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The National Digital Health Mission (NDHM) of India: A Concurrent Assessment

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Abstract

India launched the Ayushman Bharat Digital Mission (ABDM) in 2021 to strengthen the digital health eco-system by developing and integrating health data records and registries. The ABDM focuses on five digitalization activities pertaining to registration of health providers and beneficiaries. We undertook a concurrent assessment of the mission by analyzing data from ABDM official website and found notable progress in beneficiary registration (400 million, as on June 3, 2023) and health records linkage (273 million). Over 208,000 health facilities and 190,000 healthcare professional registrations have been verified by ABDM. Inter-state variations, particularly in health facility and health professional registrations, are significant. Going forward, ABDM should expand its strategic framework from inputs and processes to connect with the broader ultimate health system goals of improved health, beneficiary satisfaction and risk protection.

1. Introduction

The role of digitalization in health has evolved considerably in the last two decades. This includes deliberations in the World Health Assembly (WHA 2013 and 2018) and development of the global strategy for digital health endorsed by the 2020 WHA. The digital era offers great opportunities to health systems to be more efficient and responsive to the health needs of the population. Some of the early references to digital technologies can be traced back to the 2005 WHA, which urged Member States to develop digital infrastructure for health. However, digital health has a wide scope whose implementation must be sensitive to country capacities. It is only reasonable that every country plans its digital health agenda to be consistent with the national context, including available resources and core principles.

The World Health Organization (WHO) defines digital health as "*The field of knowledge and practice associated with the development and use of digital technologies to improve health. Digital health expands the concept of eHealth to include digital consumers, with a wider range of smart-devices and connected equipment. It also encompasses other uses of digital technologies for health such as the Internet of things, artificial intelligence, big data and robotics*" (WHO, 2021).

India is among the first set of nations to develop a national digital health blueprint (NDHB) to strengthen the various building blocks of the health system to achieve the core objectives of the National Health Policy (2017). The NDHB establishes the need to create a framework for evolving the national digital health eco-system. It outlines guiding principles and building blocks—and recommends setting up a National Digital Health Mission (NDHM) for successful implementation of the strategies. The NDHB also prescribes other physical, digital and artefact deliverables to measure the progress of the digital health initiative. Accordingly, the NDHM was piloted in 2020 and rolled out nationwide in 2021. The NDHM was subsequently renamed as the Ayushman Bharat Digital Mission (ABDM) and is implemented under the purview of National Health Authority (NHA).

Notwithstanding the wide scope of digital health, India has set out to pursue the digital health agenda with an initial focus on strengthening the digital health eco-system for data, information, and infrastructure services via a citizen-centric ABDM. The ABDM aims to align various health-related data records and registries by developing a federated architecture that has well-defined norms for data standards and management of electronic health records (EHR).

The early phase of ABDM focuses on five digitalization activities: 1) Ayushman Bharat Health Account (ABHA), 2) Healthcare Professional Registry (HPR), 3) Health Facility Registry (HFR), 4) ABHA Mobile App, and 5) Unified Health Interface (UHI). The ABHA (#1) is a system for identification and authentication of individual patients, while the HPR (#2) and

HFR (#3) serve as repositories of information on verified healthcare professionals and facilities. The ABHA mobile app (#4) allows user access to personal and healthcare information. Finally, UHI (#5) facilitates inter-operable digital health service delivery via open networks.

Digitalization bridges physical barriers, and has additional virtues, including minimizing direct and indirect costs through value addition of health-related information (Mitchell & Kan, 2019). The overall impact of the entire initiative, however, can be assessed only after the program is stabilized and fully functional. Nevertheless, an appraisal of the initial progress, including sub-national variations in roll-out and key actions, can provide early insights for troubleshooting and course corrections.

With this motivation, this paper aims to provide a concurrent assessment of NDHM/ABDM by focusing on certain parameters to gauge the progress of the mission. This involves a situation analysis of the management of the digital environment in terms of its spread and coverage across the states. Based on data from the official dashboard of the ABDM (https://dashboard.abdm.gov.in/abdm/), the assessment focuses on unevenness in coverage status of digital information and associated indicators that increase the efficiency of health services delivery. Finally, it discusses the results within a broader context of the challenges and opportunities in transfer and exchange of digital health information as envisaged under the ABDM. Given that the mission is in an early phase, these findings and conclusions are expected to contribute toward digital health policymaking to support ABDM traverse its first set of milestones.

