

TRANSFORMING HEALTH IN INDIA

The 2030 Innovations Agenda

Oommen C. Kurian and Shoba Suri

Editors



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Foreword

India's health gains over the next decade will be predicated on healthcare systems that are trusted, equitable, and resilient. Care and belonging are the primary currencies of well-being; without them, healthcare systems lose their ethos of “do no harm”. Trust is similarly paramount—it is a decisive factor that binds providers to patients, states to citizens, and partners to purpose. Without trust, healthcare systems are but a house of cards.

Transforming Health in India: The 2030 Innovations Agenda collates 17 essays from experts in various fields related to health. The volume unapologetically confronts systems and asks: What will it take to deliver reliable primary healthcare, finance their delivery sustainably, leverage technology with a human-centred approach, and use data responsibly so that care is continuous, portable, dignified, and trustworthy?

The message from these essays is clear. We live in an affection economy—where communities beget cooperation and economic success—and the systems that people choose to belong to are the ones that endure. A responsive healthcare system shows up at the first mile and stays with people until the last. It treats data as connective tissues rather than a commodity; as a result, information follows the person and improves decisions. It builds institutions and teams that command trust, not just infrastructure that delivers services. It aligns finance, technology, and regulation to one purpose: continuity and dignity of care. It prepares for shocks without losing sight of everyday reliability, and it invests in relationships across capitals and regions, the public and the private sectors, and science and industry, putting India on the path to converting scale into quality outcomes. When reliable care is respectful and predictable, citizens stay with the system—and therein lies our path to *Viksit Bharat 2047*.

Transforming Health in India: The 2030 Innovations Agenda stands tall on the shoulders of ORF's earlier work that has tried to make debates more meaningful by enabling the movement from rhetoric to implementation.

Diversion of Used Cooking Oil into the Food Stream: A Study of Four Indian Cities (August 2022) studied a pervasive, system-level food safety health risk and the regulatory and enforcement responses it demands. The year after, *Pandemic-Proofing the Future: Lessons from the G20's COVID-19 Response and Recovery* (November 2023) made a powerful case for collective preparedness and clearer rules for supply chains, data, and financing in crises. *Health Equity and Inclusion in Action* (February 2024) set a pragmatic template for closing health access gaps through tech- and data-enabled models. And *Sustainability and Resilience in the Indian Health System* (February 2024) assessed governance, financing, workforce, service delivery, medicines and technology, information, and environmental sustainability, and offered concrete recommendations to fill the gaps. Together, these four prior publications formed a point of departure, and this volume takes those conversations forward into this comprehensive, 2030-ready playbook.

These essays are ambitious but offer executable insights. They challenge us to measure what matters, invest where returns are highest—in people—and build and deliver results at scale.

Dr. Samir Saran

President

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Introduction

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India's health system stands at a critical juncture: complex and carrying a heavy burden, but harbouring greater ambitions as seen in the decision by the Union government to make health insurance free for those ages 70 and older. Indeed, in the decades since Independence, the country has made strides in extending life expectancy, eradicating the most insidious infectious diseases like polio, and building a nationwide network of primary health facilities. These achievements, however, coexist with persistent gaps as well as emerging challenges that make the Indian health landscape in 2025 both deeply uneven and full of possibility.¹

The unfinished agenda of public health in India is today faced with a newer set of threats: a stubborn, high burden of maternal and child undernutrition,

rising obesity and rates of non-communicable diseases, mental health concerns, and growing exposure to climate-induced hazards and zoonotic spillovers. India's population is ageing and urbanising rapidly, with large-scale migration reshaping both community networks and service delivery models. At the same time, India's growing global profile in digital health, pharmaceuticals, and pandemic diplomacy demands a recalibration of its institutions and values, and an acknowledgement of its voice in the international health order.

Underlying many of these contradictions is the structure of health financing. According to the most recent National Health Accounts estimates, total health expenditure in India stood at 3.8 percent of GDP in 2021–22, of which just 1.8 percent was public spending. Out-of-pocket payments by households still accounted for nearly 40 percent of current health expenditure, despite rapid reduction in the past decade.² The gaps are especially visible in under-resourced states, where the burden of disease intersects with systemic underinvestment in public infrastructure, limited workforce capacity, and fragmented governance.³

And yet, India is not without advantages. Its legacy of public health movements—whether the Integrated Child Development Services, the National Health Mission, or in more recent years, the Ayushman Bharat—offers institutional platforms for scale. It has one of the largest and most distributed cadres of frontline health workers in the world. And increasingly, it has a growing innovation ecosystem: from AI-powered diagnostics and health-tech start-ups to vaccine manufacturing and bioinformatics platforms that position the country as a key player in global health markets. What remains elusive is a systematic strategy that integrates public, private, and community actors across sectors and scales.

India's battle with maternal and child malnutrition remains urgent, with 35.5 percent of under-five children stunted in 2019–21, 19.3 percent wasted, and 32.1 percent underweight, particularly among marginalised groups.⁴ Anaemia has worsened since NFHS-4 of 2015–16, affecting 67.1 percent of children and 57 percent of women, while gaps in Poshan Abhiyaan's coverage and delivery hinder impact.⁵ Low birth weight (17.3 percent in 2019–21) and rising NCDs in women call for a multi-pronged strategy to disrupt the intergenerational cycle of malnutrition.^{6,7} Recent research pegs gestational diabetes prevalence at 9–16 percent, highlighting the need for stronger primary care and lifestyle-based interventions.^{8,9} According to the World Bank, every dollar invested in nutrition specific interventions gives an economic return of anywhere between 4–35 dollars.¹⁰

Poshan Abhiyaan and Mission Saksham Anganwadi, though ambitious, is falling short on implementation due to lack of both human and financial resources.¹¹ Enhancing its impact requires increased investment, strengthened monitoring to bridge gaps in last-mile delivery, and ensuring equitable access in remote and disadvantaged regions. Investing in maternal and child health yields a triple dividend: healthier mothers, thriving children, and stronger communities. According to UNFPA estimates, every dollar invested in maternal health, yields 8.4 dollars in economic returns.¹² The global economic impact of malnutrition is estimated at US\$125 billion in 2030; for India, it is around US\$15-46 billion annually due to low productivity and healthcare expenses.¹³

The NITI Aayog's Strategy for New India@75 calls for attaining optimum levels of health, nutrition and cognition in order to leverage its demographic dividend.¹⁴ Aligning efforts and building synergies across sectors like health, education, social protection along with women's education and digital literacy can improve population health and well-being.

This edited volume is an outcome of the India Health 2030 Conclave, organised in February 2025 by the Observer Research Foundation in Kolkata.¹⁵ The Conclave brought together a diverse group of individuals, including policymakers, academic researchers, private sector experts, grassroots practitioners, and global health diplomats. The objective of the conference was to assess the state of Indian health systems and imagine their transformation over the next decade.

The articles contained in this publication carry the same energy, identifying actionable solutions for strengthening healthcare infrastructure, improving equitable access to medicines and services, and aligning health systems with evolving needs. With an emphasis on sustainable reforms, collaborative approaches, and future-ready investments, it aims to help shape a robust and inclusive health agenda for India by 2030.

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I

**Reimagining
Health Systems
for Equity
and Resilience**

Strengthening Health Systems for an Equitable and Sustainable Future

Rajeev Sadanandan

Abstract

Indian health systems and health indicators have improved considerably since independence. Today they face the task of responding to challenges arising from societal changes, as well as shifts in demographic and disease patterns. These include emerging and re-emerging pathogens with pandemic potential and a surge in non-communicable diseases. An effective urban primary healthcare model is needed to address health needs of the poor populations in cities. Such a health system must redesign the provision of health services to make primary healthcare the foundation. Financing healthcare should move towards pooled, prepaid funds rather than out-of-pocket expenditure at

the point of consumption. Quality assurance systems, and empowering local governments and community engagement are needed to improve health services in India.

Introduction

At the time of Independence, India, especially the regions directly governed by the colonial apparatus, had poor health indicators and a weak overall healthcare system. The system has improved since then, although coverage and quality remain inferior in comparison to many countries. Meanwhile, the population continues to grow even as diseases evolve. Since healthcare is highly contextual, the system too, must evolve continually, in anticipation of the directions that society, population, and disease patterns will take. This article will examine how health systems can adapt to the emerging epidemiological and economic scenario in India. India's healthcare sector has grown in the last 25 years. Many indices have improved, and the capacity for service provision has increased manifold, as shown in Table 1.

Table 1: Change in Health Indicators (1950-2020, India)

Indicator	1950	2020
Life Expectancy at birth	41.2 ¹	72 (in 2023) ²
Maternal Mortality Ratio	647 ³ (1985)	97 ⁴ (2018-20)
Infant Mortality Rate	167 ⁵ (1953)	28 ⁶
Beds per thousand population	0.46 ⁷ (1960)	1.6 ⁸ (in 2021)

However, improvements in India's health system are still below the nation's potential when compared to other countries who were at a comparable level at the time of independence (Table 2).

Table 2: Health Statistics: India and Other Countries

Indicator	India	Sri Lanka	Thailand	Bangladesh
Life Expectancy at birth ⁹	72	77	76	75
Maternal Mortality Ratio ¹⁰	97	43	24	215
Infant Mortality Rate ¹¹	28	5	8	24
Beds per thousand population ¹²	1.6	4.0	2.3	0.9

India's healthcare system is also characterised by regional and social inequity. The state of the health systems and indicators of good health are uneven across states.¹³ Urban areas have disproportionately higher access to healthcare services. Those in the higher-income groups can avail world-class health facilities that are largely inaccessible to the poor. While effecting the system-wide improvements discussed in the rest of this article, ensuring equity in access to services must remain an important policy consideration.

Emerging Challenges

Health systems of the future should be capable of mitigating new challenges that will arise from the ongoing demographic and epidemiological transition while continuing to address the demand for services in reproductive and child health, diseases caused by malnutrition, and communicable diseases.

The acceleration of genomic modification by climatic stress and the increased destruction of wildlife habitats are leading to more frequent wildlife-human interactions. Pathogens are spreading rapidly, and the threat of emerging and re-emerging pathogens with pandemic potential is only set to heighten.¹⁴

Non-communicable diseases (NCDs), including cardiovascular, metabolic diseases, and cancers, will lead to a heavy burden on the Indian health system.¹⁵ This needs to be reduced through preventive measures, including addressing causative factors, early detection, and management through lifestyle modification and pharmacological treatment.

With nuclear families becoming the norm, the support provided by joint families to patients needing palliative care and those with mental health disorders will reduce in the future. Healthcare and social services should devise a comprehensive plan that spans even home healthcare services to meet this shortfall. With proper training and certification, there is potential to create a labour force for the care economy.¹⁶

Lastly, there is a rapid and unplanned urbanisation occurring in India today.¹⁷ Its consequences—overcrowding, loss of green spaces, pollution, and the heat island effect—impact the poor disproportionately. India has to develop a model of primary healthcare that is appropriate for urban areas.¹⁸

Re-Engineering Service Provision

Guided by the Bhore committee report, India attempted to create a universal, comprehensive, tax-funded, and government-provided healthcare system at the time of independence. However, this has not been entirely successful, as acknowledged by the Mudaliar committee created in 1959 to evaluate the health sector.¹⁹ In many states, the government health sector is in disrepair. While the private sector has stepped in to fill the gaps, the integration of private providers into the national health objectives roadmap remains incomplete.

Re-imagining Government Health Systems

The foundation of the government health system in India is primary healthcare (PHC) consisting of health subcentres which cater to a population of 5,000 (2,000 in hilly areas) and primary care centres which serve a population of 30,000 (20,000 in hilly areas).²⁰ In a well-designed health system, primary healthcare providers are expected to function as managers of the care pathway on behalf of the patient, diagnosing their conditions, providing them care, and when they are unable to do so, helping them navigate higher levels of care within the health system. In India, they are held back from playing this role due to higher individual workloads, lack of competencies, and the faulty design of the health system. This can change only if the country realises the value of primary care, builds the capacity of primary care teams, provides them with essential diagnostic tools and laboratory support, as well as preferential access to referrals for their patients.

Health services should be organised as a hierarchical cluster, with PHC as the foundation and the gateway to a higher level of hospitals. If private health insurance moves from hospital-based coverage to comprehensive coverage organised around primary care teams, similar systems can emerge in the private sector too. With well-designed financial incentives and guardrails to ensure quality, unnecessary referrals can be avoided, reducing the cost of healthcare.

Primary care has focused almost entirely on maternal and child health, and controlling the spread of infectious diseases. Arresting the increase in incidence of non-communicable diseases continues to be a massive challenge, with the National Family Health Survey (NFHS-5: 2019-21) indicating that only 7 percent of patients had their blood glucose levels under control, and 7.8 percent had their

blood pressure under control. Uncontrolled hypertension and diabetes could lead to chronic kidney disease, stroke, and cardiovascular diseases. The poor may have to forego treatment owing to limited public sector capacity, and seeking treatment in the private sector could be prohibitive.

Essential Public Health Functions

At the population level, health outcomes are impacted by essential requirements, such as safe drinking water, quality housing, liquid and solid waste management, and nutrition, even more than medical interventions.²¹ It is the task of primary care teams to orchestrate and coordinate the provision of such determinants to protect population health. The 73rd and 74th amendments of the Constitution delegated many of these functions, along with primary care, to local governments. Empowering the representatives through skilling and capacity building, assigning funds to them, and providing them with technical support will be an efficient way to bring together all the factors involved in the production of health, to ensure superior outcomes.

Digital Health

Health systems of the future will need to leverage digital and analytical tools to improve quality and efficiency. This is facilitated by the creation of the Ayushman Bharat Health Account (ABHA), which enables individuals and healthcare institutions to be uniquely identified, and for individual longitudinal health records to be built up with every interaction with the health system. This record, compiled over patients' lifetimes, can prove to be a valuable repository of information to individuals and healthcare providers. Since any additional information can be added whenever available (e.g., genomic data), this repository can provide predictive analysis and enable personalised management. With proper safeguards, the data can also be used for training Large Language Models (LLMs), which can aid individuals and providers with more accurate conclusions to support treatment decisions.

With digitalisation, primary care teams can have access to the digital health records of the patient base assigned to them, constantly assessing the status of the population and creating predictive models that enable them to take preventive measures. It will also facilitate efficient referrals, prevent unnecessary treatments, and co-create individual care plans for each patient. It will also support financial planning with accurate cost projections and reduce fraud. Longitudinal health data

and the results of the analysis shared between healthcare providers will also help remote diagnostics and telemedicine reach underserved demographics, efficiently improving services for populations in remote regions.

Urban Health

Many aspects of urbanisation—such as lack of physical activity, the absence of efficient transportation systems, poor-quality housing, the lack of sanitation, and worsening pollution—impact health outcomes. Therefore, the sector should actively engage with the urban planning machinery to ensure that “health in all policies” is followed, and existing policies that promote good health are scaled.²²

Since cities are the centres of wealth creation, government funding could be restricted to the poor, especially to the less-fortunate and slum-dwelling populations. The contributory models of health financing, including primary care and digital technologies, will enable the provision of quality services to the urban non-poor. This calls for designing urban health systems anew and not co-opting the model of rural primary care.

Financing Healthcare

The mixed nature of healthcare provision in India is reflected in its financing. More than 70 percent of individual healthcare is covered by out-of-pocket payments. This has a perverse incentive for providers to generate demand for and subject patients to unnecessary and expensive treatment. Unless the health system has an incentive to be cost-effective, the cost of healthcare will continue to increase, and the burden of payment will fall on patients. This is compounded by reduced paying capacity as users or patients forego wages due to illnesses or caring for the sick.

In modern health systems, providers are paid from pooled funds, which are collected in advance either through tax funding or income-linked universal health insurance.²³ The pooled pre-paid system operates on the principle that not all people will be sick at the same time, some will certainly fall sick, and it is not possible to predict who will. The cost of treatment can be astronomical for one family, but if the total amount that all sick persons will pay for their episodes of illness is estimated, and the amount is divided between the entire population, the load on individual families will be manageable and predictable. With equitable premiums linked to patients' capacity to pay, the healthcare costs of the poor will be subsidised by the rich. Similarly, the young will subsidise the old by creating a virtuous intergenerational

chain of 'paying it forward', and the healthy will subsidise the unhealthy. Since funds will be professionally managed and the managers have an interest in keeping the outflow within the total collection, hospitals will be restrained from unnecessary procedures and inflated claims. Since society has an interest in avoiding complex and expensive conditions, prevention will be emphasised. The pressure for cost control will lead to constant innovations and reform in programme management and service provision.

The government must play the stewardship role by nudging the health system to ensure equity and efficiency. Given the informational and managerial complexity of such a system and the powerful stakeholders who will unite against it, reform has to be deliberately planned, piloted, and rolled out by the government. Situating it in the three streams framework of problems, policies, and politics catalyses the need for reforming the current system. Academics, researchers, and practitioners have to analyse the requirements of the reformed system and refine them through pilot implementation. Policy entrepreneurs and activists have to make the issue visible enough to win the endorsements of the political power centre.²⁴

Quality and Accountability

Healthcare providers bear considerable responsibility due to the nature of their profession and the information asymmetry that exists between them and their consumers. Therefore, monitoring quality is an essential systemic requirement. However, India does not have a mechanism in the public or private sector to ensure quality by learning from mistakes and near-misses. Adapting quality control mechanisms from advanced health systems and moving to a non-punitive and learning culture can help improve service delivery in the country. India should also use Health Technology Assessment tools to evaluate the efficacy and cost-effectiveness of new interventions, drugs, and equipment before they are introduced into practice.

Community Participation

While the centrality of citizens and communities in healthcare is highlighted in literature, they are often ignored in practice. Top-down targets that the health workers are compelled to meet leave them with no room to ascertain and accommodate community aspirations. They also lack the capacity to motivate community members to participate in co-creating and co-implementing health programmes. Community ownership of promotive, preventive, and rehabilitation services, lifestyle

modification initiatives, controlling environmental causes of ill health, and support for palliative care would make them more effective. Empowered and capacitated local governments and primary care teams can facilitate this process. The community will then assume responsibility for their health needs and be proactive in achieving them instead of being passive recipients of services. With the increasing prevalence of lifestyle-related and degenerative diseases, governments and communities will have to develop pathways to work together if emerging health needs are to be addressed.

Conclusion

Since Independence, the Indian health system has been focused on population control, ensuring better outcomes in maternal and neonatal healthcare, and managing infectious diseases. Although India has achieved success in these areas, domestic health systems have to be prepared for newer challenges that are emerging. Urbanisation, climate change, an ageing population, and the high prevalence of NCDs and their complications call for large-scale reform and investment in the sector. Primary care should serve as the foundation of the system, supported by secondary and tertiary hospitals. Health financing also has to change concomitantly, moving from out-of-pocket payments to a pooled, prepaid system focused on universal health coverage even for preventive and promotive care services. Local governments have to be empowered to provide primary care and manage the social determinants of health. Communities should evolve from being passive recipients of care to co-creators and co-implementers who assume responsibility for their health.

Health has become more politically salient in many states. Economic growth is driving demand and investment for healthcare. If policymakers are able to reform the service provision, financing and governance systems, India has the potential to develop an advanced health system capable of addressing the challenges that the country will face in the future.

Rajeev Sadanandan is the former Health Secretary of Kerala, with a keen interest in health systems and health policy research.

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‘One Health’ in India: From Reactive to Resilient

Rajib Dasgupta

Abstract

‘One Health’ is a holistic approach to health that recognises that the health of human beings is interconnected with that of animals, plants, and the shared environment. The concept has gained traction following the many zoonotic epidemics that have broken out in recent years, especially the COVID-19 pandemic. However, putting One Health into practice in a vast and diverse context such as India’s, as the National One Health Mission seeks to do, has its challenges. It calls for engaging with multiple disciplines, building complex systems, and designing real-world solutions with the combined work of experts in the natural sciences, medical and veterinary sciences, laboratory sciences and social sciences.

Introduction

The term ‘One Health’ is used in different contexts by experts and practitioners depending on their respective disciplinary backgrounds. Translational Medicine, in the context of One Health, “translates” knowledge of basic scientific disciplines into new or improved therapies, procedures, diagnostic tools, or policies for individuals and populations. ‘Zoobiquity’ refers to a “species-spanning approach” across infections, cancers, metabolic diseases, and even mental health, by integrating human and veterinary medicine and biology. Evolutionary Medicine, meanwhile, seeks to adapt biological ideas of macro- and micro-evolution, fitness, and the environment, to medical thinking.¹ The soul of the One Health philosophy (and its related concepts) is “a collaborative and trans-disciplinary strategy” to attain optimal health and well-being at the interface of human beings and Nature.² It is often said that One Health started as a concept, upgraded to an approach, and is now considered a movement.³ The current understanding of One Health transcends anthropocentrism and collaborates for optimal health for humans, animals, plants, and their shared environment, contributing to sustainable development. It has six identified focus areas: laboratory services, zoonosis (zoonotic diseases), neglected tropical diseases, antimicrobial resistance, food safety, and environmental health.⁴

An example of how One Health is operationalised at the national level is the United States (US) National One Health Framework.⁵ It has a primary focus on zoonotic diseases while casting its net wide to address the other aspects of One Health and strengthen public health preparedness around all of them. It considers seven aspects: coordination, collaboration, and communication; prevention; preparedness; coordinated outbreak investigation, response and recovery; surveillance; laboratory; and workforce. Led by coordination at the national level, it has a wide range of stakeholders: state, tribal, local, and territorial (STLT) agencies; non-government organisations (NGOs); academia; and private sector partners. Collaborations with relevant international partners are another element.

Why Emerging Infectious Diseases Matter

The World Health Organization (WHO) defines ‘emerging infectious diseases’ (EIDs) as those that appear in a population for the first time, or those that may have existed previously but are lately rapidly increasing in incidence or geographic range.⁶ These include both relatively ‘new’ diseases such as Human Immunodeficiency Virus and Acquired Immunodeficiency Syndrome (HIV/AIDS), Legionnaires’ Disease, and Hantavirus Pulmonary Syndrome, and enduring ones such as malaria and

tuberculosis. The principal drivers of accelerated emergence and spread of EIDs are said to be certain human activities, such as increased human-wildlife or human-domestic animal interaction; biodiversity shifts; land use changes and urbanisation; increased global travel; and globalised trade.⁷

EIDs are a cause of concern for several reasons: their rapid spread (Severe Acute Respiratory Syndrome or SARS, for instance, spread to five countries in 24 hours of its first detection in November 2002, and 30 countries in six months); high fatality rates (Ebola has an average fatality rate of 50 percent, which went up to 90 percent in some outbreaks); or slow and costly treatment development (while the first case of HIV/AIDS was detected in 1981, the first retroviral drug came only in 1987).

Around 60 percent of EIDs are attributed to zoonotic pathogens, with 71.8 percent of them originating from, or linked to, wildlife, particularly bats. Between 1980 and 2000, 30 new pathogens have been detected, 75 percent of them of animal origin.^{8,9} Tropical regions seem to harbour a disproportionately high number of emerging zoonosis, including Nipah, Hendra, filoviruses, SARS-like coronaviruses, and possibly Middle East Respiratory Syndrome (MERS).¹⁰ While earlier, a large number of EIDs (25.4 percent) were viral pathogens, they are now increasingly (54.3 percent) bacterial or rickettsial. This points to the emergence of drug-resistant bacterial strains and signals a shift towards antimicrobial resistance (AMR) as a global health crisis.

Diseases never previously observed in humans have continued to emerge through new pathways and unexpected reservoirs in the last few decades: apart from AIDS in 1981, three new viral EIDs—Hendra, Menangle and Nipah—manifested themselves between 1994 and 1998, all of them from pteropodid bats in Australia and Southeast Asia. These have been followed by the H5N1 and H7N9 avian influenzas, SARS, Ebola, and MERS.¹¹ Vector-transmitted EIDs are mostly passed on by ticks and mosquitoes, including Lyme Disease, Rocky Mountain Spotted Fever, West Nile Fever, Dengue, and Zika.¹²

Models for Navigating the One Health Curve Ball

The “Quadripartite”—a collaboration of the Food and Agriculture Organisation of the United Nations (FAO), the UN Environment Programme (UNEP), the World Health Organization (WHO) and the World Organisation for Animal Health (WOAH)—provides the global leadership to address risks at the human-animal-ecosystems

interface.¹³ The One Health Joint Plan of Action (2022-2026) is an integrative effort of multiple disciplines working locally, nationally, and globally to achieve optimal health for people, animals, and the environment. It encourages collaborations in research at multiple levels across disciplines such as human health, animal health, plants, soil, environmental and ecosystem health, in ways that improve, protect, and defend the health of all species.¹⁴ The following are the ways in which this is being done:

Collaborative Model

Three types of collaborations have been identified in One Health literature: level-based collaborations (individual, population, or research), solutions-based collaborations, and third-party-based collaborations. Individual-level collaborations occur when physicians and veterinarians share knowledge which helps them both to understand better the risks of zoonosis and support early detection. If this is promoted systemically, such as, for example, by starting joint master's programmes for human and animal health practitioners, it would be individual-based collaboration, and would in turn help build a cadre of epidemiologists with a broad understanding of both human and animal disease control and prevention. Population-level collaborations, for their part, typically occur during outbreaks and involve coordination between human and animal health systems; for example, disease-specific surveillance such as of arbovirus in Serbia. At present, collaborations typically emerge only during disease outbreaks that require coordination between human and animal health systems; there are no established channels for working together. Again, at the research level, human and animal research institutions can collaborate to gain scientific insights into how diseases spread between hosts and pathogens.

In solutions-based collaboration models, human and animal health system actors work for a specific purpose (such as to contain outbreaks) while in the third-party model, a centralised agency or government department acts as knowledge broker between human and animal health professionals.¹⁵

Participatory Model

This is a multi-level and multi-stakeholder approach strongly rooted in a social paradigm—a 'Community of Practice' (CoP) that works together to manage public health, livestock, and environmental resources as common public goods. The CoP model straddles a range of interdisciplinary stakeholders such as environmental and agricultural officers, social workers, social scientists, and ecological scientists—all

focused on knowledge sharing to better understand how the environment-pathogen interacts with social processes, such as local practices and risk perceptions. It calls for field-based actions and stakeholder integration at the international, federal/provincial and local levels to ensure consistency and programme scaling-up.¹⁶ Stakeholders interact and work together as a collective, both in formal and informal settings for experiential learning from field to laboratory. They collaborate on fieldwork, aided by participatory tools, with inputs from social scientists to generate heterogeneous data from different sectors and disciplines.¹⁷

3Ps Integrative Approach

This approach combines three models—process, pattern, and participatory (the 3Ps)—to provide insights. They synergise different perspectives, encouraging cross-disciplinary interaction and promoting a composite model. Recognising that principles of epidemiological knowledge are complex, rapidly evolving, and in some contexts limited, the 3P approach involves locals in contextualising the mysterious processes—akin to a ‘black box’—of disease transmission. The details of how the different models are integrated depend on the purpose for which they are to be used—be it for understanding disease emergence or managing an ongoing epidemic.¹⁸

Relational One Health

Human, animal, and ecosystem health has social, cultural, historical, political, economic, and biophysical dimensions. Relational One Health approaches multispecies health holistically, subverting the prioritising of human health above that of other beings. While the human-animal-environment interconnections in zoonoses control and transmission are well-delineated, an implicit hierarchy of humans over animals prevails. Animals are viewed as ‘exposures’ or ‘threats’ to human health, leading to the marginalisation of the environmental domain. The advent of the Planetary Health movement in 2014, and the expansion of the Tripartite (WHO, FAO, and WOAHA) handling global health into a Quadripartite in 2020 by including the UNEP, marked a critical shift in integrating the environmental domain into One Health.

This model transcends the traditional human-health centric approach within a biomedical reductionist framework. The relational One Health approach has been tried out in specific cases in Brazil, Ethiopia and Israel with remarkable results. In Ethiopia, for instance, it was found that the increased overseas demand for certain

camel products had led to changes in camel husbandry—such as allowing camels to graze in protected areas—which had in turn increased the risk of transmission of the MERS-related coronavirus between humans, camels, and wildlife. In Israel, where camels are reared mostly by Bedouin communities in the south, distrust of formal medical institutions among the Bedouin has spiked transmission of brucellosis^a pathogens between human-animal and animal-animal contact networks.¹⁹

Critical Challenges

Being a relatively recent initiative, One Health faces challenges in several areas, as WHO has enumerated. These are the following:

- Information sharing and data management
- Identifying best practice examples
- Mapping existing initiatives and capacities for research and building the next generation work force
- Creating successful models of an integrated surveillance system
- Setting up mechanisms for routine and emergency coordination with relevant stakeholders
- Acquiring a better understanding of why zoonoses spread. Which of these factors is responsible—animal trade, agriculture, livestock farming, urbanisation or habitat fragmentation—and to what extent?
- Developing a standardised approach to assess the risks of pathogens spilling over between different animal and human populations, including risks arising in food systems and finding ways of identifying and reducing spill over risks.²⁰

Social sciences²¹ have not been used sufficiently to understand the sociological, cultural, economic, demographic, historical, linguistic, geographic, political, and other drivers of the challenges One Health faces. Social and behavioural scientists will need to unravel the complex connections between sectors, actors, disciplines, and sub-systems and contribute to One Health's policy framing.²² The insights from social sciences will not only help break down and deconstruct the silos that may exist between human health, animal health and the environment, but could also provide the philosophical moorings on the basis of which knowledge is to be acquired and treated, and the power dynamics around those.²³

^a Brucellosis is a bacterial disease that is transmitted through contact with infected animals or contaminated animal products; those with occupational exposure to animals or animal products may face increased risk.

Lessons for India

Though India's response to EID outbreaks has been characterised as generally 'reactive', it has built some of its own models of One Health. The National One Health mission, overseen by the Prime Minister's Science, Technology and Innovation Advisory Council, was launched in July 2022. Some research collaborations, such as between the Indian Council of Medical Research (ICMR) and the Indian Council of Agricultural Research (ICAR), have been institutionalised.²⁴ There is a Roadmap to Combat Zoonoses in India (RCZI), an initiative of the Ministry of Health and Family Welfare, the Ministry of Agriculture, and the Wildlife Institute of India in collaboration with Public Health Foundation of India (PHFI) that was launched way back in June 2008.²⁵ In Tamil Nadu, solutions-based strategic collaboration involving various departments at all levels has begun on improving data collection on dog bite surveillance and rabies control.²⁶

In March 2019, the National Institute for One Health (initially called the Centre for One Health) was set up at Nagpur, focused on tackling zoonoses, particularly those with epidemic and pandemic potential.²⁷ The emphasis is on surveillance methodologies, developing countermeasures such as vaccines, diagnostics and monoclonal antibodies^b for diseases that involve animal, plant or environmental infections, conducting mock drills, and creating cross-learning platforms.²⁸ A start has been made, but the institute also needs to harness newer technologies such as Oxford Nanopore's Rapid Sequencing,^{c,29} wastewater-based epidemiology,^{d,30} or remote patient monitoring (to gather and transmit patient health data to healthcare providers outside of traditional clinical settings).³¹

^b Monoclonal antibodies are artificially created antibodies that bind to a specific target, or antigen and can be used for diagnostic or therapeutic purposes.

^c A method for rapid barcoding of genomic DNA and is optimised for fast library preparation requiring minimal laboratory equipment.

^d Entails surveillance of wastewater or sewage to determine the exposure to specific pathogens.

India has also been a first-mover in drafting a unified legal and policy framework to support One Health implementation. Jointly initiated by the Ministry of Law and Justice, the Ministry of Health and Family Welfare, NITI Aayog, the Ministry of Environment, Forest and Climate Change, and the Department of Animal Husbandry and Dairying,³² the National Consultation for Legal Environment Assessment for One Health Activities aims to evaluate the existing legal framework relating to health, facilitate multi-sectoral dialogue, develop actionable legal recommendations, and strengthen collaborations across human, animal, and environmental health. It also seeks to address the gaps and overlaps in laws relating to human health, animal health, and environmental protection, and bring about sectoral balance.³³

In April 2017, India also released a National Action Plan (NAP) on ways to contain the rapidly growing problem of antimicrobial resistance (AMR). Several State Action Plans on Containment of Antimicrobial Resistance (SAPCARs) have since been developed; Kerala, Madhya Pradesh, Delhi, Andhra Pradesh, and Tamil Nadu have operationalised such plans, while states such as West Bengal are in the process. Indeed, an updated NAP-AMR 2.0 is also being worked on since 2022. Under the Prime Minister's Ayushman Bharat Health Infrastructure Mission (PM-ABHIM), state-level infrastructure is being strengthened in surveillance, prevention, and management of zoonotic and other diseases.³⁴

A scheme to set up Integrated Public Health Laboratories (IPHL) at various hospitals, down to the district level, drawn up in 2022, is in progress. These laboratories will provide guidance on standardisation, integration and strengthening of comprehensive diagnostic facilities to support clinical management and public health surveillance across human, animal, and environmental health sectors.

India's One Health goal is part of Prime Minister Narendra Modi's vision of 'One Earth, One Health'. It was also under India's presidency of the G20 in 2022-23 that the first G20 Health Track was launched.

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The Changing Public Health Landscape of India: Vision 2047

Rajni Kant

Abstract

The public health landscape of India is evolving in view of socio-demographic changes, rapid global travel, zoonotic infections, and climate variability. There is a triple burden of the unfinished agenda of infectious diseases, the rising incidence of non-communicable diseases (NCDs), and the emerging threats of outbreaks, epidemics and pandemics. To be sure, the country has done well over the years in eliminating certain age-old diseases, improving life expectancy, and reducing maternal and infant mortality. Diseases like leprosy, leishmaniasis, filariasis, tuberculosis, and malaria have been controlled to a great extent, and efforts aimed at their elimination are underway. Finding better preventive solutions for rising NCDs, and tackling

outbreaks and epidemics are the emerging challenges that the healthcare system must now address.

Introduction

The sheer diversity of India's geography and climatic zones, coupled with inconsistent population behaviour, brings to the forefront a variety of health burdens. The public health landscape of India is changing due to urbanisation, climate change, frequent travels, and demographic transition with the triple burden of existing infectious diseases, rising non-communicable diseases and the threat of outbreaks, epidemics and pandemics.

Despite these imminent health challenges, there are noteworthy gains in terms of improved life expectancy, declining maternal and infant mortality, along with the elimination of diseases like smallpox, polio, neonatal tetanus, and trachoma. New Initiatives like Mission Indradhanush, Prime Minister Ayushman Bharat Health Infrastructure (PM-ABHIM) and Ayushman Bharat, which are directed towards Universal Health Coverage (UHC), may be a game-changer in realising the dream of 'Viksit Bharat 2047'. This chapter will explore healthcare transformation and shed light on the efforts being made to eliminate diseases like tuberculosis (TB) and malaria. It will also outline key strategies for the prevention of non-communicable diseases (NCDs) and examine health system preparedness in terms of infrastructure, surveillance, diagnostics, as well as reducing health disparities and enhancing access to healthcare.

