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An analysis of eHealth adoption and utilisation in Kerala

Mohammed Asharu Jaman[1], Bhavya Fernandez[1*], N. Mahesh[2] and Jithesh Veetilakath[1]

*Correspondence:
Bhavya Fernandez
bhavya.fernandez@gmail.com
[1]State Health Systems Resource Centre-Kerala, Thiruvananthapuram, India
[2]Directorate of Health Services-Kerala, Thiruvananthapuram, India

Abstract

Background Digital transformation in healthcare is gaining momentum globally, with eHealth systems playing a key role in improving service delivery and data integration. Kerala's eHealth initiative aims to digitalise the state's public healthcare system by introducing a centralised digital platform to streamline services.

Objective This study aims to determine the extent of eHealth adoption across public healthcare facilities in Kerala and examine its utilisation in service delivery.

Methods A descriptive analysis was conducted using secondary data from the eHealth dashboard and the Directorate of Health Services (DHS). Adoption data from the launch of the program in 2016 to April 2024 were used to assess implementation across districts and facility types. Utilisation data, covering May 2023 to April 2024, included outpatient (OPD) visits, inpatient (IP) admissions, laboratory investigations, UHID coverage, and online appointment bookings.

Results As of April 2024, 43.86% of public healthcare facilities in Kerala had adopted the eHealth system. Adoption was highest in Medical Colleges (85.71%) and General Hospitals (70.59%), and lowest in Community Health Centres (11.51%) and Taluk Hospitals (26.14%). During this period, 36.42% of OPD visits and 35.85% of IP admissions were recorded via eHealth. Only 6.7% of lab investigations and 0.87% of OPD visits were processed through online booking. UHID coverage reached 14.89%.

Conclusion While eHealth adoption in Kerala shows promise, key features remain underutilised. Expanding UHID coverage, promoting online services, and strengthening digital infrastructure are essential for realising the full benefits of healthcare digitalisation.

Keywords eHealth, Public health digitalisation, UHID, Digital health

1 Introduction

In the current era of global digital transformation, the healthcare sector is undergoing significant changes with the integration of digital technologies into healthcare systems, fundamentally revolutionising the delivery, management, and accessibility of medical services. This transformation generates momentum toward enhancing efficiency, improving accessibility, and prioritising patient-centred care as healthcare systems worldwide adapt to evolving demands and complex challenges [1]. eHealth systems have

emerged in many countries as key tools for achieving these goals [2]. The World Health Organization (WHO) defines eHealth as "the use of information and communications technology in support of health and health-related fields, including services for public health, clinical care, patient education, and health systems management" [3]. This shift encompasses a broad array of innovations, including electronic health records, telemedicine, artificial intelligence, wearable health technologies, and more [4]. By leveraging digital infrastructure, healthcare systems can optimise health outcomes and advance the goals of Universal Health Coverage (UHC) [5].

India's healthcare system is organised through a decentralised structure, comprising primary care centres (Sub-Health Centres, Primary Health Centres), secondary care centres (Community Health Centres, Sub-District Hospitals, District Hospitals), and tertiary care centres (Medical Colleges, Specialty Hospitals) [6]. This decentralised framework allows services to be delivered efficiently at different levels of care, depending on the complexity of health needs and helps cater to diverse local populations. The push towards digitalising healthcare has gained momentum in India in recent years. The National Health Policy (NHP) 2017 emphasised the creation of a Digital Health Technology Ecosystem to improve healthcare access, quality, and data integration [7]. To further these goals, the National Digital Health Blueprint (NDHB) was developed, leading to the launch of the National Digital Health Mission (NDHM) in 2020 [8]. This initiative was later renamed the Ayushman Bharat Digital Mission (ABDM) in 2021, aiming to create a secure, interoperable digital health ecosystem across India [9, 10]. The success of national digital platforms such as Co-WIN and U-WIN in managing immunisation and public health services illustrates the growing reliance on digital systems for health service delivery in India [11].

Even ahead of the national initiative, Kerala took a pioneering step towards digital transformation in healthcare by launching its eHealth Project in 2017 to modernise its public health infrastructure. The project was first implemented as a pilot in the Thiruvananthapuram district in mid-2016 before its official launch. This World Bank-aided project was developed with the support of the Ministry of Electronics and Information Technology (MeitY), Government of India, and the Department of Health and Family Welfare, Government of Kerala [12]. The project seeks to transform the state's healthcare system by establishing Electronic Health Records (EHR) along with other key e-Health modules for all citizens, effectively digitalising and centralising health-related data. Its primary objective is to streamline hospital operations and develop a centralised state health information system, which facilitates improved continuity of care across government hospitals [13].

The project was initially piloted in eight healthcare institutions within the Thiruvananthapuram district and has since been proposed for broader implementation across hospitals and clinics under the Directorate of Medical Education (DME) and the Directorate of Health Services (DHS). This proposed expansion encompasses various modern medicine facilities, including Sub-Health Centres (SHCs), Family Health Centres/Primary Health Centres (FHCs/PHCs), Community Health Centres (CHCs), Taluk Hospitals (THs), District Hospitals (DHs), speciality hospitals, and government medical colleges [14].

