Sattva Knowledge Institute SKI perspective

LEVERAGING DIGITAL HEALTH TO ACCELERATE MATERNAL & CHILD HEALTH OUTCOMES

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Acknowledgements

Authors

This perspective has been written by **Granthika Chatterjee**, **Anurag Garg** and **Gyanika Narayanaswamy**. The technical review was done by **Lakshmi Sethuraman**.

Contributors

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Disclaimer

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Sattva Knowledge Institute (SKI), established in 2022, is our official knowledge platform at **Sattva**. The **SKI** platform aims to guide investment decisions for impact, shedding light on urgent problems and high potential solutions, so that stakeholders can build greater awareness and a bias towards concerted action. Our focus is on offering solutions over symptoms, carefully curating strong evidence-based research, and engaging decision-makers actively with our insights. Overall, **SKI** aims to shift intent and action toward greater impact by influencing leaders with knowledge. All of our content proactively leverages the capabilities, experience and proprietary data from across **Sattva**.

Design: **Usha Sondhi Kundu**; *cognitive.designs@gmail.com*

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Glossary

ABDM	:	Ayushman Bharat Digital Mission
ANC	:	Antenatal Care
ANM	:	Auxiliary Nurse and Midwife
API	:	Application Programming Interface
ASHA	:	Accredited Social Health Activist
AYUSH	:	Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy
CDSS	:	Clinical Decision Support Systems
CHC	:	Community Health Centres
CHO	:	Community Health Officer
CTG	:	Cardiotocography
ECHO	:	Extension for Community Healthcare Outcomes
ECG	:	Electro-cardiography
EMG	:	Electro-myography
EMR	:	Electronic Medical Records
IHRPTM	:	Integrated High Risk Pregnancy Tracking & Management
IMR	:	Infant Mortality Rate
IVRS	:	Interactive Voice Response Systems
MMR	:	Maternal Mortality Rate
NFHS	:	National Family and Health Survey
NHM	:	National Health Mission
NST	:	Non Stress Test
PHC	:	Primary Health Centres
PNC	:	Postnatal Care
POC D/T	:	Point of Care Devices/Testing
PPP	:	Public Private Partnership
RMNCH	:	Reproductive Maternal and Child Health
SBA	:	Skilled Birth Assistants
SDG	:	Sustainable Development Goals
WHO	:	World Health Organisation

Executive Summary

In recent years, India has made considerable progress in its maternal and child health indicators and reduced IMR and MMR by a considerable fraction. Frontline workers like ASHA and ANM have played a central role by improving accessibility, generating awareness and enhancing utilisation of ANC and PNC services.

However, there exist several challenges across the continuum of care that need to be mitigated in order to reduce regional disparities and overcome systematic bottlenecks. These include:

- Shortage of skilled personnel like gynaecologists and paediatricians, resulting in poor performance in cases of complex medical situations;
- Lack of conveyance to transport women to care facilities in case of obstetric emergencies;
- High out-of-pocket expenditure in both public and private facilities which affects affordability of institutional birth facilities and;
- Limited health-seeking behaviour, fuelled by lack of education, poor perception of public facilities and poor awareness about support programmes.

Digital health has emerged as a viable option to overcome these challenges in an effective and efficient manner. Tech-enabled solutions can be deployed across the care continuum to bridge the gap between beneficiaries and providers and augment capabilities of frontline workers, generate awareness and improve access to specialist services. In this document, we have outlined the various components of the maternal and child health care continuum and the archetypes of digital solutions, namely IVRS, chatbots, mHealth apps, EMR and point-of-care devices.

This perspective identifies four core areas for funders looking to harness the potential of technology to accelerate maternal and child health outcomes. These include:

- Increasing health-seeking behaviour for expectant mothers and the community by using low-cost, high-reach solutions like IVRS and chatbots to generate mass awareness.
- Increasing access to specialist care and strengthening service delivery by allowing remote consultations using telemedicine, mHealth applications and better diagnosis via point-of-care devices.
- Empowering frontline health workers and enabling task shifting to improve efficiency, and deliver standardised care by leveraging mHealth apps for tracking beneficiary health data.
- And lastly, strengthening data-enabled decision-making at all levels of healthcare by using Electronic Medical Records to store and aggregate data at various levels for effective policy formulation.

In this perspective, we identify core principles that can be used to create replicable models for sustainable digital adoption. These principles include economic viability, ease of use, and functionality in low resource settings. Availability of infrastructure, patient capital and technical support are also crucial in order for a digital health solution to be adopted successfully. Using these principles, funders can identify the right solutions that can be scaled for impact.

Background and Context

India has made significant progress in maternal and child health by reducing maternal and child mortality by 25.38% and 28.20% respectively since 2014 (Press Information Bureau [PIB] 2022). Accredited Social Health Activist (ASHA) and Auxiliary Nurse and Midwife (ANM) workers on the ground have been the key drivers of service delivery and demand generation by rigorously working on covering large populations with critical MNCH services. Efforts by these frontline health workers have enabled improvements in institutional registration of pregnancy, increase in service utilisation of Antenatal (ANC) and Postnatal Care (PNC). Facility-based processes have been strengthened and nearly 80% of mothers and newborns are now receiving postnatal care within two days of delivery (Ministry of Health and Family Welfare [MoHFW] 2021).