The Landscape of Infectious Diseases

Diseases Targeted for Elimination

India has made great progress in combating TB, with a 17.7-percent decline in incidence between 2015 and 2023. However, India still contributes 26 percent of the TB case burden globally. To accelerate TB elimination efforts, the Government of India has launched the Prime Minister TB Mukht Abhiyan to improve treatment outcomes, ensure community involvement, and seek corporate social responsibility (CSR). Nikshay Mitra, an innovative scheme, was launched to encourage health functionaries and individuals at various levels across the country to register cases under their care. As per the National TB Elimination Program, over 1.6 lakh Nikshay Mitras have been registered and linked to 11.4 lakh TB patients as of 31 July 2024. The government has also launched a 100-day TB campaign with a

focus on intensified testing, using handheld X-rays, Nucleic Acid Amplification Test (NAAT), and community participation to help diagnose hidden cases. With such new initiatives, including shorter treatment regimens and new vaccine candidates, India aims to advance towards its TB elimination targets.^{1,2,3}

In the case of malaria, meanwhile, the burden declined by around 80 percent between 2015-2023, with cases dropping from 1,169,261 to 227,564 and deaths from 384 to 83 in that period. India has also been removed from WHO's High Burden to High Impact (HBHI) group.⁴ Efforts need to be further strengthened to achieve the malaria elimination target by 2030 as there are high-burden, extremely remote areas. There is a need to expand the coverage of effective interventions like Long Lasting Insecticide-treated Nets (LLINs), Indoor Residual Spray (IRS), and Artemisinin-based combination therapies (ACTs) in remote areas. The issue of drug and insecticide resistance, and the challenges related to climate change and cross-border transmission, need to be urgently addressed.

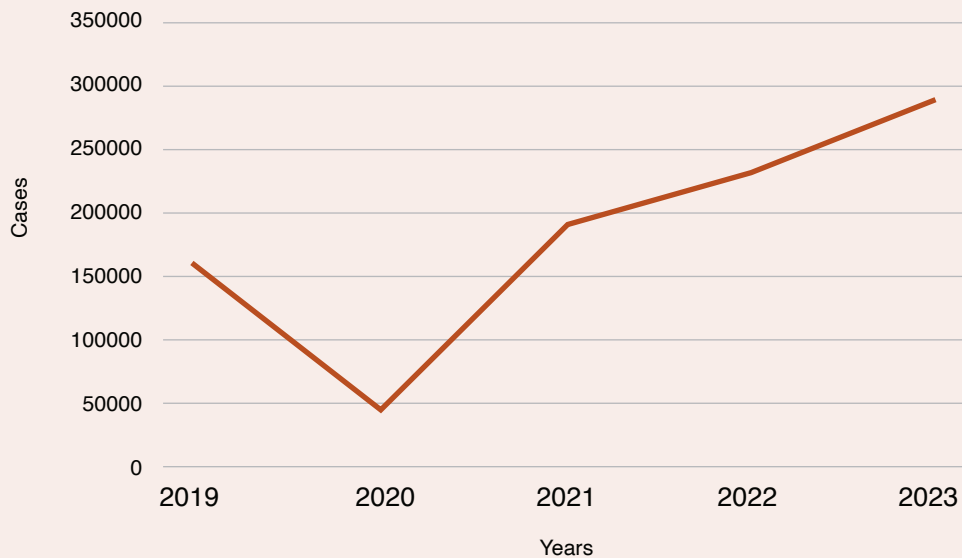
Viral Outbreaks and Zoonotic Infections

The country's geographical variabilities and porous international borders, coupled with high travel rates, pose a risk of viral outbreaks, as well as emerging and re-emerging infections. Landscape changes, deforestation, and erratic weather patterns have worsened the spread of zoonotic diseases due to the increasing proximity between animals and the human population. According to estimates by WHO (2010), about 60 percent of infectious diseases and 70 percent of emerging infections among humans are zoonotic in nature.⁵ The recent outbreaks of H1N1, H5N1, Crimean Congo Haemorrhagic Fever (CCHF), Kysanur Forest Disease (KFD), Nipah, Zika and mpox are examples of these zoonotic outbreaks. KFD, which was first reported in India in the Shimoga district of Karnataka in 1957, has now spread across the Western Ghats from Karnataka to Goa, emerging as a disease of public health importance.⁶ CCHF has also caused concern, and outbreaks have been reported in Gujarat.⁷ Since 2018, Kerala has experienced Nipah virus (NiV) outbreaks with variable clinical manifestations ranging from acute encephalitis syndrome (AES) to acute respiratory distress syndrome (ARDS). In July and September 2024, two NiV outbreaks were reported from Malappuram, Kerala, with AES as the predominant clinical manifestation. The Pteropus bat serves as the natural host and constantly poses a threat to the human population due to spillover events.^{8,9}

The mpox is known as the largest orthopoxvirus infection since the elimination of smallpox. This virus was previously exclusive to West and Central African nations and caused endemic diseases in monkeys. It has recently been linked to human infections in non-endemic areas, including the United States (US) and more than 30 other countries.¹⁰ In India, 30 Mpox cases have been reported since WHO declared it a Public Health Emergency of International Concern (PHEIC) in 2022. These cases were reported from Kerala and Delhi.¹¹

The Impact of Climate Change on Emerging and Re-emerging Infections

Climate plays an important role in disease transmission as it favours the breeding and proliferation of disease vectors. When temperatures increase, mosquito larvae mature rapidly, and female mosquitoes digest blood faster, becoming active for the next feeding and subsequently increasing transmission potential. During extreme heat and drought conditions, rivers turn into pools and enable the breeding of *Anopheles culicifacies*, the primary vector of malaria. Excessive and erratic rainfall enhances mosquito breeding due to an increase in breeding habitats and suitable humidity. The temperature rise at higher altitudes makes hilly areas also prone to vector-borne diseases. An increase in dengue incidence in the last two decades has been linked to climate change, as there are around 100-400 million annual cases in more than 100 countries, according to WHO. India currently carries over one-third of the global dengue burden, with cases rising from around 28,000 in 2010 to 2,33,400 in 2024, according to the National Center for Vector Borne Diseases Control (NCVBDC). This reflects a growing threat to public health with all four serotypes circulating across the country.

Fig.1. The Rise of Dengue in India

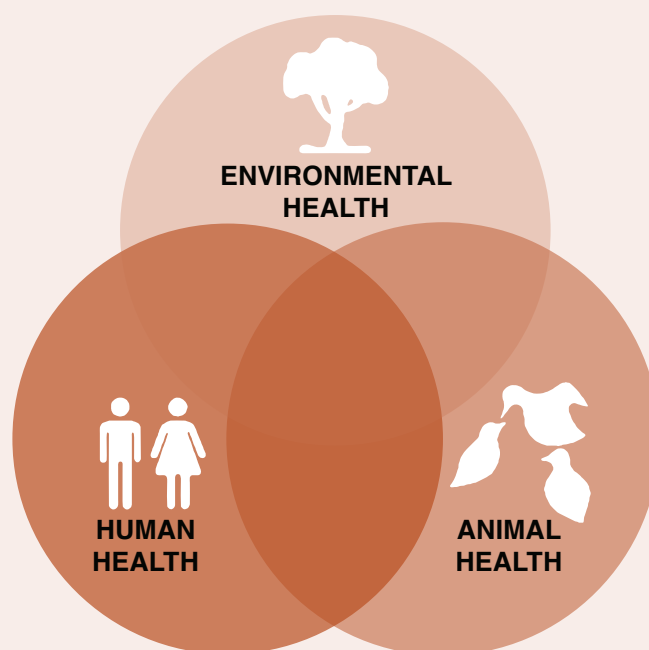
Scrub typhus and leptospirosis are also emerging and spreading rapidly, sometimes leading to complications like AES. A comprehensive and holistic approach with multiple-partner involvement and strong political will can strengthen disease management.¹²

‘One Health’, Emerging Threats, and Health Systems Preparedness

‘One Health’ is a concept that encompasses animal health, human health, and environmental health, understands their interconnectedness, and informs appropriate measures, as animals can be carriers of various pathogens. The Government of India has launched a National One Health Mission (NOHM) under the control of the Principal Scientific Advisor, in collaboration with 13 other ministries and departments. This will enable a holistic approach through interconnectedness, with a focus on capacity-building, strengthening surveillance, and finding innovative solutions through research and innovation. The National Institute of One Health (NIOH) is being established under the Indian Council of Medical Research (ICMR) at Nagpur to accelerate research. ‘Vishanu Yudh Abhyas’ (Virus War Exercise), a drill to increase pandemic preparedness, was conducted in Ajmer, Rajasthan, in August 2024. This led to the formation of a National Joint Outbreak Response Team that included experts from human health, animal husbandry, the wildlife

sectors, the state health department, and ministries under NOHM. This is a step in the direction of effectively addressing future outbreaks. The NITI Aayog has also prepared a framework for pandemic preparedness and emergency response that will help in making appropriate plans in times of crisis.¹³

Fig.2. The Interconnectedness Within the ‘One Health’ Concept



Source: https://en.wikipedia.org/wiki/One_Health

The Network of Virus Research, Diagnostic Laboratories, and Other Health Infrastructure

COVID-19 exposed the fault lines in India's existing health infrastructure. The ecosystem was equipped with only one lab, i.e., the National Institute of Virology (NIV) in Pune, which diagnosed COVID-19 and dealt with outbreaks, epidemics and pandemics in general. As the ICMR was already in the process of rolling out a network of Viral Research and Diagnostic Laboratories (VRDLs) across the country at regional, state and medical college levels, these existing labs were trained and strengthened to address COVID-19 and similar outbreaks. At the same time, other

private labs were handheld and strengthened through infrastructure and capacity building that helped increase the laboratory network from one to more than 3000 in less than a year. Today, there are more than 160 VRDLs across the country.

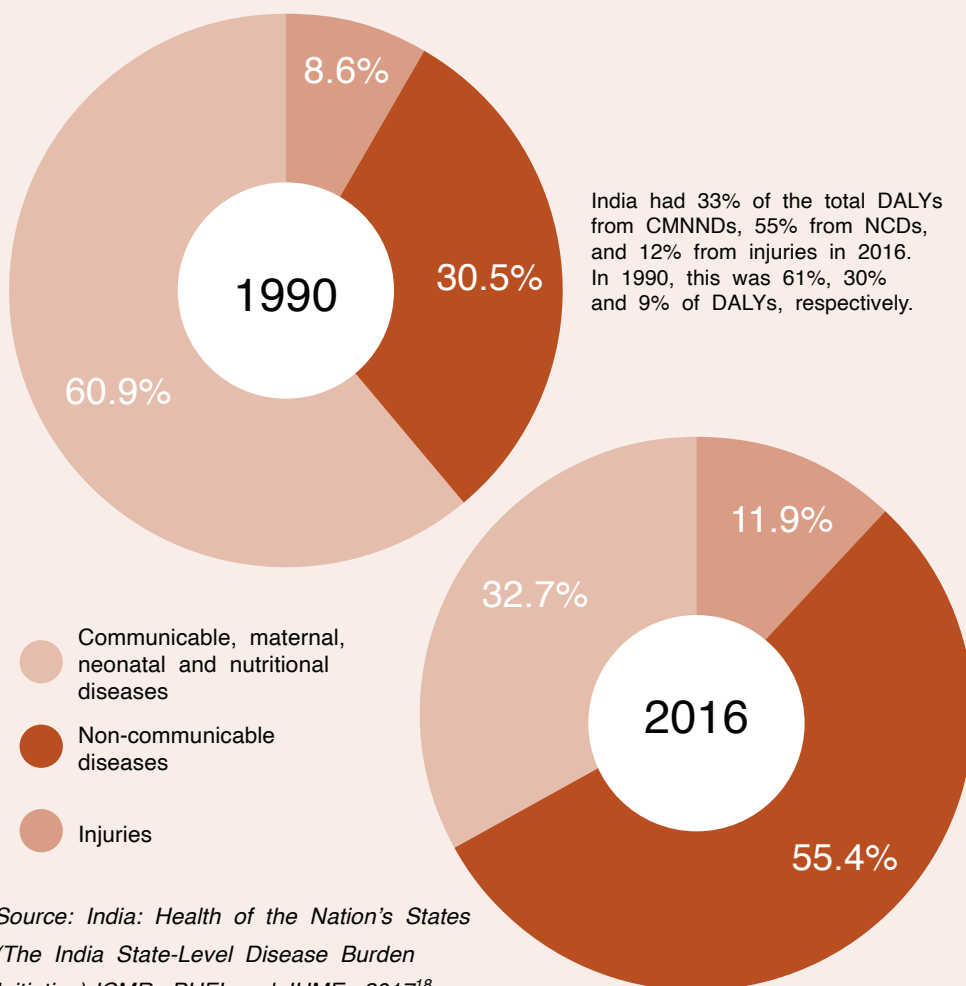
Additionally, four new NIVs are being set up at Dibrugarh, Jabalpur, Bangalore, and Jammu, along with NIOH at Nagpur under PM-ABHIM. These entities are expected to boost pandemic preparedness and nurture a robust health infrastructure for early diagnosis and prompt treatment. The Indian SARS-CoV2 Genomic Consortium (INSACOG), initiated by the Ministry of Health and Family Welfare, in partnership with the Department of Biotechnology (DBT) and the ICMR, is a consortium of 54 laboratories that monitor genomic variations.

RESEARCH (Regional Enabler for South-East Asia Research Collaboration for Health), a new platform designed to combat emerging and re-emerging infectious diseases and address cross-border infections, was launched by the ICMR in partnership with WHO and 10 countries in Southeast Asia.

Non-Communicable Diseases and Public Health Challenges

While India is strengthening its health infrastructure towards pandemic preparedness and combating infectious diseases in the post-COVID era, NCDs like cardiovascular diseases (CVD), diabetes, hypertension, chronic kidney disease (CKD), cancers, and mental health also require great attention.^{14,15} There is also a gradual but alarming shift of this trend from urban to rural areas. India has undergone a rapid demographic and epidemiological transition, with NCDs accounting for 61.8 percent of all deaths in 2016, surging from 37.9 percent in 1990.^{16,17}

Fig. 3. The Contribution of Disease Groups to Total Disability-Adjusted Life Years (DALYs) in India and the Shift from Infectious to NCDs



NCDs are now the leading cause of death in the country, contributing to 60 percent of all deaths.¹⁹ Four diseases, viz., heart disease, cancer, diabetes, and chronic pulmonary diseases, contribute to nearly 80 percent of all deaths and share four common risk factors: tobacco use, harmful use of alcohol, unhealthy diet, lack of physical activities leading to obesity, elevated blood pressure, heightened blood glucose levels, and increased blood cholesterol levels.^{20,21} Between 2001 and 2019, India witnessed 37.6 million premature deaths due to four NCDs, with 59.3 percent

occurring in males and 40.7 percent in females. Cardiovascular disease accounted for the highest proportion of deaths at 59.3 percent, followed by cancer (19.6 percent), chronic respiratory disease (15.5 percent), and diabetes (5.6 percent).²²

According to WHO, there are an estimated 20 crore adults in India with hypertension, of whom approximately two crore have it under control.²³ The Government of India adopted the '25 by 25' goal—aiming to reduce the incidence of premature mortality from NCDs, including hypertension, by 25 percent by 2025.²⁴ The ICMR, in partnership with the Ministry of Health and Family Welfare, WHO-India, and state governments, launched the India Hypertension Control Initiative (IHCI) in 2018-19 in 26 districts across five States in Phase 1. The initiative sought to understand the disease burden and advise on preventive measures. Currently, it has been expanded to 141 districts of 25 states, covering a population of 303 million.²⁵

India is struggling with the increasing incidence of diabetes, with 41 million patients, and around 20 million more being overweight and obese, and thus susceptible to developing the disease.²⁶ The InDIAB study initiated by the ICMR helps assess the burden of diabetics and pre-diabetics in the country, and the National Cancer Registry Program launched in 1982 helps in understanding the cancer burden and the most crucial risk factors, and guides patients with the appropriate measures.

India's elderly population is growing fast and is projected to touch 340 million by 2050 (19.1 percent).²⁷ This demographic shift increases vulnerability to disabilities, chronic diseases, and multimorbidity, placing pressure on healthcare systems and resources. More than one in two older adults ages ≥ 45 years in India without an established history of diabetes or hypertension have four or more NCD-related risk factors.²⁸ There is a need for tailored interventions, including lifestyle modifications, coupled with comprehensive health education programmes to increase knowledge about risk factors to limit the growing burden of NCDs.^{29,30} The prevalence of common mental disorders like depressive and anxiety disorders was found to be 5.1 percent, with a treatment gap of 80.4 percent.³¹ Community participation in mental healthcare is a pivotal strategy.

The National Programme for Prevention and Control of Non-Communicable Diseases under the National Health Mission works with the state governments for the prevention and management of NCDs. It focuses on strengthening infrastructure, human resource development, early diagnosis, referral to an appropriate healthcare facility for treatment, and health promotion and awareness for the prevention of NCDs.

India is committed to achieving Sustainable Development Goal-3 (SDG-3), which looks to ensure healthy lives. It is also promoting well-being in line with the vision of 'Viksit Bharat 2047'. The time is ripe for accelerating efforts to ensure multi-institutional partnerships, promote medical innovations, community engagement and empowerment to achieve this goal. Strengthening the primary healthcare infrastructure and achieving universal health coverage will be a crucial step in this regard. There is also a need for robust, data-driven decision-making with stringent surveillance, utilising artificial intelligence (AI), digital health, reducing rural-urban health disparities, and enhancing access to healthcare.

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The Role of India's Private Sector in India's UHC Journey

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Abstract

India's path towards Universal Health Coverage (UHC) is impeded by persistent gaps in the healthcare infrastructure, inter-regional disparities in the workforce, and unequal access across its vast and diverse population. Despite government initiatives like the National Health Mission and the Pradhan Mantri Swasthya Suraksha Yojana, a scarcity of trained healthcare workers continues to impede progress. With the private sector delivering nearly 70 percent of outpatient and 60 percent of inpatient care, there is a growing need for structured public-private partnership (PPP) models. This article proposes a framework anchored in an Ease of Doing Business in Healthcare (EoDBH) approach to strengthen partnerships for UHC.

Drawing on lessons from telemedicine, workers training, and MedTech innovation, it outlines recommendations in the following domains: enhancing access, regulation, and last-mile delivery; lowering costs; and developing a qualified workforce. This would allow India to turn its PPPs into long-term agents of equity, resilience, and innovation by capitalising on a diversified private sector.

Introduction

India's healthcare delivery is met with many challenges while attempting to address the varied demands of a 1.4 billion-strong population dispersed across geographies and socio-economic classes. The health system is under strain due to a shortage of healthcare workers and state-level inequalities in their availability, which detracts from the vision of achieving Universal Health Coverage (UHC) by 2030.¹ Healthcare is a state subject, and this adds another layer of complexity, creating multiple regulatory variations and impacts across different states.²

At present, gaps in healthcare delivery are exacerbated by the unequal distribution of both physical and digital infrastructure, as well as a persistent shortage of HCWs across the healthcare pipeline—from doctors and nurses to allied healthcare professionals—largely due to the immense demand created by India's demographically diverse population.

Despite having the largest number of medical colleges globally, India has one of the lowest medical graduates per capita, with a meagre 4.1 graduates per 100,000 of the population.³ This is starkly different from the larger global imperative, where there is a shortage of approximately 2.3 million doctors, nurses, and midwives across 57 countries.⁴ In India, the supply-demand gap remains acute, with a shortfall of some 137,559 doctors and 1.37 million nurses and midwives.⁵ Although rural India is home to almost 65 percent of the population, it has fewer than 20 percent of the nation's doctors. Cities, with 35 percent of the nation's population, have more than 80 percent of the doctors.⁶ Even within the public healthcare system, there are regional inequalities in the supply of HCWs.

Over the last few years, the government has implemented steps towards strengthening the physical infrastructure under the Pradhan Mantri Swasthya Suraksha Yojana (PMSSY) and has made a concerted effort to address the HCW shortages under the National Health Mission (NHM).⁷ Skill enhancement programmes have been implemented through the National Skill Development

Corporation's (NSDC) Healthcare Sector Skill Council.⁸ The public sector has also seen a notable increase in undergraduate and postgraduate medical seats, with new medical colleges being commissioned in a number of states to enhance regional access to trained practitioners.⁹

India's private sector accounts for nearly 70 percent of outpatient care and 60 percent of inpatient care.¹⁰ However, addressing the challenge of building a well-trained and skilled healthcare workforce requires the collective efforts of both the public and private sectors. Tackling this shortage must be a priority, and a more structured Public-Private Partnership (PPP) model is essential to drive investments, promote Research and Development (R&D), deploy digital tools, and monitor outcomes.

The Role of PPPs in Healthcare and Training

PPPs in healthcare could emerge as a viable mechanism that aligns varied interests towards the goal of achieving UHC. Healthcare requires a focused programme along the lines of an Ease of Doing Business (EoDB) mechanism that can provide the impetus to boost economic activity and promote investments across different sectors of the economy.¹¹ This article proposes the framework of Ease of Doing Business in Healthcare (EoDBH). At its core, EoDBH would acknowledge the critical role of the private sector in PPPs by facilitating improved access, enhancing operational efficiency, and reducing costs across the healthcare delivery spectrum. It could help develop partnerships that not only promote the adoption of new digital tools but also equip human HCWs to train and upskill in new technology.

Under the Ayushman Bharat Digital Mission (ABDM), such collaborations with the private sector have started with the digitisation of healthcare records. Along with Pradhan Mantri Jan Arogya Yojana (PMJAY), these initiatives have enhanced private sector partnerships, improving access for millions.¹² Innovative technologies have also accelerated the adoption of digital healthcare delivery as well as training tools since the COVID-19 pandemic. Partnership opportunities in digital dispensaries and mobile medical units (MMUs) are one of the encouraging outcomes. These are often operated by private hospitals with government support and have been able to address healthcare gaps in underserved areas. Private players have such partnerships across states: with the Government of Andhra Pradesh for Electronic Urban Primary Health Centres (E-UPHCs) and e-Eye Kendrams, the Government

of Uttar Pradesh for tele-radiology services, the Government of Jharkhand for digital dispensaries, and specialised telemedicine initiatives in high-altitude regions of the Himalayas.¹³ The human resources that power these technologies in Primary Healthcare Centres (PHCs) and MMUs, or first points of contact with communities in Common Service Centres (CCSCs), have to be continuously trained and upskilled.

Operational Lessons for India's Healthcare PPPs

PPPs have demonstrated diverse operational strengths across India's healthcare ecosystem. The National Family Health Survey (NFHS-5, 2019-21) highlights that 50 percent of respondents do not typically use government health facilities, preferring private care due to concerns around quality, waiting times, and service availability.^{14,15} While government involvement enhances credibility, PPPs must also prioritise continuous availability of skilled HCWs and community engagement to maintain public trust.

PPPs could help drive cost efficiency in healthcare by utilising economies of scale, operational expertise, and technological advancements. The success of eSanjeevani demonstrates how technology in PPPs has been able to provide scale and impact.¹⁶ Similarly, digital dispensaries in Madhya Pradesh, operated by trained HCWs through a Corporate Social Responsibility (CSR)–state government collaboration, have delivered affordable primary care, reducing the cost of care from US\$12 to US\$8 per person annually, under the World Economic Forum's One Billion Lives challenge.^{a,17,18}

India is also emerging as a global leader, delivering high-quality clinical outcomes at a fraction of the cost compared to other nations.¹⁹ India's health sector excels in cost-effective specialties like cardiology, oncology, orthopaedics, and organ transplants. India performs around 18,000 transplants annually but remains behind several high-income countries in transplantation rates.²⁰ Cross-subsidised PPP models can help bridge these gaps and expand access to life-saving treatments. In a rapidly evolving technological landscape, PPPs also enable critical workforce development. Private institutions, often in partnership with the government, are advancing Artificial Intelligence (AI)-driven diagnostics, robotics, and simulation-

^a The World Economic Forum's EDISON Alliance: One Billion Lives Challenge is an international effort to trigger digital inclusion by making digital goods widely available and affordable for one billion individuals in health, education, and finance by 2025. The Alliance, started in 2021, convenes public and private sector leaders committed to co-creating and scaling collaborative solutions that bridge the digital gap, particularly for underserved and low-income communities.

based medical training. These efforts would equip HCWs with future-ready skills.²¹ According to industry estimates, digital health programmes have the capability to trigger national-level savings of approximately US\$5 billion annually through the prevention of complications, improved drug compliance, and efficient resource deployment.²² The future of healthcare will extend beyond traditional ‘brick-and-mortar’ hospitals, and rely on multi-skilled, digitally fluent workforces ready to adapt to emerging health challenges.

On the insurance front, the AB PMJAY, covering over 500 million people, exemplifies the success of PPPs in expanding insurance coverage.²³ By engaging private insurers and providers, the scheme has scaled access to cashless, quality healthcare. Andhra Pradesh’s Arogya Raksha scheme is another example, where partnership with insurance companies and private clinics has enabled cashless treatment through a network of government and corporate hospitals.²⁴ By leveraging the private sector’s expertise, an inclusive health insurance process can be created to extend coverage to the missing middle in Tier II and Tier III cities.²⁵

India’s R&D efforts in healthcare, particularly in pharmaceuticals, vaccines, and Medtech, stand to gain from PPPs. Initiatives such as ‘Vaccine Maitri’ have demonstrated India’s ability to drive large-scale healthcare collaborations.²⁶ For this purpose, facilitating policies like the National Medical Devices Policy 2023 and the Promotion of Research and Innovation in the Pharma-MedTech Sector (PRIP) Scheme can play an important role.^{27,28}

Overcoming Challenges in Implementing Healthcare PPPs

To build successful PPPs, expectations of stakeholders have to be aligned with an aim to achieve access, affordability, efficiency and quality. Often the biggest stumbling block is the misalignment of objectives, such as prioritising financial returns over equitable access and affordability. Once the intent to work on the same outcome is established, it becomes easier to overcome differences and conduct course-corrections. In resource-constrained settings, as revealed by the success of digital dispensaries, alternative funding, like CSR contributions, projects with international agencies and impact investments, could help form “blended funding” that prioritises social returns and impact.

An EoDBH approach can enhance PPPs in healthcare by providing an enabling environment for private investment and innovation. For instance, fiscal incentives such as offering Goods and Services Tax (GST) exemptions, accelerated

depreciation on medical equipment, and simplified tax regimes can lower costs even with longer than usual gestation periods. Faster onboarding and streamlined approvals can further reduce costs and delays.²⁹ There are also successful PPPs that demonstrate how EoDB principles have facilitated and nurtured. The Himachal Pradesh Telehealth Services (HP-THS) programme, India's first, was started in 2015 and is leveraging a tie-up between a private provider and the Himachal Pradesh state government to offer emergency and speciality consultations to rural, high-altitude towns.³⁰

A more competitive bidding process that gives due weightage to the technical component will also attract more efficient private sector delivery providers and eventually make the PPPs more trustworthy and affordable. Incorporating clear accountability mechanisms in contracts and monitoring systems is also important to facilitate transparency, quality service delivery, and adherence to targeted outcomes, thereby making the partnerships more reliable in the long run.

Pathways to Enhancing PPPs

In India, OOP (Out-of-Pocket) expenses comprise over 39.4 percent of total health spending, and public health expenditure is approximately 1.9 percent of Gross Domestic Product (GDP). The pathways to achieving sustainable models of PPPs in healthcare need more work and streamlining.^{31,32} An EoDBH framework approach, tailored specifically to the healthcare sector, can serve as a guiding architecture to ensure that private sector involvement is not just reactive but transparent and equitable.

1. **Streamlining Access:** The healthcare investment environment in India is highly fragmented, with several layers of state and central clearances required for land acquisition, environmental clearances, and the licencing of facilities. These hurdles cause project delays. The launch of a one-window clearance system specific to healthcare PPPs based on the model of the Invest India portal or the EoDB model for industry can cut through red tape, enable quicker onboarding, and encourage greater private sector action in Tier II and Tier III cities. Simplification of access, however, needs to go from physical infrastructure to outcome-based payment systems that shift financial incentives from the quantity of services delivered to the quality and effectiveness of the services.

2. **Driving Affordability:** To incentivise private investment in low-revenue and resource-poor geographies, the government will need to provide tailor-made fiscal incentives and performance-based payment arrangements. These can include GST relief on high-end medical equipment and services, depreciation allowances, and providing subsidies to verifiable improvements in health outcomes, like decreases in disease prevalence, increased immunisation coverage, or effective control of non-communicable diseases.
3. **Strengthening Governance:** PPP governing models should prioritise transparency, accountability, and evidence-based monitoring. This can be facilitated through the real-time digitisation of monitoring systems to assess the quality of service delivery and healthcare outcomes within facilities. Also, the use of biennial third-party audits can ensure that system bottlenecks are identified, performance measures are monitored, and the appropriate corrective action is taken promptly. This would not only enhance public trust but also ensure that partnerships remain on track with planned standards of care.
4. **Expanding Last-Mile Delivery:** Scaling last-mile delivery must be the primary consideration of PPP planning. The scalability of such partnerships is typically hampered by factors like overextended physical infrastructure, disintegrated data systems, and logistical challenges in remote and underserved localities. However, through strategic government intervention, like providing digital infrastructures, transport networks, and policy support, most PPP models can be scaled to successfully provide affordable healthcare to the poor.
5. **Advancing Workforce Training:** PPPs should be at the centre of driving healthcare workforce training by embracing international best practices and regularly revising training modules in response to changing needs. All these should be phased in along with supply-demand gaps projected for regions and cadres, and funded by dedicated mechanisms with a long-term focus on capacity enhancement instead of quick fixes. Aside from inclusiveness, flexibility of the training systems is of primary importance, especially in crises like climate-sensitive diseases, misuse of digital health technologies, and impending dangers from disease or zoonotic pandemics. Creating a nationwide digital dashboard to monitor PPP-nurtured training programmes, capturing progress, pinpointing gaps, and recognising areas of excellence would help India build its in-country healthcare delivery capabilities.

Despite the initial success of many PPP projects, the massive potential of the model is yet to be harnessed. With the twin handicap of low public health spending and high OOP, there is a need for an institutionalised and overarching PPP framework. India's diverse private sector must also play its part in uplifting the country's ranking on the global health table through programmes like Heal in India and the Medical Value Travel (MVT) programme.³³ These measures can make India a preferred destination for medical tourism, synonymous with quality and cost-effective care. This is also being supplemented by private sector contributions to medical education led by the Diplomate of National Board (DNB) courses and super-speciality training, which address manpower deficits in public healthcare facilities.³⁴

To leverage such potential, PPPs would have to go beyond infrastructure and service delivery to build human capital, health innovation, and elevate India's global health profile. Institutional backing, funding based on output, transparent government, and flexible regulation would be the drivers in scaling up such partnerships. This way, India can enhance its resilience in the health system, attain higher equity in the availability of services, and become the reference point as a global health provider and talent source.

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Scaling Health Tech Across the Urban–Rural Landscape: Infrastructure, Investment, and Inclusive Partnerships

Sameer Kanwar

Abstract

Technology in healthcare is becoming indispensable to effective service delivery. Successful deployment of digital health technologies requires a prepared health system—physically, digitally, and supported by strategic investment, inclusive public–private partnerships, and actionable policy frameworks. In India, large-scale digital health implementations such as during the 2024 Kumbh Mela have demonstrated how innovative technologies enhance real-time crowd management, disease surveillance, and clinical decision-making in complex, high-pressure environments. Yet, embedding these functions into the routine public health system, primarily in rural and underserved areas, remains a challenge. This chapter explores this and other challenges,

highlights lessons from successful deployments, and outlines best practices to advance inclusive digital health transformation at scale.

Introduction

Emerging technologies such as artificial intelligence (AI) and the Internet of Things (IoT) are witnessing accelerated adoption across socio-economic and geographic contexts in both developed and developing countries. These innovations can enhance productivity, improve operational efficiency, reduce costs, and support evidence-based decision-making.¹ To realise their full societal value, their transformative potential must be strategically directed toward public welfare sectors such as healthcare.

The 2024 edition of India's largest mass gathering, the *Kumbh Mela*,² served as a testbed for advanced technologies aimed at improving public service delivery, particularly in logistics and healthcare. AI-powered surveillance systems monitored crowd density in real time, while IoT sensors tracked the use of sanitation facilities, enabling efficient resource allocation and maintenance of hygiene standards. Predictive analytics supported crowd and traffic management, equipping authorities with actionable insights to respond proactively to evolving situations.

In the health sector, a temporary central hospital facilitated large-scale screenings for non-communicable diseases, tuberculosis, and vision-related conditions using AI-enabled diagnostic tools. This real-time application of AI in a high-density environment highlighted its potential to strengthen disease surveillance, support early detection, predict outbreaks, and enable timely clinical intervention.³

Similar technology-driven efforts have been observed in other mass gatherings, such as the *Char Dham Yatra*, where government collaboration with non-profits led to the development of accessible primary healthcare systems for pilgrims and local populations. These interventions underscore the transformative role of digital tools in delivering high-quality healthcare under challenging conditions.⁴

However, the success of such initiatives in high-stakes, time-bound events—with dedicated resources and well-coordinated management—does not automatically translate to routine healthcare settings. Broader integration of these technologies into everyday public health systems remains limited, highlighting a critical implementation gap that must be addressed to realise their full potential.

The deployment and scaling of technology-driven innovations are most critically needed in rural and remote regions, where vulnerable populations face persistent barriers to affordable, adequate healthcare. Paradoxically, these are also the most challenging regions for implementation. Geographic isolation, socio-economic marginalisation, and demographic disparities hinder digital healthcare delivery. These challenges are further compounded by poor physical and digital infrastructure. Deficiencies such as unreliable electricity supply, insufficient backup systems, limited availability of IT hardware, poor internet connectivity, and low digital literacy collectively undermine the integration of technology into local health systems.

Overcoming these systemic deficits is fundamental to ensuring that technological interventions serve the communities that stand to benefit most. However, infrastructure alone is not sufficient; it is imperative to shift from fragmented, short-term pilot initiatives—often described as ‘graveyard of pilots’—to the systematic mainstreaming of digital solutions into existing clinical and administrative workflows. These technologies must be embedded not as adjunct tools, but as core enablers, shaped by contextual realities and actual health system needs. The objective is not to impose innovation where it offers little value, but to apply it strategically where it can bridge service delivery gaps and substantively improve care quality.⁵

Towards ‘Digital India’

India’s digital infrastructure has expanded rapidly, with internet subscribers reaching 971.5 million. Rural users now constitute 55 percent of active internet users, with 46 percent being female, signalling a narrowing gender gap in digital access for digitally excluded populations.⁶

Smartphone penetration is a key driver of this transformation. As of early 2025, India had 700 million smartphone users, a number expected to surpass 1 billion by year-end,⁷ making it the world’s second largest smartphone market. In rural areas, smartphone ownership has surged, with penetration doubling from 36 percent in 2018 to 74.8 percent in 2022.⁸

According to the Annual Status of Education Report (ASER) 2022,⁹ around 88 percent of households have smartphones and internet connectivity.¹⁰ This rapid expansion, fuelled by increasing internet adoption, is accelerating the uptake of teleconsultations, e-pharmacy, and health-related applications, placing rural India at the forefront of the global digital revolution.