2. Framework for assessment of NDHM/ABDM

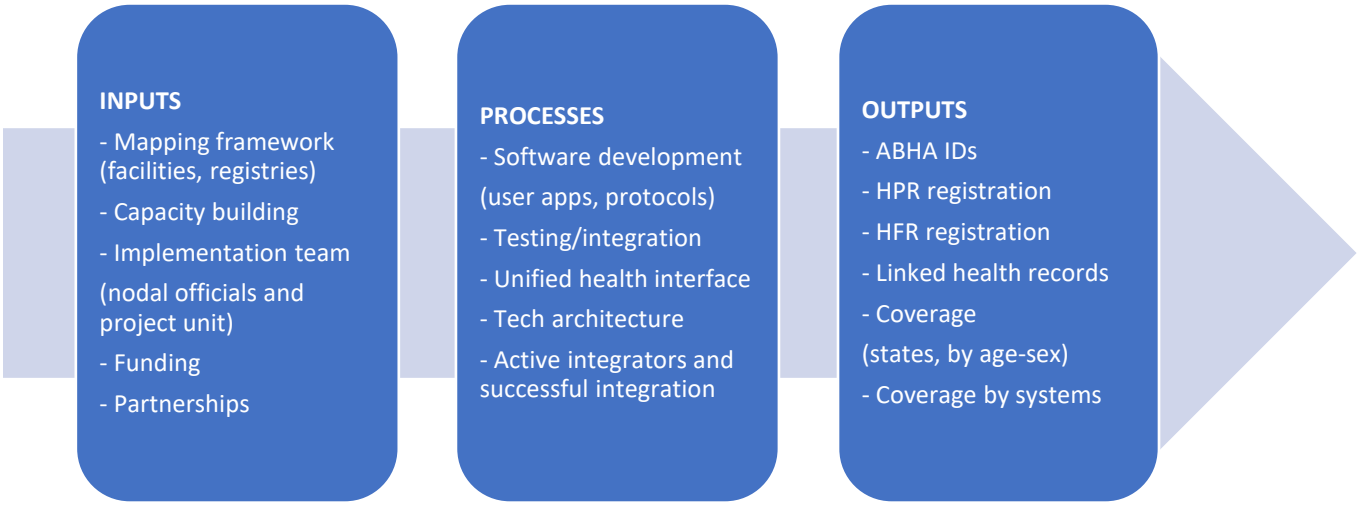
We follow the "control knobs" approach as the analytical framework applied here for the assessment of ABDM (Roberts et al., 2004). As outlined in the control knobs approach, the focus is on three core components: inputs, processes, and outputs. The input indicators are associated with conventional programmatic requirements, such as funding and implementation staff. The NDHM envisaged capacity building and partnerships as critical inputs for the success of the mission and hence they are reviewed accordingly. Mapping of key registries and health care facilities are also important inputs to facilitate linkages.

Software development (in terms of various user apps, gateways and protocols) are the key processes of the ABDM. The software testing platforms and integration are also qualitatively reviewed. The development of the technology architecture, along with a network of active integrators, is a critical process in the early phase of the mission. The ABDM's outputs are assessed using objective and quantitative indicators, such as the number of digital identifications completed in terms of beneficiaries, healthcare facilities, and healthcare providers. Further, the status of linkages across patient records and registration status by age and gender is reviewed across states. The role of the public and private sectors in registration

processes, as well as their respective systems of healthcare, is also reviewed as a key output of the NDHM.

The framework also acknowledges that the mission is in its infancy; hence, ascertaining the impact in terms of service delivery improvements and equity may not be feasible. Nevertheless, some information on progress towards telemedicine consultations is reviewed to examine the utility of digital health alternatives for coverage and equity.

Figure 1: Framework for this concurrent assessment of ABDM



The secondary data used in the assessment was sourced from the official ABDM website, which is under the purview of MoHFW. The ABDM dashboard provides information on several indicators related to the progress of the mission. This includes: information on health identification numbers created as Ayushman Bharat Health Accounts (ABHAs), health facility registry (HFR), health professional registry (HPR), status of health records linking with ABHA, demographic patterns in ABHAs created by gender and age groups, and a list of verified facilities by sector and system of medicine.

For comparisons across states, the count-based information was converted into percentages by normalizing them with respect to the state population from the projection report of the expert group constituted by MoHFW. Similarly, the health facility registration status across states is compared with a denominator based on information sourced from the facility registries for the respective states. Further, a desk review of reports and documents on the NDHM website, including the annual report of NHA (2021-22), also offered insights regarding the progress of the mission.

India's health system is characterized by a diverse range of healthcare providers from both the public and private sectors. The public sector offers a range of healthcare services. However, financial constraints and inadequate infrastructure mean the quality of services is often

compromised, despite offering coverage and treatment for many patients, mostly from low-income backgrounds. The private sector, on the other hand, is very heterogenous in its composition and service delivery. The private sector is also skewed—it comprises both high-end tertiary care facilities catering to better-off households and a huge number of informal providers that provide treatment to patients from low-income households. Integrating this wide range of patients and providers from both the public and private sectors is a mammoth task ahead of the NDHM/ABDM. Moreover, filtering out the unqualified practitioners and ensuring inter-operability are equally important tasks.