Figure 1: Evolution of key MNCH indicators in India

	2005-06	2015-16	2020-21	2030 SDG Targets
Percentage of mothers who had 4 ANC visits	37	51.2	58.1	-
Percentage of mothers who received postnatal care from a health personnel* within 2 days of delivery for their last birth	36.8	62.4	78	-
Maternal Mortality Rate [deaths per 1,00,000 live births]	254	176	97	70
Infant Mortality Rate [deaths per 1,000 live births]	56	35	28	28
Under-5 Mortality Rate [deaths per 1,000 live births]	74	50	32	23

*Doctor/nurse/LHV/ANM/other

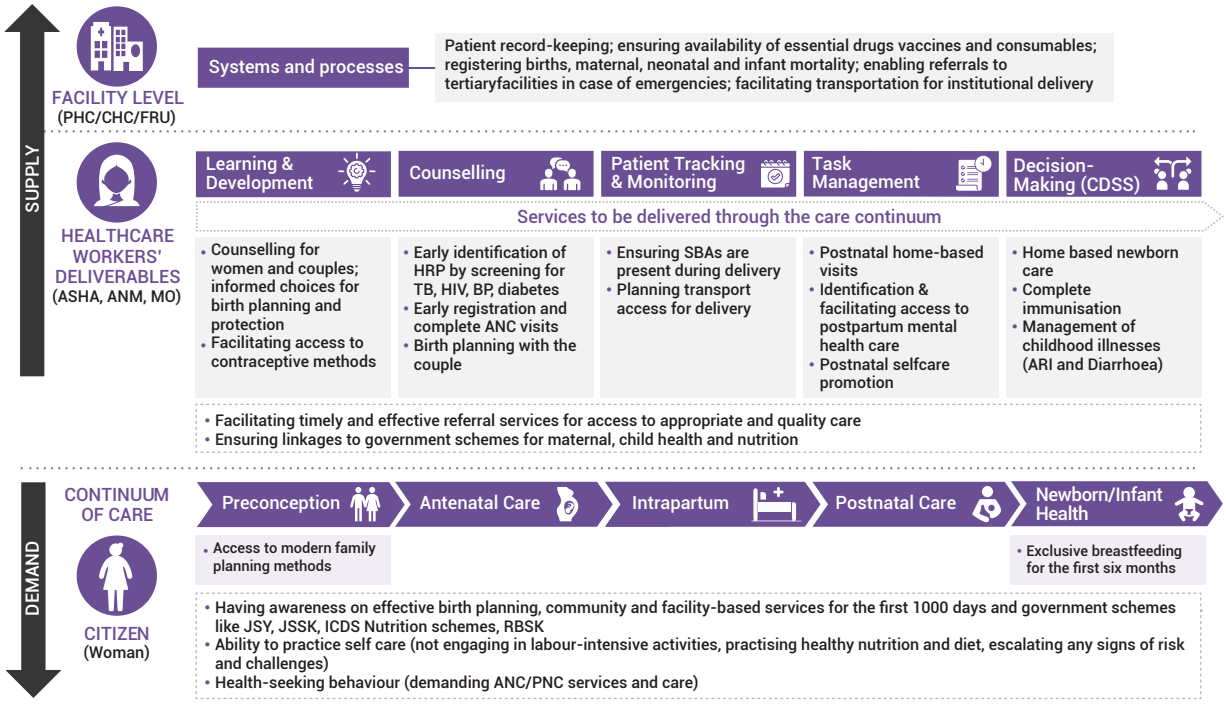
(Source: MoHFW 2022; World Bank n.d.; National Health Mission [NHM] n.d.; MoHFW 2006; MoHFW 2016; MoHFW 2021)

However, despite the overall progress in the health outcomes for women and children, certain indicators across geographies still need improvement. Conditions like anaemia which can increase the chances of complications in the mother during pregnancy, delivery and postpartum, are on the rise. Child anaemia is associated with an increased risk of delayed growth and development in the child, with increased vulnerability to illnesses. Maternal and child anaemia have both increased by 3.57% and 14.50% respectively since NFHS-4. States such as Bihar, Madhya Pradesh, Uttar Pradesh, Arunachal Pradesh and other north-eastern states have particularly low rates of postnatal care for mothers and newborns. Complete antenatal care continues to be significantly low in the majority of the states (IDI 2022).

Challenges Across the Care Continuum of Maternal and Newborn/Infant Health.

The framework of the First 1,000 Days care continuum functions as a guideline for the healthcare system to ensure access, availability, and affordability of quality care to mother and newborn/infant. It begins from conception and ends when the child turns two years of age (National Health Mission 2018). The guideline lists down services to be delivered during the stages of pregnancy, delivery, postpartum, neonatality and childhood. It sets a clear precedent for providing preventive care in a cyclical manner, instead of delivering care only at critical junctures or during emergencies.

Figure 2: Continuum of care for the First 1,000 days and requirement of necessary interventions



Despite the intensified efforts at the national and state levels, there are several challenges that India continues to encounter when improving maternal and newborn/infant health status.

- **Shortage of skilled manpower and adequate care delivery infrastructure:**
  - India's doctor-population ratio has improved to 1:854, which is now better than the World Health Organisation (WHO) standard of 1:1000 (PIB 2019). However, this ratio has been achieved through the inclusion of AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homeopathy) doctors. There is still a 20% shortage of allopathic doctors.
  - Availability of specialists for maternal and child care, especially gynaecologists and

paediatricians, to mitigate emergencies and complications continues to be a challenge (Sahoo et al. 2021). There are only 1,433 gynaecologists at rural Community Health Centres (CHC) against the requirement of 5,481 (Rural Health Statistics 2021). Only 3% of home births were conducted by Skilled Birth Assistants (SBAs) (Sahoo et al. 2021).

* There is also a lack of diagnostic facilities at the primary care centres, compelling women to travel long distances to get the requisite diagnostics (Sahoo et al. 2021). There is a 29% shortfall of Primary Health Centres (PHC) across the country.