A centralised data system streamlines patient management, reduces redundancy, facilitates coordinated care and aids in health research [15]. By creating a centralised state

health information system, Kerala's eHealth initiative aims to enhance the efficiency of healthcare delivery across all levels of care. This digital platform is designed to streamline hospital operations through a suite of integrated modules that include features such as patient registration systems, longitudinal electronic health records, appointment scheduling and the management of laboratory tests and prescriptions. Introduction of UHID (Unique Health Identification) - a unique ID for all the healthcare needs of an individual across institutions, enables the creation of lifelong health records. The UHID is Aadhaar-based, Aadhaar being a biometric enabled, mobile linked nationally recognised 12-digit unique identification number for Indian residents issued by the Unique Identification Authority of India (UIDAI) [16, 17]. UHID based health records can be securely accessed by healthcare providers across the state using an OTP-based authentication system, with the OTP being sent to the concerned patient's Aadhaar linked mobile. In situations where patients visit health centres without an Aadhaar card, a temporary health ID number is issued as a makeshift arrangement to enable access to services. However, this practice often results in incomplete or fragmented patient records over time, especially when different mobile numbers are used for registration. This issue is especially common among the elderly, who frequently rely on the phone numbers of their children or neighbours for registration [13]. However, once a permanent UHID is created for such patients, the records from their temporary UHIDs can be merged with the permanent one, ensuring continuity and completeness of their health information. The interoperability between facilities through UHID ensures continuity of care, reduces waiting times, and minimises the risk of inadequacies in care due to incomplete or inaccessible patient records [18]. In addition to streamlining administrative processes, the eHealth Project is expected to significantly reduce the burden on healthcare staff, allowing them to focus more on direct patient care rather than administrative tasks. The integration of digital tools also supports better decision-making, enabling healthcare providers to access real-time data and make informed clinical decisions [19]. These data are used by clinicians for treatment decisions, by facility administrators for service delivery management, and by health system officials through dashboards for monitoring and planning purposes.

The eHealth Project in Kerala was launched in 2017 as a pivotal step towards digitalising the state's healthcare infrastructure, with the goal of improving the quality, efficiency, and accessibility of public health services. As of 2024, the project has been in progress for nearly seven years, making it timely and necessary to evaluate how well eHealth has been adopted across the state's public healthcare facilities. This assessment will provide a clearer picture of how digital health systems have evolved in the state over time. The objectives are to determine the extent of eHealth system adoption across public healthcare facilities in the state and to examine how eHealth is utilised in service delivery within these facilities.

2 Methods

This study is a descriptive secondary data analysis, assessing the utilisation and adoption of the eHealth system in public healthcare facilities across Kerala. The study evaluates data available from May 1, 2023, to April 30, 2024, and provides a district-wise and facility-type-wise breakdown of eHealth adoption and usage trends. Key areas of analysis

include UHID coverage, advance bookings through eHealth and online consultations, Outpatient Department (OPD) visits, Inpatient (IP) admissions, and lab investigations.

2.1 Data sources and collection process

The data for this study were collected from two primary sources: the eHealth Dashboard and the Directorate of Health Services (DHS).

From the eHealth Dashboard, the following datasets were extracted for the period from May 1, 2023, to April 30, 2024:

- eHealth adoption: Data on the number of healthcare facilities adopting eHealth from 2016 to May 2024, disaggregated by district and facility type.
- eHealth utilisation: Total OPD visits, IP admissions, and lab investigations recorded through the eHealth system for the specified period.
- Advance bookings and online consultations: Number of UHID cards issued, categorised by district, and the number of advance bookings and online consultations facilitated through the eHealth Portal during the same period.

From the Directorate of Health Services (DHS), data were obtained on:

- Healthcare facilities: The total number of public healthcare facilities across Kerala, categorised by district and facility type, serves as a baseline for calculating eHealth adoption rates.
- Service utilisation: Total OPD visits, IP admissions, and lab investigations across all public health facilities, both eHealth and non-eHealth, for the period from May 1, 2023, to April 30, 2024.

2.2 Data processing and analysis

Once collected, the data was processed and analysed to derive meaningful insights into the adoption and utilisation of the eHealth system, which includes the following domains:

eHealth Adoption Rate: Adoption rates were calculated by comparing the number of facilities that implemented eHealth, as per data extracted from the eHealth dashboard, to the total number of healthcare facilities (from DHS data) based on district and facility types.

Service utilisation: OPD, IP, and Lab utilisation Rates: Calculated as the percentage of services (OPD visits, IP admissions, and lab investigations) recorded through the eHealth system versus the total number of services provided (from DHS data).

UHID Coverage: The percentage of the population with UHID cards was calculated by dividing the number of UHIDs issued (from the eHealth dashboard) by the total population of each district (from DHS population data).

Advance Bookings and Online Consultations: The number and percentage of OPD visits booked in advance through the eHealth portal and online consultations facilitated were compared with the total OPD visits recorded through the eHealth system.

2.3 Ethical considerations

The study used secondary, aggregated data from publicly available dashboards and government reports. No personal or identifiable patient data were accessed, ensuring full compliance with ethical standards for data privacy and confidentiality.

3 Results

The following section presents the findings from the analysis of eHealth uptake and utilisation across public health facilities in Kerala.

We focused on various aspects of eHealth integration in the health system, including its use for recording Outpatient Department (OPD) visits, Inpatient (IP) admissions, laboratory investigations, and prescription management. Additionally, we also explored the UHID coverage, rates of advance bookings, and online consultations facilitated through the eHealth system. The results will provide insights into the distribution of eHealth utilisation across districts and facility types, highlighting areas with high adoption as well as regions where the system is underutilised.

3.1 eHealth adoption status in Kerala

3.1.1 Trend analysis of eHealth adoption

As seen in Fig. 1, the adoption of eHealth in public health facilities across Kerala has steadily increased over the years, with fluctuations in growth rates. In 2016, 10 facilities adopted the eHealth system, marking the initial phase of the program. The adoption rate remained low in 2017, with only 3 new facilities coming on board. Starting in 2018, the pace picked up, with the total number of facilities having adopted eHealth increasing to 19 in that year.

