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6 April 2024

Online at https://mpra.ub.uni-muenchen.de/125303/
MPRA Paper No. 125303, posted 28 Jul 2025 13:36 UTC

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ABSTRACT
This paper explores the role of telecommunications infrastructure as an emerging social determinant of health, focusing on its relationship with life expectancy. While traditional determinants such as income, education, and healthcare access remain vital, the integration of digital infrastructure has introduced new pathways through which health outcomes are shaped. Drawing on recent literature and guided by a conceptual framework that incorporates digital access, labor market informality, and institutional capacity, this study argues that digital inequality mirrors and exacerbates existing health disparities. The paper highlights how the interplay of these structural factors can explain why improved infrastructure does not uniformly translate into longer life expectancy. Emphasis is placed on the need for multidimensional policy interventions that promote digital inclusion, address informality, and strengthen institutions. The findings underscore the importance of treating digital infrastructure not merely as a technical issue, but as a central component of health equity in the digital age.

Keywords: Life Expectancy, Digital Inequality, Telecommunications Infrastructure, Informality, Health Equity

JEL Codes: I15, O33, J46

Introduction

Life expectancy is among the most widely used indicators of human development, closely linked to income, education, public services, and institutional quality. While traditional public health literature has long focused on medical access, nutrition, sanitation, and income as the primary determinants of longevity, a growing body of interdisciplinary research now points to a newer, understudied variable: digital infrastructure. In a world increasingly shaped by connectivity, access to telecommunication systems—particularly in the form of internet, mobile networks, and fixed-line infrastructure—has become essential to economic opportunity, social protection, and health information. This raises an urgent question for development scholars and policy-makers alike: To what extent does digital inequality shape life expectancy and related public health outcomes across countries and regions?

This paper argues that telecommunications infrastructure is not merely a technical or economic input, but a structural determinant of health. As countries digitize their economies, social safety nets, and health systems, digital exclusion increasingly reinforces existing inequalities in health outcomes—particularly in contexts marked by labor market informality, institutional fragility, or geographic remoteness. The analysis draws on recent empirical and theoretical literature, including Gazilas (2024c), who investigates factors influencing life expectancy in low-income countries, and Gazilas (2024a), who emphasizes the role of telecom density in shaping economic performance. The paper also integrates broader insights from the institutional literature (e.g., Soares, 2006; Neumayer, 2003) and comparative health studies (e.g., Roser & Ortiz-Ospina, 2018), arguing that digital access influences health not only directly—by enabling remote care or public information—but also indirectly, through its impact on income, insurance coverage, education, and civic participation.

Telecommunications infrastructure expands what people can do and access in the public sphere, including how they interact with health systems. In well-developed contexts, this infrastructure supports telehealth services, electronic medical records, digital appointment systems, health insurance platforms, and mobile health education campaigns. In lower-income or digitally marginalized regions, the absence of such infrastructure often leaves communities disconnected from even basic services—delaying care, limiting prevention, and reducing the quality of institutional contact. This asymmetry has become more visible since the COVID-19 pandemic, when telehealth and online health resources became critical lifelines for millions. Yet millions more—those living in telecom "cold zones" or outside the reach of digital literacy—were left behind.

The structure of national labor markets plays a crucial mediating role in this equation. As Gazilas (2024d) and Piva & Tizzani (2024) suggest, a large share of the global workforce operates in the informal sector, where workers are not covered by public insurance schemes, do not contribute to national pension or health systems, and lack protections for occupational injury or illness. These populations are doubly disadvantaged: they are often excluded from formal health financing mechanisms and simultaneously more likely to live in areas with poor infrastructure, including telecommunications. In effect, they face both health exclusion and digital exclusion, reinforcing a vicious cycle of vulnerability. When informal workers fall ill, they are less likely to seek care (due to cost, distance, or lack of knowledge), and less able to recover economically after illness—contributing to intergenerational poverty and lower overall life expectancy in their communities.

Institutional quality also matters. A country's ability to deploy telecommunications infrastructure equitably—and integrate it meaningfully into its health system—depends on regulatory capacity, public investment, and good governance. As Gazilas (2024b) points out in his European study on homicide and economic conditions, the interplay between governance, inequality, and public trust significantly shapes social outcomes. In countries with weak institutions, telecom expansion may serve only urban elites or become politicized, leaving rural or minority regions underserved. Moreover, without coordination between health ministries and digital regulators, even strong infrastructure may not translate into meaningful health access. In contrast, high-performing welfare states in Northern Europe have paired telecom access with universal digital IDs, public health portals, and proactive service delivery, demonstrating the potential for synergy between infrastructure and inclusion.