- **Transportation to the facility and broken linkages between facilities:** Travelling long distances to undergo diagnostic tests during the antenatal period and after childbirth becomes a complex and expensive affair, leading to delayed identification of health issues and consequent delay in seeking appropriate care. Often, ambulances or other transportation are unavailable to ensure institutional deliveries. It is estimated that approximately 20% of maternal deaths could happen during transit (MoHFW 2017).

- **High Out-of-pocket Expenditure:** The average out-of-pocket expenditure per delivery in a public health facility is INR 2,900. Out-of-pocket expenditure can be estimated to be much higher when women seek private care instead of public facilities due to unavailability, misconceptions or previous experience of inadequate care quality. Moreover, external factors like pandemics, natural disasters and displacement due to loss of occupation and migration can take a significant toll on individuals' access to affordable care (MoHFW 2021).

- **Limited awareness of health and well-being:** Poor functional literacy, a lack of emphasis on education within the healthcare system, and a society that places little value on health have a negative impact on health-seeking behaviour of individuals (Kasthuri 2018). Poor perceptions about the effectiveness and safety of health treatments at public health institutions (specifically at the primary level) lead to high reliance on high-cost private care (Selvaraj et al. 2018). Limited awareness of government schemes, including cash assistance schemes, affects public health service utilisation as well (Prinja et al. 2017).

Technology as an Enabler to Overcome Challenges

The above challenges, therefore, call for catalytic innovations. Digital health is emerging as a key lever to bridge gaps in healthcare delivery by improving overall efficiency, effectiveness, and transparency of health services.

Digital health refers to the use of digital, mobile and wireless technologies to support the achievement of health objectives. Despite the boom in the technology sector, its application in

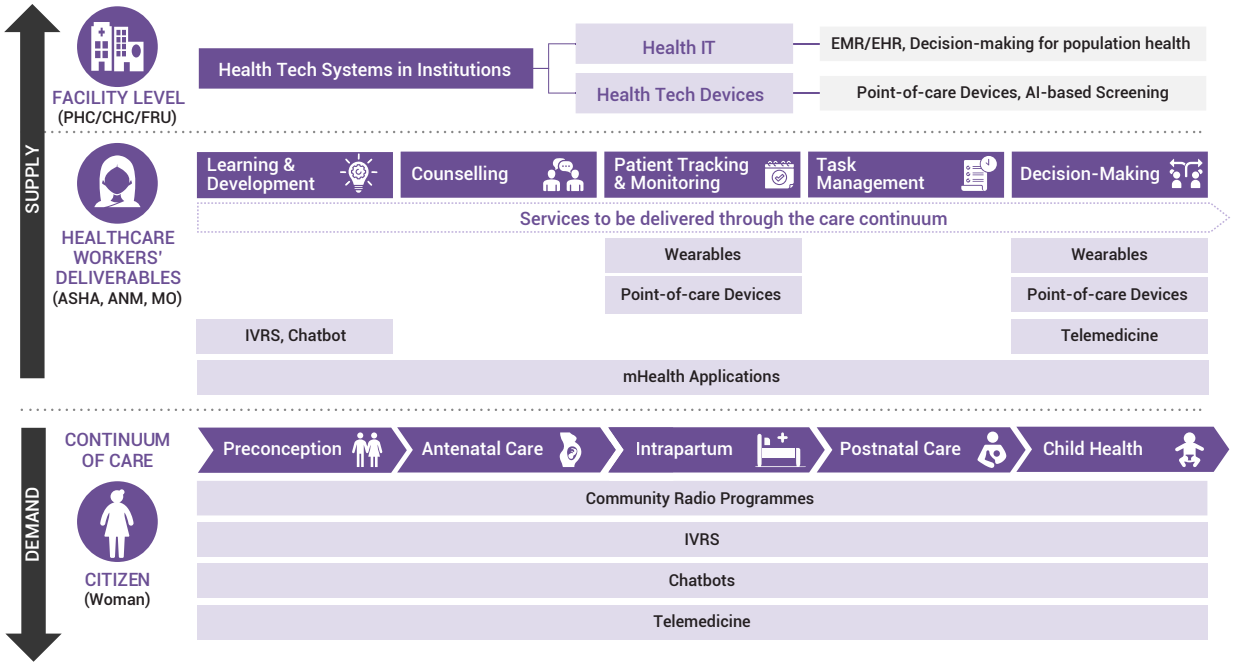
healthcare is largely untapped. Digital health has the potential to make health systems more efficient and sustainable, enabling them to deliver good quality, affordable and equitable care.

While digital health cannot directly solve all systemic problems, it can act as an enabler by

- Enhancing health workers' knowledge through training platforms, enabling them to deliver care to remote geographies through tele-health solutions;
- Streamlining payments to health workers and disbursal of cash assistance to mothers and their families;
- Delivering standardised quality of care across facilities and increasing access to specialist care in remote geographies through tele-health solutions;
- Strengthening referral systems between facilities and reducing the burden on tertiary care facilities by avoiding unnecessary referrals;
- Strengthening the supply chain to prevent stock-out of life-saving medications for mother and child at the facilities;
- Increasing the demand for better healthcare by improving access to information, awareness and enabling patient feedback loop and
- Collecting anonymised and aggregated data to enable better public health decision-making.