The digital health ecosystem has developed specific mechanisms to address such fundamental concerns emanating from a fragmented structure of health service utilization across various regions. The annual report of the National Health Authority is also cognizant of these challenges. The problem of information asymmetry among patients is noted as a key concern. Often, patients extensively rely on word of mouth to identify and locate their desired healthcare facility. Sometimes the referral mechanisms among providers are also inefficient, as reliable institutions within the vicinity of the patients are often undermined because major centers are preferred. Another major concern in the Indian context is the abundance of informal and unqualified healthcare providers. The digital health strategy offers a means for registration and subsequent verification and validation of authentic service providers. This includes both individuals and institutions.

Finally, a major task of this early phase of the digital health mission is to ensure seamless transfer of and access to patient information for designated health personnel. This information can be accessed by various levels of healthcare providers across geographies. Such features are expected to minimize procedural requirements, including expenditure-sensitive components such as repeat diagnostics and their credibility.

The ABDM follows a set of business and technology principles. The former – also referred to as the health domain principles – mandate ABDM to be wellness-centric and wellness-driven. The aim is to educate and empower individuals to avail themselves of such health and wellness services. One specific focus is on equity and inclusion of all sections of the population, irrespective of geographical barriers to connectivity. The business principles have a specific focus on security and privacy issues. The ABDM also aims to inculcate accountability that can be assessed through performance of health service providers. Finally, seamless portability is also identified as a key principle. Meanwhile, the technology principles mandate development of an overarching but federated architectural framework, with building blocks and components that conform to open standards and are interoperable with open-source software products.

Several of the necessary actions underlying these principles require procedural tasks related to information technology and communication (ICT) infrastructure and protocol development. Some of these are too technical and confidential to be reviewed from a broader program

perspective. This also constrains the scope for an early assessment of such features. Notwithstanding these limitations, this concurrent assessment, nevertheless, focuses on efforts that could be perceived as immediate or short-term objectives of the mission. In this regard, the WHO Global Strategy on Digital Health (2020-25) offers a set of short-term priorities that can be reviewed to comprehend the progress of such efforts by countries.

The following short-term actions are relevant for assessment in the Indian context. Advances in governance mechanisms and federal collaborations for transfer of digital health information are necessary and immediate tasks for the success of the mission. The progress of digital health strategies is also gauged through the formation of effective national coordination mechanisms. Development of a national digital health strategy or equivalent strategic framework is also regarded as a key milestone. Further, this involves efforts, backed by stakeholder consultations, to allay reservations from the stakeholders and the public at large. Engagement of communities and health care workers are also considered as part of this aspect of a digital health strategy. The digital health strategy also emphasizes the need for people-centered health systems. Accordingly, avenues for use of digital health products by the population for monitoring their health and well-being is considered an early achievement of the digital health strategy.

3. Major Findings

3.1. Budget allocations

In financial year (FY) 2020-21, ABDM had a budget allocation of Rs.30 crore, out of which 48.1% was utilized or released. In the subsequent FY (2021-22), a total of Rs.75 crore was budgeted for the mission, out of which 56.4% was released or utilized. The apparently low level of fund utilization suggests gaps in execution of plans during these years. While the impact of COVID-19 pandemic cannot be overlooked, it is critical that the available budget be effectively utilized.

3.2. Applications and architecture

On most counts, the ABDM has initiated processes and activities for development of applications and integration of the data ecosystem through a federated architecture. For this purpose, ABDM has conducted stakeholder consultations and capacity building workshops, as well as providing financial incentives for various stakeholders to participate in the process. State-level teams have been constituted to monitor the implementation of ABDM activities. Each team is headed by a State Mission Director, who is supported through nodal officials for IT, Administration and Coordination. Each team also has a project management unit with consultants for specific roll out and troubleshooting tasks. Hardware guidelines for the states are shared, with scope for modification to suit the contextual requirements.

3.3. Linked health records

3.3.1 ABHA ID

The number of linked health records, as well as active and successful integrators, is also increasing steadily. As of 2021-22, there were 980 active integrators and 58 had received certificates for successfully integrating at least one ABDM application. About 26 capacity building programs were conducted between August 2021 through 2022 to promote successful integration and engagement of more entities. Information, Education and Communication (IEC) initiatives are planned to promote greater awareness and uptake of digital health initiatives by individuals and institutions. The inter-operable and scalable building blocks of ABDM (namely, ABHA, HPR, HFR, and ABHA Mobile App) are live for registration with considerable uptake.

As of May 15, 2023, a total of 376.2 million ABHA accounts had been created. As of May 31, 2023, 48.4% of the total ABHAs have been created for females. Across age groups, 54.5% of the ABHAs were created for the 19-45 years age group. Children and adolescents (below 18 years) account for 12.9% of the total ABHAs created, whereas 20.4% of the ABHAs are created for older adults in the age group 46-59 years. Elderly people (60+ years) account for 12.2% of the total ABHAs. Based on the projected population, this is estimated to be 26.6% coverage of ABHAs among the Indian population.