This upward trend continued into 2019, with a total of 89 facilities adopting the system, and in 2020, the number more than doubled to 174 facilities. By 2021, eHealth adoption surged further, reaching a total of 324 facilities, which further increased to 486 facilities by the end of 2022. In 2023, 116 new adoptions were recorded, raising the

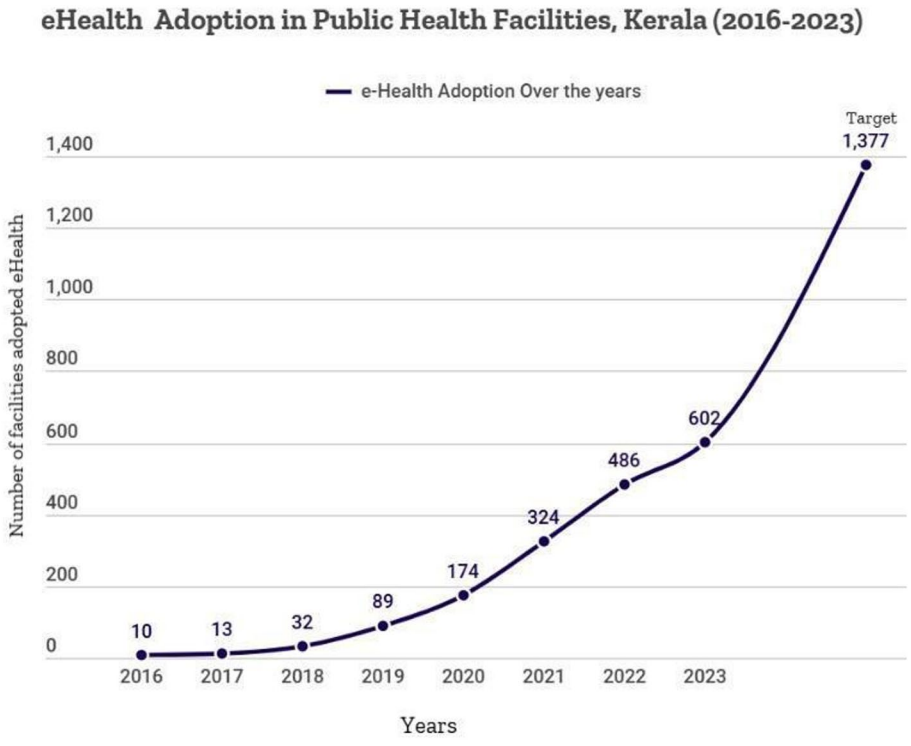

Fig. 1 eHealth adoption over the years 2016-23

cumulative total to 602. The 2024 data, representing figures from the initial months of the year, shows 2 additional new adoptions, making a total of 604 institutions.

3.1.2 District-wise eHealth adoption status

The adoption of the eHealth project in Kerala has been uneven across the 14 districts, with an overall average adoption rate of 43.86%. Thiruvananthapuram, which was one of the first districts to implement the eHealth project, beginning with eight institutions in the first phase when the project started in 2016, stands out as the leader in this effort, with 76.47% of its facilities having adopted eHealth. Thrissur follows with an adoption rate of 56%. Notably, 8 districts, such as Kollam, Pathanamthitta, Alappuzha, Kottayam, Idukki, Palakkad, Kannur, and Kasaragod, have eHealth adoption rates below 40%. A detailed overview of the district-wise eHealth adoption rates is provided in Table 1.

Other districts with adoption rates higher than 40% include Ernakulam, Malappuram, Kozhikode, and Wayanad. 56.14% of the state's healthcare facilities have not yet adopted the eHealth system.

3.1.3 Facility-type-wise eHealth adoption status

Kerala's Public healthcare system comprises various types of facilities, each playing a distinct role in providing care at different levels. The adoption rate of eHealth across these facilities varies. As seen in Table 2, Family Health Centres[1] and Primary Health Centres (PHC) exhibit a notable eHealth adoption rate of 53.95%.

Urban Primary Health Centres (UPHC) follow closely with a 49.02% eHealth adoption rate. However, Community Health Centres (CHC) lag with a relatively low adoption rate of 11.51%. Taluk Hospitals and District Hospitals have moderate adoption rates of 26.14% and 38.89%, respectively. In contrast, General Hospitals and Medical College Hospitals have high adoption rates of 70.59% and 85.71%, respectively, setting a benchmark for digital excellence in secondary and tertiary-level healthcare. Specialty Hospitals such as Women and Child Hospital, Coastal Specialty Hospital, Cochin Cancer

Table 1 District-wise eHealth adoption rates in Kerala

District	Total number of facilities	No. of facilities implemented eHealth	Percentage
Thiruvananthapuram	136	104	76.47
Kollam	94	31	32.98
Pathanamthitta	67	20	29.85
Alappuzha	97	32	32.99
Kottayam	90	32	35.56
Idukki	63	20	31.75
Ernakulam	131	57	43.51
Thrissur	125	70	56.00
Palakkad	118	45	38.14
Malappuram	135	55	40.74
Kozhikode	105	56	53.33
Wayanad	39	18	46.15
Kannur	116	41	35.34
Kasaragod	61	23	37.70
Total	1377	604	43.86

[1] *Family Health Centres (FHCs) are expanded forms of Primary Health Centres (PHCs) under the Aardram Mission. These centers typically employ more than one doctor and have a higher number of nursing staff compared to standard PHCs, enhancing their capacity to deliver comprehensive primary healthcare services.*

Table 2 Facility type-wise eHealth adoption status

Type of facility	Total number of facilities	Number of facilities implemented eHealth	Percentage
FHC and PHC	849	458	53.95
UPHC	102	50	49.02
CHC	226	26	11.51
TH	88	23	26.14
GH	17	12	70.59
DH	18	7	38.89
Medical College Hospital	14	12	85.71
Specialty Hospital	34	10	29.42
Other	29	6	20.69
Total	1377	604	43.86

Centre, and other centres such as Public Health Laboratories and Mental Health Centres have relatively low adoption rates of 29.42% and 20.69%, respectively.

