Chapter 4

Telehealth and Maternal-Child Health in LMICs: A Multidisciplinary Approach to Improving Life Expectancy

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Abstract

Maternal and child health (MCH) outcomes remain suboptimal in many low- and middle-income countries (LMICs), contributing to reduced national life expectancy. Telehealth has emerged as a potential solution to address these service delivery gaps, yet limited evidence exists on its impact in LMIC contexts. The present study draws motivation from the United Nations Sustainable Development Goals-(UNSDG-3), that highlights on good health and well-being. A comparative mixed-methods study was conducted across Nigeria, Kenya, India, and South Africa for the period 2015-2023. Quantitative analysis included maternal mortality ratio, under-five mortality, antenatal care coverage, skilled birth attendance, immunization rates, and life expectancy, alongside a composite Telehealth Readiness Index. Correlations between digital readiness and MCH outcomes were explored using Pearson coefficients. Also document analysis was guided by the Consolidated Framework for Implementation Research (CFIR), assessing policy strategies, infrastructure, workforce readiness, and cultural acceptability.

Substantial variation was observed in telehealth integration and MCH outcomes across countries. India and South Africa exhibited higher digital readiness scores (India: 61; South Africa: 69) and MCH performance indices (India: 77; South Africa: 82), alongside lower maternal mortality (India: 103; South Africa: 119 per 100,000). A strong inverse correlation ($r = -0.97$, 95% CI: -0.99 to -0.78, $p = 0.030$) was found between telehealth maturity and maternal mortality. In contrast, Nigeria and Kenya had lower readiness scores (Nigeria: 28; Kenya: 39) and faced implementation barriers such as weak infrastructure, low digital literacy, and fragmented policy execution.

Telehealth can enhance maternal and child health outcomes when implemented within supportive structural, policy, and sociocultural environments.

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https://doi.org/10.58830/ozgur.pub891.c3668

1. Introduction

Globally, maternal and child mortality rates remain alarmingly high in low- and middle-income countries (LMICs), contributing significantly to lower national life expectancies. According to the World Health Organization, 94% of all maternal deaths occur in LMICs (with sub-Saharan Africa accounting for approximately 70%).[1] The global under-five mortality rate in 2022 was 35 per 1,000 live births, but exceeded 70 per 1,000 in parts of sub-Saharan Africa.[2] These disparities reflect healthcare access barriers and systemic inequities affecting women and children in resource-constrained settings.

Telehealth - the use of telecommunications and virtual technologies to deliver healthcare remotely is increasingly recognized as a tool to bridge maternal and child health (MCH) service gaps. In MCH, telehealth facilitates interventions like virtual antenatal care, remote pregnancy monitoring, health education via SMS/apps, immunization reminders, and on-call obstetric consultations. The COVID-19 pandemic accelerated telehealth adoption globally, underscoring its value in maintaining care continuity when physical access was restricted.[3] High-income countries (HICs) have made substantial progress integrating telehealth, but LMICs lag due to infrastructural deficits, low digital literacy, fragmented policies, and limited trust in virtual care.[4] Even within LMICs, uptake varies widely. For example, India's National Digital Health Mission (NDHM) has integrated digital tools into reproductive, maternal, newborn, and child health (RMNCH+A) services, whereas Nigeria and Kenya have primarily early-stage or pilot telehealth initiatives.[5]

Improved access to MCH services is linked to increased life expectancy. However, few studies explicitly examine how telehealth interventions might influence this relationship. This study addresses that gap by:

i. analyzing telehealth adoption levels for MCH in four strategically selected LMICs representing different geopolitical regions and digital maturity levels;

ii. assessing associations between telehealth-supported interventions and MCH outcomes (maternal mortality, under-five mortality, antenatal and immunization coverage);

iii. evaluating the implications of these changes for national life expectancy.

By examining the intersection of digital health innovation and public health outcomes in LMICs, this study contributes to a growing but underexplored field of global health research. Its findings can inform national strategies and

international development efforts aimed at leveraging telehealth to reduce mortality, improve health equity, and ultimately enhance life expectancy in some of the world's most vulnerable populations.

2. Methods

Study Design

This study applied a comparative mixed-methods approach using a multiple case study design to examine telehealth adoption and its implications for maternal and child health (MCH) outcomes in Nigeria, Kenya, India, and South Africa. These countries were purposively selected to reflect variation in economic classification, digital infrastructure maturity, and telehealth policy development, while representing different geographic regions with significant maternal and child health challenges.