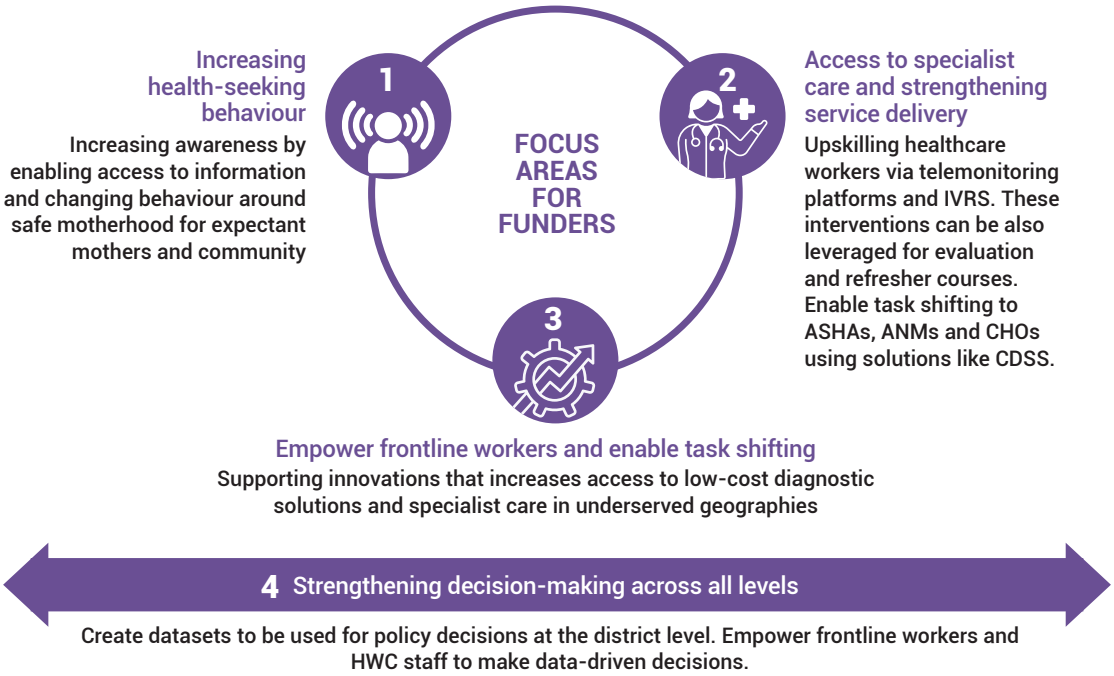
In the care continuum of maternal and child health, various archetypes of digital solutions have an advantage in implementing care and building capacity of the healthcare providers.

Figure 3: Possible areas of interventions across the care continuum during the first 1,000 days



Through secondary research and expert validation, we have identified four focus areas for funders looking to harness technology to accelerate maternal and child health outcomes. Philanthropic funders, especially corporates and domestic foundations can help mainstream the adoption of digital health solutions to improve maternal and child health outcomes using the following levers:

Figure 4: Focus areas for funders



The subsequent section discusses in depth each area and the archetype of digital health solutions that can augment maternal and child health service delivery and accelerate the above outcomes at scale.

1. Increasing health-seeking behaviour around safe motherhood for expectant mothers and the community

Corporate funders with areas of operations in remote rural regions can bring about sustained, positive behavioural change in these communities through contextualised solutions that surpass challenges such as limited internet access, low smartphone ownership and low digital literacy, that are prevalent in these areas.

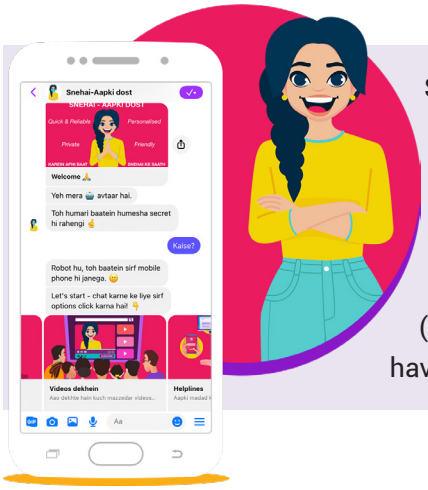
Interactive Voice Response Systems (IVRS) are instrumental in providing information in communities that are rural, remote and experience connectivity challenges. The NFHS-5 found that almost 54% of women in India own a mobile phone. This makes IVRS a viable option for spreading awareness and facilitating self-care at the household level for women. Community radio-driven awareness programmes can generate mass awareness in areas

with low internet penetration and lack of digital literacy. These solutions are some of the fastest methods to access a large population base in low-resource settings, making them ideal for awareness campaigns that can influence health-seeking behaviour for improved uptake of antenatal care, institutional delivery, immunisation and child-feeding practices (Prasad 2011).

Kilkari is a mobile-based education service provider that helps pregnant women and new mothers with important information about reproductive, maternal, neonatal and child health. It aims to generate awareness and create a knowledge base to improve the uptake of preventive health practices. By the use of IVRS technology, it delivers time-sensitive audio information directly to families' mobile phones, with a primary focus on the critical time between the second trimester to when the baby is 1 year old. It has played a vital role in bridging information gaps for remote settings and increasing access to information in areas with low connectivity. These information systems have been vital, especially during periods of pandemics, natural disasters and migration for beneficiaries to access information. Kilkari is the largest mobile-based maternal messaging programme in the world. It has scaled to 18 states and union territories and has reached over 29 million women and their children till date, and currently has two million active users.

(Source: Bashingwa 2021; ARMMAN n.d.)

For funders working in urban areas or regions with moderate to high digital literacy, **application-based or WhatsApp chatbot-based solutions** can be scaled to deliver awareness-related content. Chatbots could have multimedia content that includes text, audio, video and even games, creating an interactive experience for the beneficiaries.



SnehAI is a chatbot, housed on Facebook Messenger which provides a non-judgemental space to address the concerns of young people in a secure and personalised manner and educate them about issues related to sexual and reproductive health (SRH) as well as digital safety. Launched in Hinglish (Hindi+English), SnehAI has over 1,36,000 users who have had a total of 8.6 million conversations.