India's mobile network expansion has been dramatic. By late 2024, 95.6 percent of villages had 4G coverage, and 5G rollout was underway in 779 of 806 districts—marking the world's fastest 5G deployment. Mobile broadband speeds surged from 1.3 Mbps in 2014 to ~95.7 Mbps, while data costs fell by over 95 percent (from INR269/GB to INR9/GB), making e-health services more affordable.¹¹

While smartphone and connectivity has improved, digital literacy^a in India remains uneven, with only 38 percent of households considered digitally literate. Urban areas fare better, with 61 percent digital literacy, compared to 25 percent in rural regions.¹²

The BharatNet programme, the world's largest rural broadband initiative launched in 2011, has connected 214,000+ Gram Panchayats using optical fibre, radio, and satellite technologies. This has enabled digital classrooms and telehealth services, improving access to medical expertise in remote villages.¹³

Common Service Centres (CSCs) serve as decentralised hubs for essential services, including healthcare, finance, and education. Thousands of CSCs, run by village entrepreneurs, now host telemedicine consultations and health kiosks, leveraging BharatNet connectivity to link rural patients with remote doctors. For remote or disaster-prone areas, India has piloted satellite-linked telemedicine, building on ISRO's programme to connect far-flung clinics with speciality hospitals.¹⁴ Over 100 hospitals—including 78 in rural areas—have been connected to urban specialty centres, enabling more than 25,000 consultations. This initiative proved vital during disasters like the 2004 tsunami, while also reducing patient costs by up to 81 percent in some regions through reduced travel.¹⁵

Edge computing^{b,16} and offline-capable health apps are emerging as game changers, enabling AI-powered diagnostics to run locally on smartphones or IoT devices. These reduce dependence on continuous internet while preserving patient data privacy.¹⁷

^a If at least one person in the household has the ability to operate a computer and use the internet (among individuals who are 5 years of age and older), they are defined as a 'Digitally Literate Household'.

^b Edge computing allows devices in remote locations to process data at the "edge" of the network, either by the device or a local server. And when data needs to be processed in the central data centre, only the most important data is transmitted, thereby minimising latency.

Reliable power infrastructure and energy-efficient devices, such as low-power IoT sensors with long battery life or solar-powered alternatives, can minimise reliance on grid electricity, ensuring sustainable and continuous digital operations.

India's push for government-owned cloud infrastructure and empanelled Cloud Service Providers¹⁸ (CSPs)^c further supports digital health solutions by enabling secure, cost-effective hosting while reducing reliance on physical data centres. While upcoming 5G use-cases with ultra-high bandwidth and low latency such as real-time telerobotic surgery and remote ICU monitoring—promise to transform specialist care access for rural patients.

With India's AI healthcare market projected to reach US\$17.75 billion by 2032—growing at a compound annual growth rate of 40.5 percent—and estimates suggesting that AI adoption could boost the region's GDP by 13 to 18 percent (nearly US\$1 trillion),¹⁹ it is imperative to channel this momentum toward purposeful innovation.

Data is the foundation for AI and IoT-enabled health solutions, driving their effectiveness in real-world settings. To scale these technologies across a vast country like India, robust mechanisms are needed to develop national health data lakes that ensure high-quality, diverse, and context-specific data collection, annotation, secure sharing (where appropriate), and efficient analysis. A well-structured public health digitisation framework should prioritise safe, unbiased data capture and guide the use of emerging technologies at each level of care. Together, these efforts will augment sustainable, ecosystem-driven approach to digitisation.

It Takes Two to Tango: Policy and Strategic Financial Investment

Policy Environment as a Lever for Scale

As India upgrades its digital infrastructure—particularly within the health sector—it is increasingly clear that technology alone cannot close the healthcare divide. Bridging this gap requires an enabling policy environment, targeted funding, and

^c MeitY embarked on MeghRaj cloud initiative to harness the benefits of Cloud Computing and accelerate delivery of e-services. MeitY undertakes empanelment of Cloud Service Offerings of the Cloud Service Providers (CSPs) that includes compliance to the empanelment requirements followed by an audit.

partnerships. In recent years, India has recognised this need and has been building its digital health governance prowess accordingly.

A key development was the Indian Council of Medical Research's (ICMR) release of the *Ethical Guidelines for AI in Healthcare in 2023*.²⁰ These guidelines articulate 10 patient-centric principles, emphasising transparency, informed consent, and human oversight in AI-enabled healthcare decisions. While not legally binding, they offer a reference framework for ethics committees and innovators, signalling India's intent to advance responsible AI.

Regulatory mechanisms have also expanded. The 2020 amendment to the Medical Device Rules brought IoT-enabled devices and AI-based diagnostic tools under the purview of the Central Drugs Standard Control Organisation (CDSCO).²¹ These technologies must now be certified as Software as a Medical Device (SaMD), ensuring that safety and efficacy standards are upheld.

Complementing this, the Digital Personal Data Protection (DPDP) Act²²—India's primary data privacy legislation—provides a legal framework to safeguard personal data, including sensitive health information.

In parallel, the Ayushman Bharat Digital Mission (ABDM)²³ is laying the groundwork for a unified digital health ecosystem, integrating health IDs, electronic medical records, and registries across both public and private sectors. By establishing health data standards and consent protocols, ABDM creates the foundational architecture necessary for scaling AI and IoT solutions responsibly.

The India AI Mission,²⁴ under the Ministry of Electronics and Information Technology (MeitY), has recognised safe and trusted AI as a national priority. Although a dedicated healthcare AI policy has yet to be formalised, ongoing discussions are exploring the establishment of regulatory sandboxes²⁵—controlled environments where developers can test AI innovations in real-world settings, while ensuring regulatory oversight to maintain safety, fairness, and accountability. Future regulatory instruments are being considered, such as an Indian Medical AI Act or AI-specific provisions within biomedical device regulations, which would govern registration, certification, and clinical validation benchmarks.

As digital regulatory and governance frameworks evolve, a key challenge is balancing soft law mechanisms—such as voluntary guidelines and frameworks—with enforceable regulations that ensure the ethical deployment of emerging

technologies. Accelerating adoption requires proactive leadership to translate policy into concrete action.

A pivotal step towards this goal would be the establishment, or designation, of a dedicated regulatory authority²⁶ focused exclusively on digital health. Currently, multiple institutions—including the Ministry of Health and Family Welfare’s e-health division, the National Health Authority,²⁷ the Indian Council of Medical Research (ICMR), and civil society think tanks, contribute to digital health initiatives. However, their efforts often remain fragmented, hindered by limited demand generation, weak inter-agency coordination, and inadequate budgetary allocations, undermining cohesive implementation and diluting accountability.

In contrast, sectors such as FinTech and Telecom have demonstrated disruptive progress—enabled by strong regulatory institutions like the Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), and Telecom Regulatory Authority of India (TRAI), which have shaped policy, managed multi-stakeholder ecosystems, and ushered in sector-wide reforms.

In the complex domain of digital health, the establishment of a dedicated regulatory authority can accelerate responsible digital transformation. Such a body could offer directives on compliance and certification norms, define and enforce interoperability standards, and support ethical integration of emerging technologies like AI and IoT, thus demonstrating institutional convergence.

Adopting a Strategic Outlook for Financial Investments

Beyond desirability and technical feasibility, financial viability is essential in developing economies to ensure that the opportunity cost of health is justified and that deployment offers a justified return on investment for scaling these forward-looking solutions. While national programmes like the India AI Mission and Ayushman Bharat Digital Mission (ABDM) are driving digitisation through central funding, private sector investment and international development assistance are also contributing to a paradigm shift in leapfrogging innovation. Government-led initiatives such as the Biotechnology Industry Research Assistance Council (BIRAC), the Centre for Cellular and Molecular Platform (C-CAMP), private venture capital, and startup challenges provide incubation, mentorship, and grant access to early-stage health innovators.

The expansion of financing avenues is beginning to align with the growing appetite for healthcare innovation, gradually narrowing funding gaps across India. However, a critical challenge remains: funding patterns continue to be predominantly reactive, shaped more by prevailing market trends than by a strategic alignment with the country's most pressing public health priorities.

For instance, India continues to face a high burden of undetected tuberculosis, with an estimated 40–50 percent of cases being asymptomatic.²⁸ AI-powered tools like Qure.ai's QXR, already deployed in both the public and private health sectors, could be systematically leveraged under the National Tuberculosis Elimination Programme, (RNTCP, renamed as NTEP in 2020)²⁹ to detect subclinical cases through chest X-rays, especially in underserved or high-burden regions.^{30,31}

Similarly, addressing maternal and infant mortality—often driven by the delayed diagnosis of high-risk pregnancies—requires the deployment of innovative AI-enabled solutions capable of functioning effectively in remote settings. Portable fetal and maternal monitoring devices, such as DotoHealth's Fetosense³² and Janitri's Keyar,³³ demonstrate the potential to facilitate early detection, risk stratification, and timely referral. However, such technologies must not be confined to isolated or opportunistic deployments. Instead, their integration must form part of a coordinated, system-wide strategy anchored in public health priorities and aimed at delivering measurable outcomes at scale.

To ensure justified scale-up of emerging digital health technologies, there is a need for rigorous evidence generation. This includes systematic assessments of effectiveness, cost-efficiency, and measurable improvements in health outcomes through health technology assessments (HTAs), economic evaluations, and robust monitoring and learning frameworks. Such evidence not only strengthens policymaking and builds trust among stakeholders but also plays a pivotal role in attracting investment. A dedicated team should be tasked to evaluate outcomes, quantify impact, and disseminate findings through academic publications, policy briefs, and impact reports.

Forging Partnerships to Build Better Together

While government-led financial investments remain foundational, the involvement of the private sector in piloting and scaling digital health interventions highlights the need for purposeful partnerships. Cross-domain collaboration is essential to mobilise complementary resources and therefore accelerate sustainable innovation.

State-led digital health initiatives, such as Telangana's *Medicine from the Sky* drone project³⁴ and the 10-bed ICU model across southern and northeastern states,³⁵ highlight how state governments are driving innovation—often in partnership with startups and private hospitals. The Centre for Excellence in Healthcare,³⁶ launched by the All India Institute of Medical Sciences (AIIMS) and the Indian Institute of Technology (IIT), Delhi, further reflects the Centre's focus on advancing AI-driven solutions in medical research and care.

From supporting AI-driven health start-ups through initiatives such as the AI and Robotics Technology Park (ARTPARK) at the Indian Institute of Science to large-scale collaborations like the partnership between Apollo Hospitals, the Government of Meghalaya, and the World Economic Forum (WEF) to deploy AI for cancer care in the Northeast region, these efforts demonstrate the strategic alignment of technological expertise with pressing public health needs.³⁷ In such models, technology innovators contribute advanced solutions and technical know-how, while governments enable access to health data, provide regulatory and infrastructural support, and facilitate scale. Together, they co-create contextually relevant interventions that can transform healthcare delivery, particularly in underserved and resource-constrained regions.

While various stakeholders—academia, researchers, technologists, government institutions, and innovators—are advancing efforts to make AI in India and India ready for AI, each actor operates in their own echo chambers. To move forward efficiently, the notion of singularity must be challenged. Policymakers, technologists, and industry leaders should build shared knowledge and resources that benefit everyone. Each stakeholder often operates within their own echo chamber, limiting opportunities for collective learning and synergy. A concerted push towards building shared repositories of knowledge, interoperable tools, and collaborative platforms, anchored in mutual benefit and public interest—will be key to fostering an inclusive health technology ecosystem.

A notable global example is WHO's Global Initiative on Artificial Intelligence for Health (GI-AI4H),³⁸ initiated in 2023, which focuses on pillars such as enabling standards, governance, and evidence-based policy guidance for AI in health (AI4H), and facilitating pooled investments and cultivating a global community of experts. India can incorporate similar principles while institutionalising consortiums to fast-track the adoption of emerging health technologies.

The success of AI and IoT technologies in healthcare depends on acceptance by service providers and citizens. This requires a strong focus on change management, digital literacy, and targeted communication strategies that clearly convey the tangible benefits these technologies offer to different sections.

For the healthcare workforce, these technologies can automate manual hospital operations, reduce administrative workload—freeing up time for patient-centred clinical tasks—and streamline processes related to diagnosis, referrals, and treatment. For instance, AI-powered ambient listening technologies have been shown to reduce physicians' documentation time by up to 30 percent, thereby enhancing clinical productivity.³⁹

For citizens, these innovations translate to more accessible, affordable, and timely healthcare—potentially even from the comfort of their homes. However, despite these advantages, resistance to change, lack of familiarity with digital tools, and concerns about data security remain. Overcoming these barriers necessitates adaptive capacity-building approaches tailored to different user groups. Personalised training programmes and hands-on demonstrations can enhance the digital competencies of healthcare providers, equipping them with the confidence and skills needed to integrate these technologies into their workflows.

While efforts to bridge the digital divide and improve access to emerging technologies continue, it is equally important to acknowledge the growing risks associated with unsupervised self-diagnosis and self-treatment. In India, a survey has found that approximately 52 percent of Indians self-medicate,⁴⁰ which drives antimicrobial resistance and places additional pressure on the healthcare system. The widespread availability of self-screening devices and treatment support technologies—coupled with weak regulations—exacerbates this issue. As digital health tools become more accessible, it is imperative to implement robust safeguards, including stricter regulations, public awareness campaigns, and clearer usage guidelines to prevent misuse and ensure patient safety.

Conclusion

Scaling AI- and IoT-enabled health technologies across India's rural and urban settings requires more than technological solutions; it calls for systematic transformation. By harnessing digital progress, fostering cross-sector partnerships, and aligning supportive policies, India can drive sustainable health innovation. A holistic approach—centred on interoperability, data security, financial viability, and inclusion—is essential. With the right enablers, India's experience can offer a replicable model, demonstrating how thoughtfully applied technology can bridge health inequities globally.

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II

A Life–Course Approach to Nutrition and Health

A Five-Fold Strategy for Breaking the Intergenerational Cycle of Maternal and Child Malnutrition in India

Suparna Ghosh-Jerath and Ridhima Kapoor

Abstract

India continues to struggle with widespread maternal and childhood malnutrition, whose detrimental effects are multi-fold and lead to high risk of mortality and weakened human capital. The imperative is to create multidisciplinary strategies addressing the fundamental causes of malnutrition, including: 1) life-course approach to break intergenerational cycle of malnutrition, with focus on early nutrition and timely mid-course correction of existing interventions; 2) using cross-sectoral approach involving multiple stakeholders, like policymakers, nutritionists, food industry representatives, non-government organisations, and consumer bodies; 3) investments in nutrition-specific and nutrition-sensitive interventions for

higher dividends; 4) incorporating social equity lens to strengthen existing nutrition interventions; and 5) implementation of double-duty actions. Such an approach may potentially shift focus towards underlying determinants of malnutrition, build convergence across different sectors, and widen the scope of existing programmes and policies. With the proposed approach, fair, equitable, and sustainable access to nutritious diets can be achieved among Indian women and children, resulting in their improved nutritional status.

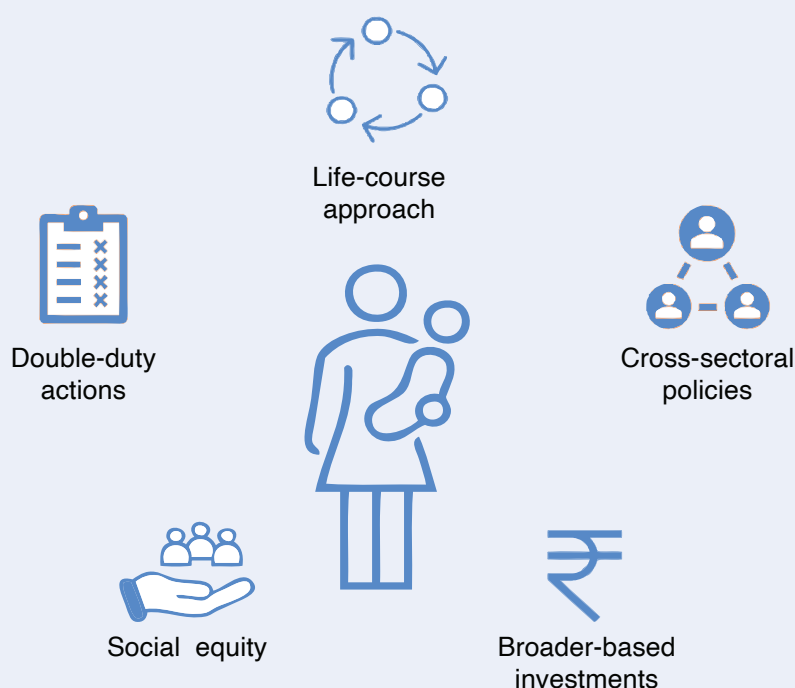
Setting the Context

In recent decades, India has witnessed rapid economic growth with concurrent transitions in health indicators.¹ Yet, it continues to grapple with the double burden of malnutrition, including undernutrition, micronutrient deficiencies, and diet-related non-communicable diseases (DR-NCDs). Malnutrition remains widespread and threatens the potential demographic dividend that India can derive from the schoolgoing children and adolescents cohorts by limiting their physical, cognitive, and economic potential.² According to latest national estimates, one in every five women (18.7 percent) is underweight (i.e., body mass index (BMI) $< 18.5 \text{ kg/m}^2$), while a quarter (24.5 percent) are overweight or obese (BMI $\geq 25.0 \text{ kg/m}^2$), and more than half (57 percent) are anaemic (Hb $< 12.0 \text{ g/dl}$).³ Malnourished women are likely to become malnourished mothers, negatively impacting their offspring.⁴ About 18 percent of children are born with low birth weight, 19.3 percent are wasted, and one in three is stunted (35.5 percent) or underweight (32.1 percent).⁵ Overweight and obesity remain relatively low among pre-school (2 percent) and school-going children (8 percent), but are projected to rise to 24 percent by 2035.^{6,7} Nationwide surveys also indicate a growing risk of DR-NCDs in children, with over one-third having elevated serum triglyceride and one-quarter showing low high-density lipoprotein.⁸

The negative impacts of malnutrition can weaken India's economic momentum and affect future generations, compromising their development and physical productivity.⁹ A five-fold approach that combines interdisciplinary strategies to address the direct, underlying, and fundamental causes of malnutrition holds promise (Figure 1). These strategies include:

- i) incorporating a life-course approach in nutrition interventions;
- ii) using a multi-sectoral approach to address malnutrition;
- iii) investing in broader-scope nutrition programmes;
- iv) viewing malnutrition through a social determinants lens; and
- v) implementing the interventions through a double-duty approach.

Figure 1: A Five-Fold Approach to Address Maternal and Child Malnutrition



Source: Authors' own

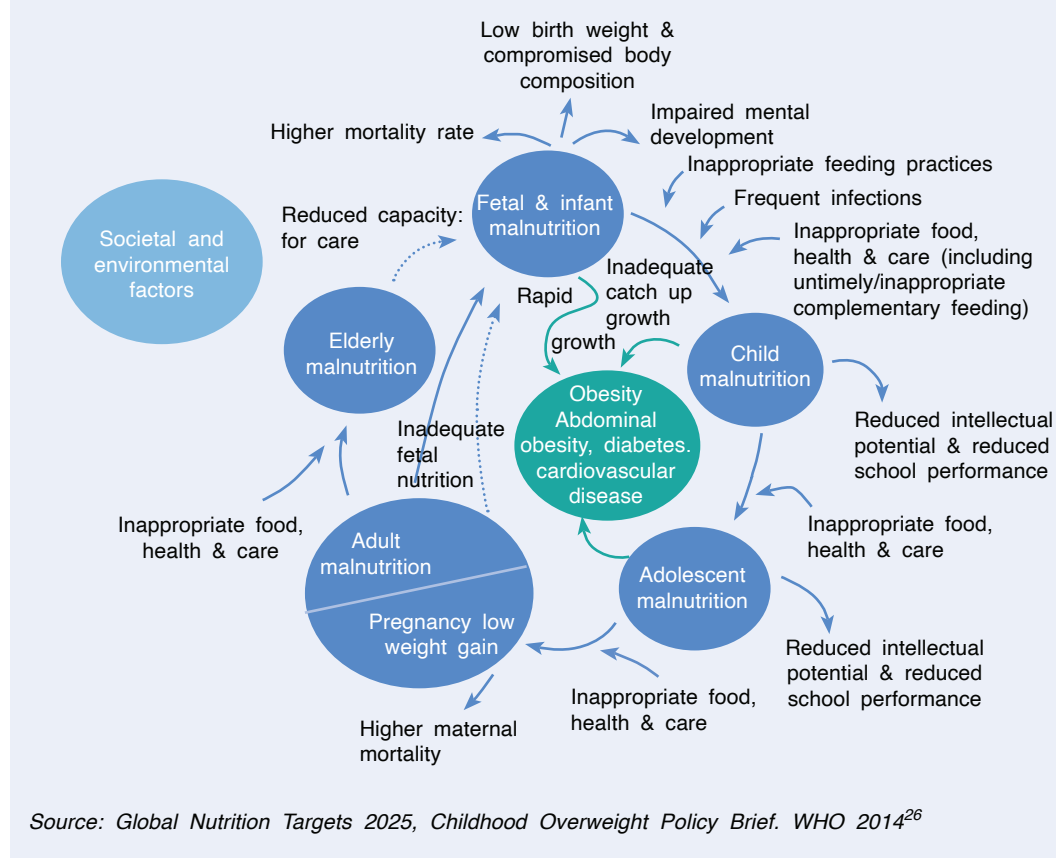
Incorporating a Life-Course Approach in Nutrition Interventions

A life-course approach is required to break the intergenerational cycle of malnutrition, as nutritional exposure and associated risks in one generation can influence outcomes in subsequent generations.¹⁰ Nutritional needs vary across life stages—from conception to old age—particularly for women and girls, who have unique needs during early childhood, adolescence, pregnancy, and lactation.¹¹ Children's nutritional needs also evolve from the womb through adolescence.¹² The first 1,000 days of life (from conception to child's second birthday) are especially crucial, marked by rapid growth and heightened nutritional vulnerability. During this period, children undergo huge physiological change.¹³ Optimum nutrition during this period can lay the foundations for the proper physiological and psychological development of an individual.¹⁴ It is also when essential neural pathways form at a rate of 700–1,000 per second, resulting in 80 percent of brain development.¹⁵

Global research, policy, and practice recognise this window as a unique opportunity to build cognitive abilities, motor skills, and socio-emotional development (Figure 2).¹⁶ Evidence also highlights that early life exposures during this period can reduce the risk of obesity later in life.¹⁷ Specialists indicate that insufficient nutrition can lead to irreparable damage to the child's body, brain, metabolism, and immune system.¹⁸ Therefore, an adequate supply of macro- and micronutrients for mothers and infants is critical for proper foetal and early childhood development.¹⁹ Pregnancy and lactation are nutritionally distinct phases, requiring additional calories (on average, +350 kcal/day during pregnancy and +550 kcal/day during lactation) and micronutrients to maintain maternal reserves, support foetal growth, and prevent low birth weight anaemia and impaired cognitive development in infants.²⁰ Research also indicates that sufficient intake of glucose, branched-chain amino acids, oxygen, and iron during early childhood helps support cellular metabolism and cell differentiation, necessary for optimal brain development.²¹

When children are denied adequate nutrition during this singular window of opportunity, intergenerational cycles of malnutrition perpetuate, widening the nutrition gaps across the population.²² Evidence indicates that stunting is mainly irreversible beyond the first 1,000 days of a child's life, leading to a cycle of hindered growth and development across generations.²³ These cycles extend beyond health and nutritional outcomes, contributing to poverty through poor learning, reduced wages, and higher unemployment, ultimately derailing national social and economic progress.²⁴

Over the last five decades, the Indian government has implemented programmes targeting maternal and child nutrition using a life-course approach and promoting early childhood development. However, implementation gaps, low awareness, and behavioural challenges at the population level hinder progress.²⁵ This calls for collective efforts by the government, research organisations, and civil society to prioritise early nutrition and ensure timely implementation of mid-course corrections to address existing challenges.

Figure 2: Life-Course-Proposed Causal Links

Making Nutrition Policies Cross-sectoral in Implementation

Malnutrition cannot be addressed by food alone; there is a need to nourish the population rather than merely feed it. Nutrition problems are multi-sectoral, with maternal and child malnutrition driven by recurring, intersecting factors.²⁷ The immediate determinants of maternal and child nutrition are linked to the dietary practices of women and children, which are, in turn, shaped by broader household and community-level factors.²⁸ These include livelihood practices, education, socio-economic factors, gender issues, social protection, access to health services, agricultural policies, and climate change.²⁹ Thus, India needs to adopt cross-sectoral policies to promote nutritious diets by integrating nutritional considerations in programmes across sectors.³⁰ For example, the agriculture sector should align with nutrition-sensitive strategies like production diversification, prioritising traditional crops, and disseminating knowledge on improved food processing, storage, and preservation techniques. These steps can improve access to affordable, nutritious, culturally appropriate, and safe food in adequate quantity and quality.³¹ Livelihood-

generation programmes can also contribute to nutritional improvements by leveraging agriculture and food systems for income generation and directing spending towards nutritious foods.³²

However, India is undergoing a rapid nutrition transition across all socioeconomic classes, driven by the unchecked rise and aggressive marketing of hyper-palatable, packaged, ultra-processed foods (UPFs) high in salt, sugar, and fat, which are displacing traditional diets.³³ Both globally and in India, the UPF industries are supported by corporate interest groups and for-profit organisations that influence food systems governance, policy processes, and scientific activities.³⁴ Literature suggests that quick commerce and online ordering have worsened the nutrition scenario by making nutrient-poor foods readily available to communities across socio-economic classes.³⁵ At the same time, lack of nutrition-sensitive policies in agriculture, poor knowledge transfer on crop diversification, and suboptimal post-harvest technologies are making nutritious foods unaffordable and inaccessible to those who need them the most. Thus, key actors, structures, incentives, and dynamics across food systems need to be identified to better understand governance processes and ground-level implementation of policies and programmes.³⁶

Agricultural and retail subsidies can increase the affordability of nutritious diets, while strategies like nutrition-focused regulations, restrictions on advertising and marketing of UPFs, front-of-package labelling to guide healthier choices, and higher taxes on UPFs can help restrict rising consumption.³⁷ Effective nutrition policy implementation must adopt a systems-thinking approach and involve multiple stakeholders, including policymakers, nutritionists, food industry representatives, non-government organisations, and consumer bodies.³⁸ Therefore, improving the nutritional status of children and mothers requires efforts and support across multiple sectors and intervention levels.

Investments in Nutrition with a Broader Scope

Investments in nutrition are pivotal, offering high returns through healthier populations, a better-qualified workforce, and greater earning potential.³⁹ The World Bank estimates that such investments could prevent one million stillbirths and save the lives of six million under-five children over the next decade.⁴⁰ However, investments must not be limited to food-based interventions to bridge the nutrient gaps in malnourished populations. Investments in nutrition-sensitive interventions must also be prioritised to address the underlying determinants of malnutrition, be it better schooling, generating livelihoods, improving access to better sanitation and hygiene, or diversifying the national food security programmes and current agricultural practice.⁴¹ Recognising these pathways, the World Bank's *Investment*

for *Nutrition Framework 2024* now incorporates gender and climate considerations to shape population-wide nutritional outcomes more holistically.⁴²

Investments in human resources for nutrition are especially vital to improve the technical capacity of care providers to assess risk factors and improve outcomes. For example, growth monitoring—while a simple technique to identify childhood malnutrition—requires specific technical skills. Strengthening this capacity entails investments in workforce training, high-quality equipment, and standardised protocols for competency enhancement. Such investments will also equip health and nutrition professionals to act as effective communicators, capable of assessing community food behaviours and promoting positive behavioural change.⁴³ This is the imperative, as food behaviours are ingrained within the structure of a society and need special efforts for modifications while actively engaging with the community. Broad-based nutrition investments can deliver dividends by ensuring not only access to nutritious foods but also long-term gains in health, education, and employment.⁴⁴

Adding a Lens of Social Determinants

Malnutrition, both globally and in India, needs to be analysed under a social equality lens, as it disproportionately affects women and children due to their distinct nutritional requirements, coupled with systemic inequalities and societal norms.⁴⁵ Addressing this persistent challenge requires a focus on the social determinants of malnutrition and the creation of equitable development pathways, while linking nutrition to broader sustainable development goals (SDGs). The Weekly Iron and Folic Acid Supplementation (WIFS) programme under *Rashtriya Kishor Swasthya Karyakram* offers an example of a well-conceptualised, multifaceted initiative that has struggled to achieve its intended reach and impact.⁴⁶

A government-approved survey across 10 states revealed challenges stemming from both demand and supply sides, indicating irregularities in tablet supply, inventory management issues, poor awareness in schools, and resistance among the beneficiaries due to fear of side effects.⁴⁷ High school dropout rates in rural regions also limit programme outreach—particularly for girls, who may leave school due to early marriage or miss school during menstruation because of inadequate toilet facilities.^{48,49}

This calls for a need to go beyond conventional explanations and identify context-specific social risk factors that hinder the effectiveness of nutrition programmes. For example, women's time use and its impact on their dietary intake.⁵⁰ In rural areas, women's lives are physically and mentally exhausting due to unpaid domestic

work, childcare responsibilities, and active roles in agriculture. These demands limit their ability to prepare and consume nutritious meals, which is detrimental to their own nutritional status as well as their family's nutritional wellbeing. Studies have also established the links between water security and a child's dietary practices.^{51,52} Analysing the nationally representative demographic and health survey data for India, a study found that children living in households with suboptimal water access were less likely to meet minimum dietary diversity in comparison to those with optimal water access.⁵³ The reasons were linked to the gendered and competing demands on women's time, as they spent more time fetching and managing the water and devoted less time to prepare nutritious meals.

Meanwhile, climate-change-induced infectious diseases and famine events, disproportionately affect pregnant and lactating women, infants, and young children, restricting their access to primary healthcare and adequate nutrition. Social determinants thus play a crucial role in shaping maternal and child nutrition, and these social inequities must be addressed to ensure a healthier and more equitable society for women and children.

Making Policies and Programmes Double-Duty

As mentioned earlier in this article, the double burden of malnutrition stems from shared biological, environmental, and socio-economic drivers.⁵⁵ Improving maternal and child nutrition in India thus requires the implementation of double-duty actions, with strategies addressing both intermediate and distal causes of the double burden of malnutrition. Double-duty actions include interventions with the potential to simultaneously reduce the risk of the double burden of malnutrition.⁵⁶ This approach builds upon existing programmes and policies to utilise the resources (fiscal, human, and time) more efficiently and achieve multiple goals and targets for holistic nutritional benefits within the population.⁵⁷

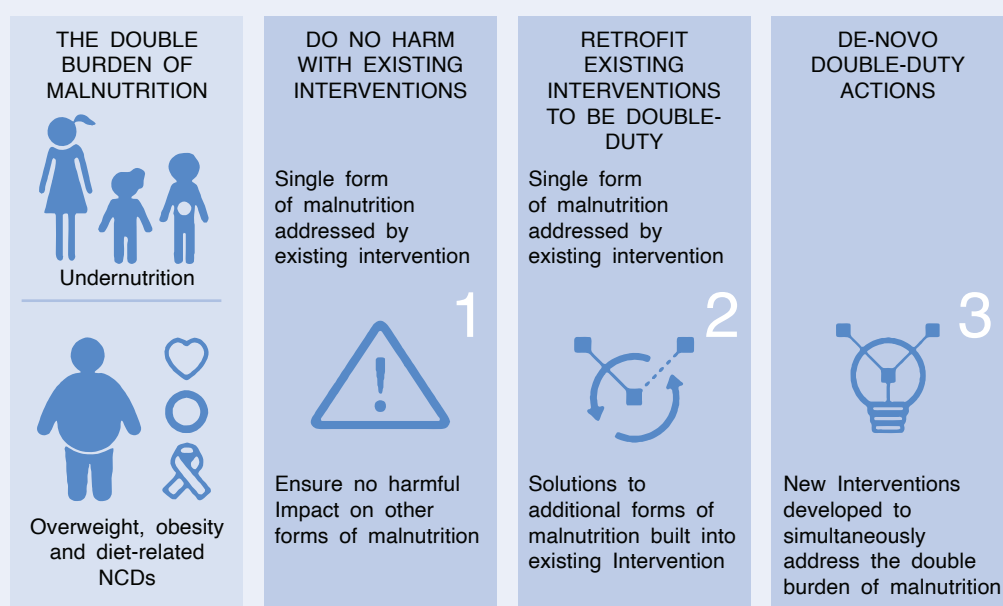
Double-duty actions are achieved at three levels (Figure 3):

- i) ensuring no unintended negative impacts on the existing interventions;
- ii) incorporating different solutions into one intervention to address multiple forms of malnutrition; and
- iii) identifying innovative solutions that can be interwoven into the existing interventions.⁵⁸

In India, the current policy narrative must expand beyond undernutrition to encompass all forms of malnutrition. This change can be made possible by incorporating double-duty actions within platforms across sectors like health, social protection, agriculture, and education. For example, nutrition programmes targeting early childhood and school-age populations can be remodelled to go beyond hunger alleviation by promoting diverse diets, encouraging locally grown nutrient-rich foods, regulating food marketing, and restricting the sale of UPFs around schools. Such measures can tackle both undernutrition and emerging DR-NCD risks. Interventions utilising this model have shown substantial improvements in dietary diversity among children.⁵⁹

Similarly, pairing social protection schemes—such as conditional cash transfers—with well-designed nutrition education strategies can lead to sustained improvements in dietary practices among women and children. This approach minimises negative household coping mechanisms and helps shift entrenched, suboptimal dietary behaviours.⁶⁰ To create more opportunities for integration of double-duty actions in existing platforms, policymakers would need to collaborate with stakeholders from various components of the food systems (like food industry, agricultural organisations, and consumer bodies).⁶¹ This would help transform the nutrition landscape of the country and ensure that safe, affordable and nutritious diets are available to all.