Table 1 shows the status of these key indicators disaggregated by state, as of May 15, 2023. Union Territories (UTs) (such as Andaman and Nicobar Islands (100%), Ladakh (98.3%) and Lakshadweep (100%)) have achieved universal coverage of ABHAs. Among major states, five display higher coverage than other states: Andhra Pradesh (45.5%), Assam (41.7%), Chhattisgarh (49.8%), Madhya Pradesh (47.4%), and Odisha (52.7%). The lowest coverage of ABHAs is estimated to be in Meghalaya (6.2%), followed by Tamil Nadu (7.3%) and Tripura (9.2%). Given their vast populations, coverage in Bihar (13.9%) and Uttar Pradesh (14.7%) is also low.

As of May 15, 2023, 257.0 million individuals had their health records linked with ABHA (Table 1). This amounts to 18.2% of the health records linked for the total estimated population of India. It is worth noting that bulk of record linking is associated with Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (AB PM-JAY). The MoHFW press release (number 1903146) reported that over 98 million of AB PM-JAY health records are linked to ABHA. Kerala (91.7%) has the highest proportion of population that have their health records linked followed by Chandigarh (86.1%) and Uttarakhand (52.9%). The progress in health records linkage is slow in several states and UTs.

Table 1: Status of key digital health coverage indicators, India (as of May 15, 2023)

States	% ABHAs	% Health Records Linked	% Verified HFR	% Verified HPR
Andhra Pradesh	45.5	48.4	30.3	10.9
Arunachal Pradesh	12.9	10.8	23.2	17.8
Assam	41.7	2.5	27.0	0.7
Bihar	13.9	13.6	19.4	35.3
Chhattisgarh	49.8	45.4	64.8	15.6
Goa	25.8	22.0	17.0	10.8
Gujarat	38.4	17.4	27.1	1.2
Haryana	30.6	25.4	5.7	0.8
Himachal Pradesh	26.1	28.4	53.4	3.8
Jharkhand	16.9	28.7	12.7	7.4
Karnataka	31.1	11.9	93.9	16.8
Kerala	39.9	91.7	11.8	13.5
Madhya Pradesh	47.4	22.7	19.1	0.8
Maharashtra	18.0	10.7	9.4	2.6
Manipur	15.2	21.2	1.0	NA
Meghalaya	6.2	9.5	35.8	100.0
Mizoram	27.6	34.4	16.7	13.2
Nagaland	22.3	14.7	3.7	0.6
Odisha	52.7	7.3	0.0	0.2
Punjab	18.3	28.2	12.7	6.0
Rajasthan	21.8	8.8	0.0	0.1
Sikkim	47.0	0.2	46.9	33.3
Tamil Nadu	7.3	2.7	0.0	0.1
Telangana	24.3	6.3	17.5	1.2
Tripura	9.2	27.1	3.8	2.9
Uttar Pradesh	14.7	10.7	18.9	14.2
Uttarakhand	27.2	52.9	7.8	11.7
West Bengal	28.7	6.0	0.0	0.1
Union Territories				
A & N Islands	100.0	57.2	73.0	NA
Chandigarh	52.1	86.1	28.6	100.0
Delhi	30.7	29.6	2.9	16.5
D&N Haveli / Daman & Diu	70.8	44.8	88.1	NA
Jammu & Kashmir	46.7	38.3	35.9	26.1
Ladakh	98.3	45.1	0.0	NA
Lakshadweep	100.0	1.3	100.0	NA
Puducherry	58.1	19.5	29.4	100.0
India	**26.6**	**18.2**	**20.3**	**8.2**

Source: Author estimates based on ABDM dashboard. Denominators are from various reports of the MoHFW.