Theoretical Framework

Three theoretical frameworks guided this inquiry:

i. The Consolidated Framework for Implementation Research (CFIR) provided a structured approach to analyze intervention characteristics, organizational context, individual capabilities, and the broader implementation process.[6]

ii. Rogers' Diffusion of Innovation Theory explained the spread of new technologies, emphasizing factors like relative advantage, compatibility, and observability.[7]

iii. The Technology Acceptance Model (TAM), developed by Davis, focused on perceived usefulness and ease of use as key determinants of user acceptance, particularly relevant to both providers and users of telehealth.[8]

Data Sources and Collection

The quantitative data spanned 2015 to 2023 and examined key health system indicators such as maternal and under-five mortality rates, life expectancy, antenatal care, skilled birth attendance, and immunization coverage, using sources like WHO, UNICEF, DHS, and World Bank. Digital readiness was assessed through internet penetration and mobile subscription rates, based on data from the ITU, GSMA, and national ICT surveys. As of 2023, internet coverage reached 68% in South Africa and 36% in Nigeria, while mobile subscriptions ranged from 85 per 100 people in Nigeria to 155 per 100 in South Africa.[9]

Telehealth adoption was estimated as the share of maternal and child health (MCH) services delivered remotely, drawn from literature and pilot reports. For example, South Africa's MomConnect reached around 500,000 mothers, suggesting moderate coverage. Adoption rates in the studied LMICs were considerably lower than in high-income countries (HICs), ranging from under 5% in Nigeria and Kenya to 15-30% in India and South Africa.

To contextualize these findings, national digital health strategies and telehealth program reports were qualitatively analyzed, including India's NDHM Strategy, Nigeria's Digital Health Strategic Framework, Kenya's eHealth Policy, and South Africa's eHealth strategy updates.

Variables and Measurements

Two composite indices were developed to facilitate cross-country comparisons: the Telehealth Readiness Index (TRI) and the Maternal and Child Health (MCH) Performance Index (MPI).

The Telehealth Readiness Index (TRI), scored on a scale from 0 to 100, integrates several weighted indicators that reflect a country's capacity to deploy and sustain telehealth services. These include the proportion of the population with internet access, the number of mobile subscriptions per 100 people, and the presence and maturity of a national telehealth policy framework. Additionally, the index incorporates the extent to which telehealth is integrated into maternal and child health (MCH) programs and the level of digital literacy among healthcare providers, each assessed on a scale of 0 to 10.

Similarly, the MCH Performance Index (MPI) captures key indicators of maternal and child health outcomes. It includes the percentage of women receiving at least four antenatal care visits, the rate of skilled birth attendance, and the proportion of children who are fully immunized. To balance the index, maternal mortality ratio and under-five mortality rate are included as inversely weighted components, ensuring that higher mortality figures reduce the overall performance score.

2.1. Data Analysis

Quantitative data were analyzed using SPSS version 28.0, with descriptive statistics and cross-country comparisons. Correlation analyses explored links between telehealth readiness, MCH outcomes, and life expectancy (2015-2023), using Pearson coefficients and regression models. Confidence

intervals (95% CI) were calculated for all correlation coefficients, and statistical significance was set at $p<0.05$.

3. Results

Telehealth Readiness and Digital Infrastructure

A comparative analysis revealed wide disparities in telehealth readiness and digital infrastructure across Nigeria, Kenya, India, and South Africa. While South Africa and India demonstrated moderate to high integration of telehealth in maternal and child health (MCH) services, Nigeria and Kenya remained in early stages of adoption. Shown in table 1 is summary of the telehealth policy environment, infrastructure, and notable mHealth initiatives across the four countries. It also highlights digital infrastructure as a major factor influencing telehealth readiness. South Africa stands out with strong mobile and internet access, while India benefits from robust policy support and large-scale platforms. Kenya has policy frameworks in place but faces implementation challenges. Nigeria lags due to fragmented, donor-driven efforts and weak national coordination.