Figure 3: Three Levels of Incorporating Double-Duty Actions



Source: WHO (2017)⁶²

Conclusion

India has a number of well-conceptualised policies and programmes targeting maternal and child nutrition; however, their success rates are undermined by the lack of convergence across different sectors, limited consideration of underlying determinants of malnutrition, and a narrow focus on food-based interventions. To fully harness its demographic dividend, India must move beyond calorie- and supplement-focused strategies and adopt double-duty and equity-driven actions across sectors. The five-fold integrated, and multidisciplinary approach discussed in this chapter intends to widen the spectrum of existing food-based strategies and solutions to include social, cultural, economic, and environmental elements.

By addressing both direct and underlying determinants of malnutrition, this approach can pave the way for a more nutritious future through comprehensive, coordinated, and sustainable actions. In this way, India can break the intergenerational cycle of malnutrition and ensure fair, equitable, and sustainable access to nutritious diets for its mothers and children, resulting in better nutritional outcomes.

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Unlocking India's Demographic Dividend Through Nutrition, Healthcare, and Social Protection for All

Vanessa D'Souza and Rohan D'Souza

Abstract

India is undergoing a demographic transition marked by declining fertility and mortality rates, placing it on the brink of Stage 4 of the demographic transition model. It has a large young population capable of driving faster economic growth and development, if adequately supported—potentially giving the country their so-called 'demographic dividend'. This chapter emphasises the critical role of healthcare, nutrition, and social protection in unlocking such demographic dividend. It focuses on maternal and child health, especially in the first 1,000 days of life and adolescence; malnutrition and obesity—a health paradox that young Indians, in particular, face; the health of adolescents, who comprise a fifth of the population; the role of social

protection programmes; and harnessing community and private sector engagement. This article makes a case for a coordinated, multi-sectoral approach to maximise the benefits of India's demographic transition and promote inclusive development.

Introduction

As economies grow, technological advances and better healthcare, coupled with higher education, especially for women, lead to steep declines in birth and death rates. This shift brings about a transformation of society accompanied by new opportunities and challenges. Understanding this phenomenon and preparing for it is vital to unlocking a brighter future.

India is expected to reach 'Stage 4' of the demographic transition^a in 2026, a period defined by a decline in the rates of infant and child mortality, and fertility. The fertility rates of 22 of the country's 28 states are below 2. Its fall can be attributed to better access to contraception and higher education for women, while the low death rate is the result of lower rates of disease and improved food production.¹ Even so, at present, India has a greater proportion of children, adolescents, and young adults than the older population. A larger proportion is likely to enter the labour force in the coming years than in most other countries, making their productivity of paramount importance. Productivity, in turn, depends on health and nutrition, as well as increasing opportunities for education, employment and income.²

This chapter looks at some of the key factors that will impact India's success in this transitory period.

^a The stages of demographic transition are as follows: Stage 1, high birth rate accompanied by high death rate, resulting in slow population growth; Stage 2, falling death rate along with high birth rate, leading to faster population growth; Stage 3, falling death rate alongside falling birth rate, slowing down the population growth; and Stage 4, low death rate and low birth rate, leading to a stable population.

The Building Blocks of Access to Health and Nutrition

Good health and nutrition plays a crucial role in ensuring the well-being of all. The first 1,000 days of life, and the period of adolescence, offer a unique opportunity to build lifelong health and intelligence, enhancing human capital, reducing healthcare costs, and supporting national development.

Ensuring Maternal Health

Maternal healthcare is among the key indicators of population health and economic development. Adequate pre-conception care of the girl child/woman enables her to prepare for future parenthood by accessing essential interventions (such as for anaemia), and developing health literacy. Interventions that support child survival and healthy growth, such as quality antenatal care, essential newborn care, 'kangaroo mother care'^b for premature and low-birth weight infants, exclusive breastfeeding and appropriate complementary feeding, immunisation, and timely management of childhood illness, are all critical.³

India's maternal mortality rate (MMR) has fallen sharply in the past decade but is still at 97 per 100,000 live births against the UN's Sustainable Development Goal (SDG) 2030 target of 70 per 100,000. Anaemia in pregnant women, a key determinant of child health outcomes, is still high at 52 percent. The incidence of anaemia persists despite 85 percent of pregnant Indian women receiving antenatal care from a skilled provider, and 70 percent getting similar care in their first trimester.⁴

Pregnancy is also a period of rapid hormonal changes which could put women at increased risk of mental health issues. Socio-economic factors such as domestic violence severely affect the mental well-being of pregnant women. The last National Family Health Survey (NFHS-5, 2019-21) noted that, among women in the 18-49 years category, 3 percent had experienced violence during pregnancy. Thus, for long-term improvement in birth outcomes, antenatal and post-natal services should include counselling. Health facility staff and government frontline workers need to be adequately trained to provide comprehensive care rather than fragmenting care across multiple service providers.

^b 'Kangaroo mother care' involves putting the newborn baby in direct skin contact with the mother's chest for warmth and support.

Social determinants of health, including food insecurity, financial instability, inadequate resources, lack of education, social exclusion and lack of access to affordable health services, are key factors influencing health outcomes of disadvantaged populations.⁵ For improved maternal health, these sections need social protection. India is doing well in this regard: social protection coverage has doubled from 24.4 percent in 2021 to 48.8 percent in 2024, marking an expansion in welfare reach.⁶ This is attributed to a series of government initiatives, which have extended benefits such as health insurance, pensions, and employment support, to millions.

Enhancing women's education improves their health-seeking behaviour and, consequently, their ability to reach their full potential.⁷ Male partners should be encouraged to share responsibility for women's health, including responsible parenthood, prevention of unwanted and high-risk pregnancies, and shared control of and contribution to family income. Dissemination of appropriate information and couple counselling can reduce gender inequities and provide women, especially those with low literacy and agency, much-needed support.

Nurturing Care

The *Lancet* series, *Advancing Early Childhood Development: from Science to Scale*,⁸ highlights the profound benefits of investing in Early Childhood Development (ECD). It coined the term 'nurturing care' as a central tenet of optimal child development. Nurturing care requires an environment that protects from threats, promotes health and nutrition, and enables opportunities for early learning. The key interventions are responsive care, which includes the caregiver's ability to notice, understand, and respond to a child's signals appropriately; promotion of early learning, where infants and children are given learning activities during the first three years of life; integration of caregiving with nutrition interventions for optimal nutrition of infants and young children; and focus on maternal mental health to help pregnant women and new mothers manage relationships, stress and conflict.

The *Lancet* series included a UK study of the IQ scores of adolescents from impoverished communities in Brazil and South Africa. It found that responsive caregiving and learning opportunities during the pre-school ages were positively associated with adolescent human capital, even after adjusting for early adversities. A nurturing early home environment during pre-school ages mitigated negative effects of early cumulative adversities on adolescent IQ.⁹ Another study made a distinction between stunted children whose caregivers had received support for responsive caregiving and consequently provided the children with early learning

activities, and those whose caregivers had not. It was found that those in the former category, despite their nutrition-deprived childhoods, earned an estimated 25 percent more as adults than the latter.¹⁰

The Challenge of Malnutrition

The Nurturing Care model acknowledges nutrition as a key contributor to children's physical and intellectual growth. While India has made some progress in reducing child malnutrition, absolute levels continue to be high. NFHS-5 showed that 32.1 percent of Indian children were still underweight, 35.5 percent were stunted, and 19.3 percent were 'wasted' (among them, 7.7 percent were 'severely wasted').¹¹

Over the years, non-profit organisations have brought about substantial reductions in child malnutrition in their areas of activity through targeted and systematic work. The Society for Nutrition, Education and Health Action (SNEHA), covering a population of 300,000 in Greater Mumbai, for instance, has been able to reduce prevalence of wasting by 28 percent in just over two years among children ages 0-3 years.

Stunting results from sub-optimal nutrient intake, restricting the child's growth. This could have severe short-term consequences, including poor educational performance and cognition, as well as long-term ones, such as low adult earnings and poor productivity.¹² Growth trajectories are set early in life, and 70 percent of stunting occurs in the first 1,000 days of a child's life.¹³ The harm done is largely irreversible.¹⁴ Addressing stunting requires multi-sectoral collaboration between the health, nutrition, sanitation, community development, and social protection sectors. Further, studies have emphasised the importance of women's status and decision-making power in countering stunting, along with access to and uptake of family planning services and support for survivors of domestic violence. Ultimately, a multilateral effort is needed to ensure the success of nutrition-specific interventions by focusing on women's underlying health and social status.¹⁵

The Malnutrition-Obesity Paradox

While there is an urgent need to address undernutrition in children, there is also a paradoxical prevalence of obesity in children under five (Table 1). Overweight in childhood has immediate health concerns like type 2 diabetes, heart disease, joint problems, and breathing difficulties. It can also lead to psychological and emotional

challenges like low self-esteem and depression, and increases the risk of obesity in adulthood and, consequently, early cardiovascular disease. Excessive intake of unhealthy foods and beverages from a young age and persuasive food marketing of such foods are widely acknowledged as factors contributing to this trend.

Table 1. Malnutrition in Children 0-5 Years

	NFHS-4 (2015-16)	NFHS-5 (2019-21)	SDG Target 2030 for India
Wasting	21.0	19.3	5.0
Stunting	38.4	35.5	21.0
Overweight	2.1	3.4	0.0

The Importance of Trained Government Frontline Workers

India has included early childhood development as a component of Poshan 2.0, a flagship programme of its Women and Child Development ministry, which provides comprehensive health, nutrition, and development support for children. *Anganwadi*^c workers can play an important role in observing children's growth at the government child care centres and in counselling mothers and caregivers to provide nurturing care. Such interaction is important, especially for children who are at risk of sub-optimal growth or have a developmental disability. These government frontline workers should thus be trained and motivated to provide adequate support to mothers and children.

The Role of Mass Media

With increasing connectivity and digital penetration in India, channels like the radio, television, mobile messaging, chatbots and help lines can be used to facilitate dissemination of timely and credible information on nutrition and early childhood development.

^c Childcare centres run by Integrated Child Development Services (ICDS), a central government programme in India.

Preparing Adolescents for Lifelong Health and Wellness

Adolescence (10-19 years) is a unique phase of life during which an individual experiences rapid physical, cognitive, and psychosocial growth. India has 243 million adolescents, comprising 21.4 percent of its population.¹⁶ Adolescents are vulnerable to a wide spectrum of communicable and chronic disease conditions, including nutritional deficiencies, substance abuse, mental health concerns, violence, injury, and reproductive and sexual health problems. Deeply entrenched gender norms, along with excessive use of technology and social media, could potentially contribute to early marriage and parenthood, sexual abuse, and mental health concerns for many of them. Acknowledging the importance of investing in adolescent health, India's Ministry of Health and Family Welfare launched the National Adolescent Health Programme (Rashtriya Kishor Swasthya Karyakram) in 2014, a flagship health programme by the Government of India aimed at addressing the health needs of adolescents.

The first step to improved adolescent health is investment at the school level. Availability of facility-based services like anthropometry, anaemia screening, reproductive services, and mental health counselling, along with outreach efforts towards adolescents and parents will increase awareness of adolescent issues and encourage uptake of their support services. Mainstreaming health education is crucial; schools must include information on nutrition, menstrual hygiene, reproductive health, gender and gender-based violence, the importance of exercise, yoga and meditation as part of the syllabus, and provide counselling services.

As noted earlier, mass media is a critical channel that can impact mindsets. But adolescents are especially vulnerable. In India, 88.2 percent of male adolescents and 71.5 percent of females use mass media.¹⁷ A 2004 Chennai study of the age group 11 to 17 years reported that 90 percent of respondents said they watched television during meals, 82 percent were influenced by TV advertisements while deciding on what food products and snacks to buy, 59 percent preferred watching TV to outdoor activities, while only 42 percent followed a specific diet.¹⁸ There have been studies associating excessive television viewing among children and adolescents with obesity, poor fitness, and raised cholesterol in adulthood, along with a greater propensity to take up smoking.¹⁹

Social media has also become ubiquitous, bringing its own challenges, essentially changing the way young people connect socially with family, peers, and broader communities. Digital and social media have been shown to have both positive and negative effects on adolescents' well-being.²⁰ Media can also play a positive role

in influencing adolescents by disseminating content that promotes positive attitudes and behaviours.

The family, the school, and the community can help adolescents forge much-needed social connections that can have a critical effect on development.²¹ Parents, teachers and other relevant stakeholders play a role in providing adolescents with a supportive network. In the US, the National Longitudinal Study of Adolescent Health found that adolescents who reported feeling connected to home or school between the ages of 12-17 were as much as 66 percent less likely to engage in health risk behaviours related to sex, substance use, and violence, and to have better mental health in adulthood than less connected peers.²² Developing interventions that strengthen adolescent relationships can improve their well-being. Evidence-based interventions that strengthen young people's relationships with their families and peers and within their schools and communities need to be employed.

Recommendations

There needs to be mass awareness of the long-term outcomes of optimal child development right from conception, and the role of mothers and caregivers in promoting it. Continuous paediatric training of government frontline workers and facility-based staff can greatly help ensure the growth and development of healthy children. Counselling mothers and caregivers on early childhood development should be integrated with health and nutrition services; there should be appropriate referrals for children with developmental delays. Additional attention to children with special needs should be well triaged between the home, the *Anganwadis*, and the closest health facility to ensure early treatment and appropriate follow-up.

Policies such as a minimum wage for those working with children and adolescents, universal health coverage, family-friendly workplace policies, and affordable and accessible childcare services will go far in supporting caregivers. India needs to set up functional governance and coordination mechanisms at national and state levels to facilitate multi-sectoral collaboration, including between public and private sector entities.

While social protection schemes do provide a buffer for marginalised families, limited awareness of rightful entitlements, outdated and arbitrary eligibility criteria, and challenges in documentation for vulnerable migrant populations remain barriers

to availing these schemes. Greater focus is needed on awareness building (using mass media), capacity building (of government functionaries), revising of eligibility criteria, and ease of documentation.

Communities also play an important role in creating a supportive environment for caregivers and children. Understanding the community's values and strengths and enabling community participation is vital to the feasibility, effectiveness and sustainability of childhood growth and development strategies. Giving children what they need to develop is the only way to enhance human capital, reduce inequities, and realise human rights.

The private sector too, is contributing to improving the quality of the demographic dividend. Section 135 of the Companies Act 2013 mandates that large companies^d must earmark 2 percent of their average net profit of the past three years on corporate social responsibility activities. Hindustan Unilever's Project Shakti, for instance, started in 2001, employs rural women to sell the company's products in rural areas across 18 states. It now has 1.9 million such saleswomen called 'Shakti Entrepreneurs' (SEs), 80 percent of whom, according to an appraisal the company conducted, are contributing more to their household income than before, while 90 percent have shown improvement in social empowerment indicators such as independent decision-making and social status. So too, the Nandghar project by Vedanta Foundation, has established a network of 8,000 'model' *Anganwadis* in 15 Indian states to support nutrition initiatives, early digital education, healthcare services, and women empowerment activities.

Corporate houses can contribute to better nutrition through regulated marketing and advertising of foods with high fat, sugar and salt, as well as through correct labelling of such foods. This could be coupled with nutrition literacy, advertisements issued in the public interest, to enable consumers to make the right food choices. They should make use of the strong training capacity they possess, employing technology and their outreach networks. Capacity building of government staff

^d These are companies with a net worth more than INR 500 crore, or with turnovers of over INR 1,000 crore per year or those with profits of over INR 5 crore per year.

working with mothers and children would give them the tools to improve their rapport with the community and perform more efficiently. More research is also needed to understand the root causes of poor physical and mental health, to which corporate houses with strong research capabilities can contribute, partnering with the government and NGOs if necessary. Corporate technology capability can be leveraged for health communication, improving efficiencies and reducing costs of healthcare.

A successful demographic transition requires a “whole-of-society” approach to provide better opportunities for women, adolescents and children to exercise their right to good health, nutrition, safety, independent decision-making, higher education and income generation.

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Finding Solutions to India's Nutrition Paradox: Scaling Innovations for Equitable Health Outcomes

Rohini Saran

Abstract

India stands at a pivotal juncture in its development journey, marked by remarkable strides in public health and the simultaneous challenge of a complex nutrition paradox. Undernutrition, obesity, and hidden hunger co-exist across rural and urban landscapes, reflecting both structural inequities and shifting dietary patterns. While food security has improved, nutrition security remains elusive, revealing deep-rooted gaps in policy design, service delivery, and behavioural change. This chapter explores the multiple burden of malnutrition as a symptom of fragmented governance, insufficient investment in preventive care, and inadequate frontline support. It examines how isolated policymaking and underutilised community platforms hinder the

potential of otherwise promising interventions. The need is not for new solutions, but for political will, system alignment, and the courageous scaling of what already works.

Introduction

India's public health has advanced markedly since life expectancy increased from 63.5 years in 2000 to nearly 70 by 2022, with reductions in maternal and child mortality,¹ and expanded health access through initiatives like Ayushman Bharat.² At the same time, India exemplifies the nutrition paradox where undernutrition, obesity, and micronutrient deficiencies coexist. This triple burden often exists within the same household and spans socioeconomic groups.³

Data from the fifth round of the National Family Health Survey (NFHS-5) indicates that 35.5 percent of children under five exhibited stunted growth, 19.3 percent were wasted,^a while 24 percent of women and 23 percent of men ages 15–49 are overweight or obese.⁴ Moreover, over 101 million Indians have diabetes, and more than 135 million are pre-diabetic.⁵ Urban diets increasingly rely on processed, calorie-dense foods, and sedentary lifestyles are rising, particularly among the urban middle class.⁶ Meanwhile, rural and underserved areas face undernutrition driven by maternal malnutrition, inadequate sanitation, poor infant feeding, and limited access to clean water.⁷

Despite being a large, rapidly growing economy, India ranks moderately or poorly on many global development indices.⁸ Numerous promising interventions have also led to remarkable improvements. This article examines India's nutrition paradox, identifies systemic challenges and policy gaps, highlights scalable interventions, and offers cross-sectoral, equity-focused recommendations.

Understanding the Burden

India's nutrition crisis reflects a deeper structural enigma: while food security has improved, nutrition security remains elusive. The Public Distribution System (PDS) primarily distributes calorie-dense staples like rice and wheat, achieving basic

^a Meaning that their weight was too low for their height.

food access but little to no dietary diversity or adequate micronutrient intake. However, the introduction of rice fortification with iron, folic acid, and vitamin B12 at scale under government initiatives is a promising start.⁹ Diversifying the food basket necessitates a policy shift, given that minimum diet diversity is now a key Sustainable Development Goal (SDG) indicator.¹⁰

School-based platforms such as the Mid-Day Meal Scheme (PM POSHAN) and POSHAN Abhiyaan offer opportunities for integrated nutrition and health education through fortified meals and school health ambassadors.¹¹ However, persistent gaps remain, particularly among rural and tribal populations who face compounding geographic, financial, and cultural barriers to preventive and curative health services.¹²

Maternal undernutrition remains widespread in states like Bihar, Jharkhand, and Uttar Pradesh, contributing to low birth weight and child mortality.¹³ These challenges are worsened by poor integration of nutrition with reproductive and maternal health services.¹⁴

Urbanisation and sedentary lifestyles have facilitated a shift in dietary patterns across all socio-economic strata. The increased consumption of ultra-processed foods high in salt, sugar, and trans fats is particularly visible among adolescents.¹⁵ Adolescent undernutrition leads to a vicious intergenerational cycle. Undernourished girls are more likely to carry this pattern into motherhood, giving birth to low-birth-weight infants who are at higher risk for chronic diseases.¹⁶ Malnutrition reduces socio-economic resilience and fuels a lifelong health and productivity deficit. Child malnutrition alone is estimated to cost India up to 4 percent of its GDP and 8 percent of its productivity annually.¹⁷

Economic inequities further exacerbate the crisis. High-income groups often consume excess calories without understanding micronutrient needs, while low-income households struggle with both awareness and affordability of healthy food choices. Globally, stunting contributes US\$548 billion in annual losses (0.7 percent of Gross National Income), followed by US\$507 billion from suboptimal breastfeeding, US\$344 billion due to low birth weight, and US\$161 billion from child anaemia. In women of reproductive age alone, anaemia leads to US\$113 billion in lost income each year.¹⁸

Innovative, scalable models like the Akshaya Patra Foundation's centralised kitchens and startups offering millet-based snacks for school nutrition exemplify context-

sensitive solutions that promote sustainable food systems. Yet, nutrition literacy remains low, and the rise of non-communicable diseases (NCDs) is increasingly straining public health systems.¹⁹ Finally, equity issues ranging from caste- and tribe-based exclusion to climate-linked nutritional stress and the emerging link between mental health and nutrition demand urgent, inclusive attention within nutrition policy and implementation.

Innovative Models in Action

Amidst the scale of India's health and nutrition crisis, scalable and innovative models across states and districts demonstrate what is possible when community engagement, public systems, and technology converge effectively. These examples, when scaled, can convert local success into structural transformation.

Public-Private Partnerships (PPPs) are a vital lever to bridge infrastructure and delivery gaps. Tamil Nadu's Mobile Medical Units (MMUs), for instance, send diagnostic-equipped vans to 25–30 remote villages, screening for NCDs such as diabetes and hypertension.²⁰ This PPP-based initiative ensures preventive healthcare and early detection, reducing long-term health expenditures. The Jan Aushadhi Scheme is another powerful model. With over 13,822 outlets nationwide, it provides generic medicines at 50–80 percent cheaper rates than branded alternatives, improving access to affordable medication, particularly for chronic diseases.²¹

Technology is emerging as an equaliser. The e-Sanjeevani telemedicine platform has facilitated over 368 million consultations through 17,122 hubs and 132,000+ Ayushman Arogya Mandirs. It enables rural populations to access specialist consultations without incurring travel costs, improving both coverage and affordability.²² Project ECHO adapts virtual mentoring for rural providers through a hub-and-spoke model. Urban medical experts train rural practitioners in managing complex diseases like cancer and multidrug-resistant tuberculosis, enhancing local capacity without requiring physical relocation.²³

Community-led models also play a crucial role in bridging infrastructure gaps. In Chhattisgarh, the Mitani Programme empowers local women to act as health volunteers, delivering maternal and child care and advocating for behaviour change within households. Their credibility stems from their deep community roots and integration within the formal health system.²⁴ Similarly, Bihar's Kilkari mobile messaging programme delivers behaviour-change communication (BCC) on pregnancy and infant care. It operates in multiple languages and has scaled up to

handle 1.2 million calls per day, with over 48 percent of users listening to half the message content and 43 percent to three-quarters.²⁵

India's underinvestment in quality BCCs limits the impact of health and nutrition programmes. Without well-designed, culturally sensitive, and adequately funded BCC initiatives, efforts to promote healthy behaviours and improve nutrition outcomes struggle to achieve sustainable impact, reducing community engagement and slowing progress on key health goals.

Policy Gaps and Structural Challenges

Despite the growth in institutional investments, India's nutrition and health outcomes continue to be undermined by systemic and structural inefficiencies that demand governance reform, cross-sectoral coordination, and better financing. The siloed nature of policy design is a core issue, as nutrition remains disconnected from key determinants, such as sanitation, education, and livelihoods. This results in fragmented service delivery and missed opportunities for integrated interventions in the last mile.

Frontline personnel like Accredited Social Health Activist (ASHAs) and Anganwadi workers form the backbone of community-level implementation. Yet, they are often overburdened, underpaid, and insufficiently supported. Training is sporadic, supervision is weak, and incentive structures vary widely across states.

Although health spending has increased, India allocated only 1.9 percent of its GDP (Gross Domestic Product) to health in 2024, with a minimal share directed toward nutrition-specific programmes.²⁶ This financial constraint weakens infrastructure such as rural sub-centres, community kitchens, and nutrition rehabilitation units. Consequently, malnutrition of all forms also brings massive losses in productivity and work potential, posing challenges to employers in high-, and low- and middle-income countries (HICs and LMICs) alike.²⁷ At an assumed rate of 80 percent coverage, nutrition interventions, such as complementary food production and mass media education campaigns, would potentially save between 0.16 and 3.20 years of life per child. The average cost-effectiveness ratio ranged from US\$9 to US\$2,000 per life-year saved.²⁸

Timely granular data is essential for informed policymaking, yet national surveys are infrequent and lack sub-district-level detail. This restricts real-time, evidence-based decision-making and hinders the ability to target interventions in a precise manner.

Furthermore, there is a dearth of impact evaluations for flagship programmes. Few initiatives undergo independent, longitudinal assessments that capture both outcomes (e.g., child growth) and outputs (e.g., meals served).

India's multi-ministerial governance structure for nutrition results in diluted accountability. Without a consolidated results framework, it becomes difficult to assign responsibility or take corrective action when outcomes fall short. District and block-level coordination platforms also struggle with limited funding and political prioritisation.

To close these policy and implementation gaps, India must invest in integrated delivery models, frontline workforce sustainability, real-time data systems, and a unified accountability architecture.

Scaling What Works: Six Recommendations for Better Health and Nutrition Outcomes

1. Co-design Localised Interventions: To address India's nutrition challenges meaningfully, interventions must be designed in collaboration with the communities they intend to serve. Participatory diagnostics rooted in local contexts should identify barriers related to cost, accessibility, social norms, or awareness. Initiatives such as POSHAN Abhiyaan and the National Health Mission can be strengthened by embedding citizen feedback loops, community scorecards, and bottom-up planning processes. This not only increases the relevance of intervention but also fosters a sense of ownership by transforming passive recipients into active co-creators of solutions. Effective co-design ensures culturally responsive approaches and greater uptake at the grassroots.

2. Institutionalise Outcome-Oriented Public-Private Partnerships (PPPs): PPPs need to move beyond input-based collaborations to models that prioritise measurable outcomes, such as improved immunisation coverage, reduced anaemia rates, or increased dietary diversity. These partnerships must be built on transparent frameworks with shared accountability and a focus on long-term impact. Successful examples, such as Tamil Nadu's Mobile Medical Units and the Jan Aushadhi Scheme, offer replicable blueprints. Expanding the scope of PPPs to include nutrition, diagnostics, and health promotion can dramatically enhance access and efficiency, particularly in under-resourced regions.

3. Digitise and Integrate Service Delivery Platforms: India's digital public infrastructure (DPI) presents a unique opportunity to unify fragmented service delivery across nutrition and health. Integrated digital dashboards can help monitor child growth, track service delivery, and send real-time alerts for malnutrition or missed vaccinations. Ensuring interoperability between data systems, safeguarding privacy, and investing in capacity-building at local levels are essential for effective implementation. Digital integration must also be accompanied by training frontline workers and strengthening data literacy at the block and district levels to improve decision-making and accountability.

4. Empower and Support Frontline Workers: Community-based personnel such as ASHAs and Anganwadi workers are critical to the delivery of nutrition and health services. However, they often face heavy workloads, low compensation, and limited opportunities for professional development. Reducing administrative burdens through mobile reporting tools, improving remuneration, and creating structured career pathways can boost morale and effectiveness. Peer support systems like the Saathiya model^b and remote mentoring schemes can enhance skill-building and motivation, ensuring consistent and quality service delivery.

5. Establish a National Maternal and Child Health PPP Framework: There is a pressing need for a unified framework that aligns public and private actors under the Reproductive, Maternal, Newborn, Child, and Adolescent Health and Nutrition (RMNCHA+N) umbrella. A centrally guided strategy, potentially under the NITI Aayog's leadership, should set national goals while allowing for state-level adaptations. This framework should foster multi-sectoral collaboration and facilitate funding, resource sharing, and joint monitoring, creating a cohesive ecosystem for maternal and child well-being.

6. Leverage CSR and Philanthropy Strategically: Corporate Social Responsibility (CSR) and philanthropic capital must evolve from one-off activities to systemic enablers. Investments should target infrastructure gaps, such as cold chains, nutrition surveillance, and digital skilling. Industry association platforms like the Confederation of Indian Industry's (CII) CSR compendium should be scaled, and

^b A peer-education initiative under National Health Mission (NHM) & Rashtriya Kishor Swasthya Karyakram (RKSK) that trains adolescents to promote health, conduct sessions, and link peers to services, aided by a resource kit and the "Saathiya Salah" app.

public-facing dashboards can enhance transparency. Further, engaging faith-based organisations, instituting food-labelling norms, and exploring sugar taxation can embed nutrition priorities across society.

Conclusion

India stands at a crossroads, confronted by a deep-rooted nutrition crisis yet equipped with the tools and experience to respond effectively. What the country requires is not a fresh slate of innovations, but the political will and institutional coherence to scale proven solutions with urgency and equity. The persistence of undernutrition, obesity, and hidden hunger reveals the risks of fragmented policymaking and underinvestment in preventive health. However, it also underscores the opportunity to redefine development through a holistic, nutrition-first approach. The path forward lies in integrating community-led insights, technology-enabled systems, and outcome-based partnerships into a unified framework that prioritises long-term human capital. Public systems must be strengthened with data-driven decision-making and frontline workforce empowerment, while private and philanthropic actors must align more intentionally with national goals. Nutrition must be recognised not as a sectoral issue, but as foundational to education, productivity, and climate resilience.

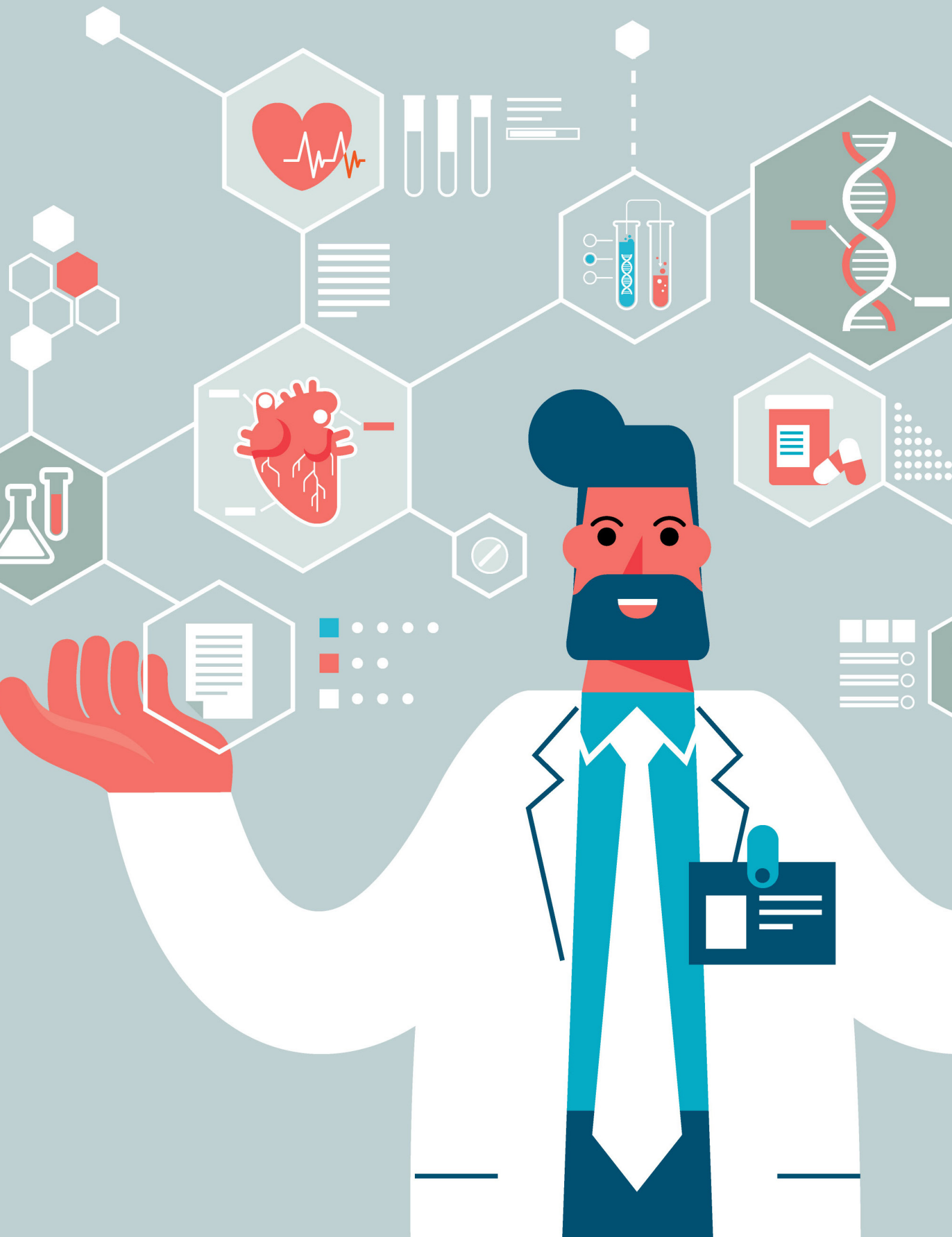
India's leadership in promoting climate-resilient crops like millets, expanding digital public goods, and fostering social innovation positions it well to lead a broader shift across the Global South. However, this potential can only be realised through bold and coordinated action that centres dignity, accountability, and inclusion. Nutrition should no longer be seen as a downstream outcome of economic growth—instead, it must be treated as a catalyst. By reimagining governance through the lens of health and equity, India can transform its nutrition paradox into a model of integrated development and sustainable prosperity. Bold, coordinated action today will transform nutrition from a crisis into a catalyst for smart governance and inclusive national growth.

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III

Health Innovation and Access at Scale

Breaking Barriers: India's Journey Towards Equitable Access to Medicines

Shubnum Singh, Swati Thakre, and Alveera Nadeem

Abstract

India's pharmaceutical industry, known as the 'pharmacy of the world', exports to over 200 countries, providing 20 percent of global generic drugs supply and 60 percent of total vaccine production. Despite this manufacturing prowess, millions of Indians lack access to affordable, quality medicines due to regulatory inconsistencies, quality concerns, and fragmented healthcare delivery. The Pradhan Mantri Bharatiya Janaushadi Pariyojana, through which generic drugs are sold at reasonable prices at more than 15,000 dedicated outlets, has enabled consumers to save around INR 30,000 crore (approx. US\$ 3.39 billion) since the scheme was launched. However, challenges persist, including that of substandard drugs being provided by these

outlets, inadequate bioequivalence testing, and limited healthcare infrastructure. Critical reforms are needed to transform India's pharmaceutical capabilities into equitable healthcare delivery—unified regulatory standards, mandatory generic prescribing, expanded insurance coverage for medicines, and increased clinical trial capacity.