These structural insights require us to rethink the framework through which health disparities are understood. Life expectancy is not solely a result of disease burden or hospital availability—it is a composite outcome shaped by how well social systems, including labor, education, and digital sectors, coordinate to support human well-being. Telecommunications systems, therefore, act as a platform that can either reduce or reinforce existing disparities. For instance, digital infrastructure can reduce the rural-urban divide in health access, or it can widen it if rural networks remain underdeveloped. It can empower women with reproductive health information, or marginalize them if platforms are inaccessible or culturally exclusive. As such, the distribution, design, and governance of telecom infrastructure must be understood as a central component of health equity.

This perspective is consistent with emerging research that links digital access with health literacy and health outcomes. Studies by Giuliani et al. (2024), Piva & Tizzani (2024), and others show that populations with higher digital literacy tend to demonstrate stronger health-seeking behavior, better chronic disease management, and earlier diagnosis. The causal mechanisms may be both informational and institutional: individuals with digital access are more likely to engage with public health campaigns, access symptom checkers or online consultations, and even participate in health-related civic engagement (e.g., contacting MPs, participating in digital petitions, or enrolling in health insurance). Meanwhile, those without digital access often fall through the cracks—unable to register for appointments, apply for benefits, or stay informed about preventative measures. This is not just a technical problem; it is a structural barrier to health equality.

This paper contributes to the literature in several ways. First, it integrates the concept of digital inequality into the established model of social determinants of health, offering a broader structural view of health disparities. Second, it links this discussion to labor market structures, showing how digital and labor informality overlap and reinforce each other. Third, it draws from cross-regional comparisons and recent empirical findings to offer policy-relevant insights into how governments and institutions might address these compounded inequalities.

The structure of the paper is as follows. Section 2 provides a literature review on telecommunications infrastructure, health outcomes, and digital inequality. Section 3 introduces a conceptual framework linking digital infrastructure, labor informality, and health disparities. Section 4 discusses regional variations and policy implications, integrating findings from both high-income and low-income countries. Section 5 concludes with reflections on future research and recommendations for inclusive digital health strategies. By centering digital access in the analysis of life expectancy, this paper seeks to bridge a critical gap in development research. In a world where connectivity increasingly defines opportunity, digital exclusion is becoming a form of structural health inequality—and must be addressed as such in public policy and global health debates.

Literature Review

The relationship between life expectancy and structural factors has long been a central concern in both public health and development economics. Classical studies have emphasized

the roles of income, education, sanitation, and access to healthcare in shaping health outcomes across populations. However, recent literature has expanded this framework to include more complex, interrelated variables such as institutional quality, labor market dynamics, and technological infrastructure. Within this context, telecommunications infrastructure has emerged as a potentially critical but underexplored determinant of health.

Gazilas (2024c) explores life expectancy in low-income countries using panel data analysis, identifying several macro-level drivers including public health expenditure, GDP per capita, and education levels. However, his findings also point to structural constraints that go beyond direct health investments. One such constraint is the limited presence of enabling systems such as telecommunications infrastructure, which may indirectly shape health outcomes by affecting access to services and information. In a parallel study, Gazilas (2024a) focuses on telecommunications infrastructure in Greece, showing its impact on firm-level efficiency and sectoral productivity. Although the study's focus is economic, it suggests broader social spillover effects of fixed-line and digital connectivity.

The idea that infrastructure can function as a social determinant of health is not new, but the integration of digital infrastructure into this framework is relatively recent. Neumayer (2003) and Wilkinson and Pickett (2009) argued that inequality and institutional cohesion affect health outcomes more than absolute income levels. Adding telecommunications into this equation reveals how digital connectivity might mitigate or worsen these inequalities. For instance, individuals living in digitally connected areas may benefit from more timely medical care, access to health knowledge, and smoother integration into insurance or public welfare systems. In contrast, digital exclusion may restrict not only information but also administrative access to health-related services, from appointment booking to benefit enrollment.

