REVIEW ARTICLE

Role of Public Health Institutions in Operationalising the One Health Approach: A Narrative Review

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Abstract

The One Health approach is an integrated and collaborative framework that recognises the interdependence of human, animal, and environmental health. It promotes multisectoral and transdisciplinary collaboration to address complex public health challenges, including zoonotic diseases, antimicrobial resistance, environmental degradation, food safety concerns, and the health impacts of climate change. Public health institutions play a central role in operationalising this approach by facilitating integrated surveillance, evidence-based policymaking, intersectoral coordination, outbreak preparedness and response, research, workforce development, environmental health monitoring, and community engagement.

A narrative literature review was conducted using PubMed, Scopus, Google Scholar, and official publications from the World Health Organization (WHO), Food and Agriculture Organization (FAO), World Organisation for Animal Health (WOAH), United Nations Environment Programme (UNEP), Centers for Disease Control and Prevention (CDC), Indian Council of Medical Research (ICMR), National Centre for Disease Control (NCDC), and the Government of India. Literature published between January 2010, and March 2025 was reviewed.

The review highlights the critical role of public health institutions in strengthening integrated surveillance systems, promoting evidence-based governance, supporting multidisciplinary research, enhancing laboratory capacity, building a skilled workforce, and fostering community participation. Recent national initiatives, including the National One Health Mission, National Action Plan on Antimicrobial Resistance (NAP-AMR), Integrated Disease Surveillance Programme (IDSP), Integrated Health Information Platform (IHIP), and Antimicrobial Resistance Surveillance and Research Network (AMRSN), demonstrate India's growing commitment to implementing the One Health approach through coordinated institutional mechanisms.

Despite considerable progress, implementation continues to be constrained by fragmented governance structures, limited interoperability of surveillance systems, shortages of trained multidisciplinary professionals, inadequate financial investment, and disparities in infrastructure, particularly in resource-limited settings. Strengthening intersectoral collaboration, expanding

integrated surveillance, investing in research and workforce development, leveraging digital health technologies, and promoting community engagement will be essential for strengthening health systems and improving preparedness for future public health emergencies.

KEYWORDS
Antimicrobial Resistance, Environmental Health, Health Systems, Intersectoral Collaboration, One Health, Surveillance

INTRODUCTION

The concept of health has evolved considerably over the past century, reflecting advances in scientific knowledge and an improved understanding of the complex interactions between humans, animals, and the environment. Traditionally, health systems have focused primarily on the prevention, diagnosis, and treatment of human diseases. Although this approach has contributed significantly to improvements in life expectancy and disease control, it has often overlooked the ecological and environmental factors that influence health. In recent decades, the emergence of complex public health challenges has demonstrated that human health cannot be considered in isolation but is closely interconnected with animal health and the surrounding environment. The One Health approach has emerged as an integrated framework that recognises these interrelationships and promotes collaborative, multisectoral, and transdisciplinary efforts to achieve optimal health outcomes.[1-4]

Zoonotic diseases have been a major driving force behind the adoption of the One Health approach. Approximately 60% of known infectious diseases affecting humans are zoonotic, while nearly three-quarters of emerging infectious diseases originate from animals.[5,6] The increasing frequency of outbreaks such as influenza, Ebola virus disease, Nipah virus disease, Severe Acute Respiratory Syndrome (SARS), Coronavirus Disease 2019 (COVID-19), and highly pathogenic avian influenza has highlighted the close interface between humans, animals, and the environment.[7,8] These outbreaks have resulted not only in significant morbidity and mortality but also in substantial economic losses, disruption of healthcare services, threats to food security, and adverse social consequences.[8] Their emergence has reinforced the need for integrated surveillance systems, coordinated outbreak response, and collaboration across sectors to prevent and control future health threats.[9,10]

The emergence and spread of zoonotic diseases are influenced by multiple interconnected factors. Rapid urbanisation, population growth, changing land-use patterns, deforestation, agricultural intensification, wildlife trade, and increased encroachment into natural ecosystems have increased interactions among humans, domestic animals, wildlife, and vectors, thereby facilitating pathogen spillover.[6] Climate change further influences disease transmission by altering the distribution of vectors and reservoirs and increasing the likelihood of infectious diseases emerging in previously unaffected geographical regions.[11] Environmental degradation, biodiversity loss, pollution, and ecosystem disruption reduce ecological resilience and create favourable conditions for the emergence and re-emergence of infectious diseases.[12,13] Consequently, the One Health approach extends beyond zoonotic disease control and encompasses antimicrobial resistance, food safety, environmental sustainability, biodiversity conservation, and planetary health.[2,13]

Despite increasing recognition of these interconnections, health systems in many countries continue to operate in sector-specific silos, with limited coordination among human health services, veterinary services, environmental agencies, wildlife authorities, and agricultural sectors.[14,15] Fragmented surveillance systems, inadequate laboratory networking, poor interoperability of databases, and limited information sharing often delay the early detection of disease outbreaks and reduce the effectiveness of

response measures.[9,10] The One Health approach addresses these limitations by promoting integrated surveillance systems, interdisciplinary research, collaborative governance, coordinated outbreak preparedness and response, and evidence-informed policy development.[10] By encouraging collaboration across sectors, it provides a comprehensive framework for addressing increasingly complex health challenges that cannot be managed by a single discipline alone.