Table 1. Telehealth MCH Integration Status (2023)

Country	Telehealth Strategy for MCH	Mobile Penetration (per 100)	Internet Coverage (%)	Notable mHealth Initiatives
Nigeria	Fragmented; donor-dependent pilots	85/100	36%	Pilots in Lagos, Kaduna (e.g., text-for-moms)
Kenya	Included in policy; limited scale	91/100	43%	*Linda Mama* free maternal care SMS platform
India	Strong national framework	81/100	50%	*eSanjeevani* telemedicine; *RMNCH+A* program
South Africa	Moderate; urban-focused	155/100	68%	*MomConnect* (maternal SMS), *B-Wise* youth health

Source: GSMA (2023) Mobile Connectivity Index; National digital health reports.

As shown in Figure 1 below, infrastructure gaps significantly influence telehealth readiness across countries. South Africa leads in both mobile and internet connectivity, while Nigeria lags with the lowest internet access highlighting a critical digital divide that hampers effective telehealth implementation.

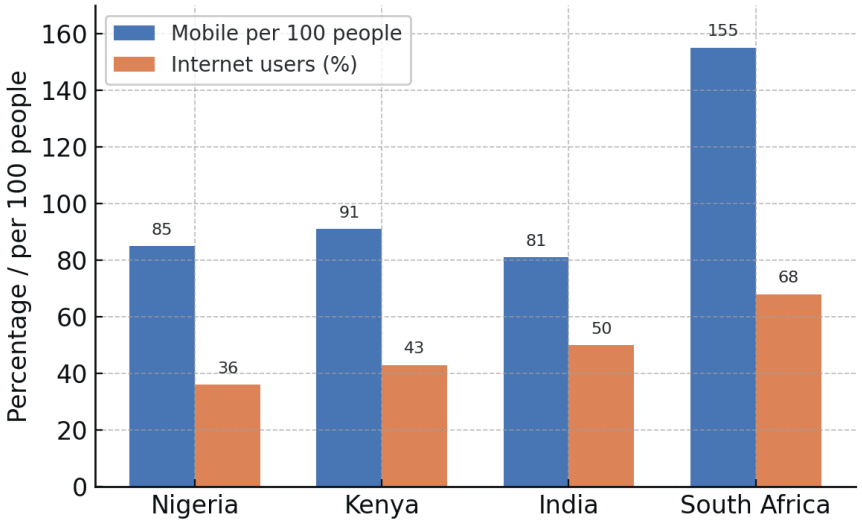

Figure 1. Digital Infrastructure for Telehealth in 2023.

Health Indicators and Life Expectancy Trends

Population-level health indicators like maternal mortality, under-five mortality, and life expectancy reveal the impact of telehealth-enabled systems. As shown in Figure 2, life expectancy is rising across all countries, with India leading due to improvements in maternal and child health services. Nigeria's minimal progress underscores the need for systemic reforms and stronger digital integration to achieve meaningful health outcomes.

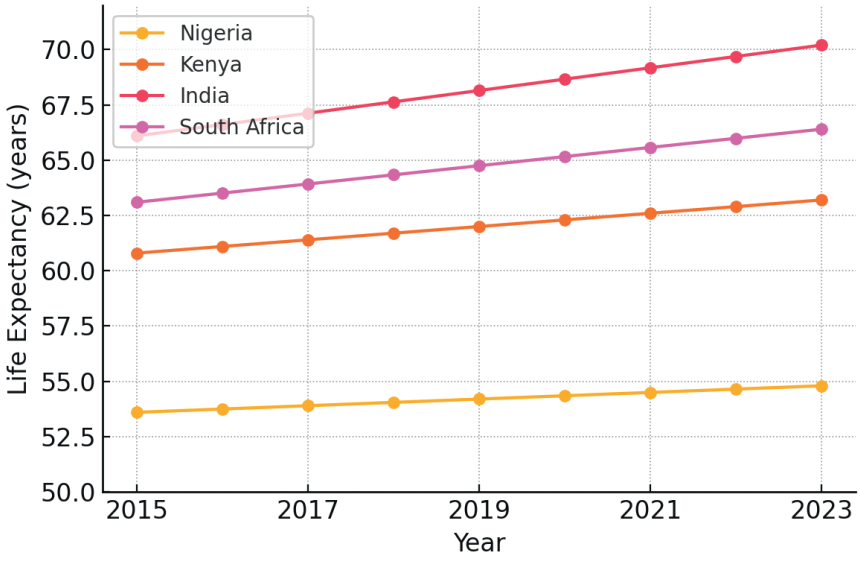

Figure 2. Life Expectancy Trends (2015–2023).