Telecommunications can also influence health through its impact on labor markets. As Gazilas (2024d) shows in his analysis of uninsured employment in Greece, labor market informality is closely tied to both regulatory frameworks and institutional enforcement. Informal workers, who lack health insurance and social protection, are less likely to engage in preventive healthcare and more likely to delay treatment. This vulnerability is exacerbated when such populations are also digitally disconnected, as they may be unaware of available services or unable to access them due to technological barriers. Piva and Tizzani (2024) argue that the growing platform economy, while expanding economic opportunities, has also increased the share of precarious workers who fall outside traditional health and insurance systems.

In the broader literature, telecommunications infrastructure is increasingly recognized as a facilitator of health system efficiency. Studies by Giuliani et al. (2024) and Latif et al. (2023) have shown that digital health initiatives, such as telemedicine and mobile health education, can significantly improve outcomes for chronic disease management and maternal health in low- and middle-income countries. However, these benefits are unevenly distributed. Giuliani et al. note that access to such services is heavily dependent on both digital literacy and the quality of underlying telecommunications networks. In regions where infrastructure is weak or digital education is lacking, the promise of these technologies remains unrealized.

The concept of digital inequality captures both infrastructural and individual-level barriers to digital participation. Warschauer (2003) distinguishes between physical access to technology

and the skills and institutional frameworks required to use it meaningfully. This framework is critical when assessing the health implications of digital access. Simply installing telecommunications infrastructure does not guarantee improved health outcomes if individuals cannot afford devices, do not trust institutions, or face language and literacy barriers. Thus, the relationship between telecommunications and life expectancy is mediated by a complex set of socioeconomic and institutional factors.

From a governance perspective, institutional capacity plays a key role in ensuring that telecommunications infrastructure translates into meaningful public health benefits. Gazilas (2024b), in his European study on economic factors influencing homicide rates, emphasizes the role of institutional quality in shaping social outcomes. Similarly, Soares (2006) finds that improvements in governance and public policy, more than economic growth alone, contributed to declining homicide and improving life expectancy in Latin America. These findings support the idea that digital infrastructure must be paired with effective regulation and public investment to produce tangible improvements in public welfare.

Several cross-country studies offer further insight into these dynamics. Roser and Ortiz-Ospina (2018) document global life expectancy trends, noting that improvements are often uneven and closely tied to governance and infrastructure quality. In high-income countries, digital technologies have been integrated into health systems in ways that enhance access and efficiency. In contrast, many low-income countries face a digital divide that mirrors existing health and income inequalities. This divide affects not only individuals but entire regions, reinforcing spatial patterns of deprivation and limiting national progress toward health equity.

The COVID-19 pandemic served as a stress test for these systems. Countries with robust telecommunications infrastructure were able to pivot rapidly to digital service delivery, including telemedicine, digital contact tracing, and online health information dissemination. Studies by Latif et al. (2023) and OECD (2021) suggest that these digital tools played a role in mitigating the public health impact of the pandemic. Yet, the same studies highlight that populations without access to stable internet or mobile networks experienced worse outcomes, including lower testing rates, delayed treatment, and higher mortality. This reinforces the view that telecommunications infrastructure is not merely a convenience but a core element of health system resilience.

In summary, the literature supports a multidimensional understanding of life expectancy that incorporates digital infrastructure as a contributing factor. This relationship is both direct, through enhanced access to health services and information, and indirect, through effects on employment, education, and institutional engagement. Digital inequality thus emerges as a key lens through which to understand modern disparities in health outcomes. However, the impact of telecommunications on life expectancy is contingent on the broader institutional and socioeconomic environment, including labor market structures, governance quality, and public investment priorities.

Conceptual Framework

Understanding life expectancy as a function of digital infrastructure requires a framework that moves beyond conventional health economics. Rather than treating telecommunications as an isolated technological variable, this paper views it as part of a broader network of social and

institutional systems that influence individual and population-level outcomes. Specifically, the conceptual framework proposed here integrates three critical dimensions: digital infrastructure, labor market informality, and institutional capacity. These elements are interconnected and collectively shape access to healthcare, health information, and the structural conditions necessary for longevity.