Introduction

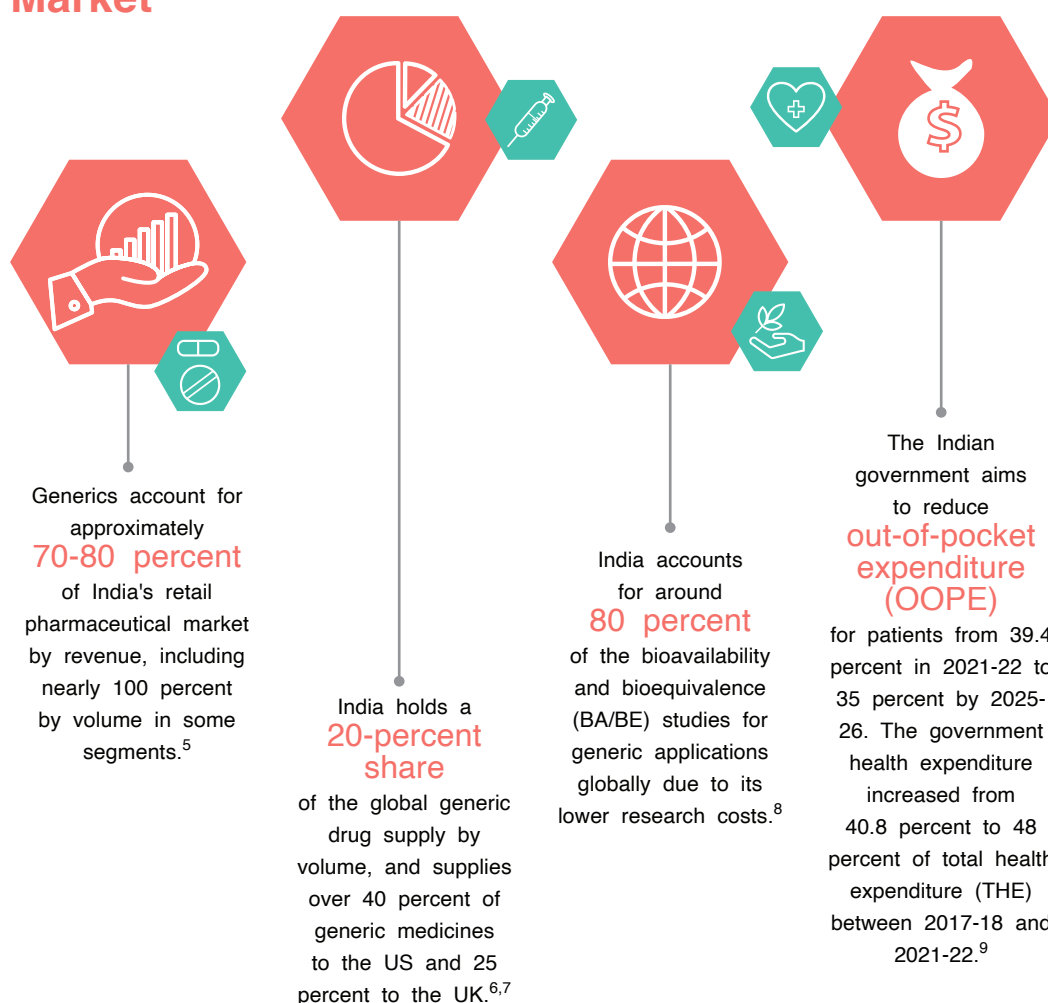
India's pharmaceutical industry, exporting to 200 countries and supplying 20 percent of the world's generic drugs and 60 percent of all vaccines, was valued at over US\$370 billion in 2022 and could reach US\$450 billion by 2047.^{1,2,3,4} India's healthcare system has expanded domestic access to essential medicines through various innovations, including schemes such as the Pradhan Mantri Bharatiya Janaushadhi Pariyojana, high-quality diagnostic devices, AI-enabled platforms, and diagnostic tools. These are increasing the affordability and accessibility of medicines in both rural and urban regions. Healthcare delivery models are evolving as well through home-based chronic care services and rural franchises. Indian start-ups have demonstrated how technology and partnerships can drive innovation, integrating it with affordability and accessibility.

However, despite India's global reputation, millions of Indians still struggle to access essential drugs due to high costs, counterfeit products, and fragmented delivery systems. Ensuring the availability of medicines while addressing quality concerns and overcoming systemic barriers—including urban-rural disparities, inadequate infrastructure, workforce shortages, and financial constraints—remains a massive challenge.

The Role of Generic Drugs

Generic medicines are critical to India's pharmaceutical sector. They offer cost-effective alternatives to branded drugs, expand access to essential treatments, and alleviate financial burdens on individuals and healthcare systems. This is particularly true in developing economies with limited medication access.

Indian Generics Market



The Pradhan Mantri Bharatiya Janaushadi Pariyojana (PMBJP), launched in November 2008, has contributed to making generic drugs domestically affordable. Run by the Pharmaceuticals and Medical Devices Bureau of India (PMBI), under the Ministry of Chemicals and Fertilizers, it operates around 15,000 Jan Aushadhi Kendras (people's drug centres) offering low-cost generics, and hopes to increase the number to 20,000 by end-2025 and 25,000 two years thereafter. From its start till August 2024, PMBJP had facilitated sales worth INR 5,600 crore, saving citizens an estimated INR 30,000 crore of expenditure had they bought branded alternatives.¹⁰ In 2023-24 alone, Jan Aushadhi Kendras reported INR 1,470 crore in medicine sales, generating estimated savings of INR 7,350 crore.¹¹ Already, out of pocket expenditure's (OOPE) share of total health expenditure (THE) in India has declined from 62.6 percent in 2014-15 to 39.4 percent by 2021-22.¹²

However, despite the PMBI's sustained efforts to popularise its centres through digital channels—even launching an app to assist consumers in locating the nearest generics outlets—awareness remains limited, impeding the programme's success.¹³ A continuing challenge is the scepticism among healthcare providers and consumers regarding the effectiveness of generic drugs; there are also persistent supply chain issues.

Prescribing Generics

The Medical Council of India's (MCI) Professional Conduct, Etiquette and Ethics Regulations, 2002 requires doctors to prescribe generic drugs only (if available), and not their branded counterparts. With the passing of the National Medical Commission (NMC) Act, 2019, the NMC has replaced the MCI, but the old regulations remain in place, overseen by its Ethics and Medical Registration Board (EMRB).¹⁴

In August 2023, the NMC introduced new guidelines, reiterating that doctors must prescribe only generic medicines, providing penalties for non-compliance. The new guidelines faced opposition from the Indian Medical Association (IMA) and other professional bodies, which claimed that the quality of generic drugs was not always assured and patient safety could be potentially at risk if the guidelines were strictly enforced—this led the NMC to put the implementation of the guidelines on hold. Thus, Clause 1.5 of the 2002 Regulations remains the foundational legal and ethical requirement, urging doctors to prescribe drugs using generic names to promote rational drug use and affordability. States have also been advised to ensure generic drug prescription and to conduct regular prescription audits in public health facilities.¹⁵

Quality Concerns

Though affordability is a key advantage of generics, quality concerns persist. Each state has its own State Drug Regulatory Authority (SDRA), and India's decentralised drug regulation system gives SDRAs autonomy, leading to inconsistencies in quality control and enforcement. Reports indicate that some generic formulations do not match the efficacy of their branded equivalents. A 2018 report by the Central Drugs Standard Control Organization (CDSCO) maintained that 4.5 percent of generic drugs it tested were substandard.¹⁶ In August 2024, over 50 widely used generic drugs, including paracetamol and antacids, were identified as substandard or counterfeit. A Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh, study revealed that only 29 percent of patients reached therapeutic levels with generic itraconazole compared to 73 percent with their branded counterparts.¹⁷

Bioequivalence refers to the scientific demonstration that generic drugs deliver the same active ingredient amount into patients' bloodstreams at the same rate as original branded drugs. This is measured through bioavailability studies tracking drug circulation and absorption speed. For approval, generics must demonstrate performance within 80-125 percent of reference drugs.¹⁸

Studies like that of PGIMER highlight the need for stricter bioequivalence testing and quality assurance measures, as treatment failures reinforce the scepticism of healthcare providers and undermine confidence in India's generics system. Additionally, according to an Organization for Economic Cooperation and Development (OECD) report, India accounted for nearly 53 percent of total seized counterfeit medicines in 2016, prompting calls for stronger regulatory oversight, better tracking systems, and enhanced enforcement against counterfeit operations.¹⁹

Vaccines: Manufacturing Excellence but Distribution Challenges

India continues to play a vital role in global vaccine supply, supporting immunisation efforts in over 70 low- and middle-income countries through partnerships with Gavi, the Vaccine Alliance, and COVAX.^a In 2025, India pledged US\$20 million to Gavi, doubling its previous contribution.²⁰ When the COVID-19 pandemic raged, the Pune-based Serum Institute of India (SII) was a key COVAX supplier, ensuring equitable vaccine access worldwide.

Indian manufacturers including Bharat Biotech, Biological E, Zydus Lifesciences, Panacea Biotec, and Indian Immunologicals, have increasingly supplied vaccines even after COVID-19 has abated. Bharat Biotech is collaborating with global pharma giant GSK to supply the world's first malaria vaccine to Gavi by 2028.²¹

However, despite its manufacturing strength, India faces vaccine distribution challenges. Cold chain infrastructure gaps, especially in rural areas, hinder temperature-sensitive vaccine delivery. Coverage disparities exist with rural populations, and even rural adults are often under-vaccinated compared to urban children. Rising vaccine hesitancy driven by misinformation threatens public health efforts.

^a COVAX is a partnership of the World Health Organization, Gavi, the Vaccine Alliance, the Coalition for Epidemic Preparedness Innovations (CEPI) and the United Nations Children's Fund (UNICEF)

Systemic Barriers in Healthcare and Pharmaceutical Policies

India's public healthcare infrastructure remains underdeveloped, particularly in rural areas. There is a severe shortage of healthcare facilities, hospital beds, and medical professionals. The doctor-to-patient ratio stands at approximately 1:1,834, well below the WHO-recommended 1:1,000 ratio.²² Many public hospitals are overcrowded and lack adequate medical supplies. While programmes like Ayushman Bharat aim to reduce OoPE, coverage gaps prevent full benefit realisation. Public health funding—only 1.9 percent of the gross domestic product (GDP)—remains well below the National Health Policy (2017) target of 2.5 percent by 2025.²³

The lack of a comprehensive and systematic approach to health policies, inadequate and inefficient health financing mechanisms, and fragmentation between the public and private sectors are the primary barriers to attaining universal health coverage (UHC) in India.

Strategies for Policy Alignment

Transforming India's healthcare system requires strengthening regulation, expanding generics adoption, optimising supply chains, and improving healthcare integration. This article makes the following recommendations:

Strengthen Regulatory Oversight

A concern with generic medicines in India is inconsistent regulatory enforcement. While CDSCO sets standards, state-level variations in implementation lead to substandard or counterfeit drugs entering the market. Currently, regulatory and inspection procedures vary across states, causing compliance challenges.

To address this, drug regulations must be harmonised between central and state authorities to ensure uniform quality control. Leveraging digital tracking technologies—such as QR codes on medicine packs—can prevent counterfeit sales. Creating a centralised inspection database will improve compliance tracking, enhance transparency, and reveal regulatory issues in real time. Strengthening pharmacovigilance systems is also important to monitor adverse drug reactions and ensure robust post-market surveillance of generic medicines.

Enforce Stricter Quality Standards

Achieving world-class quality for generic medicines should be a national priority. Following its revision of Schedule-M,^b India should aim to secure memberships of both the Pharmaceutical Inspection Co-operation Scheme (PIC/S)^c and the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH)^d by 2030. Stringent enforcement of the revised Schedule-M must be ensured, with fixed timelines for large, medium, and small-scale manufacturers.

Mandatory bioequivalence and stability testing should be enforced for all generics prior to market approval, ensuring that safety and efficacy benchmarks are met consistently. Regular post-market surveillance and random drug testing should be conducted to identify and remove substandard medicines from circulation. Investing in drug-testing laboratories, digital tracking infrastructure, and AI-powered quality monitoring systems can enhance the reliability of generic medicines. Increasing the number of drug inspectors and regulatory officers will also strengthen overall regulatory oversight and improve compliance across all levels of the supply chain. International examples offer useful benchmarks for strengthening India's regulatory ecosystem. The US Food and Drug Administration (USFDA) mandates rigorous bioequivalence testing and post-market surveillance through its Generic Drug Programme, while the European Medicines Agency (EMA) ensures uniform quality standards across member states via a centralised drug approval system.^{24,25} China has implemented reforms making bioequivalence testing mandatory and has removed thousands of substandard generics from its market.²⁶

Promoting Generic Medicines Use

Despite policies like the PMBJP, brand loyalty and physician preference for branded drugs limit generic uptake. The PMBJP drugs list must include all essential drugs featured in the National List of Essential Medicines (NLEM). The Bureau of Pharma Public Sector Undertakings of India (BPPI) should only procure drugs that have passed mandatory bioequivalence tests; in parallel, generics should be mandatorily de-branded in phases.

^b Schedule M is the section of the Drugs and Cosmetics Act, 1940, that lays down good manufacturing practices. It was revised and updated in December 2023.

^c PIC/S, started in 1995, is a non-binding, informal arrangement between regulatory authorities worldwide to promote good manufacturing practices.

^d The ICH brings together regulatory authorities and pharmaceutical industry representatives from around the world for greater harmonisation in the development of safe, effective and high-quality drugs.

PMBJP's procurement and distribution systems require a comprehensive review to resolve recurring supply chain issues. Pharmaceutical policy reforms are needed to promote generic medicines at scale, including regulatory measures that support mandatory generic prescribing by doctors and enable pharmacists to substitute branded drugs with generic equivalents. Jan Aushadhi Kendras should be expanded across rural and underserved areas for reliable last-mile delivery and equitable access to affordable medicines.

Address Supply Chain and Pricing Barriers

High drug prices and supply chain inefficiencies disproportionately affect low-income populations. While the prices of drugs listed in India's NLEM are regulated, many critical drugs remain unaffordable. Price control should be expanded to include a broader range of essential drugs and medical devices under the Drug Price Control Order (DPCO). Encouraging domestic production of raw materials for Active Pharmaceutical Ingredients (APIs) of bulk drugs (which are currently mostly imported from China), biosimilars, and vaccines can reduce import dependence and bring down manufacturing costs. Strengthening public procurement systems is vital for consistent availability of generic medicines in government hospitals.

Technology, such as AI-driven demand forecasting, can play a transformative role in optimising supply chains, reducing stock-outs and wastage. Investments in logistics infrastructure can enhance timely delivery of quality-assured generics nationwide. Additionally, blockchain technology can track drug production and distribution, helping curb counterfeit medicines and improving transparency in the pharmaceutical supply chain.

Integrate Healthcare Delivery with Pharmaceutical Policies

Fragmentation between healthcare delivery and pharmaceutical policies leads to inefficiencies. While Ayushman Bharat provides health coverage, access to medicines remains inconsistent. To close this gap, pharmacy benefits should be integrated within Ayushman Bharat to cover outpatient medicines and reduce OOPEx. Primary healthcare centres (PHCs) should be consistently stocked with essential medicines and attended by trained pharmacists. Public-private partnerships (PPPs) should be promoted to expand affordable generic medicines, particularly in remote and underserved areas. Community health workers should be involved in educating rural populations about affordable treatment options to promote generics at the grassroots level.

Enhance Consumer Uptake of Generic Medicines

A strategic combination of policies, awareness campaigns, and education initiatives can accelerate consumer uptake of generic medicines. For example, Continuous Medical Education (CME) programmes targeting pharmaceutical detailing should be conducted, alongside sustained marketing efforts focused on educating healthcare professionals—general practitioners, diagnosticians, and providers in Tier 2 and Tier 3 cities—about the efficacy, affordability, and availability of generic alternatives.

Expanding public healthcare literacy is important. Key Opinion Leaders (KOLs) in every region should be roped in. A widespread public education campaign that normalises and encourages generic use by emphasising reduced costs, comparable quality, and increased accessibility, should be integrated into school and university curricula and wellness initiatives by corporations. Citizens should be better-informed about government efforts like the PMBJP, Jan Aushadhi Kendras, and the stringent quality checks that generic drugs undergo.

Provide Policy Support for Skilling and Upskilling

Enhancing capability and capacity building will be essential to realising the growing aspirations of the Indian healthcare and pharmaceutical sectors. Building talent across both manufacturing and regulatory bodies—at central and state levels—must be a national priority.

Course curricula must be continuously updated to match the industry's evolving needs. Inspiration can be drawn from the Bayh-Dole Act in the US,^e which propelled research in academic institutions.²⁷ India must build a high-quality talent pool in specialised areas such as cellular biology, biomedical sciences, and biomedical engineering. Taking inspiration from the United Kingdom's Catapult Centres,^f India can also build training centres for healthcare and pharmaceutical professionals, aligned with national needs and enhanced by tech-driven solutions.²⁸

^e The Bayh Dole Act, 1980, allows universities, small businesses and non-profit organisations to own their inventions and commercialise them, even if they were created with federal funding.

^f A network of nine organisations set up by the UK government to promote research and development.

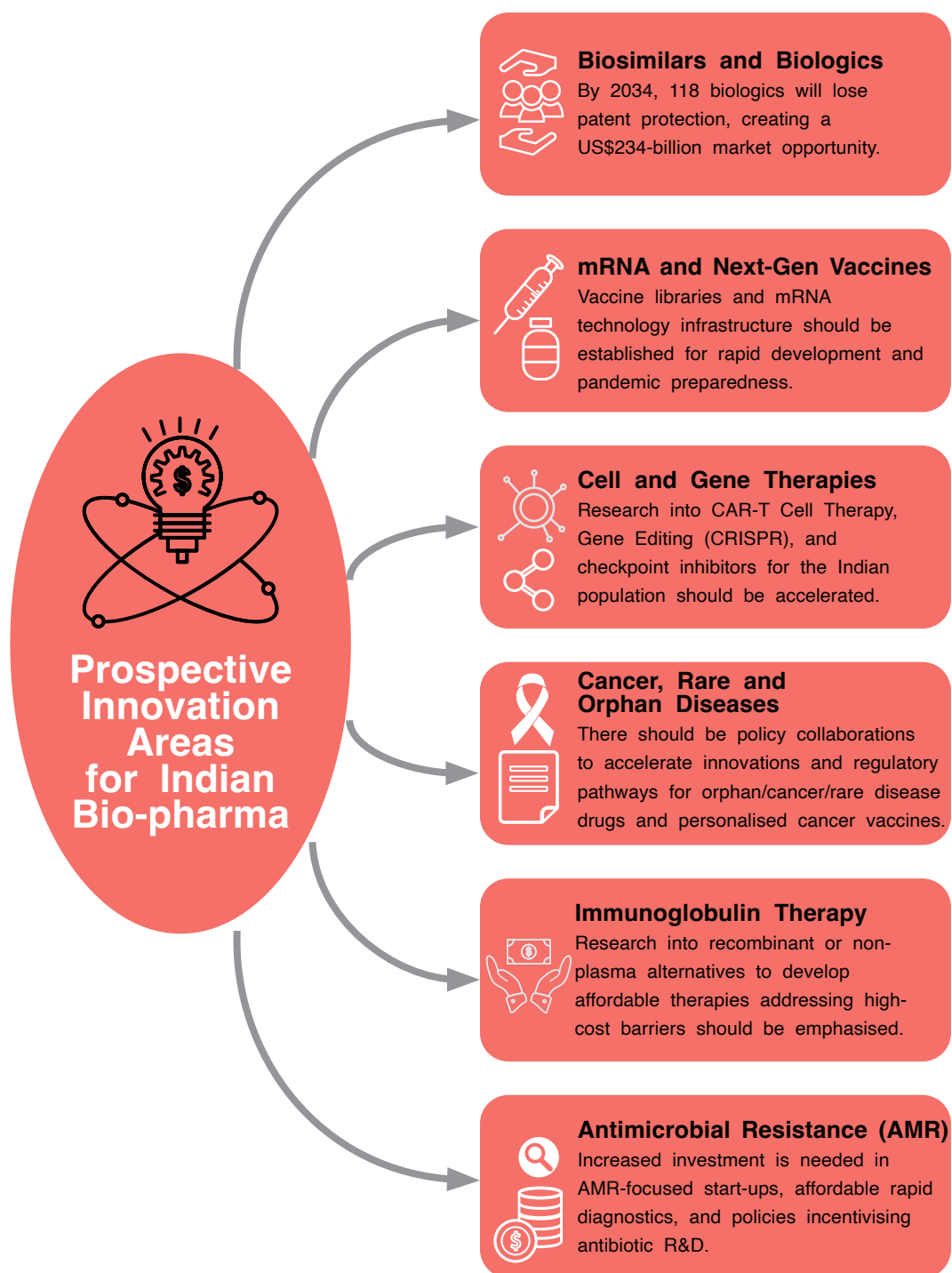
Moving from Volume to Value-Based Growth

By volume, India ranks third worldwide in pharmaceutical production, but in overall value, it stands at 14th.²⁹ Compared to global pharmaceutical firms that typically spend around 20-25 percent of their revenues on research and development (R&D), Indian companies spend approximately 8 percent.³⁰ This disparity limits India's potential to move up the pharmaceutical value chain. Apart from generic formulations, new technologies are revolutionising drug discovery and improving healthcare outcomes. However, exploiting these advances in India to develop new drugs and get them to patients can be extremely challenging.

India accounts for approximately 2 percent of global clinical trials despite having 16 percent of the world's population. It needs to more than double global clinical trial share to 5-6 percent and become a global R&D hub, which could have 50-60 percent lower trial costs compared to the US and the EU. To support this transition, Indian trial data should align with US FDA and EMA regulatory standards. Benchmarking Indian regulations against international frameworks—adopting International Council for Harmonization-Good Clinical Practice (ICH-GCP) standards and establishing fast-track recognition agreements with regulators—like the USFDA, EMA, and Japan's Pharmaceutical and Medical Devices Agency (PMDA)—is crucial to meet global quality and safety standards.

Public-private R&D collaboration must be strengthened through targeted incentives, including cost-sharing models with the government, robust industry-academia partnerships, and post-development enablers like temporary exemption from price regulation for novel, high-impact drugs. Strategic focus should extend beyond diagnostics and sequencing to include advancements in bio-manufacturing processes and novel drug formulations, including genomic insights, which are increasingly guiding targeted therapies, personalised medicines, and gene-based treatments, demanding precision-oriented manufacturing methods and innovative formulations for stability, targeted delivery, and bioavailability.

Inter-agency coordination between regulatory bodies such as the Review Committee on Genetic Manipulation (RCGM) and CDSCO must be institutionalised through formal communication channels and joint review mechanisms.



Conclusion

India's pharmaceutical prowess as the world's largest generic drug and vaccine supplier contrasts sharply with the lack of access to the same for millions of Indian citizens. In keeping with the goal of Viksit Bharat by 2047, India needs to fast forward a visionary policy, develop infrastructure, and invest in people and R&D to create value.

Of the recommendations made earlier, four are most crucial: unifying regulatory standards; mandating universal generic prescribing; integrating medicines into Universal Health Coverage; and accelerating innovation. India's policymakers, healthcare leaders, and the pharmaceutical industry must unite to transform the country's pharmaceutical strength into genuine healthcare equity, serving as a model for emerging economies worldwide. By aligning policy intent with implementation, India can strengthen its health system while reinforcing its global leadership in pharmaceutical equity.

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AI in Healthcare: Game-Changer or Game of Chance?

Divleen Jeji

Abstract

Artificial Intelligence (AI) is transforming global healthcare, offering unprecedented opportunities to improve access, efficiency, and outcomes. This chapter explores AI as both a “game-changer” and a “game of chance”. It outlines AI’s transformative potential across key domains: enhancing diagnostic precision, accelerating drug discovery, enabling personalised medicine, optimising hospital operations, supporting public health, and redefining patient engagement. These advancements promise faster, more equitable care and cost-effective innovation, but they also pose ethical risks. They include privacy threats to information, algorithmic bias and its capability to amplify health disparities,

uninterpretable “black-box” models and loss of interpretability, failure in real-world implementation due to poor-quality data, displacement of the workforce, uncertainty about regulation, and cultural resistance.

Introduction

Artificial Intelligence (AI) is rapidly integrating into the healthcare sector, presenting a profound opportunity to address global challenges such as widespread lack of access to essential healthcare services and persistent staffing shortages. This chapter explores AI’s dual nature: its capacity as a “game-changer” through its transformative applications and its character as a “game of chance” due to various ethical, operational, and regulatory hurdles. AI is delivering benefits across healthcare—from improving diagnostic accuracy and speed, to accelerating drug discovery, enabling personalised treatments, and streamlining operational efficiencies. Together, these advancements promise better patient outcomes, lower costs, and a more responsive healthcare system. However, integration is not without risks. Concerns include the sensitivity of patient data, algorithmic bias that could worsen health disparities, unresolved issues of accountability and liability, and the challenges of real-world implementation. If not carefully managed, these risks could erode public trust, cause unintended harm, and stall the adoption of valuable AI technologies.

To fully harness AI’s immense potential responsibly, a balanced and strategic approach is imperative. This involves establishing robust regulatory frameworks, adhering to comprehensive ethical guidelines, fostering continuous engagement amongst all stakeholders, and maintaining a “human-in-the-loop” model where AI serves to augment, rather than replace, human expertise. Such a deliberate and thoughtful integration is crucial to navigate the complexities and ensure AI truly becomes a transformative force for global health.

The Transformative Potential of AI in Healthcare

AI is poised to revolutionise healthcare by enhancing accuracy, efficiency, and accessibility. It is rapidly being deployed, reshaping how diseases are diagnosed, treatments developed, care personalised, and operations managed. The following sections explore its transformative applications and potential as a powerful force for change.

A. Enhanced Diagnostics and Medical Imaging

AI, particularly advanced deep learning models like Convolutional Neural Networks (CNNs), demonstrates exceptional ability to analyse vast quantities of medical imaging data—such as X-rays, MRI, CTs, and Optical Coherence Tomography (OCT) scans.¹ In specific diagnostic tasks, this analytical power often surpasses human capabilities in both accuracy and speed.²

One of AI's most impactful contributions lies in early disease detection. AI can interpret brain scans and detect early signs of over 1,000 diseases.³ A UK study found that an AI tool successfully detected 64 percent of epilepsy-related brain lesions previously missed by radiologists, spotting subtle or obscured anomalies faster than the human eye.⁴ Additionally, AstraZeneca has developed a machine learning model that can predict diagnoses years in advance by identifying predictive “signatures” in an individual's medical data for conditions such as Alzheimer's, chronic obstructive pulmonary disease (COPD), and kidney disease.⁵

In pathology and radiology, AI provides crucial diagnostic assistance for conditions such as cancer, retinal diseases, and pneumonia.⁶ Deep learning models trained on extensive datasets of annotated pathology images can diagnose, grade, and predict disease progression with high precision—at times outperforming human histopathologists in tasks like classifying melanoma.⁷

The efficiency and accuracy brought by AI-powered diagnostic tools are substantial, leading to a reduction in both false positives and false negatives, which in turn results in more reliable screening programmes.⁸ This enhanced diagnostic capability facilitates prompt action before medical conditions escalate, ultimately contributing to a reduction in healthcare costs associated with late-stage diagnoses.⁹

AI's primary role in diagnostics is not to replace human clinicians but to enhance their capabilities. It acts as an intelligent assistant—processing vast datasets, identifying subtle patterns, and flagging anomalies at speeds beyond human capacity. This synergistic relationship frees human experts to concentrate on complex cases requiring nuanced judgment, empathy, and direct patient interaction, ultimately improving diagnostic accuracy and efficiency. The goal is to make practitioners more effective and expeditious, not obsolete.

B. Accelerated Drug Discovery and Development

Traditional drug discovery and development is protracted and expensive, often spanning over 12 years and incurring costs exceeding US\$2 billion, with high rates of clinical trial failure.¹⁰ AI is revolutionising this landscape by accelerating timelines and reducing associated expenditures.

Models like AlphaFold improve protein design by offering detailed insights into protein behaviour and interactions.¹¹ AI can also generate entirely novel drug suggestions.¹²

Furthermore, AI plays a role in clinical trial optimisation. It aids in risk prediction and safety monitoring, identifying potential adverse events early in the trial process.¹³ Insilico Medicine utilised its AI models to advance a treatment for idiopathic pulmonary fibrosis to clinical trials within 18 months—a process that typically takes four years.¹⁴

C. Precision and Personalised Medicine

AI is revolutionising medical care through precision and personalised medicine by tailoring interventions to an individual's unique genetic profile, medical history, lifestyle choices, and real-time data from wearable devices.¹⁵

A key aspect is predictive modelling, where AI algorithms determine optimal drug types and dosages based on genetic information.¹⁶

AI systems can integrate with wearable devices to continuously monitor patient health, detecting early signs of conditions like arrhythmias and alerting clinicians to potential medical issues.¹⁷ Beyond alerts, AI-integrated devices, such as insulin pumps, can dynamically adjust therapy based on real-time patient data.¹⁸

D. Optimising Operational Efficiency and Administration

Healthcare systems worldwide are burdened by extensive administrative tasks that consume much of medical professionals' time, often diverting them from direct patient care.

Companies like Google and Microsoft (with its Dragon Co-pilot) are already providing AI solutions to streamline these administrative functions.¹⁹

An example is the Johns Hopkins Capacity Command Centre, which leverages AI-powered predictive analytics to anticipate surge demands and optimise bed allocation.²⁰

E. Robotics in Surgery

Precise and minimally invasive AI-powered robotic surgery improves outcomes and expands the accessibility of complex surgeries. This enhances the capacity and quality of surgical care globally, potentially making advanced surgical interventions available to more individuals who previously had limited options.

F. Public Health and Patient Engagement

AI is also transforming public health initiatives and enhancing patient engagement, shifting the focus towards more proactive and personalised healthcare interactions. Virtual health assistants and AI-powered chatbots are increasingly being implemented to improve patient care and engagement.²¹

In the realm of public health, predictive analytics platforms are proving invaluable. For example, Brazil's EpidemicAI is able to make accurate forecasts of disease outbreaks, enabling timely resource mobilisation and containment.

In India, the HealthAI mobile app has been used by over 100,000 patients at the time of writing, improving treatment adherence by 40 percent.²²

The Pitfalls and Perils: Navigating the “Game of Chance”

A. Data Privacy and Security Concerns

AI systems in healthcare require processing highly sensitive patient data, including diagnoses, clinical images, genetic information, and comprehensive medical records.²³ While digitisation enables AI's capabilities, it also heightens the need to secure this information.²⁴

B. Algorithmic Bias and Health Disparities

A critical risk associated with AI in healthcare is algorithmic bias, which can lead to systematically prejudiced results and exacerbate existing health disparities.¹⁵ AI systems learn patterns from the data they are trained on, and if that data

is unrepresentative, historically biased, or lacks diversity, the AI will inevitably reproduce and often amplify those biases.²⁵

This necessitates a proactive, ethical imperative to ensure diverse datasets, transparent algorithms, and inclusive design to prevent AI from becoming a tool that widens health disparities.

C. Accountability and Liability

A challenge is the “black box” problem, where many cutting-edge AI technologies, especially deep learning systems, operate with opaque algorithms.²⁶ This “black-box reasoning” makes it difficult, if not impossible, to understand precisely how these systems arrive at their conclusions, hindering trust and validation by clinicians.²⁷ Addressing this requires strategies for accountability, including prioritising Explainable AI (XAI) to make models more interpretable.²⁸ Open-source development for peer review and comprehensive training for clinicians on AI’s capabilities and limitations are also vital components.²⁹

D. Implementation Hurdles and Past Failures

Despite AI’s promise, its adoption in clinical practice remains limited due to implementation challenges.³⁰ These hurdles often transform AI initiatives from “game-changers” into a “game of chance” with a high probability of failure.

Common pitfalls contributing to unsuccessful AI implementations include:

- **Misaligned Use Cases:** Organisations often embark on AI initiatives without a clear understanding of the problem AI is intended to solve, leading to solutions that do not meet actual needs or integrate effectively into existing workflows.³¹
- **Poor Data Quality:** AI models are highly dependent on the quality, diversity, and representativeness of their training data.³² Over-reliance on synthetic data or insufficient real-world data can lead to inaccuracies and ineffective models, as demonstrated by the IBM Watson for Oncology case.³³ Data, siloed across different healthcare facilities further complicates the development of broadly applicable models.³⁴
- **Lack of Resources:** Many organisations initiating AI projects underestimate the need for specialised Machine Learning engineers, adequate data storage, and sufficient computational resources required for training and running AI solutions.³⁵

- **Integration Challenges:** Legacy technology systems in healthcare often lack compatibility with modern AI tools, creating complex technical and interoperability issues during integration.³⁶
- **High-Cost Considerations:** The initial investment required for advanced AI tools, digital scanners, and comprehensive staff training can be prohibitive, particularly for smaller or budget-constrained healthcare providers.^{37,38}
- **Cultural Resistance:** Non-technical barriers, such as scepticism toward AI and doubts about its ability to grasp the nuances of human care, contribute to resistance within healthcare institutions.³⁹

Notable failures underscore these challenges. The IBM Watson for Oncology project, once launched with high expectations, encountered serious issues by 2018 due to inaccurate and unsafe recommendations and was ultimately discontinued in 2023.⁴⁰

E. Workforce Impact: Displacement vs. Augmentation

The integration of AI into the healthcare workforce often raises concerns about job displacement. However, a prevailing perspective among experts is that AI serves primarily as a “catalyst for change, not a competitor” to human healthcare professionals.⁴¹ AI is seen as an ally that augments human capabilities rather than replacing them entirely,⁴² suggesting a redefinition of roles rather than outright elimination.

F. Trust Barriers and Patient Expectations

A challenge to the widespread adoption of AI in healthcare is public scepticism and a general lack of trust in AI for health advice or critical medical decisions. This scepticism is often rooted in concerns about accuracy. The demand for transparency is high; 80 percent of consumers would want to be informed if a doctor used AI in medical decision-making.⁴³

Key Ethical Principles for AI in Healthcare

Despite differing regulatory approaches across jurisdictions, a global consensus is emerging around common ethical principles to guide the responsible development and deployment of AI in healthcare.⁴⁴ These principles are fundamental to building trust and ensuring that AI serves humanity’s best interests.