Correlation Analysis: Digital Readiness and Health Outcomes

To evaluate the impact of digital infrastructure on health outcomes, a correlation analysis was conducted between telehealth readiness and key indicators—maternal mortality and life expectancy. As shown in Figure 3, countries with stronger digital integration like South Africa and India reported much lower maternal mortality rates. A strong negative correlation ($r = -0.97$, 95% CI: -0.99 to -0.78, $p = 0.030$) highlights the potential of digital health to significantly improve maternal outcomes.

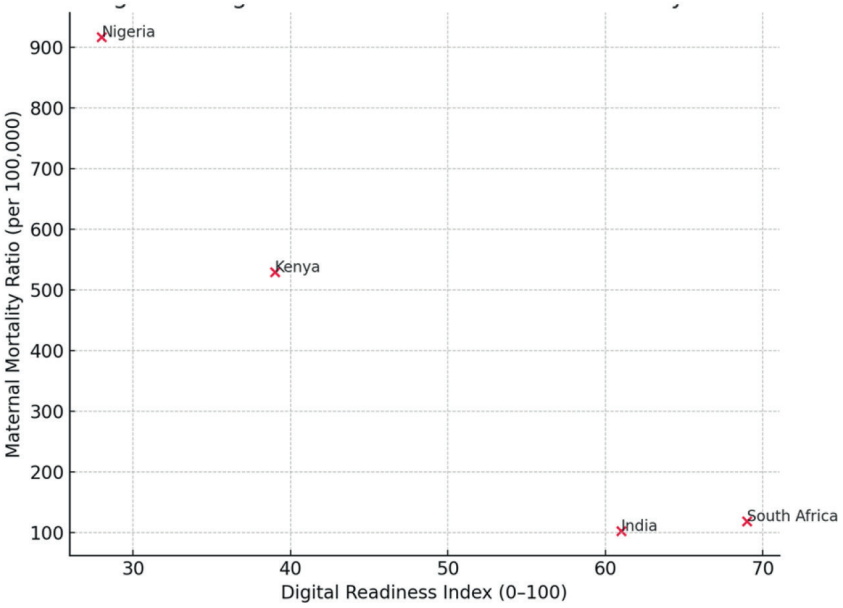

Figure 3. Digital Readiness vs Maternal Mortality Ratio

As seen in Figure 4 below, a scatter plot comparing digital readiness with life expectancy reveals a strong positive correlation (r = 0.89, 95% CI: 0.37 to 0.98, p = 0.042), suggesting that countries with more advanced digital infrastructure tend to have higher life expectancy. Although this does not confirm causation, the alignment of strong digital systems with improved outcomes in India and South Africa reinforces the value of scaling digitally-supported maternal and child health (MCH) initiatives.

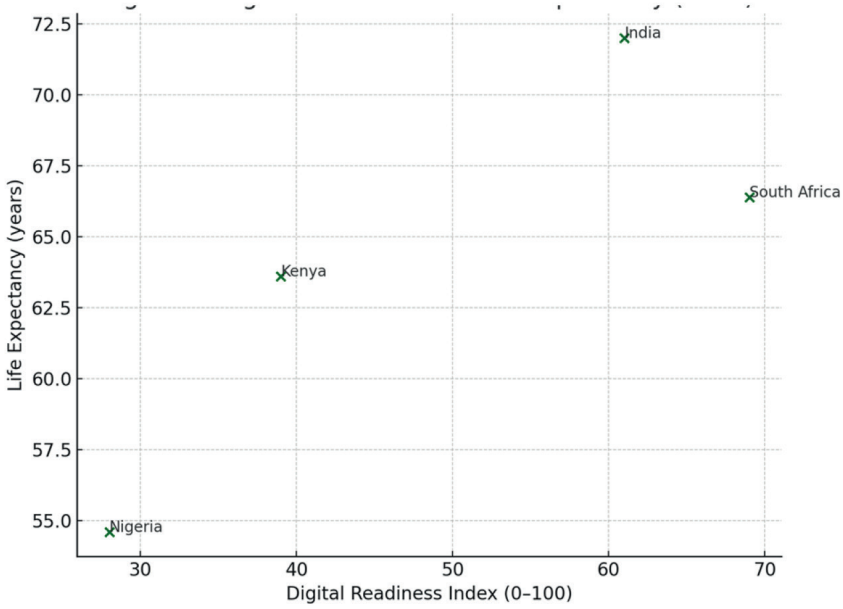

Figure 4. Digital Readiness vs Life Expectancy

Composite Index Comparison

A composite index comparing telehealth readiness and MCH performance reveals a positive alignment between digital infrastructure and health outcomes. As shown in Table 2, countries with stronger telehealth systems tend to perform better in maternal and child health indicators. While index construction involves some simplification, the findings underscore the role of digital systems in advancing MCH outcomes.