The foundation of this framework lies in the notion that telecommunications infrastructure is both a platform for service delivery and a channel for information dissemination. In the health domain, access to digital networks allows for remote medical consultations, access to health records, and participation in digital health promotion initiatives. It also facilitates the administrative processes surrounding healthcare, such as registration for public health programs or digital applications for health insurance. In theory, these benefits should contribute to improved preventive care, earlier diagnoses, and better treatment adherence. However, these outcomes depend on the extent to which individuals and communities are digitally included, both in terms of infrastructure availability and digital literacy.

Digital access is unevenly distributed both between and within countries. In many low- and middle-income regions, telecommunications infrastructure remains concentrated in urban centers, leaving rural and remote areas under-served. Even within well-connected regions, digital participation is stratified along lines of income, education, and employment status. This creates layers of exclusion that overlap with existing health disparities. The framework proposed here emphasizes that digital inequality is not only about infrastructure deficits but also about unequal capacity to engage with digital systems. These structural disparities in digital access can thus reinforce existing inequalities in health outcomes, including life expectancy.

Labor market informality is the second core component of the framework. Informality refers to employment that is not regulated by formal labor laws, often lacking social protections such as health insurance, sick leave, and retirement benefits. Gazilas (2024d) highlights the prevalence of uninsured employment in Greece and its connection to regulatory shortcomings. Informal workers often operate outside the purview of state institutions, and as a result, they are more vulnerable to health shocks and less likely to access formal healthcare. When informal employment overlaps with digital exclusion, the compounded effects can significantly reduce an individual's capacity to maintain health and access necessary services.

The link between informality and digital inequality is both structural and spatial. Informal employment is often concentrated in marginalized urban neighborhoods or rural areas where infrastructure investment is low. These regions may suffer from poor telecommunications access, creating what can be termed a double exclusion—where individuals are excluded both from formal labor protections and from digital health systems. Moreover, informal workers frequently lack the time, resources, or documentation required to engage with online health systems, even where digital infrastructure exists. This highlights the importance of considering labor market structure as a mediating variable in the relationship between digital infrastructure and health outcomes.

Institutional capacity forms the third component of the framework and acts as the enabling or constraining context in which telecommunications and labor market structures interact. Institutional capacity refers to the ability of public authorities to design, implement, and enforce policies effectively. As shown in Gazilas (2024b), institutional weakness can lead to

adverse social outcomes, even in the presence of favorable economic conditions. In the context of digital infrastructure and health, weak institutions may fail to ensure equitable access to telecommunications, or may lack the regulatory coherence necessary to integrate digital platforms into health service delivery. They may also fail to address the needs of informal workers or to enforce standards for inclusive digital health systems.

This conceptual framework proposes that life expectancy outcomes are shaped not by any single factor, but by the intersection of these three dimensions. High digital infrastructure alone is not sufficient to improve life expectancy if large portions of the population remain excluded due to informality or institutional failure. Similarly, strong labor market protections may not deliver health gains if digital tools are inaccessible or underutilized. In contrast, the combination of inclusive telecommunications infrastructure, formal labor integration, and capable institutions creates a synergistic environment where health systems can be both accessible and responsive, leading to improved longevity.

This integrated framework has important implications for both policy and research. It suggests that health interventions targeting life expectancy must consider not only direct medical factors but also the broader digital and labor ecosystems in which individuals are embedded. For example, expanding mobile broadband coverage in rural areas may improve access to health information, but its full potential will only be realized if those populations are also integrated into formal health and labor systems and supported by responsive institutions. Similarly, programs aimed at reducing labor informality may also yield health dividends, especially if coupled with digital literacy training and improved infrastructure access.

By highlighting the interdependence of digital access, labor structure, and institutional quality, this framework helps explain persistent health disparities across countries and within regions. It offers a lens through which to evaluate existing health policies and development programs, particularly those that rely on digital technologies for delivery or monitoring. The next section applies this conceptual framework to a comparative discussion of how different countries navigate the intersection of telecommunications, informality, and health outcomes.

Discussion

Applying the conceptual framework developed above reveals the nuanced ways in which digital infrastructure interacts with labor informality and institutional capacity to shape life expectancy outcomes. In this discussion, key themes from the literature are connected to real-world patterns observed in different regional and national contexts. The aim is to highlight the mechanisms through which telecommunications infrastructure contributes to health equity or reinforces existing disparities, depending on the broader socioeconomic environment in which it operates.