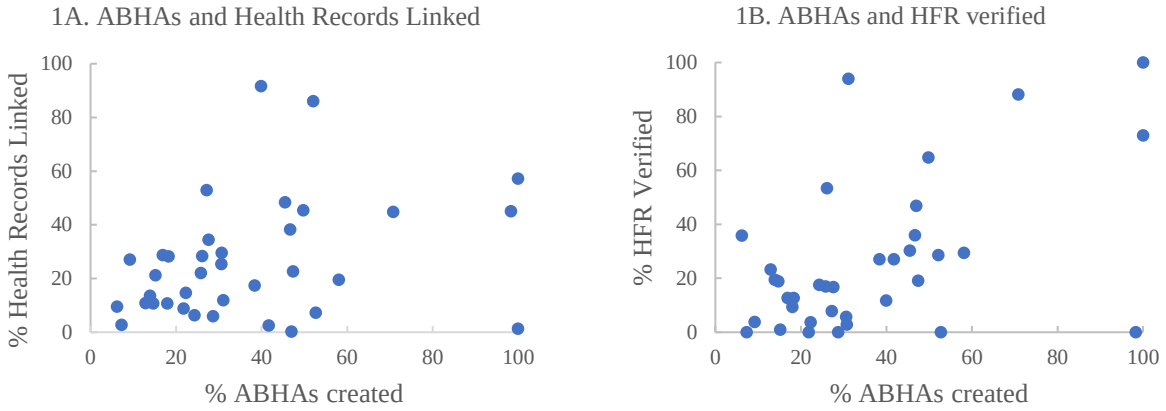
3.3.2. HFR and HPR

As of May 15, 2023, over 206 thousand health facilities (20.3%) were verified by the HFR. Among the verified health facilities, 25.7% are from the private sector whereas the bulk (74.3%) are from public sector. Across the verified facilities, 85.1% are from the modern medicine, 7.3% from ayurveda, 2.9% from dentistry and 2.3% from homeopathy systems. Physiotherapy (1.5%), Unani, (1.7%), Siddha (0.1%) and Sowa-Rigpa (0.1%) have small shares. Among major states, 93.9% of the health facilities in Karnataka and 64.8% of the health facilities in Chhattisgarh were verified. The ABDM has launched an incentive scheme to promote registration of health facilities. The ABDM dashboard shows that 365 facilities registered under the scheme, including 181 health facilities and 184 diagnostics and lab facilities.

The progress in verification from the HPR is slow. Just over 8% of professionals had been verified nationwide. Bihar shows the highest percentage (35.3%) of health professionals verified per the HPR. As of June 3, 2023, over 295,000 applications had been submitted by professionals seeking verification. About 65% of these professionals are now verified. Among the verified cases, 89.9% of the professionals belong to the modern medicine system and approximately 6.2% are from ayurveda system. Some dentists and homeopathy professionals had also been verified, accounting for about 3% of the verified professionals. Verification is also available for professionals from the Siddha, Unani, and Sowa-Rigpa systems.

Figure 1 shows the associations among the four selected indicators. The scatter plots show that there is little consistency in coverage and uptake across all four indicators for any given state.

Figure 1: State-level association between the key digital health coverage indicators



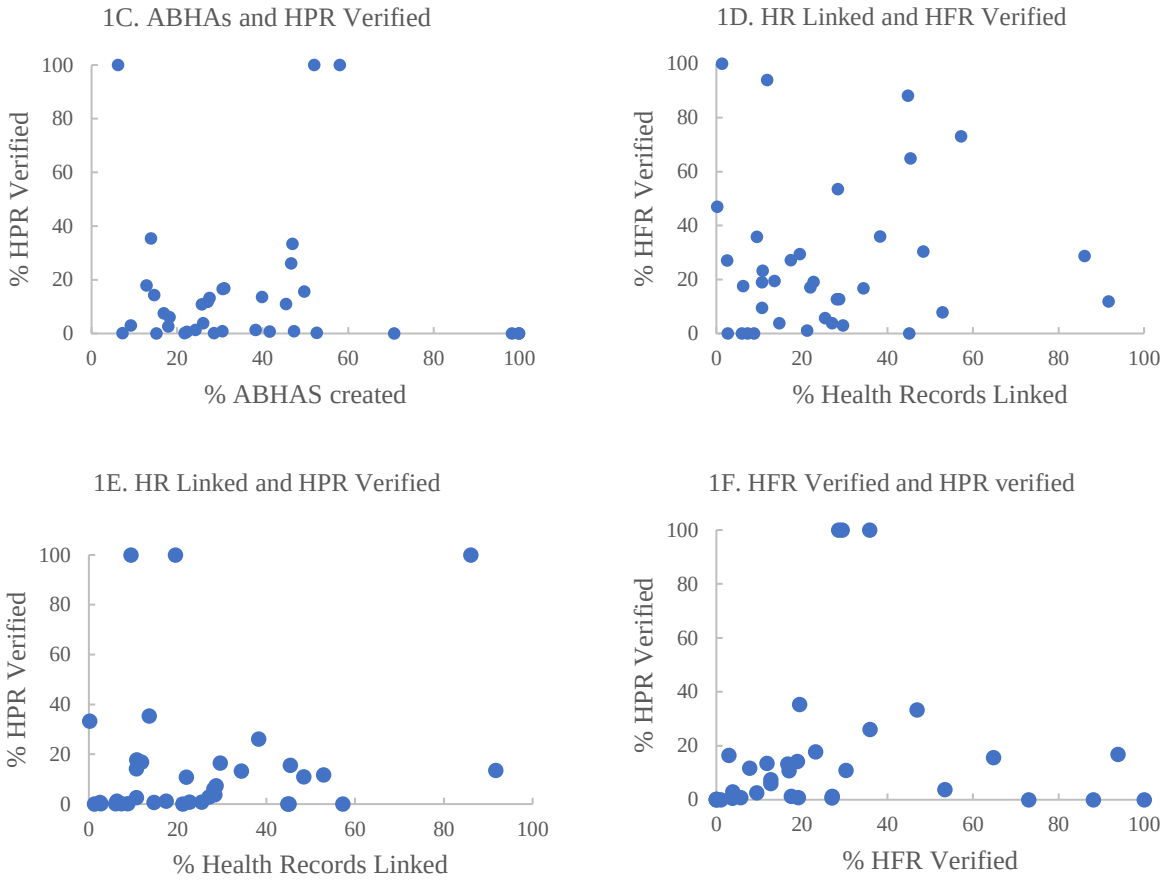


Table 2: Correlation between state-level progress across selected indicators

	% ABHAs	% HR Linked	% Verified HFR	% Verified HPR
% ABHAs	1.000			
	(36)			
% HR Linked	0.312*	1.000		
	(36)	*(36)*		
% Verified HFR	0.520***	0.060	1.000	
	(36)	*(36)*	*(36)*	
% Verified HPR	0.217	0.242	0.280	1.000
	(31)	*(31)*	*(31)*	*(31)*

Note: ***, ** and * denotes significance at 1%, 5% and 10% level, respectively. State/UT numbers in parenthesis ().