Table 2: Composite Scores for Telehealth Readiness and MCH Performance

Country	**Digital Readiness (0-100)**	**MCH Performance (0-100)**
South Africa	69	82
India	61	77
Kenya	39	49
Nigeria	28	34

Implementation Factors: Barriers and Enablers

To understand how policy, system capacity, and context influence telehealth effectiveness, qualitative findings were analyzed using the CFIR

framework. As shown in Table 3, successful implementation relies not just on infrastructure, but also on integration with existing systems, cultural adaptation, supportive policies, and workforce training. South Africa and India demonstrate stronger alignment across these domains, while Nigeria and Kenya face notable structural and contextual barriers.

Table 3. Telehealth Implementation Barriers and Enablers by CFIR Domain

CFIR Domain	**Enablers (India, South Africa)**	**Barriers (Nigeria, Kenya)**
Intervention Characteristics (Design & Quality)	- Locally adapted tools (apps in Hindi, Zulu etc.) making interfaces user-friendly in local languages. - Integration with existing services (telehealth linked to clinic appointment systems, immunization registries).	- "One-size-fits-all" apps not tailored to local languages/ cultures. - Low usability of platforms (complex interfaces, requiring smartphones that many low-income users lack).
Outer Setting (External context, patient needs)	- Strong telecom infrastructure in urban areas (especially RSA) enabling reliable video consults. - Donor funding for digital health (e.g., UNICEF support in India's mHealth, PEPFAR support in SA). - High community mobile phone ownership (even in rural areas).	- Rural connectivity gaps: remote regions lack network or affordable data. - Electricity unreliability: affects charging devices and running telecenters. - Socioeconomic barriers: cost of internet/smartphones for poorest women.
Inner Setting (Health system context)	-National digital health policies/strategies providing clear roadmap. - Presence of dedicated units or eHealth departments in health ministries. - Integration with primary healthcare.	- Policy fragmentation: telehealth not mainstreamed. - Resource constraints: few budget allocations for eHealth implementation. - Lack of interoperability between systems.
Characteristics of Individuals (Users: providers & patients)	- Trained workforce: India trained thousands of ASHAs to use mobile apps. - Champions and leadership advocating telehealth. - Gradually improved user trust as positive experiences accumulate.	- Limited digital literacy among health workers and patients. - Resistance from some providers fearing replacement. - Cultural beliefs: skepticism of remote advice; preference for in-person care.

Process (Implementation and Evaluation)	- Pilot evaluations and iterative improvements. - Multi-stakeholder collaboration and public-private partnerships. - Community engagement involving local leaders.	- Fragmented rollout without scale-up plans. - Lack of monitoring & evaluation data. - Dependency on donor or research projects without sustainability plans.

4. Discussion

The findings demonstrate that effective integration of telehealth into maternal and child health (MCH) systems is associated with improved service coverage and may contribute to increased life expectancy in low- and middle-income countries (LMICs). A consistent gradient was observed across the case countries: those with stronger digital health infrastructure and coherent policy frameworks - specifically India and South Africa - exhibited higher MCH coverage and more substantial life expectancy gains between 2015 and 2023, compared to countries with fragmented telehealth systems, such as Nigeria and Kenya. This pattern aligns with global literature emphasizing the importance of systemic readiness in achieving health technology outcomes[10] and offers context-specific insights into the dynamics of digital health in low-resource settings.

A statistically significant inverse correlation ($r = -0.97$, 95% CI: -0.99 to -0.78, $p = 0.030$) between telehealth maturity and maternal mortality underscores the potential of digital health systems to serve as enablers in reducing maternal mortality. Improvements in maternal and child survival are widely recognized as contributors to national life expectancy.[11] The observed correlation supports the proposition that digital interventions - by enhancing access, continuity, and quality of care - can play a meaningful role in sustaining mortality reductions, especially during health system disruptions such as those caused by the COVID-19 pandemic.