First, the role of telecommunications in health access is best illustrated by contrasting digital health systems in countries with differing infrastructure capabilities. In nations with advanced telecommunications networks, such as Sweden, South Korea, or Estonia, digital tools are fully integrated into public health systems. Citizens in these countries routinely use digital portals for booking appointments, accessing medical records, and receiving telemedicine consultations. During the COVID-19 pandemic, these systems allowed for swift information

dissemination and continuity of care. Consequently, disruptions to non-COVID healthcare were minimized, and population health outcomes were better protected.

In contrast, in countries where digital infrastructure is weak or uneven, such integration remains limited. Many low- and middle-income countries still rely heavily on in-person and paper-based systems, particularly in rural and remote areas. Even when mobile health applications are introduced, their usage is often confined to urban centers with stable internet access and high mobile penetration rates. The result is a dual health system—one that serves digitally connected populations and another that excludes those who lack access or literacy. This divide is not merely technological; it reflects deeper structural inequalities that are difficult to overcome without broader reforms.

The literature has increasingly recognized that such technological disparities are compounded by labor market informality. In countries with high levels of informal employment—such as India, Nigeria, or parts of Latin America—many workers are not covered by public or private health insurance schemes. These workers often rely on out-of-pocket expenditures or under-resourced public clinics. The lack of formal documentation and financial stability also limits their ability to participate in digital health initiatives, especially when such programs require registration, mobile payments, or formal identification. Informality thus acts as both a financial and institutional barrier to digital inclusion.

Greece presents a compelling case study in this regard. As shown by Gazilas (2024d), uninsured employment remains a significant issue in the Greek labor market, influenced by both regulatory gaps and enforcement weaknesses. This labor market informality intersects with uneven access to telecommunications infrastructure, particularly in economically depressed or remote areas. The result is a population subset that is both digitally and institutionally excluded from comprehensive healthcare services. While the Greek healthcare system is theoretically universal, in practice, access is stratified along lines of employment, geography, and connectivity.

The institutional dimension further complicates these dynamics. Even when digital tools are available, their effectiveness depends on the strength and responsiveness of public institutions. Weak governance can manifest in underinvestment in digital health infrastructure, poor coordination between agencies, or the absence of regulatory frameworks to ensure data privacy and equitable access. Gazilas (2024b) argues that institutional strength is a key determinant of social outcomes across Europe, including crime and public health. This insight extends to digital health systems, which require robust oversight and cross-sectoral collaboration to function effectively.

For example, in countries with well-functioning institutions such as Germany or Canada, digital infrastructure is supported by policies that ensure access, protect user data, and integrate services across health, labor, and welfare departments. These countries also tend to have comprehensive safety nets that cover informal workers or integrate them into formal systems through incentives and regulation. By contrast, in countries where institutions are fragmented or underfunded, digital health efforts may remain superficial, poorly coordinated, or accessible only to privileged segments of the population.

The discussion also raises important concerns about policy sequencing and coherence. Introducing digital health technologies in environments characterized by informality and

weak institutions may lead to unintended consequences, such as the exclusion of vulnerable populations or the misallocation of public funds. In these contexts, improving life expectancy may require prioritizing investments in labor formalization and institutional capacity before or alongside digital infrastructure expansion. This reinforces the value of a multidimensional approach that considers the interplay between technological, economic, and political factors.

Moreover, digital inequality is not only a developing world issue. Within high-income countries, certain communities—particularly older adults, recent immigrants, and low-income groups—experience digital exclusion. These populations may lack the devices, connectivity, or skills needed to benefit from digital health systems, despite living in well-connected countries. Thus, national averages in internet access or health system performance can obscure important within-country disparities that have direct implications for life expectancy and health equity.

The growing reliance on digital health solutions, particularly in the wake of the COVID-19 pandemic, underscores the urgency of addressing these gaps. Policymakers and public health officials must recognize that digital infrastructure is not a neutral or self-correcting force. Without deliberate interventions to promote inclusion, telecommunications systems may deepen rather than bridge health inequalities. Strategies such as subsidized internet access, community digital literacy programs, and targeted investments in underserved regions are critical to ensuring that digital tools enhance, rather than limit, public health.