Core principles, as highlighted by frameworks like FUTURE-AI and others, include:

- **Transparency and Explainability:** AI tools should provide clinically meaningful information about the logic behind their decisions. Their use, data sources, and methods should be clearly documented, accessible, and understandable to users.⁴⁵ This clarity is vital for clinicians to trust and validate AI-generated insights.
- **Fairness and Avoiding Bias:** AI systems must be carefully designed and trained on diverse, representative datasets to ensure equitable performance across all demographic groups,⁴⁶ thereby avoiding the reinforcement of existing health disparities.
- **Accountability and Human Oversight:** Clear mechanisms for determining responsibility in the event of AI errors are essential.⁴⁷ AI should function as a decision-support tool, with qualified healthcare professionals retaining final decision-making authority—a “human-in-the-loop” approach.⁴⁸ This ensures that human judgment and empathy remain central to patient care.
- **Patient Privacy and Data Protection:** Strong safeguards must govern the collection, storage, and sharing of patient data, ensuring confidentiality and compliance with regulations such as the Health Insurance Portability and Accountability Act (HIPAA) and General Data Protection Regulation (GDPR).⁴⁹ Patients should be fully informed about AI’s role in their care and retain the right to consent or opt out.⁵⁰
- **Safety and Reliability:** AI tools must undergo rigorous validation through clinical trials and continuous post-market monitoring to ensure their accuracy, effectiveness, and paramount patient safety.⁵¹
- **Usability and Universality:** AI tools should be user-friendly, seamlessly integrate into existing clinical workflows, and be generalisable across diverse patient populations and varied clinical settings to ensure broad applicability and adoption.⁵²

The widespread, ethical adoption of AI in healthcare is not merely a moral obligation but a strategic imperative for its long-term success. The “game of chance” transforms into a “game-changer” only when AI development and deployment are anchored in a robust ethical framework. Adherence to principles like transparency, fairness, and accountability builds the critical trust necessary for patients and clinicians to accept and integrate AI into their daily lives. This ensures sustainable innovation and prevents a backlash, enabling a healthcare system that is both technologically advanced and deeply human-centred.

Conclusion: Balancing Innovation with Responsibility

Artificial Intelligence in healthcare stands at a critical juncture, unequivocally presenting itself as both a “game-changer” and a “game of chance”. Its transformative power to enhance diagnostics, accelerate drug discovery, enable personalised medicine, and optimise operational efficiencies is undeniable. AI promises a more accessible, efficient, and effective healthcare system for billions of people across the globe, addressing long-standing challenges like access to care and clinician burnout.

Yet, this transformation is fraught with risks. Concerns related to the privacy and security of sensitive patient data, algorithmic bias that could deepen health disparities, complex questions of accountability and liability in AI-driven decisions, and the inherent hurdles of real-world implementation pose considerable challenges. If not proactively addressed, these issues could erode trust, lead to costly failures, and hinder widespread adoption.

Maximising AI’s benefits while effectively mitigating its risks demands a strategic, multi-faceted approach:

- **Prioritise Trustworthy AI:** Development and deployment must be grounded in principles of explainability, fairness, and human oversight. Systems should be transparent, allowing clinicians and patients to understand how decisions are reached, thereby fostering confidence.
- **Strengthen Regulatory Frameworks:** Global collaboration is key to harmonising AI regulations. Frameworks must be robust enough to protect patients and ensure ethical use, without stifling innovation. Lessons from the EU, UK, and US regulatory approaches can help shape effective pathways.
- **Invest in Data Quality and Diversity:** Tackling biased or insufficient data is essential. This requires curating diverse, high-quality datasets that reflect global populations, ensuring equitable and accurate AI performance.
- **Focus on Augmentation, Not Replacement:** The healthcare workforce must be prepared for an AI-augmented future through targeted education and training. This involves redefining professional roles to leverage AI’s strengths in data processing and automation while preserving and enhancing the irreplaceable human elements of judgment, empathy, and complex patient interaction.

- **Learn from Failures:** Past setbacks, such as IBM Watson for Oncology, offer valuable lessons. Analysing these failures is vital to avoid repeating mistakes and to develop more resilient, effective AI systems.

The future of AI in healthcare is not predetermined—it will be shaped by deliberate choices and collective action. By balancing ambitious innovation with ethical responsibility, stakeholders can navigate the uncertainties of this “game of chance” and realise AI’s full potential as a true “game-changer” for global health and human well-being.

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From the Ground, Up: Reimagining India's Digital Health Future Through Community Health Workers-Led Innovation

Sujay Santra, Pompy Sridhar, and Tirumala Santra Mondal

Abstract

India's innovation in telemedicine is being catalysed by venture capital investments, the government-initiated Ayushman Bharat Digital Mission (ABDM), and health technology adoption post-COVID-19. The market is projected to reach US\$50 billion by 2033. Despite this growth, these solutions are disproportionately urban-focused, with interest largely in pilot programmes and app-based platforms that overlook the systemic gaps in the ecosystem. This article recommends that a pivot to a Community Health Workers-led (CHW) healthcare model by 2030 can ensure equitable health outcomes and greater reach among underserved

communities. When powered by health-tech investment, this model is poised to usher in more inclusive, scalable, and sustainable innovations for the people who need them most.

Introduction

In the past few years, India has witnessed a surge in health technology (health-tech) investments. Smartphones have penetrated remote villages, government initiatives like the Ayushman Bharat Digital Mission (ABDM) have seen increased coverage, and digital health platforms encompassing remote diagnostics, e-pharmacy services, and Artificial Intelligence (AI)-assisted disease prognosis have flourished. Venture capital has poured into these platforms, driven by a large untapped consumer base and increasing digital adoption across rural and semi-urban India.¹

However, this growth conceals a crucial inequity as innovations continue to be designed for urban consumers with digital literacy and high-speed internet. A 2021 Rockefeller Foundation and PATH study revealed that more than 70 percent of digital health pilot projects remain confined to cities, and only 10 percent of India's population—mostly urban—enjoys the benefits. The remaining 70 percent of India's rural villages rely on overstretched primary care systems that lack adequate staff, equipment, and connectivity.²

This urban skew in innovation and investment is not new. Private capital tends to avoid rural health-tech solutions due to a combination of systemic challenges, including infrastructure limitations. The lack of digital infrastructure impedes both adoption and scalability in rural regions. Additionally, rural populations—with lower purchasing power and irregular demand patterns—reduce the appeal of high-growth investment.³ Rural India continues to have little to no connectivity to digital services, and the digitisation of healthcare has not necessarily improved access to public health services as intended.⁴

A lack of clear incentives or frameworks supporting rural-specific digital health innovation makes urban-centric models easier to scale. As a result, India's digital health revolution risks reinforcing existing health inequities rather than eliminating them.

The urban skew in digital health innovation and investment also poses a structural challenge to achieving universal health coverage, including Sustainable Development Goal (SDG) 3—ensuring healthy lives and promoting well-being for all. The solution to bridging the last-mile delivery gap lies in empowering Community Health Workers

(CHWs)—the frontline agents of care who form the backbone of primary healthcare in low- and middle-income countries (LMICs).⁵ CHWs have advanced population well-being through promotive, preventive, and curative services irrespective of a country's overall development.

CHWs, as they are drawn from the communities they serve, can navigate cultural, linguistic, and geographic barriers more effectively than formal healthcare professionals. Due to their sense of belongingness to the community, they are trusted and are often the first point of contact. Their responsibilities are diverse and critical, including maternal and child health, immunisation, infectious disease surveillance, and chronic disease monitoring to referral support, health education, and behaviour change communication.

In LMICs, where health systems are overstretched and underfunded and severe shortages of trained medical personnel persist, CHWs are an economically viable and trusted alternative for expanding the reach of primary healthcare services. For example, India's ASHA (Accredited Social Health Activist) programme has played a pivotal role in increasing institutional births, immunisation coverage, and early disease detection in rural regions. CHWs are also critical to digital health initiatives in LMICs, facilitating data collection and teleconsultation when equipped with digital tools and literacy. Thus, innovations that integrate digital health platforms with human infrastructure like CHWs become tools for inclusive health equity across regions and socio-economic groups.

CHWs, particularly in the form and capacity of ASHAs and ANMs (Auxiliary Nurse Midwives), are pivotal to grassroots healthcare delivery. Yet they face systemic challenges such as inadequate formal training in digital tools, limited incentives, and exclusion from tech-driven innovations.⁶ Despite their frontline connection, they remain passive users of health-tech. Designing health-tech with CHWs in mind ensures a sustainable, culturally rooted, and scalable model. Often the first and only point of contact in underserved areas, they are uniquely positioned to enhance healthcare delivery when equipped with the right digital tools and incentives.

Primary healthcare delivery driven by CHWs can enhance data accuracy, improve patient follow-up, and expand outreach. With the appropriate digital knowledge, they can be empowered to become community health entrepreneurs, offering incentive-based services and earning livelihoods. The following are a few examples selected for an exploration of how adopting a CHW-led model can democratise healthcare and improve health outcomes among vulnerable and underserved groups.

Indonesia: Halodoc

In Indonesia, mobile-based platforms like Halodoc are a one-stop platform that connects doctors, specialist diagnostics, and pharmacies in collaboration with CHWs and local clinics to serve remote users. Thus, local clinics are empowered to provide referral pathways for more complex conditions. Health packages are sold through offline kiosks and pharmacies, reducing barriers to entry. This multifaceted approach improves access to healthcare, particularly for remote, underserved populations.

What makes these models particularly effective is their hybrid architecture that connects digital platforms with offline services like pharmacies, health kiosks, and CHWs, enabling them to bridge gaps in digital literacy and trust, and strengthening the continuity of care. It goes beyond referrals, issuing e-prescriptions, and arranging for medicine deliveries and home lab tests. This approach improves healthcare access and offers valuable insights for replication in India, where similar gaps in rural access persist.⁷

Colombia: MSF

Colombia's MSF (Médecins Sans Frontières) model is supported by its CHWs network through in-person outreach. CHWs identify at-risk patients and schedule home visits and teleconsultations. They also engage in educating communities about health risks, preventive measures, and healthy behaviours. Additionally, CHWs conduct community outreach, provide health education, and deliver health messages through various channels. AI-powered triage tools help prioritise care and route patients to specialists if needed.

This approach places emphasis on prevention, early detection, and empowering CHWs as frontline providers in rural and semi-urban settings. The MSF's emphasis is on hybrid outreach, with home visits led by in-person engagement to overcome digital barriers in far-flung areas.⁸

Bihar, India: Sakhi

Sakhi, an innovative mobile application developed as part of the AMRIT initiative, enables ASHAs to digitally record beneficiary-level data, track non-communicable diseases, monitor maternal and child health, and manage immunisation, among other functions. The app streamlines data collection, reduces errors, and enhances

the efficiency of ASHAs, allowing them to focus on delivering care digitally. This has empowered ASHAs to strengthen their relationships with beneficiaries, as the community now views them as trusted advisors.⁹

Rwanda: RapidSMS

The Rwanda Ministry of Health uses RapidSMS, a text-based system that allows CHWs to track maternal health indicators. CHWs use their mobile phones to record new pregnancies in the RapidSMS system, including the mother's and infant's identification, and parameters like the last menstrual period. Data is monitored centrally for follow-ups and emergency alerts.¹⁰

India: iKure Techsoft

iKure Techsoft operates through a lightweight and scalable healthcare delivery model enabled by its digitally-equipped Community Health Activists (iCHAs). These CHWs are equipped with medic bags and portable diagnostic devices, including blood pressure monitors, glucometers, and echocardiography machines, which are integrated with a Wireless Health Incident Monitoring System (WHIMS). During home visits, patient data is uploaded in real time to cloud servers, enabling remote physicians to offer consultations. The system is also designed to apply AI algorithms to anonymised longitudinal data, to identify high-risk cases—such as pregnancy complications or potential cardiac risks.

iKure's healthcare model is driven by a network of CHWs and supported through digital health cards (Starter, Silver, Gold, Platinum), which have successfully enabled preventive healthcare access at the last mile. However, there are limitations in terms of coverage, scale, and programme evaluation—especially in addressing the underserved and hard-to-reach populations.¹¹

The coverage limitations include insufficient diagnostic infrastructure and referral challenges for patients requiring emergency interventions. While digital health cards bundle consultations, diagnostics, and medicine discounts, their reach is constrained by the digital divide, where many rural patients do not have a smartphone or are not digitally literate. In some cases, the risk of skewed coverage persists, where CHWs focus on urban, semi-urban, or digitally literate populations that are easier to reach. To address this, iKure's model engages CHWs through incentives, ensuring equitable distribution of services.

Salient Features for Successful Community-based Health Tech

Successful CHW-led models enable integration with existing national platforms, facilitating seamless communication between platforms, tools, and services for a more cohesive and interconnected digital environment. Mobile applications, when combined with global positioning system (GPS) tagging, allow real-time monitoring and tracking of health workers. This helps identify gaps in service delivery and, when linked with health cards, enables beneficiaries to remain connected with health workers. Thus, CHWs are empowered to take ownership of the services when provided with the appropriate incentives.

AI-trained community health data allows the flagging of high-risk pregnancies and non-communicable disease (NCD) risks, facilitating timely interventions. Despite the growing promise of tech-enabled CHW models, structural and systemic limitations have historically prevented CHWs from being at the centre of health-tech adoption. Most health-tech innovations have prioritised physician-led, facility-based care and often do not include health workers in design, training, or use.

CHWs also operate in low-connectivity environments with limited digital literacy, making it difficult to adopt smartphone-based solutions without sustained support. Moreover, pilot programmes—typically funded and managed by non-government organisations or private entities—lack dedicated financing for CHW incentives. In some instances, the absence of robust outcome data, particularly regarding mortality or morbidity reduction, further limits the justification for scaling within national health frameworks. These models often lack transparent patient consent mechanisms, raising digital surveillance concerns and eventually impacting community trust. In rural regions of Colombia, for example, an international NGO piloted a mobile-phone-based data collection programme designed to support CHWs in conducting health surveillance and outreach among underserved populations. Digital literacy emerged as a primary barrier as many CHWs took external technical support to maintain data accuracy and completeness. The pilot also lacked robust mechanisms for informed consent, and fueled community apprehension, especially within indigenous groups, raising questions about surveillance and privacy.¹²

Alignment with Data Commons for Equitable Health Innovation

‘Data commons’ refers to shared repositories where data is collectively governed and accessed by the community under agreed norms, rights, and responsibilities.

Unlike traditional data ownership models, where data is siloed and used without consent, data commons promote the idea that data can be a public good and can be ethically managed. They prioritise transparency, consent, equity, and collective benefit.

With the increasing role of AI in decision-making across sectors, the need for ethically sourced and representative data has never been more urgent. As attention grows on the need for data to advance AI, data commons initiatives are redefining how data can be accessed for societal benefit. When data is reimagined as a community-owned resource, it is found to support targeted interventions and evidence-based policymaking by ensuring that even the most marginalised populations are represented in datasets used to design AI tools, predictive models, and public health responses. Aligning community health systems with data commons can pave the way for equitable AI innovation, enabling data to shape the future of healthcare.

For example, iKure's collaboration with Open Data Institute-Microsoft through a peer learning network brought together organisations of different sizes to realise the benefits of data for the public good. The objective of the collaboration was to address social, economic, and environmental challenges by curating tools and solutions around the data ecosystem, data privacy and utility, data governance, and data sustainability.¹³

Community-Led Data Governance

An effective health system relies not only on accurate data but also on trusted and inclusive mechanisms to collect, manage, and govern that data. When data governance is facilitated by CHWs, it strengthens both the authenticity of health data and communities' ownership over their health outcomes.

Such bottom-up data collection models are crucial for the early detection of disease outbreaks, emerging disease burdens, or health trends. This data is used to trigger alerts, automate follow-ups, and even predict malaria or pneumonia outbreaks.

With the implementation of the Digital Personal Data Protection Act, 2023, India now mandates new norms around personal data, including obtaining informed consent and limiting data use. These policies will be critical when deploying AI and data-driven systems in rural and low-literacy environments, where community trust and concerns over digital surveillance remain high.

A Roadmap for Scalable Innovation

A key component of transforming frontline health workers into health entrepreneurs is the incentive model that provides not only service delivery—such as screening, follow-ups, and counselling—but also subscription-based healthcare packages such as health cards, prepaid care packages, or the supply of essential commodities like sanitary pads, reading glasses, soaps, oral rehydration solution (ORS), and other medical products.

A blended revenue structure through which health workers are rewarded not just for service delivery but also for generating sustainable revenue streams through products and services is at the heart of this model. This increases healthcare access for the underserved while creating recurring income and aligning financial incentives with improved community health outcomes.¹⁵

The approach meets demands for preventive care tools, creates behavioural change, and positions frontline health workers as reliable first points of contact for everyday health needs. Additionally, this shift is not merely transactional—it also fosters entrepreneurial thinking. Health workers learn to identify unmet health needs, segment their community by risk profiles, and bundle services, creating a mindset shift from passive implementers to proactive micro-entrepreneurs investing in the health outcomes of their communities.

Training them clinically and technologically further enhances their business acumen with a deeper sense of accountability and motivation. This has resulted in a win-win loop where the community receives timely and decentralised care and health workers gain recognition, purpose, and income—empowering them socially and economically.

Programmes like iKure's iCHAs and Swasti's Invest for Wellness (i4We) model have made important contributions in this area. For example, iKure trains and equips CHWs to deliver primary care bundled with products and services, ensuring that a share of the revenue goes to them. Similarly, Swasti's i4We empowers CHWs to provide a basket of preventive and primary health services bundled with financial products, creating long-term value for both patients and providers.¹⁶

Moreover, scalable innovation depends on funding that links measurable health outcomes with tangible results to drive profound transformation in health-seeking behaviour, especially in underserved populations. For example, Chhattisgarh's

Mitanin programme and Maharashtra's CHW incentives under the National Health Mission linked performance with health outcomes, achieving significant results in NCD screening and maternal-child health.¹⁷

These models suggest that outcome-linked financing, if carefully calibrated, can drive large-scale behaviour change in both CHWs and the communities they serve. However, linking CHW incentives too aggressively carries the risk of over-medicalisation, where every interaction becomes transactional and tied to targets. If CHWs are seen more as sales agents, trust—a quality that is challenging to cultivate and, when lost, restore—can eventually erode.

Therefore, financial incentives should reward public health outcomes, and not private sector penetration. The convergence of entrepreneurial empowerment and impact-based funding mechanisms offers a powerful pathway to strengthen the primary healthcare system. The way forward is not to abandon performance-based incentives but to redesign them thoughtfully—embedding scalable innovation with dignity, trust, and shared ownership of the health system.

By positioning CHWs not only as service providers but also as health entrepreneurs, they can act as catalysts to drive scalable, sustainable healthcare delivery models that are deeply embedded in the communities they serve. However, this shift demands a deliberate investment in four foundational levers:

1. **Capacity Building and Entrepreneurial Training:** Traditional training for CHWs has mostly focused on task-based healthcare delivery. When CHWs are equipped with business acumen, digital literacy, and basic financial management skills, the results are significantly improved.¹⁸ Models like the Last Mile Health initiative in Liberia and Swasti's i4We model in India have demonstrated how training can transform CHWs into entrepreneurs.
2. **Policy and Regulatory Enablers:** For CHW-led entrepreneurship to thrive, governments must offer formal recognition or integration with existing schemes such as ABDM, thereby formalising CHWs as health data stewards and further validating their roles within the health system.
3. **Financing and Incentive Models:** CHWs can access blended financing models, including performance-linked incentives or impact-based funding from philanthropic or social enterprise partners. These can strengthen outcomes if properly regulated and aligned with public health goals.

4. **Digital Infrastructure:** Empowered CHWs, when equipped with interoperable digital health systems, can manage patient data, flag health risks, and support communities in governing their own anonymised care pathways. This must be done while preserving trust and upholding ethical integrity.

Conclusion

India's health-tech revolution can take place by addressing equity in health, access, and trust. While urban-focused platforms attract investment, the future of healthcare lies in hybrid models that combine community health workers with digital tools. CHWs are not just users but co-creators of data-driven systems that reflect local needs.

The cases of Rwanda, Indonesia, India, and Colombia described in this article are testament to the fact that when technology is designed for scale, it must begin at the grassroots. These cases have demonstrated that scaling health innovations—particularly through digital tools, community health workers, and inclusive data governance—requires designing solutions that are deeply embedded in local communities.

For example, recognising CHWs as core participants in ABDM can bring last-mile populations into the digital continuum of care through clearly defined pathways. Technologies that are co-created with communities, responsive to their needs, and governed with transparency are more likely to achieve sustained adoption and systemic impact.

When digital health systems are anchored in grassroots networks, they are not just enablers but they democratise the power of data and innovation. Thus, India has the opportunity not just to digitise healthcare but to reimagine it—from a fragmented, urban-centred system to one that is decentralised, community health worker-driven, and digitally enabled—creating a truly inclusive health-tech revolution.

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Improving the Accessibility, Affordability, and Quality of Essential Medicines and Vaccines in India

Bhupendra Singh and Nimisha Chadha

Abstract

India, often referred to as the “pharmacy of the world”, plays a pivotal dual role—serving global pharmaceutical markets while striving to meet the health needs of its own population. Despite its vast manufacturing capacity and substantial contributions to the production of generic medicines and vaccines, the country continues to face persistent challenges to ensuring equitable access, financial protection, and quality assurance in the domain of medicines and vaccines. This chapter examines the structural and systemic barriers that undermine India’s efforts to provide affordable essential medicines to all. It explores disparities in the distribution of essential

medicines and vaccines, the enduring burden of out-of-pocket expenditure on households, and lapses in regulatory oversight and enforcement. Strengthening the interlinked pillars of accessibility, affordability, and quality is imperative, not only for advancing domestic health equity, but also for sustaining India's credibility and leadership in the global pharmaceutical arena.

Introduction

Essential medicines and vaccines are the cornerstones of any effective healthcare system. India presents a paradox: although considered the “pharmacy of the world”, supplying 20 percent of the generic medicines globally and producing 60 percent of global vaccines,¹ large segments of the population continue to face massive barriers to accessing quality and affordable medicines and vaccines.

Medicines constitute the single largest component of household health expenditure in India, accounting for approximately 43 percent of out-of-pocket expenditure (OOPE) in 2015-16.² A NITI Aayog report highlighted stark disparities in the availability of essential medicines at government health facilities across states: while 30-35 essential medicines were reported to be out of stock in Uttar Pradesh, around 90 percent were available in Rajasthan.³ Similar disparities persist in access to essential childhood vaccines, with full immunisation coverage reaching 91 percent in Odisha but only 57 percent in Nagaland.⁴

Access and affordability mean little if medicines are not of assured quality. A World Health Organization (WHO) investigation in 2023 linked the deaths of some 66 children in West African countries to a cough syrup manufactured in Haryana.⁵ Since 1972, five such incidents have been reported globally, resulting in deaths or severe adverse effects.⁶ In its routine inspections, the United States (US) Food and Drug Administration (FDA) regularly identifies deficiencies and quality concerns in Indian manufacturing facilities, including export facilities, often mandating corrective measures.⁷ A large-scale survey, conducted by the Central Drug Standards Control Organisation (CDSCO) in January 2024, found that about 15 percent of small-scale pharmaceutical companies were producing substandard medicines.⁸

Concerted effort to strengthen the three pillars of medicines and vaccines—accessibility, affordability, and quality—is required to help achieve this essential component of UHC.

Pillars of Medicine and Vaccine Access

Accessibility

Despite the strength of India's pharmaceutical industry, which manufactures the majority of the drugs listed under the National List of Essential Medicines (NLEM), systemic inefficiencies continue to hinder equitable access.

Supply Chains

To streamline the distribution networks, particularly in underserved areas, the Pradhan Mantri Bhartiya Janaushadhi Pariyojana (PMBJP) was launched in 2008, under which government-sponsored generic medicine stores or Jan Aushadhi Kendras (JAK) were opened across the country.⁹ As of 2024, around 13,800 JAKs had been set up. Approximately one million people procure medicines from these centres daily. The government is aiming for 25,000 outlets to enhance both accessibility and affordability, leveraging their dual utility to reach underserved areas.¹⁰ In a parallel exercise, some states have established dedicated autonomous bodies for procurement and distribution of medicines which has helped achieve greater availability.¹¹ However, challenges to ensuring consistent availability of stocks persist, along with limited public awareness. Additionally, the proportion of pharmacists, registered with the Pharmacy Council of India, who have joined the PMBJP scheme remains low, despite the offer of a 20-percent commission.¹² Outlets in remote areas remain limited and face constant supply shortages.¹³

Digital Innovation

Adopting digital inventory systems, such as the Electronic Vaccine Intelligence Network (eVIN), Health Management Information System (HMIS), and Drugs and Vaccines Distribution Management System (DVDMS or e-Aushadhi), to track stocks and consumption in real time can enable forecasting, while preventing shortages. However, its implementation across states has been uneven due to challenges associated with lack of training, unreliable internet connectivity, and parallel systems for different programmes such as those pertaining to TB and HIV.¹⁴

India is also piloting drone-based medical delivery in collaboration with the World Economic Forum, bridging last-mile access to remote and hard-to-reach communities.¹⁵ E-pharmacy platforms are gradually expanding in reach, and can better serve rural and remote populations. However, regulatory ambiguities, such as

a vague definition of e-pharmacies and challenges with the prescription verification system, are delaying the sector's expansion.¹⁶ A clear policy framework, along with incentives to set up rural warehouses and refined licensing mechanisms, can allow e-pharmacies to complement traditional models of distribution.

Manufacturing Bottlenecks

In some cases, shortages occur when manufacturers reduce or cease production of less profitable drugs, particularly when price controls or competition from rival brands render production unviable. Under the Drug Price Control Order (DPCO), 2013, the National Pharmaceutical Pricing Authority (NPPA) revises ceiling prices annually, based on the wholesale price index (WPI).¹⁷ While this mechanism is essential for affordability, it must also safeguard supply viability.

This problem is exacerbated by India's dependency on China for approximately 70 percent of active pharmaceutical ingredients (APIs), creating supply vulnerabilities in case of trade disruptions or cost escalations.¹⁸ To address this, the government has initiated the Production Linked Incentive (PLI) scheme to reduce API dependence and developed bulk drug parks with common facilities for manufacturers.¹⁹ However, as of 2024, only 34 projects have been commissioned for 25 bulk drugs under the PLI scheme.²⁰

Vaccine Infrastructure

India's Universal Immunisation Programme (UIP) is one of the largest globally, targeting over 27 million infants and 30 million pregnant women annually.²¹ Mission Indradhanush, launched in 2014, aimed at further extending reach to underserved regions.²² Over the years, the government has invested heavily in cold chain infrastructure and delivery networks, large-scale campaigns, and meticulous micro-planning to ensure accessibility and raise coverage, leading to a 76.6-percent full immunisation rate for children up to two years of age, according to the National Family Health Survey (NFHS-5).²³ However, adult immunisation uptake remains low and continued investments are required.²⁴

Affordability

The perception that medicines in India are cheaper, compared with those in developed nations, often obscures a critical reality: once adjusted for purchasing power parity (PPP), the costs impose a disproportionate financial burden on Indian

patients. Global comparisons have shown that the PPP-adjusted prices of select patented cancer drugs in India surpass those in countries such as the United States, the United Kingdom, and Australia.²⁵

Policy Interventions

The Free Drugs Service Initiative (FDSI), launched in 2015, incentivises states to offer medicines to everyone accessing public healthcare, regardless of income. Along with ensuring accessibility, the PMBJP offers generics at prices averaging 50 percent of the cost of their branded counterparts. Over the past decade, the JAKs have sold medicines worth INR 6,100 crore, estimated to have saved Indian consumers around INR 30,000 crore.²⁶ Moreover, in recent years, given the uptake in domestic production, the government has also been able to conduct public immunisation programmes free of cost for target populations.

Regulatory Controls

A 2018 NPPA report revealed that the prices of drugs, medical devices, and other medical accessories were arbitrarily inflated by as much as 1,700 percent by private hospitals.²⁷ Using a market-based pricing model, the NPPA fixed price ceilings for 928 scheduled formulations and retail prices for drugs, resulting in annual savings of INR 3,788 crore for patients.²⁸ For higher-priced patented drugs, the NPPA engages in price negotiations. In extraordinary cases and in health emergencies, compulsory licensing can be utilised, allowing the government to permit third parties to produce a patented drug without the patent holder's consent.²⁹ Additionally, the recently established Health Technology Assessment India (HTAI) continuously evaluates medicines and devices based on clinical effectiveness, cost-effectiveness, and equity to ensure affordability and quality.³⁰

Health Financing

Even though OOPE has fallen from 64.2 percent to 39.4 percent in recent years, it remains well above the global average of 17-20 percent.³¹ Among high-income nations, OOPE amounted to 13.03 percent in 2021, whereas several low-income countries like Botswana, Brunei, Cuba, and Mozambique achieved OOPE levels under 10 percent.³² While the Ayushman Bharat-Pradhan Mantri Jan Arogya Yojana (AB-PMJAY) offers inpatient coverage, outpatient care is not covered yet. However, some schemes, such as the Employee State Inpatient (ESI) scheme, also reimburse outpatient medicine purchases.³³

Demand-side Challenges

Widespread scepticism regarding the efficacy of unbranded generics continues to deter the uptake of medicines from JAKs, fuelled by perceptions of 'inferior quality'. In 2017, the prime minister announced plans to mandate that doctors prescribe medicines by their generic names;³⁴ it has yet to be enforced. Physicians who benefit from prescribing particular brands may resist, rendering the Uniform Code of Pharmaceutical Practices (UCPMP) ineffective. Moreover, the very nature of provisions under UCPMP makes it a toothless and non-practical code for enforcement.

Quality

While India's position as the third largest pharmaceutical producer by volume ensures widespread availability, the proliferation of manufacturing units and the practices of third-party manufacturing units, including established companies, across the country presents a regulatory challenge, particularly in maintaining consistent quality across both generic and branded products.

GMP Compliance

Historically, liberal manufacturing parameters have led to the proliferation of pharmaceutical enterprises across India. Many companies have been resisting the implementation of WHO-prescribed good manufacturing practices (GMP), despite longstanding concerns over quality and safety of medicines produced in India. Only recently has the government mandated that all manufacturing units must comply with WHO GMP by 31 December 2025.³⁵ Schemes like the PMBJP aim to ensure quality by offering generics procured only from GMP-compliant units, with each batch tested in laboratories accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL).³⁶

Enforcement Gaps

The CDSCO, which is responsible for approving drugs, conducts quality tests and issues alerts for stakeholders regularly.³⁷ However, no information on follow-up enforcements is available. The information asymmetry regarding the outcomes of the quality enforcement measures hampers the credibility of the Indian pharmaceutical industry. Additionally, there is a shortage of drug inspectors and testing laboratories relative to the size of the industry. India has over 10,500

pharmaceutical manufacturing units and 3,000 companies spread across states; however, as of December 2023, the CDSCO operated with only 201 working drug inspectors out of 504 sanctioned posts.³⁸

Coordination

Fragmented jurisdiction between the states and the Centre is another challenge. Manufacturing licences are issued by state authorities, but state drug controllers are responsible for monitoring production and distribution within their borders. However, when a substandard drug is made in one state and sold in another, the latter's regulator has limited authority to investigate the manufacturer outside its jurisdiction—a loophole that manufacturers often exploit. CDSCO can intervene in major cases, but it has limited field presence. A new draft Pharmaceuticals Bill (intended to replace the old Act) seeks to clarify roles and possibly introduce a system wherein critical enforcement actions can be taken in a more unified manner; however, details remain under discussion.³⁹

The Way Forward

To ensure supply and access of quality essential medicines, India must implement a cohesive strategy to carry forward existing initiatives, adopt some essential reforms still needed while systematically addressing structural and regulatory gaps.

Accessibility

The most effective way to increase accessibility is by mandating all rural and urban primary health centres (PHCs) with JAKs, to consistently stock all the essential medicines listed under the NLEM—including those not provided free under government schemes. This should be supported by the developing storage infrastructure under the Ayushman Bharat Health and Wellness Centres (AB-HWCs) scheme. Additionally, public procurement and last-mile delivery mechanisms should be strengthened to ensure continuity of supply. Beyond physical availability, institutional arrangements are also key to accessibility. Streamlining regulatory bottlenecks in expansion of e-pharmacies, expanding the number of JAKs, mandating generic prescription by physicians, and integrating public and private supply chains into a unified access strategy are necessary to make essential medicines and vaccines truly accessible across India.

Affordability

To shield households from catastrophic health expenditures, efforts need to be sustained by increasing government health spending so that essential medicines and vaccines are predominantly financed through public funding. While this remains a challenge for a developing country like India, OOPE should not exceed 10 percent. The National Health Policy 2017 recommended allocating 2.5 percent of GDP to healthcare by 2025.⁴⁰ Yet, as per the Economic Survey 2023-24, healthcare expenditure in India stands at 1.9 percent of GDP, which is inadequate given the scale of need.⁴¹ The present public-private partnerships-based approach, which distributes limited free drugs through government hospitals and offers constrained coverage under PMBJP, PMJAY, and state-sector schemes, is inadequate to achieve the desired objectives. An upscaled fiscal commitment of at least 5 percent of GDP will be required to close this gap meaningfully. In the interim, additional strategies to reduce OOPE must be explored.

A broader public provisioning model is necessary to prevent persistent challenges in drug affordability. While price regulation has proven effective in curbing exploitative mark-ups, well-designed regulatory frameworks can help prevent the dilution of public schemes. The currently used market-based pricing model, which aims to encourage pharmaceutical growth, is inadequate given the complexity of modern drug pricing. The Drug Price Control Order (DPCO) framework must allow flexibility in price-setting methodologies, including cost-plus structures, external and internal reference pricing, negotiated rates, and HTAIn's evidence-based pricing. By integrating HTAIn's recommendations, the DPCO can better align drug prices with real-world therapeutic value and economic efficiency, ensuring affordability while preserving incentives for innovation.

All prescribed medicines, by implication, are essential to patient care and should be brought within the ambit of price control. This will also prevent regulatory arbitrage, where manufacturers introduce fixed-dose combinations (FDCs) or new formulations to bypass price controls. Moreover, despite having access to data on trade margins, NPPA is yet to implement a comprehensive ceiling on trade margins, allowing mark-ups that often exceed 100 percent.⁴² A differentiated cap—based on drug criticality and market availability—should be introduced, ideally limiting margins to 50–60 percent.

Affordability must extend beyond pharmaceuticals to encompass hospital costs. In response to price caps on stents, some hospitals have increased surgical and ancillary charges to cover up for lost margins.⁴³ Under the AB-PMJAY, 18,606 instances of fraudulent or inflated procedural and hospital charges have been detected, often aimed at exhausting the INR 5 lakh reimbursement ceiling.⁴⁴ Effective and uniform regulation of hospital costs can be achieved through the implementation of the Model Clinical Establishment Act 2010 by all states, along with rationalisation of various hospital charges.⁴⁵ Without such oversight, cost-shifting practices will continue to undermine both price regulation and insurance coverage. Ultimately, sustained political will is critical to institutionalise these reforms.

Quality

At the drug approval stage, quality testing must be both rigorous and transparent. Current procedures—including evaluation of APIs, sterility, toxicity, and disintegration—should be expedited, professionally managed, and publicly disclosed by the CDSCO.

The deadline for complying with WHO GMP must be non-negotiable, with non-compliant units facing closure or licence cancellation. Consolidation within the sector may be necessary to phase out persistently non-compliant manufacturers. To enable effective monitoring, staff shortages and the inadequate number of laboratories should be addressed through increased budgetary allocations at both CDSCO and state levels.

