Digital Health Technologies in India: A Comprehensive Review

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"Digital health technologies are not just tools—they are bridges that connect patients, providers, and communities, transforming healthcare from reactive treatment to proactive well-being."

Abstract

Digital health technologies are transforming healthcare delivery by integrating information and communication tools with medical practice. In India, the rapid adoption of telemedicine, mobile health (mHealth) applications, electronic health records (EHRs), artificial intelligence (AI), and the Internet of Medical Things (IoMT) is reshaping access, efficiency, and quality of care. This comprehensive review explores the evolution of digital health in India, major technological interventions, key national initiatives such as the Ayushman Bharat Digital Mission (ABDM), and policy frameworks ensuring interoperability, privacy, and ethical governance. Challenges related to infrastructure, digital literacy, data security, and system integration are discussed, along with future directives emphasizing inclusive access, capacity building, and innovation. The review highlights India's opportunities to leverage emerging technologies, scale innovations, and achieve patient-centred, equitable, and sustainable healthcare delivery.

Keywords

Digital health, India, telemedicine, Ayushman Bharat Digital Mission, mHealth, eHealth, healthcare delivery, artificial intelligence, electronic health records, Internet of Medical Things (IoMT)

1. Introduction

The 21st century has witnessed an unprecedented digital transformation across sectors, and healthcare is at the forefront of this evolution. Digital health technologies refer to the use of digital tools such as mobile applications, telemedicine, artificial intelligence (AI), and electronic health records (EHRs) to deliver healthcare services, manage data, and enhance patient outcomes. In India, the need for equitable and accessible healthcare—especially in rural and remote areas—has driven rapid adoption of digital innovations. The COVID-19 pandemic further accelerated this transition, making digital health an essential component of national health policy.

2.Evolution of Digital Health in India

India's digital health journey reflects a gradual but transformative integration of information and communication technologies (ICT) within the health sector. The evolution can be understood across five distinct phases, each representing significant policy shifts, innovations, and technological progress.

Early Foundations (Pre-2010): Telemedicine and e-Governance Beginnings:

The earliest initiatives in digital health emerged in the early 2000s, largely as pilot projects to bridge urban–rural healthcare gaps.

- ISRO's Telemedicine Program (2001) was among the first efforts to connect remote hospitals with tertiary centers through satellite communication. By 2010, ISRO had linked over 400 hospitals across India.
- The National Informatics Centre (NIC) developed early hospital management systems (HMIS) for government facilities.

- The Department of Information Technology (DIT) initiated several e-health pilots focused on disease surveillance and electronic medical records.

These projects demonstrated feasibility but lacked scalability due to limited internet access, high costs, and fragmented implementation.

The Digital Governance Era (2010–2015):

During this period, digitalization became part of India's governance agenda:

- The National Rural Health Mission (NRHM) and National Urban Health Mission (NUHM) began adopting Health Management Information Systems (HMIS) to collect and analyze program data electronically.
- Introduction of Mother and Child Tracking System (MCTS) and Reproductive and Child Health (RCH) Portal in 2011 digitized beneficiary tracking across states.
- Pilot projects such as Online Registration System (ORS) for hospital appointments were launched.

However, health data remained siloed and fragmented across programs without national-level integration.

Digital India and Health Policy Integration (2015–2019):

The Digital India Mission (2015) marked a turning point by promoting ICT across sectors, including health.

- The National Digital Health Blueprint (NDHB) (2018–2019) provided a framework for creating a federated digital health ecosystem with unique identifiers, registries, and standards.
- Telemedicine Practice Guidelines were conceptualized and later formalized (in 2020).
- During this phase, private healthcare and startups began contributing significantly—platforms like Practo, 1mg, and Apollo TeleHealth expanded teleconsultation and e-pharmacy services.

The government's Ayushman Bharat Program (2018), with its twin components—Health and Wellness Centres (HWCs) and Pradhan Mantri Jan Arogya Yojana (PM-JAY)—created an ecosystem ready for digital transformation.