The Pearson correlation coefficient shows that the strength of the state-level correlation is significant in case of ABHAs created and health records linked (Table 2). The strength of the association is greater (correlation coefficient = 0.520) in case of ABHAs created and percentage

health facilities verified. The Gini coefficient for inter-state variations in the four selected progress indicators are as follows: ABHAs creation (Gini = 0.351), health records linkage (Gini = 0.442), HFR verification (Gini = 0.464), and HPR verification (Gini = 0.669). The variations around the state-level mean for the four indicators as captured through the coefficient of variation. The variations in progress are relatively higher in the cases of HFR (CV = 1.1) and HPR (CV = 1.6) verification, compared with ABHAs creation (CV = 0.7) and health records linkage (CV = 0.9).

3.4. eSanjeevani tele-consultations

Progress in digital health must be translated into effective health services that utilize digital technologies to reduce geographic barriers and are cost-effective by reducing transaction costs. eSanjeevani is a tele-consultation service in India that has been scaled up across the country. The reply to the Lok Sabha question No. 2200 (29 July 2022) notes that, as of June 30, 2022, there are 92,115 Health Sub-Centres (SC), 22,896 Primary Health Centre (PHC) and 4,726 Urban Primary Health Centres (UPHCs) that are connected through eSanjeevani Health and Wellness Centres (HWCs) in India.

An assessment of teleconsultation services being provided across states suggests that the uptake and practice is uneven across states. The total eSanjeevani consultations are about 100.0 million cases, which corresponds to about 7.1% of the total population of the country. As shown in Table 3, the bulk of these calls have been conducted through Ayushman Bharat Health and Wellness Centres (AB-HWC). Most of the teleconsultations took place in the South Indian states of Andhra Pradesh (36.8%), Karnataka (16.4%), Tamil Nadu (14.8%), and Telangana (12.1%).

Table 3: eSanjeevani teleconsultations as a proportion of population, India (as of Feb 16, 2023)

State/UTs	% Consultations	% At AB_HWC	% At OPD
Andhra Pradesh	36.8	36.8	0.04
Arunachal Pradesh	-	-	0.03
Assam	3	2.9	0.08
Bihar	2.6	2.5	0.05
Chhattisgarh	2.9	2.9	-
Goa	-	-	0.02
Gujarat	4.3	2.9	1.36
Haryana	1.3	0.7	0.59
Himachal Pradesh	3.8	3.8	0.07
Jharkhand	1.7	1.6	0.03
Karnataka	16.4	11.9	4.53
Kerala	1.9	0.5	1.37
Madhya Pradesh	4.8	4.8	0.01
Maharashtra	3.8	3.7	0.16
Manipur	1.3	1	0.25

State/UTs	% Consultations	% At AB_HWC	% At OPD
Meghalaya	1.7	1.7	-
Mizoram	0.4	0.3	0.01
Nagaland	0	-	-
Odisha	1.5	1.5	-
Punjab	1.2	1.2	0.01
Rajasthan	0.9	0.7	0.13
Sikkim	2.4	2.4	-
Tamil Nadu	14.8	12.7	2.09
Telangana	12.1	12	0.05
Tripura	0.3	0.3	-
Uttar Pradesh	2.4	1.6	0.78
Uttarakhand	7.9	1.4	6.51
West Bengal	12.2	12.2	0.01
Union Territories			
A & N Islands	0.1	0	0.02
Chandigarh	4.1	3	1.15
Delhi	0.2	-	0.2
D&N Haveli / Daman & Diu	10.2	10.2	0.01
Jammu & Kashmir	2.6	1.7	0.99
Ladakh	8.2	8.1	0.03
Lakshadweep	0.8	0.8	-
Puducherry	0.1	0.1	-
India	7.1	6.4	0.69

Source: Authors, based on eSanjeevani national telemedicine service (MoHFW).

Finally, the electronic health record (EHR) system can be a game changer. It is envisaged to be a collection of every clinical encounter, ideally from conception or birth, thus representing a longitudinally-arranged, clinically-relevant time series of information on the various healthcare events in a person's life. An EHR provides a plethora of health information that has manifold implications. However, such a comprehensive EHR system is yet to be universally implemented across all states in India. In recent years, some secondary and tertiary health facilities initiated use of electronic medical records by siloed vendors. This made the systems unique, but not interoperable and semantically aligned.