Lastly, drug licensing powers need to be further centralised. Currently, state-level drug control departments retain significant authority over licensing, leading to variability in enforcement and standards. Transferring all licensing responsibilities to the CDSCO would allow for more consistent oversight, while state agencies could continue to assist with sample collection and local enforcement. Such a bifurcation of roles would strengthen vertical coordination and reduce regulatory fragmentation.

Conclusion

India bears a dual responsibility: to meet domestic healthcare needs and sustain its role in the global pharmaceutical landscape. Affordability is not simply a function of pricing—it is the outcome of systemic coherence in regulation, public financing,

and institutional accountability. Moreover, in an era wherein India's pharmaceutical exports form a pillar of its soft power and economic growth, maintaining credible quality standards is non-negotiable.

The domestic public healthcare system equally relies on access to safe and effective medicines. Ensuring universal access to affordable, quality-assured essential medicines and vaccines requires stronger public sector engagement and regulatory alignment. The COVID-19 pandemic underscored the urgency of preparedness, not only in times of crisis but as a cornerstone of everyday care as well.

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India's Roadmap to Innovation and Supply Chain Resilience in Pharmaceuticals

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Abstract

India's pharmaceutical industry has matured from heavy import dependency in the 1970s to giving the country the moniker “the pharmacy of the world”. The sector is at a strategic inflection point as it aims to reach US\$120–130 billion in market size by 2030. Its continued success will depend on institutionalising quality as a cultural and operational standard, graduating from its dominance in generic medicine to globally competitive drug discovery, and expanding access to both underserved and regulated markets through cost-effective innovation. These goals must be supported by investments in sustainability, localisation of inputs, workforce development, government-backed schemes and regulatory streamlining. As India hopes to become a

US\$30-trillion economy by 2047, unleashing innovation in the pharmaceutical sector can catalyse its progress towards this vision.

Introduction

The Indian pharmaceutical industry has come a long way from being import-dependent in the 1970s to now emerging as a global leader and a trusted supplier of affordable, high-quality medicines to over 200 countries.¹ As a pillar of global health access, India has played a central role in driving equitable health outcomes through its commitment to quality, affordability, and above all, patient care.

During the COVID-19 pandemic, the Indian pharmaceutical industry rose to the occasion and ensured uninterrupted access to essential medicines and vaccines to more than 100 countries² even amidst severe supply chain disruptions. The world took notice of India's resilience and reliability beyond its manufacturing scale and efficiency.

With the US\$60 billion market split between domestic (US\$30 billion) and export segments (US\$30 billion), India ranks third by volume and 14th by value of production globally.³ To sustain and accelerate this momentum, the industry must pivot from volume leadership to value creation. The sector aims to grow to US\$120-130 billion by 2030—becoming the world's largest by volume and among the top five by value.⁴

Realising this ambition hinges on three pillars: quality, innovation, and global reach. These define what India must prioritise to unlock sustainable and inclusive growth in life sciences. First, the principle of quality must shift from a compliance requirement to a cultural cornerstone, aligning with global standards through digital transformation and regulatory harmonisation. Second, innovation must become a national priority, moving from generics to global drug discovery through robust research and development (R&D) incentives, regulatory agility, and industry-academia collaboration. Third, India must deepen its global reach by balancing affordability with cutting-edge therapeutics and expanding access to both developed and underserved markets.

To support these pillars, India requires three critical enablers: sustainability, self-reliance, and skilling. These define how India will future-proof its pharmaceutical ecosystem. Sustainability practices, including low-carbon technologies and circular manufacturing, must be embedded across the value chain. Self-reliance in Active

Pharmaceutical Ingredients (API), Key Starting Materials (KSM), and critical intermediates is key to de-risking global supply chains and ensuring national health security. Finally, a future-ready workforce trained in the digital, regulatory, and technical domains will be the engine that drives India's ascent in pharmaceutical innovation.

This integrated approach, anchored in strategic focus and enabled by systemic transformation, can position India as a powerhouse of global pharmaceutical innovation.

Quality: The Non-Negotiable License to Operate

Quality is the fundamental license to operate in this sector. India is poised to make 'quality' a sustainable competitive advantage and become the global benchmark. To achieve this, quality must evolve from a compliance obligation into a core, deeply embedded value across the entire ecosystem.

Over the past decade, India has made significant strides in improving quality standards and global regulatory compliance. It is an ever-evolving tenet of the sector, requiring continuous improvement and transformation in organisations. Therefore, a cultural transformation that places patient outcomes at the heart of every decision becomes critical. There is a direct and undeniable link between the quality of medicines and patient outcomes. By prioritising patient care among all stakeholders—doctors, customers, and shareholders—the Indian pharmaceutical sector can become the benchmark of quality.

Building a sustainable advantage of quality demands a mindset and cultural change. Quality is integrated into daily operations—from manufacturing floors to boardroom decisions. Real-world manufacturing excellence must be complemented by hands-on training, stronger quality control, and the rigorous upskilling of professionals.

Second, the Indian regulatory framework should harmonise with global standards. The Revised Schedule M,^a currently under implementation, is a step towards adopting the WHO's Good Manufacturing Practices (GMP). Through the enforcement of updated

^a Schedule M in the Indian Drugs and Cosmetics Act, 1940, outlines the Good Manufacturing Practices (GMP) for pharmaceutical products. It specifies requirements for premises, plant, and equipment, ensuring consistently high-quality drug manufacturing. The revised Schedule M, implemented in 2023-2024, aims to align Indian GMP standards with international practices

GMP norms, India aims to elevate the overall quality of drug production, ensuring patient safety, and enhancing the global reputation of its pharmaceutical exports. Soon, India should actively pursue membership in the Pharmaceutical Inspection Co-operation Scheme (PIC/S) and the International Council for Harmonisation (ICH). A PIC/S membership will allow India to participate in a global framework for GMP inspection cooperation, thereby reducing the duplication of inspections and building mutual trust with international regulators. Similarly, joining the ICH will help India align its technical guidelines for drug development and registration with globally accepted standards, facilitating the faster and smoother entry of Indian medicines into regulated markets such as the United States (US), the European Union (EU), and Japan. Together, these steps will significantly boost India's regulatory credibility, improve market access, and strengthen its position as a trusted global supplier of high-quality medicines.

Lastly, digital transformation and the adoption of advanced manufacturing technologies, such as continuous manufacturing, automation, and predictive analytics, are essential to build a quality-by-design (QbD) approach. Tools of Industry 4.0, including continuous manufacturing, automation, robotics, IoT-enabled equipment, and predictive analytics, are transforming production processes by enhancing consistency, improving operational efficiency, reducing downtime, and minimising human error. At the same time, artificial intelligence (AI) is playing a transformative role. From real-time quality monitoring to pharmacovigilance, AI-driven insights are enabling faster, more informed decision-making that not only elevates manufacturing productivity but also ensures better drug efficacy and safety.

Innovation: From Generics to Global Discovery

Innovation in life sciences is a strategic national priority for the economic engine and, most importantly, the nation's health, as the disease burden and the ageing population increase. Globally, specialty products are expected to account for two-thirds of the new active substance (NAS) launches over the next five years.⁵ Although India has little presence owing to the inherently high-risk, capital-intensive nature, with a long gestation period of 10-15 years, the tide is turning.⁶

Recent breakthroughs, including CAR-T therapies,^b novel antibiotics, and treatments for rare diseases, highlight India's growing capability in innovative therapeutics. The

^b CAR-T cell therapy is a cutting-edge cancer treatment that involves genetically modifying a patient's own T cells to recognise and destroy cancer cells.

sector has articulated an ambitious vision: to develop 100 new drugs by India's 100th year of independence.⁷ Achieving this goal requires mission-mode execution, anchored in four strategic priorities:

Robust and continuous funding for investing in research and development is the need of the hour. A recent McKinsey study reveals that every US\$1 invested in health can yield an economic return of between US\$2 and US\$4, making a compelling case for prioritising innovation.⁸ Initiatives such as the Promotion of Research & Innovation Program (PRIP) and the Anusandhan National Research Fund (ANRF) signal the government's commitment; however, translating them into tangible outcomes requires deeper public-private partnerships, pricing incentives for breakthrough drugs, and de-risking mechanisms to support high-risk, high-reward research.

Equally critical is the need for an enabling regulatory landscape. Streamlining drug approval pathways and aligning with global standards, particularly for accelerated approvals and orphan drugs, can significantly boost domestic innovation and improve timely patient access to novel therapies. The Central Drugs Standard Control Organisation (CDSCO) has already made commendable progress through capability building and digitisation, leading to greater efficiency, transparency, and predictability in regulatory processes.

A thriving innovation ecosystem also hinges on stronger industry-academia collaboration. While India has climbed from the 81st position in 2015 to the 39th in 2024 in the Global Innovation Index, it ranks only 86th in industry-academia R&D partnerships.⁹ Bridging this gap through centres of excellence in drug discovery and structured collaboration programmes will help accelerate innovation from lab to market.

In parallel, building world-class infrastructure—such as biotech parks, translational research hubs, and digital research platforms—will serve as the backbone for breakthroughs in innovation. With major pharmaceutical multinationals increasingly establishing Global Capability Centres (GCCs) in India, now is the time to market these advancements globally, attract top-tier talent, and cement India's position as a global hub for pharmaceutical innovation.

Global Reach: Championing Access and Affordability

In 2001, the introduction of a US\$1-a-day HIV treatment by Cipla transformed the global fight against AIDS.¹⁰ India is recognised not only for the scale of its pharmaceutical production but also for its ability to balance affordable access with innovation. It is one of the largest providers of generic medicines globally and plays a vital role in public health supply chains. For instance, India is the largest supplier of vaccines and drugs to UNICEF, supplying products worth US\$529 million that serve as a critical lifeline for programmes in low- and middle-income countries.¹¹

Today, India supplies 20 percent of the world's generic medicines, 60 percent of vaccine demand, 47 percent of US generics, and 25 percent of UK prescriptions.^{12,13,14} Furthermore, Indian generics have enabled US\$1.3 trillion savings for the United States (US) in the last 10 years (2013-22), with a trillion dollars' worth of expected savings in the next 5 years.¹⁵

Additionally, India is home to the largest number of United States Food and Drug Administration (USFDA)-compliant pharmaceutical plants outside the US.¹⁶ This unique combination of cost-effective production, regulatory compliance, and growing R&D capabilities makes India a key player in ensuring both global health security and innovation-driven growth.

Furthermore, access to affordable drugs is also a function of the patent regime. While patents incentivise innovation by granting exclusive rights to drug developers, they can also limit generic production, making medications unaffordable in many regions. India's patent regime, particularly Section 3(d) of the Patent Act, has been pivotal in preventing frivolous patent extensions and enabling timely access to generics.

Looking ahead, the patent expiry of 55+ blockbuster drugs (that have more than US\$1 billion annual sales) with projected US\$310 billion sales by 2032 presents a major opportunity for India to lead the development of affordable generics and biosimilars.^c

^c A blockbuster drug is a medication that generates at least \$1 billion in annual sales. These drugs often treat common conditions like high cholesterol, diabetes, and cancer, and are characterised by high volume sales due to widespread use. Examples include Humira, Lipitor, and Zoloft.

India's manufacturing strength, backed by regulatory compliance and cost efficiency, is well-positioned to remain the global leader in access while building a robust innovation engine that addresses unmet medical needs worldwide. The following enablers are key to achieving this:

The COVID-19 pandemic underscored the vulnerability of global pharmaceutical supply chains. Although India exports many bulk drugs, it remains import-dependent for critical KSMs, intermediates, and APIs.

To address this, the Government launched Production Linked Incentive (PLI) schemes worth INR 15,000 crore to spur the domestic manufacturing of raw materials and to make global champions of higher-value drugs.¹⁷ These efforts have started to reap dividends with the launch of green-field projects for production-dependent raw materials such as Penicillin G and Clavulanic Acid.¹⁸ These are cornerstone ingredients in the production of broad-spectrum antibiotics, which are among the most widely used and life-saving drugs globally. Penicillin G is a key API used to treat severe bacterial infections, while Clavulanic Acid is a critical beta-lactamase inhibitor that enhances the efficacy of antibiotics like amoxicillin by overcoming bacterial resistance. Until recently, the lack of indigenous manufacturing capacity for these inputs posed significant supply chain vulnerabilities and cost pressures for Indian pharmaceutical companies.

The PLI scheme marks a crucial step toward ensuring uninterrupted access to essential medicines, improving cost-efficiency, and building a resilient, globally competitive pharmaceutical manufacturing ecosystem in India. Strengthening backward integration is not just a matter of business strategy; it is a national health security imperative. India is poised to be a reliable partner for developed nations with shared priorities of global healthcare security and a diversified and resilient drug supply chain.

Sustainability: Deepening the Responsible Business Agenda

From energy-intensive processes to cold-chain logistics, pharma operations contribute significantly to greenhouse gas emissions. With the wake-up call during the pandemic, there has been a growing focus on sustainability in environmental, social, and corporate governance (ESG) from regulators, investors, and global partners.

Indian firms are already global leaders in ESG. According to the Dow Jones Sustainability Index, some of the world's top pharmaceutical companies are Indian, including Dr. Reddy's, Cipla, and JB Chemicals and Pharmaceuticals.^{19,20,21} Facilities from Cipla and Dr. Reddy's have also been recognised by the World Economic Forum as "Digital Lighthouses", adopting cutting-edge technologies to reduce emissions while boosting productivity.²²

As an industry-wide initiative, IPA is collaborating with the Centre for Process Innovation, UK and the National Chemical Laboratory, CSIR, India, under the UK-India partnership to boost decarbonisation. The 'Living Lab' launched in Pune will pilot continuous manufacturing technologies that reduce greenhouse gas emissions and increase efficiency.²³ Sustainability is not just an ethical mandate—it is becoming a competitive advantage. Companies that lead in renewable energy, zero-waste policies, and circular economy models will gain an edge as global regulators and investors raise the bar.

Skilling: Building Future-Ready Talent

As technology reshapes the pharmaceutical space through AI, automation, and precision medicine, the demand for new skills is evolving faster than ever. The average half-life of skills is now under five years, and even shorter in fast-evolving fields like biotechnology and AI. For a knowledge-intensive and highly regulated sector like pharmaceuticals, a skilled workforce is mission-critical.

India has a natural edge – producing over 110,000 doctors annually and an estimated 1.4 million physicians of Indian origin at the global level.^{24,25} Each year, the country also produces 400,000 pharmacy graduates and 1.5 million engineers.^{26,27} Nevertheless, reskilling is the need of the hour.

To address this, IPA companies have launched the Pharmaceutical Academy for Global Excellence (PAGE), a state-of-the-art training institute, with an investment of US\$50 million. PAGE will serve as a national centre of excellence to prepare talent across technical, regulatory, and digital domains. With a focus on real-world learning, it aims to build a workforce that remains globally competitive, agile, and aligned with future needs.²⁸

Conclusion: A Global Vision for 2047

India's aspiration to become a US\$30-trillion economy by 2047 is powered by the dynamic growth of its manufacturing sector.²⁹ The pharmaceutical industry, contributing over 10 percent of the national manufacturing output, stands as a cornerstone of this journey.³⁰ The sector recorded a compound annual growth rate (CAGR) of 8.5 percent in 2024, outpacing global averages and positioning India among the world's fastest-growing pharmaceutical sectors.³¹

The Indian pharmaceutical industry today stands at an inflection point. India's journey from the 'pharmacy of the world' to the 'pharma innovation hub of the world'³² will be built on a unified national mission, driven by collaboration among government, industry, academia, and global partners.

With quality, innovation, and global reach as the foundation—and sustainability, self-reliance, and skilling as enablers—India can shape a new global order in the pharmaceutical space that is inclusive, ethical, and future-ready. India is poised to build a healthier, more equitable, and sustainable world for generations to come.

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IV

India's Role in Global Health and Strategic Collaborations



The End of an Era: Challenges to Global Health Diplomacy

Ilona Kickbusch

Abstract

The geopolitical landscape is changing rapidly and health is becoming increasingly politicised. Official development assistance (ODA) in health has been declining and philanthropies are being reoriented as countries seek to end their dependence on external health support. Global health diplomacy is challenged to remain engaged. In response, global health financing is also evolving and now includes regional mechanisms, pooled funds, and blended finance. Countries now draw their power from providing health solutions rather than funding. The future of global health calls for difficult decisions to create a more equitable health system beyond the development paradigm. It requires countries to build robust national health policies, addressing inequity

and co-creating solutions. Global health diplomacy faces three primary tasks: determined negotiation; continuous bridge-building; and establishing equitable reform processes. With the emergence of a new technological order, global health actors must urgently build alliances for increased resilience.

Global Health System Shocks

The geopolitical landscape is shifting: fragmentation is growing, trust is eroding, and health—once seen as a neutral space—has become deeply politicised. In this environment, diplomacy is challenged to remain engaged with global health and find a way forward to ensure that the critical functions of the global health ecosystem continue unimpeded.

Three big trends mark the end of an era: first, the period of United States (US) hegemony in global health is over. As a corollary, it is also an opportunity for low- and middle-income countries to take the lead in shaping a new health system.¹ Second, the donor- and philanthropy-based financing system of global health needs to quickly shift to new approaches to giving, as countries reduce official development assistance (ODA), philanthropies reorient their priorities, and recipient countries aim for self-reliance.² Third, the global health ecosystem is likely to be overhauled and simplified with the mandate and practices of existing health-focused organisations being recast.³

Recent developments in the US, particularly President Donald Trump's drastic downsizing of the United States Agency for International Development (USAID), are an extreme expression of broader trends that the world should have seen coming. Yet the global health community, including the most influential organisations, were not prepared. It is still difficult to grasp the full extent of the imminent changes. Organisations are fighting for relevance and survival; people are losing their livelihoods and jobs in global health; and recipient countries and their people who have historically benefited from the support—like patients on HIV/AIDS medication—are taking the hardest hit.⁴ Indeed, shocking calculations have been made of the number of lives that will be lost due to the cuts being ordered by the US's new Department of Government Efficiency (DOGE), President Trump's special commission tasked with slashing federal spending.⁵

Three strategies will increasingly form the approaches to global health that countries (and other stakeholders) take following the changes: multi-alignment, an emphasis on self-reliance,⁶ combined with a shift towards selective globalisation.⁷ The new

sphere of global health diplomacy will focus on national interest, selective openness, diversification of partnerships, increasing regionalism, and geopolitically based alliances such as BRICS,^a ASEAN,^b the African Union, and the European Union. Global health financing structures are evolving beyond traditional donor-recipient frameworks to include regional mechanisms, pooled funds, and blended finance. This is complemented by an ever-growing challenge in humanitarian assistance as wars expand and increasingly target civilian populations as in Ukraine, Gaza, and Sudan, to name but some.⁸

An Emerging New Approach

In recent years, there has also been a marked trend of countries moving away from neoliberal laissez-faire to increased government intervention, which includes their blending of health policy with industrial policy, security policy, research and innovation policies, as well as digital and AI policies. Examples are India's tech and innovation policies for health, Africa's push for pharmaceutical autonomy, and China's dual circulation strategy.⁹ Brazil is promoting a Health Industrial Complex strategy to align health needs with industrial and innovation goals as well as social equity goals; it uses technology transfer agreements with multinational companies, but insists on local production capacities and shared research and development (R&D).¹⁰

National self-reliance will have clear consequences for how countries cooperate on health matters. Countries and regions increasingly seek health sovereignty, including pathogen sovereignty, as exemplified in the negotiations over access and benefit sharing. The Pandemic Treaty, passed by the World Health Assembly (WHA) on 20 May 2025, stipulates that a World Health Organization (WHO) Pathogen Access and Benefit-Sharing (PABS) System is to be established to connect the "rapid, systematic and timely" sharing of "pathogens with pandemic potential" and "the genomic sequence of such pathogens" (access) with the sharing of the "benefits arising from facilitating access to pathogens with pandemic potential" in a manner which is understood to be fair and equitable (benefit-sharing).¹¹

^a The grouping of Brazil, Russia, India, China and South Africa, which was later joined by Argentina, Egypt, Ethiopia, Iran, Indonesia, Saudi Arabia, and the United Arab Emirates.

^b The Association of South East Asian Nations.

The treaty prioritises local manufacturing and strategic autonomy, which can be complemented by continent-level health sovereignty,¹² including regional manufacturing and a bigger role for agencies such as the Africa Centres for Disease Control and Prevention (CDCs), the European Union's pharmaceutical strategy for Europe or its Health Emergency Preparedness and Response Authority (HERA). This is the path to selective globalisation, which includes addressing vulnerabilities in the supply chains of critical medicines in every region, ensuring access to important health technologies, and establishing data sovereignty. One example of such globalisation is the launch of the African Medicines Agency (AMA), which aims to safeguard pharmaceutical quality on the African continent and reduce dependency on foreign products. Another is President Trump's Most-Favoured-Nation Pricing Model, aimed at aligning US drug prices with those of other developed nations, as well as a variety of trade measures and expansion of imports.¹³

The reasons behind these developments lie not only in the geopolitical power shifts and the decolonisation agenda but also in the experiences of the Covid-19 pandemic. Vaccine nationalism came as a shock to the global health world. In response, the strategic goal of developed and developing countries alike has now moved to the reduction of dependency, sometimes linked in complicated ways to a geo-political decoupling agenda.¹⁴ This means that countries are reducing or severing ties with one another through systematic disengagement, which can be diplomatic, economic, or institutional, and include techno-decoupling, such as the US's restrictions on China's Huawei.¹⁵ Simultaneously, vaccine diplomacy turned into an important diplomatic tool for countries such as India during the Covid-19 pandemic; India now leverages its strong generic pharmaceutical industry to project itself as a global player and ensure access to geo-political alliances such as the Quad,^c where it prioritises non-traditional security issues, such as vaccine diplomacy.¹⁶

These political trends reflect the many ways in which the pandemic highlighted that health was so much more than a developmental issue. Indeed, if viewed through a different lens, it is found that the interface of the health and tech sectors, supply chain security and R&D value chains, investment in local production and

^c Quad is a diplomatic alliance between India, the US, Japan, and Australia.

innovation, and ensuring a health workforce, can be critical factors of a country's competitiveness. This blend of health policy and industrial policy is often framed as ensuring resilience, maintaining security, and protecting sovereignty. As industrial policy increasingly includes the tech sector, the challenges become even larger as the discussion around techno-nationalism illustrates.¹⁷

In Search of a New Global Health Order

This, then, is also the perspective from which many countries now see their involvement with WHO. Committed to self-reliance in health, they also recognise the need for cooperation and a commonly accepted framework within which to act, as well as the value of an organisation such as WHO—provided it is equitably governed. All those who attended this year's annual WHA meeting in May 2025 in Geneva (which finalised the Pandemic Agreement) expressed their commitment to multilateralism and rules-based global health governance. Those maintaining that multilateralism no longer works—even in health—were proven wrong. Since the US, thanks to Trump's withdrawal from WHO in January 2025, was not present, this was multilateralism without the organisation biggest (ex-) donor and hegemon—perhaps a more equitable move forward.

The old global health order might be disappearing but health cooperation is not falling into chaos. It is in the process of bringing together national interest, particularly the national interests of the countries of the Global South who see the benefits they can accrue from working together. Self-confidence and optimism about the future were clearly evident in the Global South countries' presentations of their progress at the side meetings during the Geneva conference. Expanded primary healthcare coverage and increasing use of digitalisation were at centre stage. The meeting showed a new group of leaders emerging, who drew their power not from the funding they promised but from the solutions they provided. It was noted that with the withdrawal of the US, China is now the largest contributor of assessed contributions to WHO; its delegation to the WHA was also the largest.¹⁸

Though the Pandemic Agreement has been adopted, the most difficult issue of all—access and benefit sharing—has still to be finalised. It has been relegated to an annex of the agreement and will be the subject of continuing negotiations.¹⁹ Countries have agreed to implement the amended International Health Regulations (IHR),^d as well as to support a 20-percent increase in the regular funding of WHO by its member states.²⁰ They have also adopted other important resolutions on critical health priorities—a signal that it is the normative and standard setting role

of WHO, combined with its convening power as a treaty making body, which makes it attractive to countries. This offers opportunities as WHO and its member states work on reforming the organisation. Countries continue to have common interests and shared risks in health, and they need resilient mechanisms to enable them to cooperate even when there are other tensions among them.

The Central Role of Health Diplomacy

The proceedings of the WHA, and particularly the Intergovernmental Negotiating Body (INB) for the Pandemic Agreement, underlined the central role of health diplomacy. For too long, the global health ecosystem had lived under the cloud of a development consensus that proved to be stifling. For many, the vehemence of the INB negotiations came as a shock; but it served to bring the distrust and power imbalances within the global health system out into the open, and only thereafter could work begin on finding an acceptable compromise. Multilateralism needs experienced global health diplomats, particularly when complex matters have to be thrashed out, and more so when negotiations are between ideologically polarised parties, which seems to make dialogue almost impossible. But it is precisely at such times that negotiators have to find basic common principles to not only begin a dialogue but also forge understanding.

The times when health negotiations used to be 'soft' are unequivocally over. With health having become an ideological issue, and linked to economic development as well, the 'old' approach of deciding by consensus is proving to be no longer effective. When one country asked for a last-minute vote on the pandemic agreement during a WHA technical committee meeting, it raised deep concerns that the concurrence reached till then would come undone. But it worked for the agreement's legitimacy because the wide majority agreed and only a small group abstained. Transparency is the most practical way to address any gaps in trust.

The focus of the next stage of global health will not be President Trump and his rejection of multilateralism and development aid, or trying to re-establish what he tore down. It will be building a new, more equitable global health order. Progress

^d The IHRs are an instrument of international law, first agreed upon by UN member countries in 2005, that define countries' rights and obligations in handling public health events that have the potential to cross borders.

will depend upon a mix of countries that are willing to take tough decisions on how to create a better and more equitable global health system beyond the development paradigm. Such a system cannot work without dedicated commitment to national health systems as well, and to the other policies that a nation needs to consider when it wants to ensure better health—supporting local manufacturing, technology partnerships, investing in regional research ecosystems, and enabling health sovereignty. It means actively addressing the legacy of inequity during the Covid-19 pandemic and co-creating solutions with partners and not imposing them. It also means implementing the agreed decisions: strengthening primary healthcare, implementing the amended IHR, and working towards national ratification of the pandemic treaty.

A New Balance

Health sovereignty and its implications will be the big new challenge of the Gates Foundation in Africa, given the large sums (US\$200 billion in 20 years) it is committed to spending on health development, as it reshapes its ways of working.²¹ This is roughly the same amount that WHO too, will dedicate to its work in Africa over the next 20 years. How exactly will health partnerships work, how will decisions be taken, what forms of oversight, transparency and accountability will be introduced? Similar challenges had arisen when organisations such as the Global Fund,^e or Gavi, the Vaccine Alliance,^f had to find a governance model. A new model of cooperation will have to be found for a productive path forward. The agendas of national self-reliance and selective globalisation will clash at times, and cannot be reconciled without negotiations with regional organisations, private companies, civil society activists and non-government organisations (NGOs). The old division between donors and recipients as a governance principle can no longer apply.

^e The Global Fund to Fight AIDS, Tuberculosis and Malaria, set up in January 2002, is an international financing body set up to raise funds to combat these three deadly diseases.

^f Gavi, the Vaccine Alliance, is a partnership of WHO, UNICEF, the World Bank, the Gates Foundation, and numerous others, started in January 2000, to increase the equitable and sustainable use of vaccines globally.

The INB negotiations made this clear, but the national and multilateral apparatus dedicated to interstate relations still needs to adapt. Multinational companies and most big NGOs and philanthropies have highly professional people representing their interests. They have great experience in how to interact, and make use of, inter-government diplomatic processes. But the INB process was also challenged by actors who did not see diplomacy as a two-way street leading to a compromise, but more as a univocal tool to set up their own agendas. These actors even sought to cunningly use social media to sow distrust between the negotiators.²² This was one of the reasons why the negotiations proved difficult.

Learning from this, there are three key tasks for global health diplomacy at this stage to shape a fairer, healthier global health order:

- Determined negotiation of international norms in view of new challenges;
- Continuous bridge-building across geopolitical and sectoral divides; and
- Establishing agile, inclusive and equitable reform processes to build a resilient global health ecosystem that fits the landscape in which it must function.

In a world of rising threats—from war to climate shocks and disinformation—all countries must integrate health into their broader foreign and security policies. Excessive emphasis on national self-reliance and selective globalisation that make health diplomacy more and more transactional, that aim to get the short-term deals done at any cost rather than try to find resilient solutions based on a set of rules and principles, are a clear and present danger. In response to the end of US hegemony in health, global actors must—drawing lessons from the successful IHR revisions and the pandemic agreement—build alliances for resilience.

They must work together to form a new system of global health financing, based on commitment to national investments. Above all, they must support the reform of global institutions such as WHO, and prioritise working together to set global standards for the future.²³ (Norms for global governance of digital health and AI safety to prevent online harms are, for instance, a matter of great urgency.) A new global health world is being built as the political and economic order shifts dramatically, and a new order—the technological order—emerges.²⁴ There is much at stake.

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Reimagining Global Health Funding Amid a Polycrisis

Chandrakant Lahariya

Abstract

In early 2025, two pivotal decisions made by the United States (US) government reshaped the landscape of global health and overseas donor assistance: withdrawal of its membership of the World Health Organization (WHO), and the restructuring of the United States Agency for International Development (USAID). Following the US exit, WHO was compelled to expedite long-pending internal reforms that included trimming down leadership and other staff positions at all levels. Simultaneously, the USAID scale-down affected multiple organisations across the world, especially in Asia and Africa. This moment of disruption presents an opportunity for the countries in the Global South, and for India, to recalibrate their engagement in

global health. This is true too, for India's corporate sector, which have mandated contributions as part of corporate social responsibility (CSR) to support the social sector. This is a critical juncture for the national government to increase budgetary allocations for social sector activities. The moment also calls for a reassessment of global development assistance, prioritising regional and bilateral collaborations. Large philanthropic foundations and high-net-worth individuals also have a role to play in bridging the funding shortfall and supporting priorities. It is time to foster stronger bilateral and regional collaborations in health to ensure predictability and sustainability in the face of future challenges.

Introduction

In January 2025, two pivotal decisions by the United States (US) government disrupted the global health landscape, shaking the very foundation of funding in global public health.¹ First, the decision of the US government to withdraw from the World Health Organization (WHO) impacted the funding and sustainability of the world's leading global health agency. WHO was compelled to make a number of executive decisions, including trimming down top management roles and departments at its headquarters in Geneva and curtailing some of its projects in different regions across the world. Restructuring plans are underway for WHO's regional offices.² Soon after, in early February 2025, WHO also requested increased contributions from member states to help address the funding gaps.

By the end of January 2025, in line with the US government's executive decision, USAID operations were halted.³ Orders to stop work were issued to the entities funded; regular staff were placed on paid leave; and most contractual workers were terminated. Four weeks after the initial order, the contracts with nearly 5,700 NGOs (of around 6,200) across the world that were funded by USAID were terminated.⁴ By end June, the majority of USAID operations were halted or merged with other functions.⁵ At the time of writing, it was expected that majority of USAID staff in most countries, including India, would be separated and the organisation's functioning would be either ceased or restricted to bare minimum.

These two developments, when combined with the reduction in WHO funding, have sent waves of disbelief across the world and are likely to have lasting adverse impact globally on the social sector and the domain of official development assistance (ODA). While the US decision to withdraw from WHO was anticipated—given a similar executive order was issued in August 2020 during President Trump's first term⁶—no one saw the USAID decision coming. These two moves

mean that, *inter alia*, global health is arguably going to be the worst impacted. The entire social sector and smaller, independent not-for-profit organisations rely on funding to carry out essential and independent work. There are a number of countries, especially in Africa, and programmes that are fragile and serve the most vulnerable populations; funding continuity was needed to ensure that such work could be sustained.

People across the globe are slowly adjusting to these challenges. By the end of May 2025, WHO member states had agreed on a pandemic treaty and a resolution was accepted at the World Health Assembly, marking a key global development.⁷ Yet, one continuing challenge has been the insecurity across multiple organisations in the social and health sectors, both large and small, about sustained funding. Organisations such as Gavi, the Vaccine Alliance or Stop TB Partnership, which had a large number of field-based consultants, are reworking their functioning. There have been incidents of many high-impact but smaller organisations shutting down or scaling down operations. The impact is visible, and it is time for countries and institutions within countries to look inward and think of innovative solutions.

USAID Decision and Issues with Overseas Assistance

USAID has been in existence for more than seven decades, working in nearly 100 countries.⁸ It has been the biggest donor agency in global health and social sectors. With USAID funding gone, many are asking whether other agencies or countries will step in to fill the funding gap. The short answer is that it is unlikely. It has reportedly spent in the range of US\$40-US\$80 billion annually, with nearly 30-40 percent of that funding directed towards the health sector.⁹ The overall scale of USAID funding has been far greater than that of any other organisation—even The Gates Foundation, a major donor, comes a distant second.

Another factor is that USAID's work was built over many decades, and its mammoth engagement cannot be replaced in days or months by a new partnership or agency. It has well-established programmes, funding approaches, and trust and goodwill earned by governments and the public. The Agency had the capacity and understanding to work with governments, ensuring the kind of coordination and collaboration that is difficult to replicate quickly.

The shock is a reminder to examine the ODA model and its approach, which has remained fragile and has not created sustainable financing models in the beneficiary countries or in the countries where operations have been carried out.

Yet, ODA creates a vital space for independent social sector work, which is less influenced by government agendas. Such funding is used for innovations, proof-of-concept projects, and field work, even before governments adopt and finance such activities. That represents definitive value creation for effective policymaking, economic progress, and social development.

However, the scale and scope of international development assistance over the past few decades have been steadily declining. Most developed countries, which were running development assistance programmes and funding activities, have either refocused the scope of such assistance, reduced the scope of work, or even completely withdrawn from it.¹⁰

How Social Sector Funding Has Changed in India

Some national governments in Africa have voluntarily chosen to not accept external funding for many programmes. In India, over the last 15 years, funding agencies from countries such as Australia and the United Kingdom (UK) have largely reduced their support.¹¹ India has successfully transitioned from a few largely donor-funded programmes to internally funded health initiatives, such as the Integrated Disease Surveillance Programme and the National AIDS Control Programme. A similar transition is on the cards for India's polio-elimination activities.

However, that is not the case for all low- and middle-income countries (LMICs). Several countries in Africa still rely heavily on donor-funded activities, ranging from service delivery at the grassroots level to policy engagement at the highest level. These have been destabilised and adversely impacted by the USAID decision.

Alongside these two decisions by the US Government, beginning in early February 2025, there has been trade and tariff concerns and US-imposed unidirectional trade tariffs which have unsettled financial markets and global dialogues. The 'trade and tariff war'-like situation has brought additional uncertainties in all sectors and there are increasing nationalistic sentiments across countries. Given all this, it is unlikely that any government will increase their overseas funding and donations, at least in the short term.