Pandemic-Driven Acceleration (2020–2022):

The COVID-19 pandemic served as an inflection point, catalyzing rapid digital adoption across the health system:

- The eSanjeevani telemedicine platform was scaled nationwide, offering both doctor-to-doctor (AB-HWC) and doctor-to-patient (OPD) consultations. By 2025, the platform had facilitated over 360 million teleconsultations.
- The Aarogya Setu app enabled contact tracing and risk communication to over 200 million users.
- The CoWIN portal (2021) became one of the world's largest digital vaccination management systems, handling over 2 billion vaccination records.
- Expansion of digital pharmacies, remote monitoring tools, and AI-based diagnostics (e.g., Qure.ai, Niramai) demonstrated the scalability of digital innovation in public health emergencies.

Institutionalization and Interoperability (2022–Present):

With the establishment of the Ayushman Bharat Digital Mission (ABDM) in 2021–2022, India transitioned from pilot projects to a national digital health infrastructure.
The mission's core components include:

- ABHA (Ayushman Bharat Health Account) – a unique digital health ID for citizens.
- Health Facility Registry (HFR) and Health Professional Registry (HPR) – digital databases ensuring standardized information.
- Health Information Exchange (HIE) – enabling interoperability between health systems through consent-based data sharing.

Recent developments include integration of AI and machine learning into disease surveillance, National Health Stack (NHS) for digital health data storage, and initiatives promoting data security and privacy under the Digital Personal Data Protection Act, 2023.

3. Major Digital Health Technologies in Use in India:

Technology Domain	Key Examples / Platforms	Primary Applications	Health System Impact
Telemedicine and Virtual Care	eSanjeevani (AB-HWC, OPD), Apollo TeleHealth, Practo, Tata 1mg	Remote consultations, follow-up care, specialist access in rural areas	Improved access, reduced travel cost, continuity of care, strengthened primary healthcare
Mobile Health (mHealth) Applications	Aarogya Setu, NHP App, Nikshay, RCH App, mDiabetes, private wellness apps	Disease surveillance, patient tracking, adherence reminders, health education	Enhanced awareness, improved self-management, better program monitoring
Electronic Health Records (EHR) and Digital Registries	ABHA (Health ID), Health Facility Registry (HFR), Health Professional Registry (HPR), HMIS	Health data standardization, information exchange, longitudinal records	Interoperability, data-driven decisions, improved quality and safety
Artificial Intelligence (AI) and Machine Learning (ML)	Qure.ai, Niramai, SigTuple, AI-based ECG & retinal screening	Automated diagnostics, disease prediction, workflow optimization	Faster diagnosis, early detection, reduced clinician workload
Digital Public Health and Surveillance Systems	CoWIN, IHIP, Nikshay, Integrated Disease Surveillance Programme (IDSP)	Real-time reporting, vaccination tracking, outbreak monitoring	Strengthened public health response, pandemic preparedness
Internet of Medical Things (IoMT) and Wearables	Smartwatches, glucose monitors, BP cuffs, remote sensors	Continuous patient monitoring, chronic disease management, elderly care	Personalized and preventive care, reduced hospital readmissions
Emerging Technologies	Blockchain pilots, Cloud health data systems, VR/AR in training	Data security, scalable data management, medical simulation	Innovation in data governance, capacity building, enhanced training quality

4. Policy Frameworks and Governance for Digital Health in India

India's digital health governance has evolved through comprehensive national policies that ensure interoperability, privacy, and equity. These frameworks provide the institutional and ethical foundation for implementing digital health at scale.

a. National Digital Health Blueprint (NDHB)

The National Digital Health Blueprint (2019) established a federated architecture for India's digital health ecosystem. It emphasized unique health identifiers, privacy-by-design, and interoperability across health systems. NDHB proposed digital registries, standards for data exchange, and governance mechanisms to integrate patients, providers, and policymakers through secure and consent-based information sharing.

b. Ayushman Bharat Digital Mission (ABDM)