AskNivi was launched in 2016 with a mission to enable women, men, and adolescents achieve their own aspirations for health. It is an AI-powered chatbot that guides individuals on personalised health journeys by empowering them with information relevant to their health priorities and personalised referrals to local health services and products. Nivi health journeys help individuals make informed choices regarding their sexual and reproductive health, maternal care, and early childhood health.

Operating in India, Kenya, South Africa, and Nigeria, Nivi has engaged over 2 million individuals in over 3 million conversations on SRH, maternal care, and childhood health, and worked with nonprofits, commercial entities, and government agencies to generate awareness, referrals, feedback, and insights on the populations and markets they serve.

(Source: Sneh AI n.d., AskNivi n.d.)

These solutions can be integrated with the existing health service that the funder provides through community clinics, mobile medical units and health camps.

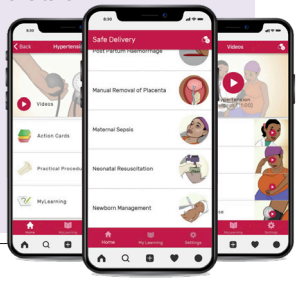
2. Increasing access to specialist care and strengthening service delivery

Innovations that improve access to care, especially specialist care in underserved geographies, and strengthen healthcare service delivery can be scaled with the support of philanthropic funding. Funders can either scale solutions that are mature with proven records of impact, or fund innovations with risk capital to address whitespaces in the areas of maternal and child health.

Mobile Health (mHealth) applications linked with national registries and the Ayushman Bharat Digital Mission (ABDM) can be leveraged to track maternal and child health indicators and service delivery rates such as ANC and PNC checkups, child immunisation rates and record of early childhood diseases. These applications provide an integrated system for the ASHAs to track the mother's health, right from registration up until her child turns two. These applications can send reminders to the frontline workers about services due, and can also act as a job aid for counselling through interactive media like videos and images already uploaded on the application. During the first 1,000 days, these applications allow frontline workers to collect data on various health parameters and monitor the woman and child's need for counselling and medical care. These applications are useful for ANMs and ASHAs to identify and mitigate risks and threats. They also allow them to connect to doctors at the facility level, facilitating referrals.

Integrated High Risk Pregnancy Tracking & Management (IHRPTM) focuses on training Auxiliary Nurse Midwives (ANMs), medical officers (MOs) and specialist doctors on high-risk pregnancy management and tracking through training, two-way communication support (WhatsApp helpdesk/thin app/call centre) with multimedia content and a learning and tracking app. Through its pilot phase in Telangana, IHRPTM is training 9,000 ANMs, 1,000 MOs and 300 specialist doctors in tracking and managing high-risk pregnancies to achieve a reduction in delayed referrals to secondary and tertiary care, thereby improving maternal and neonatal mortality and morbidity.

The Safe Delivery App is a smartphone-based free of cost application that provides skilled birth attendants with access to up-to-date clinical guidelines and works offline too. This includes life-saving information and guidance through easy-to-understand animated instruction videos, action cards and drug lists. Nursing, midwifery students (pre-service education, midwives and healthcare workers can use it on the job or stay updated in their spare time or as part of their training. There are 1,52,000 total users of the Safe Delivery app in India. *My Learning* platform, which is also part of the app allows nurses to take a case study-based exam and get certified. So far, 38,000 users are part of the platform in India, of which more than 9,000 users have achieved the champions level on the platform, with 4,000 having already achieved expert level in all modules.



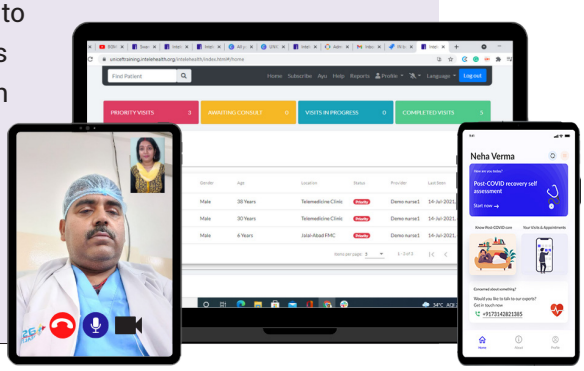
(Source: ARMMAN n.d.; Maternity n.d.)

Scaling mHealth applications can be especially useful in settings such as urban slums that witness high migration rates. The mass movement makes it harder to track these groups' health status manually. These solutions can also establish linkages between the expectant mother and government facilities, enabling the former to avail schemes related to RMNCH, such as conditional cash transfers and transport services for institutional deliveries.

Scaling **low-bandwidth telemedicine** and setting up of telemedicine kiosks in the community can be an effective way to invest in areas with low connectivity, where women are unable to obtain timely counselling services for their pregnancy, postnatal stage or child care due to geographical barriers and lack of specialist care.

In cases that require expert opinions, telemedicine can allow mothers or frontline workers to connect with specialists and have remote consultations for immediate guidance, when traveling to a facility is challenging. With video consultations, the specialists are able to conduct a more comprehensive consultation process with the patient, allowing for improved diagnosis and guidance.