3.1.4 Distribution of permanent UHID coverage across Kerala districts

The Kerala eHealth Project's introduction of the Permanent Unique Health Identification (UHID) card has been a pivotal step toward streamlining healthcare across the state. The UHID serves as an Aadhar-based unique identifier for every individual and allows access to medical records via OTP-based authentication, viewing prescriptions and lab results, thus providing citizens with a lifelong, Aadhaar-linked health record. Aadhaar is India's national biometric identity system, providing each citizen with a unique 12-digit number used for identity verification across government services. By linking UHID with Aadhaar, the system creates a lifelong health record, reduces redundant tests and paperwork, improves data accessibility for providers, and ensures more efficient and patient-centric healthcare delivery. It enhances continuity of care, improves data accessibility for providers, streamlines treatment and ensures more efficient and patient-centric healthcare across the state. As of May 2024, 4,973,912 individuals across Kerala have received their UHID, representing 14.89% of the total population. District-wise UHID distribution data reveals significant variance in coverage across Kerala. Table 3 presents the detailed distribution of UHID cards by district.

Thiruvananthapuram stands out with the highest UHID coverage, with 1,211,899 cards issued, representing 36.71% of its population. Wayanad has achieved a high coverage rate of 33.20%, with 271,345 cards issued. Malappuram also shows notable coverage, with 807,870 UHID cards distributed, accounting for 19.64% of its total population. Several districts have adoption rates that fall below the state average, such as Kollam, Kottayam, Ernakulam, Kannur, Kasaragod, Thrissur, and Alappuzha. Among these, Kottayam stands out with the lowest rate of 6.58%.

3.2 Service delivery through eHealth in Kerala

3.2.1 Utilisation of online advance booking services through eHealth

3.2.1.1 District-wise Advance booking is a key feature of the eHealth system, designed to enhance patients' convenience by allowing them to schedule their appointments online. By logging into their UHID profile, patients can select their preferred doctor and healthcare facility and book available time slots. This system aims to reduce waiting times and streamline the appointment process. Despite the potential benefits of advance booking, its actual utilisation remains minimal. Over the past year, from May 1, 2023, to April 30,

Table 3 Distribution of permanent UHID coverage across Kerala districts

Districts	Total Population (C.2011)	Permanent UHID	Percentage
Thiruvananthapuram	3,301,427	1,211,899	36.71
Kollam	2,635,375	210,546	7.99
Pathanamthitta	1,197,412	184,227	15.39
Alappuzha	2,127,789	284,167	13.36
Kottayam	1,974,551	129,836	6.58
Idukki	1,108,974	175,781	15.86
Ernakulam	3,282,388	219,865	6.70
Thrissur	3,121,200	370,991	11.89
Palakkad	2,809,934	468,721	16.69
Malappuram	4,112,920	807,870	19.65
Kozhikode	3,086,293	337,816	10.95
Wayanad	817,420	271,345	33.20
Kannur	2,523,003	173,605	6.89
Kasaragod	1,307,375	127,243	9.74
Total	33,406,061	4,973,912	14.89

2024, the statewide average for advance bookings through eHealth stands at only 0.87%. During this period, a total of 43,951,175 OPD visits were recorded via the eHealth system, out of which only 381,111 visits were booked in advance. As shown in Table 4, the utilisation of advance booking through the eHealth system varies significantly across districts in Kerala. Thiruvananthapuram led with the highest percentage of advance bookings, approximately 2.07%, with 244,497 out of 11,939,533 OPD visits scheduled online. Conversely, Wayanad has the lowest utilisation, with only 0.02% of OPD visits booked in advance, only 269 out of 1,344,823 visits. Most districts recorded a low utilisation of advances booking through eHealth, with the majority having percentages below 1%.

3.2.1.2 Facility type-wise As shown in Table 5, only 3.19% of OPD visits in General Hospitals (GH) were booked in advance through the eHealth system, which is the highest percentage among different facility types. Similarly, Medical Colleges (MCH) had 2.06% of their visits scheduled in advance, while Specialty Hospitals (SpH) recorded 1.44% of advance bookings. In the last year, advance bookings in facilities like Family Health Centres (FHC), Urban Primary Health Centres (UPHC), and Community Health Centres (CHC) were all below 1%.

3.2.2 Utilisation of eHealth for recording OPD visits

3.2.2.1 District-wise OPD visits eHealth allows citizens with a permanent UHID to easily manage their health records and book OPD appointments online or directly at facilities. For those without a permanent UHID, a temporary HID is issued to ensure their visit is recorded in the eHealth system. As shown in Table 4, the percentage of OPD visits recorded through eHealth varies significantly across the state. The overall percentage of OPD visits recorded through eHealth in the state stands at 36.42%. Thiruvananthapuram has the highest percentage, with 77.65% of its OPD visits recorded through eHealth. Kozhikode, Thrissur, and Wayanad show adoption rates close to the state average, at 43.36%, 40.25%, and 36.72%, respectively. In contrast, districts such as Kannur and Kasaragod have lower adoption rates, with 17.82% and 19.34% of their OPD visits recorded through eHealth, respectively.

3.2.2.2 Facility type-wise OPD visits The utilisation of eHealth for outpatient department (OPD) visits across different types of healthcare facilities is detailed in Table 5. The

Table 4 District-wise service utilisation through the eHealth platform in Kerala (May 2023 to April 2024)