Finally, this discussion suggests that future research and policy must adopt intersectional perspectives. Focusing on telecommunications alone risks overlooking the structural barriers that prevent its effective use. Conversely, addressing informality and institutional weakness without considering the role of digital systems may lead to outdated or inefficient service delivery. Only by integrating these perspectives can we fully understand and address the complex determinants of life expectancy in the digital age.

Conclusions

This paper has examined the complex relationship between life expectancy and digital inequality, with a particular focus on telecommunications infrastructure as a modern social determinant of health. By developing and applying a conceptual framework that integrates digital infrastructure, labor market informality, and institutional capacity, the discussion has highlighted the multifaceted ways in which health outcomes—specifically life expectancy—are shaped by a combination of technological access, labor structures, and governance quality.

The literature consistently supports the view that life expectancy is influenced by more than direct healthcare inputs. While traditional factors such as income, education, and public health spending remain important, they cannot fully explain persistent disparities, especially in contexts undergoing rapid digital transformation. Telecommunications infrastructure has emerged as a critical enabler of health information access, service delivery, and administrative inclusion. Yet, its benefits are not universally felt. In regions where infrastructure is weak, digital literacy is low, or labor markets are dominated by informal employment, the promise of digital health remains largely unrealized.

The evidence suggests that digital inequality is a multidimensional phenomenon that mirrors and often exacerbates existing social and economic inequalities. Where digital infrastructure is concentrated in urban or affluent regions, and where institutions fail to extend services equitably, the excluded populations face a compounded risk—limited access not only to traditional healthcare, but also to emerging digital tools that could potentially improve their well-being. These inequalities are particularly acute in low- and middle-income countries, but are also present within high-income nations among marginalized or rural groups.

Labor market informality further complicates this picture. Informal workers are often uninsured and disconnected from the formal health system. When these individuals also lack access to telecommunications infrastructure, their capacity to benefit from digital health interventions is minimal. As discussed in the literature and shown in Gazilas (2024d), informality in the labor market acts as a barrier to both social protection and technological inclusion, reinforcing health disparities. The intersection of informality and digital exclusion thus represents a critical area of vulnerability that requires targeted policy attention.

Institutional quality plays a central role in mediating the relationship between digital infrastructure and life expectancy. Strong institutions are essential for the equitable rollout of digital health services, the regulation of digital platforms, and the integration of informal populations into formal systems. Without adequate institutional capacity, digital health investments may remain fragmented, inaccessible, or poorly managed. As noted by Gazilas (2024b), institutional strength is a key determinant of public health and social outcomes, making it a crucial component in any strategy aimed at improving life expectancy through technological means.

From a policy perspective, the findings of this paper suggest that telecommunications infrastructure must be embedded within a broader strategy that includes labor market reforms and institutional strengthening. Investments in broadband access and mobile health applications will only produce sustainable health gains if they are accompanied by efforts to reduce informality, expand social protection, and ensure regulatory coherence. Governments should prioritize policies that promote digital inclusion, such as subsidizing internet access for low-income households, supporting community-based digital literacy programs, and expanding infrastructure to under-served regions.

Moreover, the integration of digital technologies into public health systems should be approached with a critical understanding of local contexts. A one-size-fits-all approach is unlikely to succeed, particularly in environments with diverse cultural, economic, and institutional conditions. Policymakers must ensure that digital health initiatives are inclusive by design, addressing barriers related to affordability, education, language, and trust. Community engagement and cross-sector collaboration will be essential to ensure that digital tools enhance rather than hinder access to health services.

This paper also identifies several avenues for future research. First, more empirical studies are needed to quantify the causal effects of digital infrastructure on health outcomes across different institutional and labor market contexts. Second, longitudinal analyses could help clarify the long-term impacts of digital inclusion policies on life expectancy and public health equity. Third, interdisciplinary research that bridges public health, labor economics, and digital policy could provide deeper insights into the mechanisms linking infrastructure to well-being.

In conclusion, digital infrastructure has become a vital, though often overlooked, determinant of life expectancy in the 21st century. However, its impact is contingent on broader structural conditions, including labor market formalization and institutional effectiveness. Addressing digital inequality requires more than technological investment—it demands a coordinated, multidimensional approach that places equity and inclusion at its center. Only through such an integrated strategy can countries hope to leverage the full potential of telecommunications to improve public health and extend life expectancy for all.

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