Intelehealth is a non-profit delivering high-quality healthcare via telemedicine. Their open-source technology platform is driven by an innovative digital health assistant, which connects patients and frontline health workers at the last mile with doctors, diagnostics & medications. **Intelehealth** is on track to provide healthcare for 10 million women over the next three years in partnership with Ministries of Health in India & Kyrgyzstan as well as organizations like UNICEF, Jhpiego, and MSF. To date, **Intelehealth** has enabled over **1 Million consultations, supported 3000+ frontline health workers & 950+ doctors. Their programs have resulted in a reduction in out-of-pocket expenses for rural populations and improved capacity & skill development for frontline health workforce**. The telemedicine platform comprises a Provider-to-Provider portal, and a Patient-to-Provider portal, all powered by a novel digital assistant called Ayu. Ayu is a decision support system that contains 150+ evidence-based protocols for delivering high-quality health services and improving patient outcomes. Ayu helps to shift the crucial task of clinical history-taking from a qualified doctor to that of a semi-skilled health worker, thereby supporting local health workers to provide evidence-based health services. For conditions that are beyond the capacity of the health worker, it can connect the health worker and patient with a virtual doctor over telemedicine, leading to a conclusive diagnosis. This platform has enabled ~70% reduction in distance travelled to access primary care and ~ 75% reduction in time taken to access primary care



(Source: Intelehealth 2022)

Supporting and scaling innovation **in low-cost diagnostics solutions** can increase access to diagnostic services at the last mile. This can increase timely detection of high-risk pregnancies, foetal abnormalities and birth defects in the newborn. Low-cost diagnostic solutions can include:

- Deploying comprehensive diagnostic solutions that test for maternal anaemia, gestational diabetes, hypertension, and urine parameters to determine the risk of the pregnancy.
- Deploying mobile partographs for all expectant mothers in remote areas where there is a dearth of skilled health workers. This can ensure real-time data reporting that enables supervisors to detect data irregularities. Key alerts on emergency action can also be sent to supervisors and/or referral facilities based on the data collected by the e-partographs.
- Innovating and scaling point-of-care diagnostic innovations, such as solutions to monitor foetal heart rate, low-cost portable ultrasonography machines and low-cost wearable devices for the mother and child to scale specialist service deliveries and monitor the health of the mother and child.

Point-of-care devices (POCD): Point-of-care devices are used as diagnostic devices to obtain medical test results within a short period of time. They improve access to diagnostic services in geographies where laboratory infrastructure is weak and also increase the speed

at which the care-giver is able to make treatment-related decisions for the patient. Test results from these solutions are also used by doctors located remotely to provide treatment guidance to the ANM or the Community Health Officer (CHO) (Konwar et al. 2020).

CareNX Innovations Private Limited provides a digital maternity solution platform for healthcare providers has developed various point-of-care diagnostics solutions that can be scaled at the last mile. Two notables solutions by the organisation are detailed below:

AnandiMaa is an Al-enabled, high-risk pregnancy management service that aims to ensure healthier pregnancies across the remote regions of the country with the help of healthcare providers. The AnandiMaa kit is portable, allowing the frontline worker to conduct diagnostic tests at the beneficiary's doorstep with a shorter turnaround time. It also enables them to connect with doctors through video consultations and provide immediate medical guidance to the pregnant woman. This solution has reached more than 1,00,000 mothers across 1,000 villages.

Fetosense is a wireless, interactive and smartphone-based Non-Stress Test/ Cardiotocography (NST/CTG) machine that functions as an e-partograph designed to monitor pregnancy remotely from anywhere, at any time for the doctors and mothers that provides the best fetal monitoring experience possible. Fetosense is available in 500+ hospitals from 13 Indian states, has served 1,50,000+ mothers and has been incorporated into National Health Mission's Project Implementation Plan for FY 2022-23.

(Source: CareMother n.d.)

Wearables are physical medical devices that are usually attached to the patient's body. They can collect, track, monitor and store information. This data can be viewed with the support of mobile health applications and dashboards that can provide alerts and snapshots of the individual's health status and progress.

Janitri's Fetal-Maternal Remote Monitoring System uses patented technology to help hospitals and clinics provide better care for expectant mothers and their babies.

Keyar is designed by Janitri as a Beltless Fetal Monitoring Patch to simplify labour monitoring. It is easy-to-use, wireless, and beltless which uses ECG & EMG signals to ensure clear differentiation between the maternal and foetal heart rate and measures contractions without any additional probes.

Janitri's solutions are currently used by over 200 hospitals, have benefitted over 50,000 mothers and saved over 2,000 lives.

(Source: Janitri n.d.)

3. Empowering frontline health workers and enabling task shifting to improve efficiency and deliver standardised care

Frontline workers need upskilling to work with digital job aids, information access and troubleshooting platforms. These enable task shifting, involving rational redistribution of tasks among the health workforce. Specific tasks can be shifted from highly qualified health workers to health workers with shorter training and fewer qualifications, in order to make efficient use of the available human resources.

Funders can consider the following interventions to enable upskilling and task shifting for healthcare providers, especially in the frontline:

- IVRS and chatbots developed for healthcare providers can consist of routine phone calls or messages that provide knowledge-based skilling on technical topics related to the care continuum in a scheduled manner. They can also be structured to offer quizzes for the provider, allowing them to understand their grasp on the curriculum. This can be especially useful for newly appointed frontline workers.
- Customisation of mHealth applications by the addition of counselling aids like videos, quizzes and images can be used by the provider to educate and mitigate misconceptions among the population.
- Investing and scaleup of telementoring platforms where health workers can upskill themselves, and also convene to discuss cases and share best practices.

Mobile Academy is a Reproductive Maternal Neonatal and Child health training course designed to refresh ASHA (frontline health workers) workers' knowledge of life-saving preventative health behaviours, and improve the quality of their engagement with new and expecting mothers and their families. The programme uses IVR technology that is handset-independent, audio-based and accessed via a simple voice call. The course is divided into chapters, lessons and quizzes, and the health workers receive an accumulative pass/fail score at the end. Mobile Academy is the largest mobile-based training programme for health workers in the world and has trained over 2,70,000 ASHA workers across 17 states and union territories in India.

मोबाईल एकेडमी

(Source: ARMMAN n.d.)