Launched in 2021, the Ayushman Bharat Digital Mission (ABDM) operationalizes NDHB's vision. Its key components include the Ayushman Bharat Health Account (ABHA), Health Facility Registry (HFR), Health Professional Registry (HPR), and Health Information Exchange and Consent Manager (HIE-CM). These elements enable every citizen to maintain longitudinal electronic health records and facilitate interoperable, patient-centric data exchange across public and private sectors.

c. Data Protection and Ethical Governance

The Digital Personal Data Protection (DPDP) Act, 2023 provides a legal framework for safeguarding personal health data through explicit consent, transparency, and accountability. Complementing this, the Health Data Management

Policy (HDMP) defines sector-specific norms for data collection, storage, and anonymization. Ethical governance is reinforced by NITI Aayog's Responsible AI for Health principles, promoting fairness and accountability in AI-driven applications.

d. Institutional Roles and Partnerships

The National Health Authority (NHA) leads ABDM implementation, supported by the Ministry of Electronics and IT for cybersecurity and NITI Aayog for innovation and AI integration. Public–private partnerships and platforms like the HealthTech Innovation Sandbox foster scalable, compliant digital solutions aligned with the WHO Global Digital Health Strategy (2020–2025).

5. Digital Health Reach in India

- eSanjeevani Telemedicine Platform: As of July 2024, eSanjeevani has facilitated over 276 million consultations, making it one of the world's largest telemedicine platforms.
- Ayushman Bharat Digital Mission (ABDM): By March 2024, 568 million Ayushman Bharat Health Accounts (ABHA) had been created, and over 350 million health records were digitized and integrated into the national digital health ecosystem.
- CoWIN Vaccination Platform: During the COVID-19 vaccination drive, the CoWIN platform managed the administration of over 2 billion vaccine doses, setting a global benchmark for large-scale digital health system deployment.
- Mobile Health (mHealth) Apps: The National Health Authority's mHealth applications, such as the National Health Portal (NHP) and Nikshay, have been instrumental in disease surveillance, patient tracking, and health education, reaching millions across the country.
- Digital Health Market Size: India's digital health market was valued at approximately USD 14.33 billion in 2024 and is projected to grow to USD 52.4 billion by 2030, with a compound annual growth rate (CAGR) of 24.4%.

6. Challenges and Future Directions in Digital Health Implementation

Despite rapid policy progress and technological innovation, India's digital health transformation faces multiple systemic challenges that must be addressed to ensure equitable, sustainable, and secure healthcare delivery.

Infrastructure and Connectivity Gaps

Unequal access to digital infrastructure remains a major barrier. While urban areas benefit from high-speed internet and advanced hospital information systems, rural and remote regions still experience limited network connectivity, inconsistent electricity supply, and low device availability. According to the Telecom Regulatory Authority of India (TRAI), internet penetration in rural India remains below 40%, restricting access to telemedicine and e-health services. Strengthening broadband infrastructure and integrating digital tools into primary healthcare facilities are essential for equitable reach.

Digital Literacy and Workforce Competency

Digital health adoption depends heavily on the digital competency of both healthcare providers and patients. Many health professionals lack adequate training in electronic health records, teleconsultation protocols, and data governance. Similarly, patients with low literacy or limited exposure to technology face difficulties navigating digital platforms. Capacity-building programs, such as digital health literacy training for healthcare workers and community digital education campaigns, are critical to improving utilization and trust.

Data Privacy, Security, and Ethical Concerns

As health data becomes increasingly digitized, concerns over data breaches, unauthorized sharing, and misuse are growing. Despite the Digital Personal Data Protection (DPDP) Act, 2023, gaps persist in implementation, cybersecurity infrastructure, and awareness. Ensuring compliance with the Health Data Management Policy and embedding privacy-by-design principles within digital platforms are essential. Additionally, the growing use of AI and machine learning in diagnostics raises issues related to algorithmic bias, transparency, and accountability.

Integration and Interoperability Challenges

India's healthcare system is highly fragmented, with public, private, and informal providers operating in silos. Lack of interoperability between digital platforms impedes seamless data exchange and care continuity. While the

Ayushman Bharat Digital Mission (ABDM) promotes standardized data systems, integration across legacy hospital management software and regional health programs remains incomplete. Developing uniform data standards and API-based health information exchanges will be key to system-wide coordination.