Empirical evidence confirms that where telehealth platforms have been incorporated into national health strategies, improved MCH service utilization has followed. In India, teleconsultation platforms such as *eSanjeevani*, supported by mobile health campaigns, contributed to a rise in ANC4+ visits from approximately 51% in 2015 to 84% in 2023.[12] South Africa's *MomConnect* initiative has been associated with early ANC registration and high immunization rates; by 2019, ANC 4+ visits exceeded 80% and skilled delivery rates reached 96%.[13] In Kenya, the *Linda Mama* program contributed to an increase in skilled birth attendance from 62%

in 2015 to approximately 78% in 2022,[14] though direct attribution to telehealth is limited. In contrast, Nigeria's reliance on pilot projects and lack of scalable infrastructure resulted in stagnation, with ANC4+ visits at 57% and skilled birth attendance at 43%.[15] These findings parallel existing literature on equity-centered telehealth,[16] on digital determinants of health[17], and on policy implementation failures[18].

Based on the findings, an equity-oriented, multisector model for telehealth implementation in LMICs is proposed, consisting of three interdependent pillars:

i. Infrastructure Development: Expansion of broadband, mobile networks, and power supply is critical for enabling telehealth beyond urban centers. Infrastructure should be prioritized as a core element of health system investment.

ii. Policy and Financing Reform: Development of inclusive national digital health strategies, integration of telehealth into public financing schemes, and establishment of data governance standards are necessary to ensure sustainability and trust. Movement beyond pilot-dependent models is essential for institutionalization.

iii. Community-Integrated Implementation: Engagement of local stakeholders, training of frontline workers, and adaptation of tools to local languages and literacy levels enhance trust and usability. Supportive roles for traditional health workers should be emphasized to avoid substitution-based resistance.

These pillars align with CFIR and TAM frameworks, which highlight the importance of organizational context, perceived usefulness, and user engagement. Implementation success requires a balance of technical readiness and human-centered design.

Several methodological and contextual limitations must be acknowledged. The study relied on secondary data sources, which varied in temporal coverage and reliability. Despite the use of authoritative datasets (WHO, DHS), inconsistencies in reporting years and data quality may affect comparability. The cross-sectional nature of the analysis and small sample size (N=4) limit causal inference. Correlation results should be interpreted as indicative rather than definitive. Additionally, attribution challenges exist in linking telehealth specifically to health improvements, as multiple concurrent health system strengthening efforts may contribute to observed outcomes. The rapid evolution of digital technologies and increasing smartphone penetration

may also alter the implementation landscape in coming years, potentially making some findings time-sensitive.

Future research should employ longitudinal designs with larger country samples, integration of primary data collection, and methods that can better establish causal pathways between digital health interventions and population health outcomes. Controlled implementation studies and natural experiments would be particularly valuable in strengthening the evidence base.

5. Conclusion

The role of telehealth in improving maternal and child health (MCH) outcomes and potentially advancing life expectancy in LMICs has been substantiated through this comparative analysis. Evidence from Nigeria, Kenya, India, and South Africa indicates that the adoption and effectiveness of telehealth are closely linked to the robustness of digital infrastructure, the coherence and implementation of national health policies, and the extent of cultural and community integration. Countries with more mature digital health ecosystems particularly India and South Africa, exhibited higher antenatal care coverage, skilled birth attendance, and immunization rates, which are key drivers of reduced maternal and under-five mortality. These improvements corresponded with measurable gains in life expectancy between 2015 and 2023, though multiple factors likely contribute to this relationship.

The findings suggest that the association between telehealth maturity and maternal mortality is particularly strong. However, these benefits are neither automatic nor equitably distributed. In the absence of inclusive design, equitable access, and sustained policy support, telehealth interventions risk exacerbating existing health disparities especially when disproportionately accessed by urban, educated populations while underserved rural communities remain excluded. To ensure telehealth serves as a vehicle for health equity and system strengthening, policy recommendations include: expanding rural digital infrastructure; enacting adaptive digital health frameworks with integrated financing mechanisms; embedding data privacy protections; engaging community stakeholders in culturally responsive co-design processes; and establishing robust monitoring systems with real-time analytics. When guided by these principles, telehealth has the potential to transform MCH service delivery in LMICs, reduce preventable mortality, and contribute meaningfully to longer, healthier lives for vulnerable populations.

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