ECHO India (Extension for Community Healthcare Outcomes) is a not-for-profit organisation working towards building capacities and bridging gaps in the areas of healthcare, education, and other sustainable development goals. ECHO has already established itself as the go-to platform for building capacity in many national healthcare programmes under a MoU signed in 2019 (MoFHW).

ECHO India
Project ECHO®

To help contain the number of maternal deaths in the country, ECHO India has partnered with institutions working on antepartum and antenatal care, maternity care, electronic foetal monitoring, promoting breastfeeding, and neonatal care. Further, ECHO India is training healthcare providers on Manyata, a competency-based quality certification system, in collaboration with Jhpiego.

In 2021-22, ECHO launched 5 tele-mentoring learning hubs, forged 17 new partnerships and conducted over 100 programmes reaching more than 9,000 attendances in the area of maternal and child health.

(Source: ECHO India n.d.)

4. Strengthening decision-making at all levels of healthcare

Anonymised open-access datasets and analytics that use data from the above interventions can enable apex institutions, state and district officials to make data-driven decisions with respect to policy, budget and programme implementation. Investing and promoting scaleup of technology solutions integrated with Clinical Decision Support Systems (CDSS) can empower frontline health workers to make data-driven decisions. mHealth applications can be equipped with programmed CDSS which supports ASHAs and ANMs through decision trees to make the right choice in emergencies (Charantimath et al. 2021; Modi 2019).

Khushi Baby: Khushi Baby's flagship Community Health Integrated Platform (CHIP) is a system of connected mobile health applications for the three key health workers of the Indian public health system: ASHA, ANM & Medical Officer (MO) to provide comprehensive, longitudinal primary health care in last-mile settings. CHIP utilises advanced AI/ML techniques to quantify community health worker diligence and predict communities at risk for poor primary health outcomes for early targeted intervention.

Using the platform, health workers will be enabled to perform the following core activities from their smartphone:

- Performing a digital health census to capture true population denominator and community health needs;
- Longitudinal follow-up of primary healthcare across programme verticals, e.g. family planning, maternal and child health, non-communicable diseases, tuberculosis;
- Disease outbreak surveillance for COVID-19 and other emerging infectious diseases, including symptom screenings, referrals, and vaccination follow-up.

This platform also digitally empowers health officials with GIS-based dashboards to:

- Monitor and respond to community needs and healthcare performance in real time and
- Automate personalised community engagement to health workers and beneficiaries via dialect specific voice calls or messages.

Over 60,000 community health workers have used the CHIP platform to reach 24 million beneficiaries across 35,000 villages in Rajasthan. The Indian government's National Health Mission has recently allocated ₹107.55 crores towards statewide expansion of CHIP over the next two years (2022-24).

(Source: Khushi Baby n.d.)

Electronic Medical Records (EMR) are digital versions of patient health records. These records are usually accessible to a range of healthcare providers such as doctors, nurses, and pharmacists with citizens' consent. This allows for improved decision-making and offers a clear visibility of progress of the patient's health status. EMR systems also automate and streamline workflows in healthcare institutions, improving efficacy and efficiency. As the medical records are stored digitally, they can be shared with other healthcare institutions, with prior consent, assisting in referrals or continued care for the patient (Piramal Foundation 2020).

AMRIT (Accessible Medical Records Via Integrated Technology) is an ABDM (Ayushman Bharat Digital Mission) compliant integrated healthcare technology platform developed by Piramal Foundation (Piramal Swasthya) to drive quality delivery of healthcare at scale by enabling nation-wide adoption of the ABDM ecosystem. AMRIT is designed to strengthen Comprehensive Primary Healthcare Operations through appropriate technology and referral pathways. The tech platform envisages accelerating the efforts of the states in the space of RMNCH, NCDs and CDs & general-outpatient care for acute simple illnesses and minor ailments. The API-driven technology backbone enables interoperability between disparate systems and seamless integration with PoCT devices. The extended services like 104 Helpline Application, ECD and FLW application within the platform make AMRIT unique for the ecosystem. AMRIT is deployed in at least 21 states through its multiple service lines and in partnership with states, and through PPP/CSR and has been able to generate more than 3 crore beneficiary records.

(Source: Piramal Foundation 2020)

Different Archetypes of Digital Solutions

Table 1: Archetypes and examples of digital solutions and their role in the continuum of care of maternal and child health*

Archetype	Used in/by	Examples	Scale of Impact
Chatbot	• Awareness generation for the masses, especially for taboo topics. • Provide audio-visual information for better understanding. • Provides personalised responses based on real-time data. • Capacity augmentation of frontline workers.	**AskNivi**	It has engaged over two million individuals in more than three million conversations on SRH, maternal care, and childhood health.
		SnehAI	This chatbot is available across all Indian states. With more than 1,36,000 active users, it has held 8.6 million conversations till date.