7. The Road Ahead: Opportunities, Innovations, and Future Directives in Digital Health in India

India is poised for a transformative era in healthcare, driven by rapid digital innovations, supportive policies, and an expanding startup ecosystem. These developments are reshaping healthcare delivery, particularly in underserved regions, and positioning India as a global leader in digital health.

Opportunities and Emerging Innovations:

Telemedicine and Remote Care: Telemedicine platforms such as eSanjeevani, Apollo TeleHealth, and Practo connect urban specialists with rural populations. AI-enabled portable devices and remote monitoring systems enhance access to diagnostics, chronic disease management, and mental health support.

Artificial Intelligence and Machine Learning: AI applications in diagnostics, predictive analytics, and clinical decision support are expanding rapidly. Examples include Qure.ai for chest X-rays, Niramai for breast cancer screening, and AI-driven predictive models for chronic disease risk stratification.

Mobile Health (mHealth) Applications: Government and private apps, including Aarogya Setu, CoWIN, Nikshay, and lifestyle management platforms, facilitate disease surveillance, preventive care, medication adherence, and patient education.

Internet of Medical Things (IoMT) and Wearables: Connected devices such as smartwatches, digital blood pressure monitors, and glucometers enable continuous monitoring and early intervention, reducing hospitalizations and improving chronic care outcomes.

Blockchain and Secure Data Management: Pilot initiatives under ABDM leverage blockchain to ensure consent-based data exchange, secure patient records, and traceable pharmaceutical supply chains.

Virtual and Augmented Reality (VR/AR): These technologies support medical education, immersive surgical training, and rehabilitation programs, improving patient engagement and clinical outcomes.

Startups and Innovation Hubs: Over 800 startups and innovation hubs, including C-CAMP, NIMHANS Innovation Hub, and T-Hub, foster scalable solutions, particularly in AI diagnostics, mobile monitoring, and personalized healthcare.

Future Directives:

Infrastructure and Connectivity: Expanding broadband, 5G networks, and reliable electricity, especially in rural areas, is critical to support telemedicine, AI diagnostics, and IoMT solutions.

Workforce Capacity and Digital Literacy: Structured training for healthcare providers and community education programs will ensure effective adoption of digital platforms.

Data Governance and Ethical Compliance: Strict implementation of the DPDP Act, 2023, secure storage, consent management, and ethical AI practices are essential to maintain trust and safety.

Integration and Interoperability: Developing standardized APIs and integrating legacy hospital systems with national platforms such as ABHA will enable seamless health information exchange across public and private sectors.

Evidence-Based Innovation: Research and evaluation of cost-effectiveness, usability, and health outcomes should guide scaling of AI, telemedicine, wearable devices, and personalized medicine initiatives.

Equitable Access: Digital health strategies must prioritize marginalized populations, addressing language, literacy, and affordability barriers to prevent widening healthcare disparities.

Alignment with Global Standards: Conformance with WHO Global Digital Health Strategy (2020–2025) will enhance interoperability, quality, and safety while positioning India as a leader in global digital health.

Summary

Digital health technologies in India—encompassing telemedicine, mHealth, AI, EHRs, and IoMT—have significantly improved access, efficiency, and quality of care. Supported by national policies such as the Ayushman Bharat Digital Mission and the National Digital Health Blueprint, these innovations address healthcare gaps, especially in rural areas. Challenges remain in infrastructure, digital literacy, data security, and interoperability, but

ongoing technological and policy advancements are fostering a more connected, patient-centred, and equitable healthcare ecosystem.

Conclusion

Digital health is reshaping healthcare delivery in India, enabling proactive, data-driven, and inclusive care. Strategic investments in infrastructure, digital literacy, governance, and integration of emerging technologies will strengthen health systems, improve outcomes, and position India as a global leader in digital health innovation.

Source of funding

None

Conflict of interest

None

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