Districts	Total OPD visits, *N*	OPD visits recorded through eHealth, *n* (%)	Online visits/advance booking through eHealth per total OPD visits, *n* (%)	Total IP admissions, *N*	IP admissions recorded through eHealth, *n* (%)	Total lab investigations, *N*	Lab investigations recorded through eHealth, *n* (%)
Thiruvananthapuram	15,143,757	11,759,533 (77.65)	244,497 (2.07)	223,181	183,220 (82.09)	10,553,545	2,093,386 (19.84)
Kollam	8,935,286	2,460,788 (27.54)	33,925 (1.38)	74,980	21,035 (28.05)	7,674,281	487,637 (6.35)
Pathanamthitta	4,558,508	930,884 (20.42)	670 (0.07)	33,547	0 (0)	3,520,816	78,868 (2.24)
Alappuzha	8,189,852	2,613,040 (31.91)	1079 (0.04)	96,699	60,944 (63.02)	8,631,486	261,825 (3.03)
Kottayam	6,900,445	2,172,849 (31.49)	8506 (0.39)	56,158	29,549 (52.62)	3,748,532	90,167 (2.41)
Idukki	3,600,847	740,601 (20.57)	1674 (0.23)	25,056	0 (0)	2,704,516	73,601 (2.72)
Ernakulam	10,465,098	3,512,876 (33.57)	42,464 (1.21)	88,019	27,190 (30.89)	7,758,866	335,623 (4.33)
Thrissur	11,431,568	4,601,645 (40.25)	27,014 (0.59)	127,712	69,597 (54.5)	8,305,773	881,805 (10.62)
Palakkad	8,353,302	1,950,086 (23.35)	1461 (0.07)	92,605	0 (0)	6,664,578	202,312 (3.04)
Malappuram	14,161,164	4,475,285 (31.6)	1768 (0.04)	91,654	1 (< 0.001)	6,180,990	233,067 (3.77)
Kozhikode	10,479,459	4,543,792 (43.36)	13,547 (0.3)	69,502	2676 (3.85)	4,759,925	329,061 (6.91)
Wayanad	3,662,194	1,344,823 (36.72)	269 (0.02)	31,929	0 (0)	2,957,063	148,933 (5.04)
Kannur	9,519,952	1,696,110 (17.82)	3841 (0.23)	54,905	0 (0)	4,093,508	125,792 (3.07)
Kasaragod	4,492,610	868,863 (19.34)	396 (0.05)	38,782	1804 (4.65)	3,367,792	75,952 (2.26)
Total	119,894,042	43,671,175 (36.42)	381,111 (0.87)	1,104,729	396,016 (35.85)	80,921,671	5,418,029 (6.7)

table provides a comprehensive breakdown of how eHealth is employed in recording OPD visits across various facility types. Medical college hospitals (MCH) demonstrated the highest utilisation of eHealth systems, with 94.91% of their total OPD visits recorded digitally, followed by Family Health Centres, at 56.85%, Urban Primary Health Centres (UPHC) at 42.3%, and Speciality Hospitals (SpH) at 37.57%.

In contrast, Community Health Centres (CHC) have the lowest rate of eHealth utilisation, with only 10.11% of OPD visits recorded through eHealth. Taluk Hospitals and District Hospitals have eHealth recording rates that are lower than the state average of 36.42, while General Hospitals show rates that are almost similar to the state average.

3.2.3 Utilisation of eHealth for recording IP admissions

3.2.3.1 A District-wise analysis of IP admissions through eHealth in Kerala The utilisation of eHealth systems for recording In-Patient (IP) admissions across districts in Kerala showed significant variation, as detailed in Table 4. In the last year, Thiruvananthapuram led with 82.09% of IP admissions recorded through eHealth. Alappuzha follows with 63.02% of IP admissions digitally recorded, showcasing significant eHealth adoption in IP admissions. Conversely, several districts reported very low or no IP admissions recorded through eHealth. Districts such as Pathanamthitta, Idukki, Palakkad, Malappuram, Kozhikode, Wayanad, Kannur, and Kasaragod have either minimal or zero recorded admissions via eHealth. The statewide average for IP admissions recorded through eHealth stands at 35.85%.

3.2.3.2 Facility type-wise utilisation of eHealth for IP admission Table 5 summarises the utilisation of eHealth systems for recording IP admissions across various types of healthcare facilities in Kerala. Since Family Health Centres (FHC) and Urban Primary Health Centres (UPHC) do not typically handle IP admissions, they are not considered in this section. Medical Colleges (MC) demonstrate the highest level of eHealth utilisation for IP admissions, with 83.47% of admissions recorded through eHealth.

General Hospitals (GH) and Speciality Hospitals (SpH) show notable adoption rates at 23.25% and 25.41%, respectively. District Hospital (DH), Community Health Centres (CHC), and Taluk Hospital (TH) have a lower utilisation rate. Most facilities have eHealth utilisation rates for IP admissions below the state average of 35.93%.

3.2.4 Utilisation of eHealth for recording lab investigations

3.2.4.1 District-wise lab investigations through eHealth in Kerala As shown in Table 4, the overall utilisation of eHealth systems for ordering lab investigations across Kerala remains extremely low, with an average of 6.7% of lab investigations recorded through eHealth. Thiruvananthapuram has the highest adoption rate, with 19.84% of lab investigations being recorded digitally. Thrissur follows with a utilisation rate of 10.62%. However, several districts report significantly low usage of eHealth for lab investigations. Pathanamthitta shows the lowest rate, with just 2.24% of lab investigations recorded in eHealth.

Several districts, such as Kozhikode and Kollam, show utilisation rates that are almost similar to the state average of 6.7%. All other districts show utilisation rates below the state average of 6.7%.