A revised version of the 2013 EHR standards, which was notified in December 2016, includes standards for disease classification, medicine and clinical terminology, laboratory data exchange, digital imaging, and communication for semantic interoperability. Metadata and data standards have been developed to ensure open standards. Approximately 99% of public health facilities in the country have been allocated a National Identification Number (NIN), a unique identification number that is the primary requirement for achieving interoperability and the creation of EHRs.

4. Discussion

In recent years, advocacy of health policies and programs of the government of India has become contingent on the managing and functioning of the digital initiative, central to which are various digital mechanisms, such as Aadhar ID, Unified Payment Interface (UPI), and Unified Mobile Application for New-age Governance (UMANG) (Masiero, 2018). The success of Aadhar ID and digital payment are considered avenues for thriving health programs to provide convenient health services to patients in India (Mir et al., 2020). In this context, the ABDM is envisaged to transform digital health in India, accelerating progress toward the sustainable development goals in health and achievement of universal health coverage as envisaged under NHP 2017 (Chauhan et al., 2022).

The integration of individual health accounts, with their respective health records, is a mammoth task for a country of over a billion people. But the country's experience with IT services is supporting creation of several digital public goods, which are forming the building blocks of the ABDM and strengthening the national digital health ecosystem (Sharma et al., 2023). However, the federal structure of governance and differential strength of multiple health systems influence the pace of implementation (Gudi et al., 2021, Angell et al., 2019).

Five salient findings emerged from this concurrent assessment. First, in a short span of time, ABDM has progressed to cover over 400 million individuals (as of June 3, 2023) through ABHA accounts. It has also managed to link the health records of 273 million individuals. Second, over 208,000 health facilities' and 190,000 healthcare professionals' registrations have been verified by ABDM. Third, the number of active integrators has reached 980, and over 50 of them have received certification for successful integration. Fourth, there is considerable inter-state variation in progress across the key performance indicators, particularly in HFR and HPR registrations. Finally, budgetary allocations and utilization rates for the program must be boosted to accelerate progress on the various ABDM goals and targets.

The OECD (2021) recommended adoption of six criteria or principles for evaluating developmental initiatives: 1) relevance, 2) coherence, 3) effectiveness, 4) efficiency, 5) impact and 6) sustainability. Assessment of these criteria depends on the availability of data, as well as observation of a program over time. In the context of NDHM, it is clear that the mission is of relevance to transforming health sector data management. Integration of the various data platforms used in health service delivery, which are further validated through various mechanisms, can improve health system functioning in several ways. It improves patient services by providing validated information on health professionals and health facilities, and ensures quick and easy transfer of digital information, including electronic health records of patients, across public and private sectors. Some of these digital technologies will be critical for implementation of welfare schemes, such as the PM-JAY, and can help better track and monitor the huge volume of transactions across facilities, diagnostic centers, and labs.

The ABDM is planned with a coherent set of strategies, which in principle are feasible to implement and scale up across the country. However, the strategy could go further in detailing actions to impact on a few critical barriers. As noted in the NHA Annual Report 2021-22, there are three critical barriers in adoption of the ABDM. One is the dependency on ecosystem players for creating ABDM compliant technologies and solutions. Also, currently, the health system of India lacks digitization and operates in a fragmented ecosystem that is neither necessarily cost-effective nor user-friendly. The status and functioning of existing information management systems is sub-optimal across several contexts (Dehury and Chatterjee, 2018). While these issues are being addressed through investments and capacity building for stakeholders, ecosystem inertia is a major concern (and one whose solutions are perhaps beyond the scope of the NHA). Lack of interest among facilities, professionals, and their representative associations could affect the achievement of the ultimate objective of the mission.

Notwithstanding the facility of consent management for data sharing or EHR management, protecting this vast amount of clinical information and the computer system is a contentious concern. Theft of medical identity, lack of computer literacy among health care professionals, lack of awareness regarding data security protocols, and communication silos are prominent barriers to a successful deployment of EHRs in India. These are important concerns that should be addressed while planning integration of digital records (Saksena et al., 2021, Malhotra et al., 2021). Also, similar protocols should be applied when planning to integrate disease registries (such as the cancer registry) in India to improve prevention and control efforts under national programs (Jena et al., 2022). Capacity building in all critical domains is necessary including digital literacy of the population (Gudi et al., 2021).

Nevertheless, the early experience of ABDM finds it to be effective in achieving its basic objectives. This is apparent from the evidence on registrations, such as ABHAs, HPR, and HFR. The progress in technology integrators, health records linkages, and increasing volume of digital transactions by validated facilities are all evidence of the mission's early success. The mission, however, also needs to overcome the inertia that emerges from the federal structure of the health system and the political economy of central sector schemes (CSS).