As an example, in the aftermath of the US's exit from WHO, one of the reported proposals at the Executive Board meeting in early February 2025 was to increase assessed financial contributions to the organisation by existing member states to compensate for the loss from the US's exit. There was reportedly little enthusiasm

among member states to do so. After a few rounds of negotiations, member states, at the World Health Assembly in May 2025, agreed to increase their assessed contributions by 20 percent.¹² However, the contributions coming from member states would still fall short of the requirement.

This is not to say that there have been no developments. For example, during the World Health Assembly, China pledged a voluntary contribution of US\$500 million over the next five years to WHO.¹³

Things Are Bound to Change

A few heads of nations in Africa are already talking about the need to move away from development assistance towards economic self-reliance at both national and regional levels.¹⁴ There is growing discussion that what is needed for predictable social sector financing in the future is not development aid, but investment banks. Talks have already begun about the need for the world—and particularly the Global South—to collaborate and coordinate for regional and geopolitical alliances within and between continents, and among like-minded countries, as the Global North becomes increasingly unpredictable.

Another, bigger opportunity is emerging. Recipient countries and academic researchers are calling for this funding challenge to be converted into an opportunity by prioritising country-specific health needs in development sector work. This is likely to address the Global South's concern about so-called “parachute research and science”¹⁵ where a funding agency set up in a high-income setting can send their researcher to do research on problems that are not completely local.

One of the flip sides of external aid or ODA has been that it rarely and insufficiently invests in local capacity-building in recipient countries, which have continued to depend on financial resources as well as external technical assistance. Funding agencies are often accused of pushing their policy priorities onto recipient countries.

In the backdrop of the USAID turmoil, the countries that have so far been receiving funding from the agency should contemplate investing internal domestic resources in high-level centres of excellence or full-fledged institutes for training and capacity-building in technical areas where they are currently dependent on external experts. These training programmes should not be housed as divisions within management institutes or business schools, but rather as independent national-level centres dedicated to global health.¹⁶ Such steps will pave the way for

a long-term, structured, and sustainable transition plan for overseas development assistance. These will also ensure that local priorities get greater attention through such funding, making it more predictable and resilient to external shocks.

Second, the funding by USAID and other agencies, such as UNICEF, WHO, and World Bank, remains relatively small, but it is an essential component of social sector work. Field research, national-level surveys, high-level policy research, evidence synthesis, local-level expert advice, and support for policy think tank activities receive support from such external funding.

Funding from overseas donors has been vital and essential for some technical and fieldwork activities, often preceding their inclusion in national and state government priorities. Therefore, it would be imprudent to imagine that countries can do without this kind of additional funding, which does not come from the government. The social sector needs such support. In India, on average, USAID funding amounted to around US\$150 million (INR 1,250 crore) in recent years. The question is: who can and should compensate—and arguably top up—for such financial resources in India?

Over the years, philanthropists, high-net-worth individuals, and other donors in India have been funding and supporting social sector work. Yet, arguably, most of their work has been narrowly focused on a few sectors or specific areas. Many of them prefer to support field-level implementation only. Many experts believe that most Indian social sector funding agencies compete for a limited number of areas that are already crowded, while other social areas remain barely resourced. For example, there is some funding available for tuberculosis or nutrition; however, areas such as evidence synthesis and scientific publications remain relatively underfunded.

Scientific evidence synthesis continues to be viewed primarily as the responsibility of government or government-aided agencies. The quantum of policy-supporting and policy-guiding evidence synthesis continues to remain low.

As with foreign aid agencies, Indian donor organisations also do not invest in capacity-building to provide quality technical assistance for the social sector. In the past, international agencies and USAID had supported a significant amount of evidence synthesis and health policy work—areas that arguably receive very

limited support from Indian organisations and philanthropies. That is the space which Indian donor organisations need to capture and fill, with guidance from in-house subject experts.

While there is considerable financial support from international philanthropic organisations, it is concentrated in a limited number of areas. With USAID funding nearly gone, those organisations also need to expand both their funding and the scope of their work.

CSR Funding in India as an Opportunity

The legally mandated CSR funding in India can be more efficiently used. In FY 2022-23, CSR funding in India amounted to approximately INR 30,000 crore and it is estimated to reach INR 35,000 crore in FY 2024-25.¹⁷ This amount is nearly 20-25 times higher than the total USAID funding in India. Thus, if only a small proportion of CSR funding is channelled to now-abandoned USAID-funded projects and greenfield areas, continuity may be ensured. The challenge could become an opportunity.

However, to make that happen, Indian philanthropic foundations, high-net individuals, and corporations will have to examine CSR allocations and grants, and their functioning in the country. Indian grant agencies and CSR funds are most often run by management consultants who work as fund managers with barely any sectoral experience. India's philanthropic organisations and CSR need to have a more structured approach, guided by in-house subject experts or sector-specific external experts, who can steer the work and maximise the value of every penny spent.

The ongoing USAID incident is set to change the ODA landscape. It will reshape global health and social sector funding. The future of social development at the global level will increasingly revolve around regional development banks, and bilateral and multilateral collaborations. In the years to come, trade is likely to influence most policies and engagements, including those in the social sector.

Therefore, just as there are industry associations, there is a need for social sector donor agency collaborations and CSR coordination committees at both national and state levels, wherein agencies and donors can work together to identify their areas of focus. The world is now more driven by trade and economic growth. Every

nation aspires to achieve high economic growth, and a rapid rise in per capita income and GDP.

Social sector investment contributes to improved human capital formation, which in turn supports economic growth and nation-building. Social sector investment and industry must co-exist and work in tandem.

There is a global challenge that needs to be converted into an in-country opportunity by every nation, including India. In this context, India and the Global South must not merely “cope” but take the lead in reshaping the funding ecosystem. India's growing economy and geopolitical standing, and closer collaboration with other countries present a unique opportunity that should be seized to shape health outcomes in the Global South and steer the global health agenda.

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Global Health Diplomacy at a Crossroads

Lakshmy Ramakrishnan

Abstract

Global health and global health diplomacy are experiencing seismic shocks with the Covid-19 pandemic, the United States' withdrawal from the World Health Organization, and the abrupt dismantling of the US Agency for International Development (USAID). Meanwhile, the incidence of infectious diseases is increasing, the burden of non-communicable diseases is rising, and challenges to the creation of equitable health systems persist. Health outcomes will doubtless improve with scientific and technological innovation, but compounding the disease burden are other exacerbating factors: heightened geopolitical tensions, climate change, technological decoupling, and armed conflict. This article examines the current upheavals in global

health and identifies complexities that have arisen in recent years. It underlines the imperative of global health diplomacy to ensure peace, security, and the well-being of all. It offers suggestions for health diplomacy by identifying strategic areas of cooperation under regional forums such as BRICS, and by addressing contentious issues in the pandemic treaty.

Introduction

Global health diplomacy navigates a framework comprising state and non-state actors to advance health policy goals through formal and informal means. Contemporary health issues—infectious diseases, diabetes, cancer, obesity, nutritional disorders, mental health illnesses, and tobacco use—are unlikely to abate in the coming years, and addressing them will require concerted efforts at multilateral levels. Owing to their potential spillover effects into other sectors, obstacles to healthcare can affect countries' economic and political stability. The world order is currently in flux with multipolarity gaining ground, raising the criticality of global health diplomacy.¹

Indeed, health is among the multiple global issues dominating international politics and diplomacy.² In March 2020, the World Health Organization (WHO) declared the spread of a then-novel virus—Covid-19^a—as a Public Health Emergency of International Concern (PHEIC). Covid-19 would soon change the world, leading to disruptions in everyday activities, mobility, and the transport of goods; governments scrambled to enforce regulations on using masks and getting vaccinated. Rapid dissemination of technical data, streamlining of regulatory pathways, and international scientific collaboration enabled an understanding of Covid-19 and the development of technologies to mitigate it. To address the limited supply of medical countermeasures—essential vaccines, therapeutics, and diagnostics (VTDs)—a novel multilateral initiative called Access to COVID-19 Tools (ACT) Accelerator, was introduced. Ultimately, the world grappled with the novel virus by developing state-of-the-art vaccines, utilising multiple vaccine platforms like mRNA technology and by devising sensitive diagnostic tests to curb its impact on health outcomes.

^a Covid-19 is caused by the virus SARS-CoV2.

Nevertheless, the response was not without glitches, including the early politicised and securitised responses, where the origin of Covid-19 was widely speculated upon, and the ad-hoc application of restrictive measures under ‘social distancing’ orders.³ Further, Covid-19 exposed issues of hierarchical power relations, where countries engaged in vaccine nationalism—using bilateral arrangements with geopolitical considerations to acquire vaccines and entering into exclusive agreements with vaccine manufacturers, instead of adhering to fair and equitable global distribution.^{b,4} COVAX^c—a cooperative arrangement between Gavi, the Vaccine Alliance, the Coalition for Epidemic Preparedness Innovations (CEPI), WHO, and United Nations Children’s Fund (UNICEF) —was introduced to ensure equitable access to Covid-19 vaccines. It was, however, found to be akin to a donation-based system and less effectual, as nations with surplus vaccines were mostly willing to distribute them only after they had vaccinated their domestic populations, be it through COVAX or bilateral donations.⁵ It showed both the incapacity of low- and middle-income countries (LMICs) to self-procure and well as their lack of proper storage and distribution infrastructure, while high-income countries (HICs) like Canada, ordered vaccines several times in excess of their needs.⁶

By early 2022, more than 80 percent of the population of HICs were immunised compared to less than 10 percent in low-income countries (LICs).⁷ Recognising the need for heightened responsibility and accountability measures to address health emergencies, WHO member states began negotiations to set up a pandemic prevention, preparedness, and response framework.^{d,8} Finally signed in end-June 2025, the Pandemic Agreement includes a ‘One Health’^e approach to addressing future health threats, and an outline of how data and technology should be transferred to ensure equitable distribution of medical countermeasures during health emergencies.

^b ‘Vaccine nationalism’ refers to a scenario where countries are guided, first, by their own national interests in the allocation of vaccines and less by global cooperation imperatives. See: https://www.wto.org/english/tratop_e/trips_e/techsymp_290621/bown_pres2.pdf.

^c The vaccine pillar under ACT.

^d Also known as the pandemic treaty or agreement.

^e A multidisciplinary approach that considers human, animal, plant, and environmental health to be interlinked.

Sudden Shocks

Global health has been in turmoil in recent times, following the announcements of US President Donald Trump almost as soon as he took office for the second time in January 2025.⁹ Claiming that WHO had been late in warning about the severity of the Covid-19 threat and opaque about its origins, he began to formally withdraw the US's membership from the organisation. He also scaled back US contributions to Gavi, the Vaccine Alliance, halted all activity under the President's Emergency Plan for AIDS Relief (PEPFAR), and dismantled the United States Agency for International Aid (USAID). The US was the largest contributor to WHO, putting in US\$163-816 million per year over the last 10 years and its withdrawal will severely hamper the organisation's operational activities.¹⁰ Further, the US Centers for Disease Control and Prevention (CDC) has ceased cooperation with WHO, leaving the latter without critical data and scientific expertise. It is estimated that the proposed funding cuts to Gavi will lead to the deaths of over a million children in the next five years, while the PEPFAR withdrawal means that an additional 6.6 million new HIV infections will occur by 2029.¹¹ The Global Fund to Fight AIDS, Tuberculosis and Malaria will also be badly impacted.¹²

A 'Polycrisis' in the Making

What experts call a "polycrisis"^f is brewing in global health. Countries such as Germany too, have been reducing their official development assistance (ODA) on health, diverting funds towards the conflicts in Russia-Ukraine and West Asia. Along with the US and Germany, China, Russia and India have also been increasing their military expenditure.¹³ To what extent other WHO member states and philanthropies will fill this funding shortfall remains to be seen. China, meanwhile, has announced an additional US\$500 million over the next five years to supplement its mandatory contribution to WHO, while the Gates Foundation announced a rollout of US\$200 billion over the next two decades to tackle health issues in Africa.¹⁴

^f 'Polycrisis' refers to an occurrence where multiple crises occur within the global system, become entangled, and impede progress. See: <https://wfabhmdrpib5-u5525.pressidiumcdn.com/wp-content/uploads/2022/04/What-is-a-global-polycrisis-v2.pdf>.

Global health, particularly the domain of digital health, may even be impacted as countries such as the US and China, due to their heightened geopolitical tensions and apprehensions of technologies or data being misused to cause harm—what is called “dual-use”—decouple their technologies from each other. While tech regulation is needed, decoupling can impede innovation and mutually beneficial cooperation.¹⁵

An Opportunity for BRICS

The Global South must take cognisance of these interconnected health challenges, technological advancements, and geopolitical tensions, and voice its concern. Through various South-South cooperation arrangements, South Africa, India, Brazil, and China have been giving primacy to global health. During the Covid-19 pandemic, for instance, India and South Africa jointly filed for a Trade-Related Aspects of Intellectual Property Rights (TRIPS) waiver from the World Trade Organisation (WTO), to enable temporary easing of intellectual property (IP) rights for Covid-19 countermeasures.¹⁶ Indeed, the BRICS grouping has historically emphasised the importance of universal health coverage (UHC), recognising the role of socio-economic determinants of health, and has advocated flexibility around TRIPS agreements, along with negotiations over international health regulations (IHR, 2005).¹⁷

BRICS^g can help enable more states to have increased power in collective decision-making over global health.¹⁸ It represents almost 50 percent of the world’s population and 39 percent of global gross domestic product (GDP).¹⁹ In July 2025, it formalised a global partnership for socially determined diseases and neglected tropical diseases,²⁰ which will focus on promoting equity in low-resource settings and on developing emerging healthcare technologies.

BRICS is already doing excellent work on tuberculosis (TB).^h Despite being treatable, TB presents challenges, with many asymptomatic cases that delay diagnosis, with multi-drug resistant strains and co-morbidities, while the poor air quality of cities aggravates the problem.²¹ Most BRICS countries have set up

^g The group initially comprised of Brazil, Russia, India, China, and South Africa and has now expanded to include Egypt, Ethiopia, Indonesia, Iran, and United Arab Emirates (UAE).

^h More than half the world’s TB burden is borne by BRICS countries.

national programmes for TB management, while the BRICS TB Research Network, established in 2017, strives to address the problem through research on vaccines, drugs, and diagnostics, by conducting clinical trials, and in capacity building.²² The declaration at the end of the XV BRICS Health Ministers' meeting in Brasilia on 19 June 2025 emphasised developing new vaccine technologies against TB by setting up a BRICS vaccine research and development (R&D) centre, promoting ethical AI in healthcare, and implementing diverse funding mechanisms.²³ India will host the AI Impact Summit in February 2026 with the aim to democratise AI in healthcare and invited BRICS countries to collaborate on AI governance.²⁴

India, with its scientific prowess and manufacturing capacity, is well-poised to share and co-develop TB-related health technologies through BRICS partnerships. India's AI-assisted chest X-ray, already a game-changer in TB diagnosis, is a global model and likely to be scaled up soon.²⁵ Similarly, its point-of-care TB diagnostic test, called Truenat, enabling rapid real-time diagnosis, has been hailed by the World Health Assembly (WHA), and is also being scaled-up for routine care.²⁶ India has also launched a digital health platform called TB-WIN in partnership with United Nations Development Programme (UNDP), to promote TB vaccinations in the adult population.²⁷ It could be a model for other countries to enhance public health delivery through digital technologies.²⁸

In a similar vein, BRICS will need to work together to identify other areas of alignment in healthcare and alternative sources of funding. In 2023, of the US\$4.5 billion assigned to TB from domestic resources, 63 percent was sourced from BRICS.²⁹

The Shortcomings of the Pandemic Agreement

At their meeting in Rio de Janeiro on 7 July 2025, BRICS leaders reaffirmed their commitment to multilateralism and reform of global governance, and called for further negotiations over the pandemic treaty.³⁰ As noted earlier, the WHA meeting in June had culminated in the adoption of the treaty, which outlines approaches and tools to enhance global pandemic preparedness.³¹ Negotiations had begun in December 2021, sparked by the unexpected hurdles that the distribution of Covid-19 vaccines ran into during the spread of the Omicron variant, first recorded in Botswana and South Africa in November 2021. That such a crucial treaty could be adopted without the US being part of it has been heralded as an indicator of thriving multilateralism.

However, excessive optimism over the newly adopted pandemic agreement may be premature.³² It is not yet open for signature and ratification, as negotiations over the pathogen access and benefit-sharing (PABS) mechanism, which has been moved from the main text of the agreement to its annex, are pending. These will be conducted through an Intergovernmental Working Group (IGWG) that will discuss their findings during the WHA meeting in 2026.

The goal of the PABS mechanism is to ensure sharing of pathogen samples with pandemic potential for research, as well as to provide a legal avenue for equitable supply of VTDs.³³ Its need was highlighted during the Covid-19 pandemic when it was found that developing medical countermeasures was critically dependent on global coordination, including access to pathogen samples and equitable distribution of VTDs.

However, PABS encompasses several contentious issues that will likely stall negotiations. One hurdle is that while the 'One Health' principle has been incorporated into the pandemic treaty, its conceptualisation in the agreement is limited.³⁴ Negotiations over PABS have focused on human pathogens with pandemic potential, excluding animal and environment samples. Considering that emerging and re-emerging infectious disease outbreaks often result through spillover events from animals, such exclusion will limit the treaty's effectiveness.

This aspect could have been fine-tuned and a truly inclusive One Health approach could have been obtained had inputs been taken from members of the One Health Quadripartite.ⁱ PABS would then not only have been beneficial for the production of VTDs for pandemics but would also have addressed the underlying reasons for pathogen spillovers that lead to epidemics.³⁵ Traditional knowledge and practices, which are linked to pathogens, have also been overlooked.

Research into poultry farming practices, for instance, has provided insights on influenza outbreaks, while traditional burial practices were found associated with the transmission of Ebola during its outbreak in West Africa in 2014. Existing international regimes on access and benefit-sharing (such as the Convention on

ⁱ 'One Health Quadripartite' refers to the work the Food and Agriculture Organisation of the United Nations (FAO), the World Organisation for Animal Health (WOAH), the United Nations Environment Programme (UNEP), and World Health Organisation (WHO) are doing together.

Biological Diversity^j (CBD) and the Nagoya Protocol^k) recognise the importance of traditional knowledge of indigenous people and local communities, but the negotiations over PABS have failed to incorporate this. This is vital as the PABS is intended to align with the principles of CBD and the Nagoya Protocol.³⁶ BRICS, recognised as a champion of the One Health framework, is well-poised to raise the necessity of introducing these considerations into the PABS mechanism.³⁷

Further, PABS provides that participating manufacturers must enter into legally binding contracts to supply at least 10 percent of their VTDs, produced in real-time, to WHO as a donation, but it does not specify how this directive will be implemented. There is no clarity on which manufacturers will be contracted, whether WHO can contract with them, and how this system will be monitored and enforced.³⁸ The distribution of VTDs by WHO will be based on 'public health risk and need,' according to PABS, which could be influenced by political considerations; there is thus need for transparency on the decision-making process to allocate the benefits of PABS. It is also not yet clear whether VTDs under the PABS system will be subject to IP regulations, which could drastically impact their usefulness.

Finally, PABS overlaps with another newly adopted multilateral access benefit-sharing mechanism (ABS).³⁹ PABS centres on physical samples and genetic sequence data of pathogens of pandemic potential. The ABS framework, recently adopted by the parties to the CBD, deals with digital sequence information (DSI) on genetic resources.⁴⁰ The mechanism invites pharmaceutical companies to contribute 1 percent of their profit, or 0.1 percent of their revenue, to an ABS fund (known as the Cali Fund). It is likely that genetic resource data, including those of pandemic potential, will fall under the Cali Fund. The presence of two similar ABS frameworks with fragmented and conflicting requirements will complicate global health equity. An unambiguous, unified, and multilateral legal framework to ensure equitable distribution of VTDs is needed.

^j It is an international legal treaty for "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources." Its governing body is the Conference of Parties (COP) and is a key instrument for sustainable development. See: <https://www.un.org/en/observances/biological-diversity-day/convention>

^k It is an "international agreement which aims at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way." See: <https://www.cbd.int/abs/default.shtml>

At this year's WHA negotiations, developing countries were sceptical about the developed countries' proposal to set up an 'expert scientific committee' to draft the PABS text, noting that extensive draft proposals of such a text had already been submitted by them. Concern arose over the fear that scientific experts may not be neutral in their assessments and may be motivated by their own private interests. Similarly, developed countries proposed the inclusion of industry stakeholders—who have commercial interests—further reinforcing developing nations' apprehension over conflicts of interests.^{41,42} This indicates that the expert scientific committee would be motivated by private and commercial interests instead of the principles of transparency and accountability in ABS governance structures that are outlined by the CBD and Nagoya Protocol. Instead, BRICS could advocate for legal experts to address the PABS framework, keeping the Cali Fund in mind, and provide greater transparency on its nuances. Overall, this demonstrates that the world's responsiveness to pandemics relies on addressing these shortcomings.

Conclusion

The world is undergoing dramatic changes in almost every sector and global health is no exception. Strategic partnerships to address shared interests are an imperative. Political will and diplomacy are both necessary to ensure the health of the population. In this ever-changing landscape, developing countries will need to strive to elevate global health challenges to multilateral forums such as BRICS, and will need to address contentious issues within the existing pandemic treaty to ensure health for all.

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India's MedTech Industry: A Paradigm Shift from Self-Sufficiency to Creating Global Impact

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Abstract

The Indian medtech industry, often overshadowed by the pharmaceutical sector, is at the cusp of transformation, carving its space as a global hub. The size of the Indian medical devices market was estimated at US\$12 billion in 2023-24 and is expected to grow to US\$50 billion by 2030 with a CAGR of 16.4 percent. Over the last decade, and especially following the COVID-19 pandemic, the medical device sector in India has recorded remarkable growth. A wide range of medical devices, from consumables to implantable medical devices, to high-end imaging and AI devices, are produced in India, combining innovation and affordability. With breakthrough innovations and a strong focus on digital integration, the world is increasingly looking to

India for cost-effective and technologically advanced healthcare solutions, positioning the country to play a transformative role in improving global health outcomes.

Introduction

India's medtech sector is experiencing growth driven by various factors: rising income levels, improved healthcare coverage (through private schemes and the government-led Ayushman Bharat healthcare programme), urbanisation and growth in Tier 2 and 3 towns, government initiatives such as the Production Linked Incentive (PLI) Scheme, digital platforms like Ayushman Bharat Digital Mission (ABDM), and medical tourism.¹ The healthcare landscape continues to evolve at an unprecedented pace, spanning technological advancements and infrastructure development, and shifting patient expectations. The size of the Indian medical devices market was estimated at US\$12 billion in 2023-24 and is expected to grow to US\$50 billion by 2030 with a compound annual growth rate (CAGR) of 16.4 percent.^{2,3} These factors have contributed to India's current ranking as the fourth largest MedTech market in Asia—following Japan, China, and South Korea—and among the top 20 globally.⁴ Within this dynamic situation, the challenges and opportunities in the medtech sector demand both resilience and foresight.

From Import-Dependent to Global Hub Aspirations

India's medtech exports have grown to an estimated US\$3.8 billion in 2023-24, but the sector remains largely import-dependent with over 80-85 percent of medical devices sourced from overseas, pointing to a strategic vulnerability that contributes to high healthcare costs.⁵ This places a burden on the general public who pay exorbitant prices for medical devices owing to the multiple markups on top of their import landed prices. However, during the COVID-19 pandemic, local manufacturers rose to the challenge and produced quality devices at scale.

Today, local companies are looking to increase their focus on import-dependent segments and price-sensitive markets in the European Union (EU), Asia-Pacific (APAC), Middle East and Latin American regions. Meanwhile, global multinational corporations (MNCs) increasingly focused on India for research and development (R&D), manufacturing, and global capability centres (GCC), are focusing on localisation, technology, and digital innovation. This strategic shift, coupled with the entry of local pharmaceutical companies in the medical device manufacturing space in India, marked a transformation.

As soon as a boom was in sight, especially post the pandemic, the government introduced a host of regulatory reforms, infrastructure development and R&D promotion, while describing the medical devices sector as a “sunrise sector”. The Medical Device Rules and National Medical Device Policy were revisited, PLI schemes were launched, and MedTech Mitra, the promotion of medical device parks, and the Promotion of Research and Innovation in Pharma MedTech sector (PRIP) were introduced to boost growth.

As these reforms gain momentum, India’s approach to medical device regulation is evolving to accommodate both public health imperatives and innovation pathways. Under the Medical Devices (Amendment) Rules 2020, the Central Drugs Standard Control Organisation (CDSCO) has initiated a shift towards a risk-based classification system (classes A-D) for all medical devices, with plans for phased implementation.⁷ A research paper published by ORF in July 2025 observed that while capacity constraints remain—particularly in post-market surveillance and human resources—the broader direction reflects a move toward smart regulation.⁷ Such reforms are especially important as India integrates digital health infrastructure like the Ayushman Bharat Digital Mission (ABDM)—which can serve as a backbone for interoperability, traceability, and safety monitoring of medical devices—across the care continuum.

The Department of Pharmaceuticals also launched marginal investment, labour skilling, and clinical study support schemes to boost manufacturing competitiveness, in addition to creating an Academic Centre for Excellence curated by National Institute of Pharmaceutical Education and Research (NIPER).^{8,9,10,11} Furthermore, the current global geopolitical narrative, recent Free Trade Agreements with countries such as the UK and the UAE, coupled with strategic alliances and a pragmatic approach have created a huge window of opportunity for driving India’s rise as a medtech powerhouse.¹²

These initiatives support value-added manufacturing, encourage innovation in cutting-edge medical technologies, and enable backward integration and value-based engineering similar to that of India’s IT boom two decades ago.

Powering the Next Wave: MedTech Innovations and R&D Breakthroughs

Even before COVID-19, key players in the Indian medtech industry have realised that strengthening R&D is key to ensuring self-reliance and competing with MNCs

in an evolving healthcare landscape. That, coupled with the prime minister's clarion call to "Make in India for the World", gave a strategic push to R&D that laid the foundation for improving safety standards, reducing costs, and boosting employment and exports.¹³

The focus on R&D in medical devices pushed continuous innovation that ensured affordable and high-quality products, improved patient outcomes, enhanced global competitiveness, and positioned India as a trusted hub for evidence-based medical devices and other advanced medical technologies. The INR 5,000 crore PRIP initiative could potentially attract an estimated INR 17,000 crore in R&D investment, supporting this shift.¹⁴ This gave impetus to leading medtech companies and Indian medical device start-ups to drive innovation across various segments while focusing on the themes of improved safety, enhanced efficacy, increased accessibility/affordability, and optimised efficiency.

Medtech innovation, supported by robust medical device clinical trials and R&D in India and abroad, became the core of these advancements. This propelled the industry forward, especially in high-risk categories like cardiovascular stents, imaging and related areas. With the advancement of digitalisation and AI-based technologies, a large number of innovations among MSMEs and start-ups focused on the intersection of medical devices and software, with AI and data analytics driving advancements, particularly in diagnostics.

A 2023 analysis by Ernst & Young of 50 Indian medtech start-ups found that 21 percent of innovations are purely digital, while 79 percent are medtech-focused, with 63 percent of these being digitally integrated.¹⁵ With COVID-19 slowing down the global economy, stakeholders soon realised that India must innovate across its product range, from high-volume, low-value items to advanced, high-value equipment. The path to future growth lies in adding value and enhancing competitiveness across the spectrum.

Reflecting on this emerging trajectory and realising the immense potential for innovation and impact, the industry, along with the Government of India, adopted a holistic approach combining R&D, localised innovation, and skill development to prepare the domestic industry to address the dynamic healthcare challenges. The aim is to produce solutions that meet—or even exceed—global standards, while building supply chain resilience for the future.^{16,17}

The domestic industry was actively deploying advanced technologies such as artificial intelligence (AI), internet of things (IoT), and robotics to address the complex healthcare challenges of the country's diverse population. Domestic companies led innovation, making sophisticated procedures more accessible and affordable, while frugal technologies helped shift the healthcare model from reactive to proactive.

At this juncture, collective efforts in innovation, quality enhancement, and adherence to international standards became pivotal in realising India's vision of becoming the next global powerhouse in medical device manufacturing. India is now working to develop a dedicated medtech R&D policy covering all aspects from device design to regulatory compliance for funding, including technology transfer and academia-industry partnerships for innovation and research.¹⁸

Efforts are being made to strengthen the existing Export Promotion Council for Medical Devices (EPC-MD) to drive global market access, building on methodologies to enhance fiscal incentives by offering tax rebates and subsidies to companies investing in R&D and workforce training.¹⁹ Such initiatives will pave the way for harmonising standards with global bodies like the United States Food and Drug Administration (USFDA), European Union Medical Device Regulation (EU MDR)/In Vitro Diagnostic Regulation (IVDR), Conformité Européenne (CE), and the United Kingdom Conformity Assessment (UKCA) to drive smoother global market entry, transforming the Indian medtech landscape and bringing it closer to its next phase of growth.

Complementing these trends is a nascent but promising shift in the ecosystem's orientation—viewing regulation as an enabler of trust and market expansion, and not as a barrier. The same ORF paper cited earlier notes that as India increasingly exports to regulated markets, aligning with international norms—such as those of the US FDA and European MDR—will be critical for credibility and competitiveness.²⁰ Here, digital technologies, public infrastructure, and institutional partnerships can lower entry barriers and enhance compliance efficiency for Indian manufacturers. These systemic shifts are integral to translating India's innovation potential into long-term resilience and global relevance in the medtech sector.

Building Resilience and Adopting Global Best Practices

To create a resilient, self-reliant, and globally competitive medtech sector, the focus on manufacturing competitiveness and quality excellence has become the cornerstone in the past two years. Indian companies realised that manufacturing

competitiveness stands at the forefront, and needs to be supported by an unwavering focus on quality excellence. The development of a robust testing and certification infrastructure and access to testing labs was strengthened.²¹

The government expanded India's testing network through institutions and academic centres. There have been invitations to create a pool of public-private partnerships (PPPs) that can be instrumental in establishing such testing centres and aligning them with global standards, reducing dependence on foreign regulatory bodies.

To achieve global alignment in its medical device regulatory system, enhance the competitiveness of the domestic industry, and boost transnational prominence, the Central Drugs Standard Control Organization (CDSCO) became an Affiliate Member in the International Medical Device Regulators Forum (IMDRF) in 2024.²² The membership helps align regulatory requirements across the globe, which reduces complexity for manufacturers and helps in safeguarding public health by promoting collaboration, harmonising regulations, and promoting convergence. It also helps to support innovation and timely access to new medical devices. This membership enables Indian medical device manufacturers to meet the regulatory requirements of IMDRF member countries, thereby strengthening the Indian brand across global markets.

Supply Chain Resilience

Strengthening supply chain resilience and embracing value-driven market access strategies was another important aspect. Under the PM-GATI Shakti programme,^a supply chain resilience has been strengthened while embracing value-driven market access strategies.²³ By using IoT, AI, Big Data, blockchain, robotics and other advanced supply chain technologies, pharmaceutical and medtech companies transformed their operations to ensure that not only vital drugs and medical devices are readily accessible globally, but also ensured the supply of critical raw material from the point of manufacture to the point of use.²⁴

^a Launched in 2021, the PM GatiShakti National Master Plan (PMGS-NMP) aims to incorporate the infrastructure schemes of various Ministries and State Governments to improve connectivity and competitiveness for Indian businesses, leveraging technology and spatial planning tools to provide multimodal connectivity infrastructure to various economic zones.

Investments in supply chain visibility and analytics, exploring digital solutions, and building resilient supply chains to stay ahead of disruptions were placed as an immediate policy makeshift. From a long-term perspective, the adoption of next-generation technologies such as the low-cost Geographic Information System (GIS) monitoring developed by the Indian Institute of Technology (IIT) was a step ahead.²⁵ Building on this momentum, India's strengths were leveraged to lead in digital innovation.

Skill Development

India is reported to have a 40-percent deficit in skilled biomedical engineering, biotechnology, regulatory affairs, and manufacturing technologies professionals.²⁶ To address this challenge, India developed a multi-pronged academia-industry approach. Renowned entities like NIPERs, IIT, Indian Institute of Science (IISc), and All India Institute of Medical Sciences (AIIMS) have started to work with medtech companies to develop testing and clinical sites in addition to relevant courses.²⁷

Skill centres like The Life Sciences Sector Skill Development Council (LSSSDC)—an awarding body recognised by the National Council of Vocational Education and Training (NCVET)^b—are dedicated to creating a sustainable and vocational education ecosystem for the Life Sciences sector. This includes disciplines like Pharmaceuticals, Biotechnology, Medical Devices, and R&D Services, assisting in bridging the gap between theoretical knowledge and practical expertise.²⁸ Emphasis must be placed on training, upskilling and re-skilling technicians and quality assurance professionals in medtech manufacturing, calibration, and regulatory compliance.

^b This body comes under the purview of the Ministry of Skill Development and Entrepreneurship (MSDE) and the National Skill Development Corporation (NSDC); it has industry representatives as well.

Vision 2047: The SMART Road Ahead

As stated earlier, India is at the cusp of becoming a global leader in medical device manufacturing. The healthcare sector is no stranger to global volatility, and this is most evident in the emerging economies. In this context, building resilience is not just desirable but essentially a SMART need:

S - Sustainable manufacturing

M - Measurable processes

A - Advanced (beyond Available, Affordable, and Accessible)

R - Relevant and Research-oriented towards disease shifts and healthcare needs

T - Technology-savvy that proves efficiency

Collaboration between the government and industry leaders needs to undergo such a SMART evolution to establish the future landscape of healthcare technology. This will be driven by the increasing demand for smarter, more connected, and patient-centric solutions.

As healthcare systems worldwide strive for better outcomes, reduced costs, and improved accessibility, the role of advanced medical technologies has never been more critical. Leadership in a sector as dynamic and transformative as healthcare requires a delicate balance of optimism and pragmatism. The challenges are considerable, yet the opportunities are equally significant. In navigating this evolving landscape, a consistent guiding principle is essential—combining technology with compassion to deliver meaningful, life-saving solutions.

Looking ahead, India envisions its healthcare ecosystem as one that is interconnected, inclusive, and driven by innovation. This vision extends beyond the 2030 goals to encompass the entire healthcare value chain by 2047 and well into the future. The medical devices sector holds immense potential, and the present moment offers a critical opportunity for India to commit to 'Make in India for the World,' advancing the vision of *Vasudhaiva Kutumbakam* (the world is one family). This approach seeks to redefine healthcare possibilities by harnessing the convergence of technology to ensure improved outcomes, global reach, and a healthier world.

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