3.2.4.2 Facility type-wise utilisation of eHealth for lab investigations The utilisation of eHealth for lab investigations varies across different healthcare facilities. As seen in Table 5, Family Health Centres (FHC) show the highest adoption, with 16.47% of lab

Table 5 Facility-wise utilisation of eHealth services in Kerala (May 2023 to April 2024)

Districts	Total OPD visits, *N*	OPD visits recorded through eHealth, *n* (%)	Online visits/advance booking through eHealth, *n* (%)	Total IP admissions, *N*	IP admissions recorded through eHealth, *n* (%)	Total lab investigations, *N*	Lab investigations recorded through eHealth, *n* (%)
FHC	37,034,358	21,054,097 (56.85)	27,255 (0.13)	-	- (-)	12,026,612	1,981,353 (16.47)
UPHC	2,797,351	1,183,227 (42.3)	480 (0.04)	-	- (-)	1,557,969	123,338 (7.92)
CHC	23,041,626	2,329,069 (10.11)	1646 (0.07)	45,590	1083 (2.38)	11,589,907	231,322 (2.00)
TH	26,872,179	4,745,915 (17.66)	39,955 (0.84)	233,417	2519 (1.08)	19,701,479	505,965 (2.57)
GH	9,924,817	3,641,805 (36.69)	116,197 (3.19)	189,729	44,107 (23.25)	11,800,492	598,386 (5.07)
DH	9,810,571	1,976,762 (20.15)	22,572 (1.14)	189,263	13,334 (7.05)	9,551,163	146,067 (1.53)
MC	8,019,789	7,611,523 (94.91)	157,362 (2.07)	382,610	319,361 (83.47)	11,461,760	1,459,310 (12.73)
SPH	2,383,351	895,439 (37.57)	12,885 (1.44)	61,429	15,612 (25.41)	3,232,289	95,203 (2.95)
Other facilities	-[1]	233,338 (-)	2759 (1.18)	-	- (-)	-[2]	277,085 (-)
Total	119,894,042	43,671,175 (36.42)	381,111 (0.87)	1,102,038	396,016 (35.93)	80,921,671	5,418,029 (6.7)

[1]Data for total OPD visits in "Other facilities" is not available

[2]Data for total lab investigations in "Other facilities" is not available

investigations recorded through eHealth. Medical Colleges also display a significant level of utilisation of eHealth, with 12.73% of their lab investigations. Urban Primary Health Centres (UPHC) similarly demonstrate a notable utilisation rate of 7.92%, which is higher than the state average. Several facilities report lower adoption of eHealth for lab investigations. District Hospitals (DH), Community Health Centres (CHC), Taluk Hospitals (TH), and General Hospitals (GH) all fall below the state average of 6.70%. Although Urban Primary Health Centres (UPHC) report a utilisation rate of 7.92%, which is above the state average.

4 Discussion

This study assessed the adoption of eHealth and its utilisation in public health facilities across Kerala between May 2023 and April 2024. The analysis revealed significant progress, as well as considerable disproportionalities in eHealth adoption and usage across districts and facility types. Aligning with the broader vision of digital transformation in healthcare, the state has made significant progress, with 604 of 1,377 healthcare facilities adopting the eHealth system (43.86%). However, the findings reveal substantial disparities across districts and types of healthcare facilities.

Family Health Centres (FHCs) and Primary Health Centres (PHCs) demonstrated a higher adoption rate of eHealth (53.95%), which is a positive indicator of digital healthcare reaching grassroots-level facilities. The relatively high adoption in Medical College Hospitals (85.71%) and General Hospitals (70.59%) reinforces the idea that larger, better-resourced institutions tend to lead in the implementation of digital systems. Community Health Centres (CHCs) and Taluk Hospitals (TH) lagged significantly, with adoption rates of 11.51% and 26.14%, respectively. Though previous literature suggested that smaller and rural facilities often face challenges in adopting digital health technologies due to limited resources and infrastructure [20], in Kerala, this was limited to the CHCs due to the transformation of PHCs to Family Health Centres (FHCs) under the Aardram Mission. One of the key elements of this transformation, along with infrastructural improvements, staff training and strengthened laboratory services, was systematic integration of digital health records through the eHealth platform. These targeted improvements enabled higher levels of digital adoption and service utilisation in FHCs, which explains the higher adoption rates in FHCs compared to CHCs [21, 22]. In contrast, CHCs were not the initial focus of these reforms, which resulted in the lack of comparable levels of digital readiness. At the district level, Thiruvananthapuram (76.47%) led in eHealth adoption, consistent with it being the site of the state's initial pilot rollout, followed by Thrissur (56%), which also demonstrated a high adoption rate. On the other hand, several districts exhibited low adoption, reflecting regional disparities. The lower percentages suggest ongoing challenges in the adoption of eHealth systems, which may include limited digital infrastructure, insufficient staff training, and other barriers to fully implementing a paperless record-keeping system in the state. The incomplete adoption of eHealth across Kerala's public health facilities has hindered the achievement of full interoperability, limiting seamless data exchange and continuity of care [21, 23]. The goal of the eHealth initiative is to implement the eHealth system across all 1,377 public health facilities in Kerala, and achieving this target is crucial for the comprehensive digital transformation of the healthcare system.

Only 36.94% of OPD visits, 35.85% of IP admissions, and 6.7% of lab investigations were recorded through the eHealth system during the study period. These figures suggest that while facilities may have adopted the system, the full potential of digital health services remains untapped. Modules such as outpatient registration and UHID creation are relatively easy to implement and offer immediate benefits, such as faster patient flow and digital recordkeeping. This may explain their comparatively higher uptake. On the other hand, modules like laboratory services require integration with lab information systems, staff training, and dedicated IT infrastructure, which are not uniformly present across facilities. The lower uptake of lab modules may be due to these operational complexities. One of the most patient friendly features of eHealth is the provision for advance bookings to improve patient convenience and reduce waiting times [24]. However, the findings indicate that this feature is extremely underutilised, with only 0.87% of OPD visits being booked in advance statewide. This aligns with previous observations that advanced digital healthcare features often see low adoption unless patients and healthcare providers are actively encouraged and educated about their benefits [4, 25].

The introduction of Permanent Unique Health Identification (UHID) cards was a key part of the eHealth initiative, aimed at streamlining patient records and improving continuity of care. However, the findings reveal a low UHID coverage, with only 14.89% of Kerala's population registered by April 2024. This is a significant limitation in the digital health ecosystem, as the UHID system is central to achieving the goal of integrated and seamless healthcare records across facilities. Previous literature has also emphasised the importance of digital identifiers like UHID for the successful implementation of eHealth systems [17].