The inter-state variations in HPR and HFR could be further reduced with greater engagement by the NHA with states where registrations and validations are progressing at slower paces. At the same time, the mission also needs to enhance its financial efficiency in terms of budgeting and utilization of funds as earmarked. As noted from the annual financial statements, the current levels of utilization under ABDM are low. Also, incentive schemes for HFR should be further reviewed to promote broader uptake by stakeholders. A large network of private sector providers should also be tapped, along with a structure of incentivization for registration to nodal individuals. Nevertheless, more information on costs as well as outputs would be necessary to provide a thorough assessment of the efficiency of the program.

The scope of possible comments on the impact and sustainability of the NDHM is rather limited. Nevertheless, teleconsultations are now considered an alternative for outpatient care. Observations also suggest an active use of teleconsultations in remote facilities. Staff nurses and community health officers can connect with medical doctors for teleconsultations on a few patients. This is promoted as a routine activity, although the numbers are nominal.

The unintended consequences of digital health, particularly for the HFR and HPR, offers scope to eliminate administrative irregularities in human resource management across public and private sector. Overall, a positive attitude and recognition of digital health as an alternative strategy for health and health care is another important qualitative impact. The scope for major obvious impacts of the digital health mission hinges on addressing concerns that are not necessarily within the purview of the mission, such as the infrastructure investments required for enhancing the digitalization of the health system. For instance, the public sector accounts for a major share in health care service delivery in India (in terms of patients, doctors, and health care facilities). The digital infrastructure of several of these facilities needs considerable investment. National Health Accounts (2019-20) estimates show that government spending on health is equivalent to approximately 1.35% of India's GDP. The central government accounts for one-third of the total government health spending and the state governments contribute the rest. Given past trends and the challenging fiscal environment across Indian states, it seems unlikely we will observe a boost in healthcare spending by the government (Dilip et al 2021, Shanmugam and Renjith 2023). However, prioritizing digital infrastructure investments would be a strategic choice, especially in view of competing investment options, such as insurance schemes or provisioning of free drugs and diagnostic services, gaining popularity across several states (Joe et al 2017).

It is too early to discuss the sustainability potential of the ABDM, as several of its strategies and implementation are still to be worked out. Despite the supply-side push, the initiative is equally sensitive to demand-side factors, including individuals' valuation of health, which is guided by their preferences but also conditioned by the availability of health infrastructure, involving institutions, human resources for health and, above all, access in terms of costs and pricing (Kasthuri, 2018). There are clear benefits of digitization, such as savings in terms of both patient discomfort and costs. However, interoperability of systems remains a major challenge worldwide, including in the UK and US. India can expect to leapfrog on the digital front, as IT is a natural partner in India's recent developmental performance (Nundy 2021).

While the focus of ABDM is on management of the data ecosystem, digital health is equally concerned with expanding the reach of technology for health care and service delivery. The most relevant example in the Indian context is the wide use of the national telemedicine service eSanjeevani. The COVID-19 pandemic helped shift focus to, and demonstrate the potential of, telemedicine in India, which lacked a legal framework and credibility until then. With the

expansion in the scope of eSanjeevani services, medical college hospitals and large government hospitals could act as "hubs" to provide teleconsultation services to "spokes" – namely, primary healthcare centers – in a "hub and spoke" model. With a high frequency of calls, it is critical for this initiative to be independently evaluated for its impact, to address access barriers, and to enhance the effectiveness of the service. Also, the ABDM could begin to plan ahead to adopt a broader community health perspective, bringing health and health-related sectors and programs together under the digital health agenda (Samudyatha et al., 2023).

5. The Way Forward

After much deliberation, the second draft of the health data management policy (HDMP) under ABDM has finally been released by the NHA. With clarity in terms of concepts, roles, boundaries, and actors, the HDMP should pave the way forward for rapid scaling up of the digital health initiative. In this regard, engaging the private sector is an important task. The focus initially has been on the public sector, but it is critical for the vast, yet fragmented, presence of the private sector across the health system to be integrated within the digital health framework. The incentive schemes should be reconsidered to better motivate the private sector to participate in ABDM registration processes. The current level of incentives is perhaps too low, so few facilities have registered. It would be worthwhile to conduct state-level stakeholder consultations focusing on the private health sector's concerns to promote active participation.

Training and capacity building of state-level health functionaries and data managers is critical. Involvement of district statistical officials in key states could also strengthen the statistical system for health data. The NDHM should also examine the comments received through public consultations, and work to allay fears related to consent, privacy, data confidentiality, data security, data sharing norms, grievance redressal, and effective utilization of health services. While ensuring the right to health for all, it is imperative that technological constraints and errors do not interfere with seamless access to public healthcare provisions and entitlements.

Finally, the ABDM framework should be expanded so that the intent of the digital mission is translated into quantifiable health system outcomes related to improved health status, risk protection, and a high degree of beneficiary satisfaction. This is a critical task that should be reflected in the finalized roadmap of the digital health mission of India. The implications of digital health for health and well-being are obvious, as the mission can help save direct and indirect out-of-pocket expenses for medical consultations and transport. The benefits of consulting qualified providers could be also quantified in order to understand the advantages of digital health, such as timeliness of consultation and mitigating the potential harms of consulting informal providers.

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