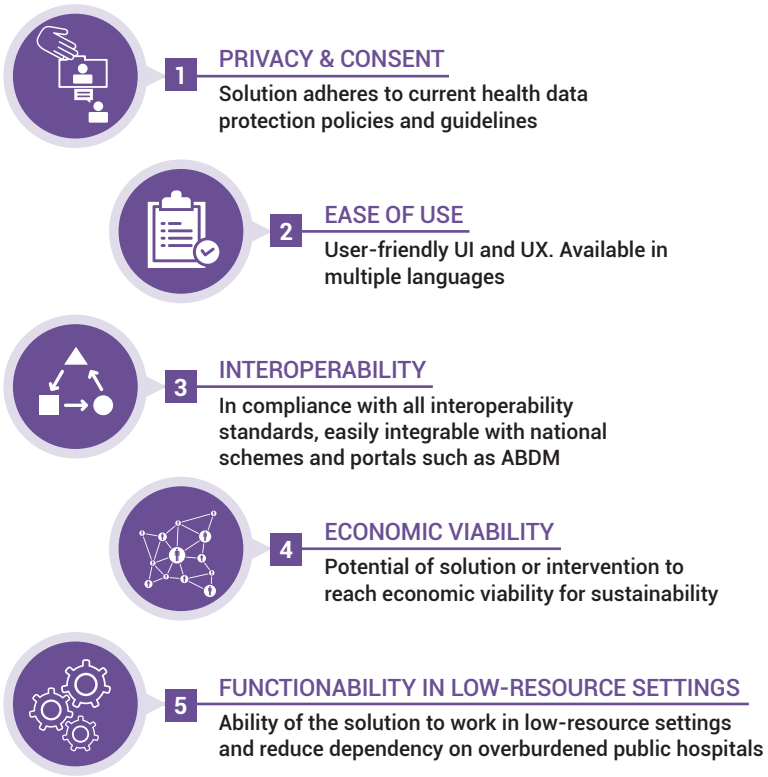
*illustrative

Integrated platforms, Dashboards and Electronic Medical Records (EMR)	• Data-driven decision making across all levels of healthcare. • EMR: Digital versions of patient health records. Offers clear visibility of progress of the patient's health status.	**Khushi Baby**	Over 60,000 community health workers have used the CHIP platform to reach 24 million beneficiaries across 35,000 villages in Rajasthan.
		AMRIT	The extended services like 104 Helpline Application, Early Childhood Development and FLW application within the platform makes AMRIT unique for the ecosystem. AMRIT is deployed in at least 21 states through its multiple service lines and in partnership with states and through PPP/CSR and has been able to generate more than 3 crore beneficiary records.
IVRS	• Awareness generation for the masses. • Provides remote consultations and appointment reminders. • Support system for frontline health workers. • Capacity augmentation of frontline workers via gamified training and assessment.	**Kilkari**	Kilkari has scaled to 18 states and union territories and has reached over 29 million women and their children till date, and currently has two million active users.
		Mobile Academy	Mobile Academy has trained over 2,70,000 ASHA workers across 17 states and union territories in India.
mHealth	• Support to ASHA and ANMs through services like task management, direct messaging and database support. • Beneficiary tracking throughout the care continuum. • Automation of referrals. • Enables better action in emergency situations.	**IHRPTM**	Through its pilot phase in Telangana, IHRPTM is training 9,000 ANMs, 1,000 MOs and 300 specialist doctors in tracking and managing high-risk pregnancies.
		Safe Delivery App	Total 1,52,000 users. So far, 38,000 users are part of the My Learning platform in India, of which more than 9,000 users have achieved the champions level on the platform, with 4,000 having already achieved expert level in all modules.
Point-of-care devices	• Used by healthcare workers to perform diagnosis in remote areas.	**AnandiMaa**	This solution has reached more than 1,00,000 mothers across 1,000 villages.
		Fetosense	Fetosense is available in 500+ hospitals from 13 Indian states. It has served 1,50,000+ mothers and has been incorporated into National Health Mission's Project Implementation Plan for FY 2022-23.

Archetype	Used in/by	Examples	Scale of Impact
Telemedicine	• Provide specialised consultation in remote areas. • Remotely administer regular checkups.	**Intelehealth**	Over 1 Million consultations, supported 3000+ frontline health workers & 950+ doctors. Enabled ~70% reduction in distance travelled to access primary care and ~75% reduction in time taken to access primary care with ~60% reduction in the average spend to access basic primary care.
Telementoring	• Build capacity of frontline health workers and help reduce the number of maternal deaths.	**ECHO**	In 2021-22, ECHO launched 5 tele-mentoring learning hubs, forged 17 new partnerships and conducted over 100 programmes reaching more than 9,000 attendances in the area of maternal and child health.
Wearables	• Collection and monitoring health parameters over the care continuum.	**Janitri**	Janitri's solutions are currently used by over 200 hospitals, have benefitted over 50,000 mothers and saved over 2,000 lives.

Our analysis of digital solutions in low-resource settings brings to light several key principles adopted by these providers to suit various contexts. Adherence to these principles can serve as a potential guideline for selecting a tech solution to scale in low-resource settings.

Figure 5: Core principles that ensure success of digital health solutions



To ensure success of these digital interventions, funders need to take a programmatic approach and consider developing additional capabilities required to ensure sustainable implementation and adoption.

- **Infrastructure availability:** Ensure availability of adequate hardware and software infrastructure, electricity and internet connectivity at the last mile to support usage.
- **Identify channels for implementation** and work with implementing partners to avoid duplication, achieve scale and strengthen existing programmes in public health.
  * Integration with established public health programmes run by philanthropic funders such as mobile medical units, community clinics and health camps.
  * Integration with district public health programmes in partnership with local administration.
  * Integration with public healthcare facilities and programmes managed by non-profits in a Public-Private Partnership (PPP) arrangement.
- **Demand Generation:** Mobilise local population and generate on-ground demand for these services through awareness generation activities that clearly communicate the value proposition of the intervention.
- **Patient capital:** Ensure availability of patient and diverse funding capital to support deployment, especially early-stage risk funding and innovative financing provisions at a later stage for mature solutions.

Conclusion

In order to achieve the SDG targets related to maternal and child health, India needs to focus on solutions that are scalable and can be implemented at the last mile. A careful selection of these solutions is crucial as it will act as a stepping stone to close India's MNCH gaps. Sustained implementation will ensure that India continues to perform well with respect to maternal and child health. As technology has the potential to replicate and scale, there is a need to leverage tech-enabled solutions to improve access, quality and affordability of maternal and child healthcare services.

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