The actual implementation has faced several practical challenges. Many patients arrive without Aadhaar cards or without being in possession of the linked mobile number, leading to an inability to generate UHID, thus necessitating the use of temporary IDs, which weakens record continuity. Low UHID coverage can limit the full functionality of eHealth, as patients without UHIDs cannot fully leverage the benefits of a unified health record. Addressing this gap requires stronger efforts in public outreach and administrative streamlining to ensure more widespread issuance of UHIDs. In several facilities, only select modules (such as OP registration) are active, while others, like laboratory and pharmacy modules, remain offline or inconsistently used. This partial rollout creates interoperability issues and limits the perceived utility of the system. Healthcare providers, in turn, may be discouraged by the additional effort required to manage fragmented workflows or re-enter data. These factors may explain why some modules demonstrate higher uptake than others and why incentives to adopt the full system remain limited. Infrastructure deficiencies and the reliance on untrained staff to manage the eHealth system have increased the workload on healthcare providers during the rollout phase, which may be a limiting factor in consistent utilisation and adoption across facilities.

While the eHealth system is designed to generate actionable data to support clinical care, facility operations, and higher-level planning, its full potential remains unrealised due to incomplete implementation and inconsistent data capture. As a result, the quality and usability of data for system-wide monitoring and performance evaluation remain constrained in many settings.

4.1 Implications for policy and practice

The findings of this study have important implications for healthcare policy and practice in Kerala. To achieve the full potential of the eHealth system, the following areas should be addressed:

Strengthening Infrastructure in Underperforming Districts: Districts with low adoption and utilisation rates require targeted interventions, including upgrading technical infrastructure and providing additional support for healthcare staff.

Increasing UHID Coverage: Since the UHID system is critical for the integration of health records, accelerating the registration process is essential. Public awareness campaigns and integration of UHID registration into routine healthcare visits could increase coverage.

Promoting the Use of Advance Booking and Online Consultations: to promote underutilised advanced features of eHealth, such as online bookings, public education campaigns and incentivising healthcare workers to encourage patients to use these services can be considered.

Prioritising Full Rollout in Selected Districts: Rather than pursuing a fragmented implementation across all districts, it may be more effective to ensure 100% rollout, including all functional modules, in at least one district. This would ensure interoperability at least within the district and serve as a demonstration model to validate system performance, identify operational bottlenecks, and build user trust in the platform.

Establishing 24×7 Technical Support Mechanisms: Sustained adoption of digital tools requires the timely resolution of technical issues, which requires establishing round-the-clock technical support.

4.2 Limitations of the study

This study relies on secondary data from the eHealth Dashboard and the Directorate of Health Services, which may contain reporting inconsistencies or gaps, particularly in the completeness of service utilisation data. Additionally, the analysis covers a limited period from May 2023 to April 2024, potentially overlooking longer-term trends or fluctuations in eHealth adoption and utilisation. Another limitation is the lack of qualitative insights into barriers to adoption and utilisation, such as staff readiness, patient awareness, or technical challenges, which could provide a deeper understanding of the underlying factors. These limitations highlight the need for further research to validate findings and explore the perspectives of stakeholders involved in the eHealth system.

5 Conclusion

This study highlights significant progress in the adoption and utilisation of the eHealth system in Kerala, with 43.86% of public health facilities having implemented the system as of April 2024. However, this progress in adoption is not reflected uniformly in all facilities under the eHealth framework. While the infrastructure and implementation have expanded across many institutions, significant gaps remain in how effectively these facilities are leveraging the system's features. The considerable disparities persist across districts and facility types, with higher adoption in larger institutions like Medical Colleges and General Hospitals, and lower uptake in Community Health Centres and Taluk Hospitals. The utilisation of key eHealth features, including advance bookings and UHID-based digital records, remains limited, indicating untapped potential in

improving healthcare efficiency and continuity of care. Low UHID coverage (14.89%) and minimal usage of advance booking services (0.87%) underscore the need for stronger public outreach, enhanced digital literacy, and improved infrastructure to ensure broader engagement with the system. Achieving full adoption and interoperability of eHealth across all facilities is critical for the comprehensive digital transformation of Kerala's healthcare system, enabling seamless data exchange, equitable access, and enhanced patient outcomes.

Abbreviations

WHO	World Health Organization
NDHB	National Digital Health Blueprint
NDHM	National Digital Health Mission
ABDM	Ayushman Bharat Digital Mission
EHR	Electronic Health Records
DME	Department of Medical Education
DHS	Directorate of Health Services
FHC	Family Health Centre
PHC	Primary Health Centre
CHC	Community Health Centre
UPHC	Urban Primary Health Centre
TH	Taluk Hospital
DH	District Hospital
GH	General Hospital
MCH	Medical College Hospital
SpH	Speciality Hospital
UHID	Unique Health Identification

Supplementary Information

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Supplementary Material 1.

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Author contributions

M.A.J., B.F., and V.J. conceptualized and designed the study. M.A.J. collected the data and performed the data analysis.M.A.J. wrote the manuscript and prepared the figures and tables. B.F. and V.J. reviewed and edited the manuscript for intellectual content. M.N. provided a critical review of the final version for accuracy and clarity.All authors read and approved the final version of the manuscript.

