digital infrastructure data with healthcare metrics, the observatory would provide the empirical foundation for targeted interventions, such as prioritizing broadband expansion in medically underserved areas or scaling community-based telehealth navigators where digital literacy is lowest. Over time, this initiative would not only improve accountability and transparency but also enable adaptive policymaking that responds to emerging needs, ensuring Puerto Rico's digital health system evolves with resilience and equity at its core.

Finally, all digital health initiatives should follow a co-creation model. By involving community organizations, patients, providers, and policymakers in the design and evaluation of digital tools, interventions will better reflect real-world needs. As several interviewees stressed, top-down deployments often miss critical contextual factors and unintentionally deepen exclusion. While digital health holds transformative potential for advancing health equity in

Puerto Rico, this promise will only be realized through comprehensive, inclusive, and sustained efforts to address the digital determinants of health with the urgency and investment they require.

## Conclusion

This thesis has shown that while digital health technologies are often framed as tools to enhance healthcare equity and access, their real-world deployment is shaped and frequently constrained by the environments in which they operate. In Puerto Rico, this promise has been tempered by deep infrastructural and systemic inequalities. Through 16 interviews and 33 survey responses, this research revealed that unreliable broadband, chronic power instability, limited digital literacy, and a lack of regulatory clarity hinder telehealth from fulfilling its potential, especially for rural, elderly, and low-income populations. Although telemedicine aims to reduce traditional barriers like geography and transportation, in practice, it often introduces new exclusions tied to socioeconomic status and digital readiness.

But this isn't a story of guaranteed failure. Community-led programs, including mobile telehealth units, digital health navigators, and teleconsultation hubs, have demonstrated viable pathways to bridge digital divides. These efforts underscore the importance of co-creating digital health strategies with the communities they serve and highlight the potential for scalable, equity-centered innovation. To unlock this potential, a policy approach is needed that includes: permanent telehealth reimbursement parity, robust broadband and energy infrastructure modernization, targeted digital literacy investment, and the development of a culturally competent digital health workforce. Puerto Rico's situation is particularly revealing. As a U.S. territory, it exists in a policy paradox: governed by federal healthcare policies designed for high-income settings while facing infrastructure challenges akin to low- and middle-income countries. This mismatch magnifies digital health disparities and exposes how poorly aligned interventions can fail those most in need. The populations most likely to benefit from telehealth,

those with chronic illnesses, older adults, and low-income rural residents, are precisely those most likely to be digitally excluded. Ironically, the very technologies meant to improve health access risk reinforcing pre-existing inequities if digital determinants of health remain unaddressed.

The significance of these findings stretches beyond Puerto Rico. As digital health becomes a permanent fixture of healthcare systems worldwide, this case offers urgent lessons. Technology alone does not equal access; contextual sensitivity, structural investment, and sustained human support are required. Without these, digital health may widen, rather than bridge, the equity gap. Importantly, this thesis emphasizes that addressing digital health disparities is not merely a technical challenge but a moral imperative. Digital health must be treated as a public good, one that requires the same policy urgency as traditional health equity interventions. Programs like the Puerto Rico Broadband Program and grassroots literacy initiatives offer promising models, but further research is essential. We need longitudinal studies on infrastructure interventions, better data on intersecting vulnerabilities such as disability or housing instability, and rigorous evaluation of which local innovations can be adapted elsewhere.

In conclusion, Puerto Rico's experience offers both a warning and a roadmap. Digital health technologies can reproduce inequality when systems are unprepared. But with policies grounded in fairness, inclusion, and community voice, they can also uplift people and contribute to a better healthcare future. Telehealth's success depends not on technology alone, but on our collective willingness to build systems that are equitable by design, from the fiber optic cable to the clinical interface. The digital divide is not just a connectivity problem; it is a justice problem. And bridging it will require a lot of commitment to digital health equity.

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# Appendices

Appendix A : Interviewees

| *Pseudonym* | *Participant Type* | *Location* | *Format* |
|---|---|---|---|
| James | Healthcare provider (Telehealth psychological counseling and mental health services) | Urban (San Juan) | Virtual |
| Patricia | Public Health Professional, Biostatistician, and Health Policy Analyst | Urban (Guaynabo) | In person |
| Jessica | Healthcare Provider | Rural (Jayuya) | In-person |
| Noah | Healthcare provider (Telehealth psychological counseling and mental health services) | Urban (Bayamon) | Virtual |
| Colin | Healthcare provider (cardiology telehealth services) | Urban (Carolina) | In-person |
| Mauricio | Public Health professor | Rural (Utuado) | Virtual |
| Andrea | Healthcare Provider | Rural (Ciales) | In-person |
| Thomas | Healthcare Provider | Rural (Jayuya) | Virtual |
| Isabel | Public Health Official, Epidemiologist, Government and Academia | Urban (San Juan) | In-person |
| Luke | Public Health Professional Epidemiologist | Rural (Lares) | In-person |
| Alexis | Public Health Professional Digital Health Consultant | Urban (San Juan) | Virtual |
| Bryan | Health care provider | Rural (Morovis) | Virtual |
| Joseph | Healthcare provider (internal medicine) | Urban (Guaynabo) | In-person |
| Bianca | Healthcare Provider | Rural (Lares) | Virtual |
| Jonathan | Epidemiologist involved in the local health system operation during COVID-19 | Rural (Morovis) | In-person |

Appendix B: Interview Questions

1. How would you describe the quality and reliability of internet access in your practice, and how has this influenced equitable access to digital health services in both urban and rural areas?
    a. Have you noticed significant differences in patient experience depending on their geographic location?

2. How has the use of digital health technologies transformed your clinical practice and your relationship with patients?
    a. What positive or negative changes have you observed in terms of communication, trust, or continuity of care?
    b. Have you observed any resistance from patients? What are the most common concerns they express?

3. Can you share specific examples where the quality of internet access has positively or negatively impacted healthcare delivery, either in your experience or that of your patients?
    a. How are issues like connectivity disruptions, power outages, or technical barriers typically managed?

4. What changes did you observe in the adoption of digital health during the COVID-19 pandemic, and what challenges or opportunities arose from this rapid transition?
    a. Do you believe these changes were sustainable in the long term? Why or why not?

5. In your experience, were there specific populations in Puerto Rico that faced disproportionate barriers to using digital health services during the pandemic?
    a. What strategies were effective—or ineffective—in addressing these challenges?

6. What do you think are the next steps or innovations needed to address current digital health disparities in Puerto Rico?
    a. What features should these solutions include to better serve underserved communities?
    b. What steps are being taken to ensure that digital health services remain resilient in the face of future natural disasters?

Appendix C: Survey Questions

1. During the COVID-19 pandemic, what challenges (if any) did you face when trying to access telehealth services (e.g., internet connection, device availability, electricity, digital literacy)? Please describe how these challenges affected your ability to attend or complete appointments.
2. Thinking about your telehealth experiences during the pandemic, how satisfied were you with the quality of care you received? What worked well for you, and what aspects felt frustrating, confusing, or incomplete?
3. How often did you use telehealth services between March 2020 and December 2022? What factors influenced how frequently you used (or avoided) virtual healthcare during that time?