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Data availability

This study used two datasets. The first dataset was extracted from the publicly available Kerala eHealth Dashboard, accessible at https://dashboard.ehealth.kerala.gov.in/. The second dataset was obtained from the Directorate of Health Services (DHS), Government of Kerala. This dataset is not publicly available due to administrative restrictions but can be obtained from the corresponding author on reasonable request and with permission from DHS. All datasets analysed during this study are with the corresponding author and can be shared upon reasonable request.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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References

1. Xiaoyan G, De Leon JM. Enhancing patient experience through digital transformation: a case study of outpatient department services in hospitals. https://ijsea.com/archive/volume13/issue8/IJSEA13081004.pdf.
2. Riahi S, Fischler I, Stuckey MI, Klassen PE, Chen J. The value of electronic medical record implementation in mental health care: a case study. JMIR Med Inf. 2017;5(1). https://doi.org/10.2196/medinform.6512.
3. World Health Organization. - Regional Office for the Eastern Mediterranean. WHO EMRO| eHealth| Health topics. http://www.emro.who.int/health-topics/ehealth/. Accessed 21 Sep 2024.
4. Mumtaz H, Riaz MH, Wajid H, Saqib M, Zeeshan MH, Khan SE, et al. Current challenges and potential solutions to the use of digital health technologies in evidence generation: a narrative review. Front Digit Health. 2023;5:1203945. https://doi.org/10.3389/fdgth.2023.1203945.
5. Ibeneme S, Karamagi H, Muneene D, Goswami K, Chisaka N, Okeibunor J. Strengthening health systems using innovative digital health technologies in Africa. Front Digit Health. 2022;4:854339. https://doi.org/10.3389/fdgth.2022.854339.
6. Chokshi M, Patil B, Khanna R, Neogi SB, Sharma J, Paul VK, et al. Health systems in India. J Perinatol. 2016;36(Suppl 3). https://doi.org/10.1038/jp.2016.184.
7. National Health Policy 2017. Ministry of Health and Family Welfare, Government of India, 2017. https://mohfw.gov.in/sites/default/files/9147562941489753121.pdf
8. National Digital Health Mission. Ministry of Health and Family Welfare, Ministry of Electronics and Information Technology, National Health Authority, July 2020.Available from: https://mohfw.gov.in/sites/default/files/9147562941489753121.pdf
9. A Brief Guide on Ayushman Bharat Digital Mission (ABDM) and Its Various Building Blocks. National Health Authority. 2021. https://abdm.gov.in:8081/uploads/ABDM_Building_Blocks_v8_3_External_Version_eabbc5c0f3_4_a96f40c645_5716a684de_b344369144.pdf.
10. Lahariya C. 'Ayushman Bharat Program and Universal Health Coverage in India'. Indian Pediatrics. 2018;55(6):495–506. https://doi.org/10.1007/s13312-018-1341-1.
11. Gulati A, Thakare MM, Dhiman A. U-WIN, E-VIN and Co-WIN: harnessing digital platforms to enhance immunisation coverage in India. Int J Community Med Public Health. 2025;12(2):1166–71. https://doi.org/10.18203/2394-.
12. e-health project launch. The Hindu. 2017. https://www.thehindu.com/news/national/kerala/e-health-project%20launch/article17079444.ece. Accessed 25 Sep 2024.
13. About e Health PORTAL. State Digital Health Mission. ehealth.kerala.gov.in/. Accessed 25 Sep 2024.
14. Directorate of Health Services, Kerala. Expression of interest for eHealth initiatives. Thiruvananthapuram: Directorate of Health Services, Kerala. 2013. https://dhs.kerala.gov.in/wp-content/uploads/2024/04/ehealth.pdf.
15. Tariq S, Tariq S, Shoukat AA. Centralized healthcare database for ensuring better healthcare: Are we lagging behind? Pak J Med Sci. 2024;40(3Part-II):257–8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10862436/. Accessed 2 Dec 2024.
16. About Your Aadhaar. Unique Identification Authority of India, UIDAI. https://uidai.gov.in/en/my-aadhaar/about-your-aadhaar.html. Accessed 31 May 2025.
17. John S, Hussain I, Aqueel U, Aadhaar: another milestone for Indian public healthcare information system integration. Int J Res Anal Rev. 2019;6(2). https://www.researchgate.net/profile/Imran-Hussain-11/publication/335920640.
18. Srivastava SK. Adoption of electronic health records: a roadmap for india. Healthc Inform Res. 2016;22(4):261–9. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5116537/. Accessed 4 Dec 2024
19. Gopal G, Suter-Crazzolara C, Toldo L, Eberhardt W. Digital transformation in healthcare– architectures of present and future information technologies. Clin Chem Lab Med. 2019;57(3):328–35. https://doi.org/10.1515/cclm-2018-0658/html. https://www.degruyter.com/document/doi/. Accessed 4 Dec 2024.
20. Kapoor S. Digital Health Ecosystem in India: Present Status, Challenges, and Way Forward. DY Patil J Health Sci. 2022;10(4):202–5. https://journals.lww.com/dypj/fulltext/2022/10040/digital_health_ecosystem_in_india_present_status,.10.aspx
21. Powell KR, PhD RN, Alexander CGL, PhD RN et al. Mitigating barriers to interoperability in health care| HIMSS. 2019. https://gkc.himss.org/resources/mitigating-barriers-interoperability-health-care. Accessed 4 Dec 2024.
22. Aardram– National Health Mission. https://arogyakeralam.gov.in/2020/04/01/aardram/. Accessed 29 May 2025.
23. Barigela R, Kodali PB, Hense. Sibasis. What is Stopping Primary Health Centers to Go Digital? Findings of a Mixed-method Study at a District Level Health System in Southern India. Indian J Commun Med. 2021;46(1):97–101. https://doi.org/10.4103/ijcm.IJCM_304_20.
24. Mardiah FP, Basri MH. The analysis of appointment system to reduce outpatient waiting time at Indonesia's public hospital. Hum Resour Manag Res. 2013;3(1):27–33. http://article.sapub.org. Accessed 4 Dec 2024.
25. Samadbeik M, Saremian M, Garavand A, Hasanvandi N, Sanaeinasab S, Tahmasebi H. Assessing the online outpatient booking system. Shiraz E-Med J. 2018;19(4). https://brieflands.com/articles/semj-60249.pdf.

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