Recognition of the One Health approach has increased substantially during the past decade. International organisations have strengthened multisectoral collaboration through the Quadripartite alliance comprising the World Health Organization (WHO), Food and Agriculture Organization (FAO), World Organisation for Animal Health (WOAH), and United Nations Environment Programme (UNEP).[16] The One Health Joint Plan of Action developed by these organisations provides a strategic roadmap for improving surveillance, governance, workforce development, antimicrobial resistance containment, food safety, environmental protection, and pandemic preparedness through coordinated action.[17] This global momentum has encouraged many countries to develop national policies that integrate human, animal, and environmental health into public health planning.

India has also made significant progress towards operationalising the One Health approach. The National Action Plan on Antimicrobial Resistance (NAP-AMR) promotes a multisectoral strategy for strengthening antimicrobial stewardship, integrated surveillance, infection prevention and control, research, and public awareness.[18] The National One Health Mission, coordinated through the Office of the Principal Scientific Adviser to the Government of India with active participation from the Indian Council of Medical Research (ICMR), Department of Biotechnology (DBT), Department of Animal Husbandry and Dairying, and several other ministries, aims to strengthen integrated surveillance, improve laboratory networks, promote interdisciplinary research, and enhance preparedness for emerging and re-emerging zoonotic diseases.[19] National initiatives such as the Integrated Disease Surveillance Programme (IDSP), Integrated Health Information Platform (IHIP), National Animal Disease Reporting System (NADRS), and the Antimicrobial Resistance Surveillance and Research Network (AMRSN) have further strengthened India's capacity for early detection, surveillance, and coordinated response to public health emergencies.[20-23] These initiatives collectively demonstrate India's growing commitment to institutionalising the One Health approach through coordinated governance, research, and evidence-based policymaking.

Public health institutions occupy a central position in translating the One Health concept into practice. Their responsibilities extend beyond conventional disease prevention and control to include integrated surveillance, policy development, intersectoral coordination, outbreak preparedness and response, research and evidence generation, workforce capacity building, environmental health monitoring, and community engagement.[24,25] By serving as coordinating platforms across sectors, these institutions facilitate comprehensive, evidence-informed, and sustainable public health interventions that improve health security and strengthen resilience against emerging health threats.[26,27]

The objective of this narrative review is to examine the multifaceted role of public health institutions in operationalising the One Health approach, with particular emphasis on surveillance, policy development, intersectoral coordination, outbreak preparedness and response, research and evidence generation, capacity building, environmental health monitoring, and community engagement, while highlighting recent global developments and the evolving Indian policy landscape.

Material & Methods

This narrative review was undertaken to examine the role of public health institutions in operationalising the One Health approach. A comprehensive literature search was conducted using electronic databases including PubMed, Scopus, and Google Scholar. In addition, relevant policy

documents, technical reports, and guidelines were retrieved from the official websites of the World Health Organization (WHO), Food and Agriculture Organization (FAO), World Organisation for Animal Health (WOAH), United Nations Environment Programme (UNEP), Centers for Disease Control and Prevention (CDC), Indian Council of Medical Research (ICMR), National Centre for Disease Control (NCDC), Department of Biotechnology (DBT), Ministry of Health and Family Welfare (MoHFW), and the Office of the Principal Scientific Adviser to the Government of India.

The literature search included publications published between January 2007 and December 2022. Search terms included combinations of "One Health," "Public Health Institutions," "Surveillance," "Zoonotic Diseases," "Antimicrobial Resistance," "Environmental Health," "Health Systems," "Intersectoral Collaboration," "Outbreak Response," "Capacity Building," and "Community Engagement."

Peer-reviewed original articles, review articles, policy documents, technical reports, and official government publications published in English were included. Literature focusing on the role of public health institutions in surveillance, governance, policy development, outbreak investigation and response, research, capacity building, environmental health, and community engagement within the One Health framework was considered for inclusion. Duplicate records were removed, and the retrieved literature was screened for relevance before inclusion in this narrative review. Given the narrative nature of this review, the findings are synthesised descriptively to provide a comprehensive overview of the evolving role of public health institutions in implementing the One Health approach.

Role of Public Health Institutions in the One Health Approach

Strengthening Surveillance Systems

Integrated surveillance is one of the fundamental pillars of the One Health approach and forms the basis for timely detection, prevention, and control of diseases affecting humans, animals, and the environment.[28-29] Public health institutions play a central role in establishing, coordinating, and strengthening surveillance systems by facilitating collaboration among healthcare providers, veterinary services, environmental agencies, public health laboratories, and research institutions.[30]

Traditionally, disease surveillance has focused primarily on human health. However, the One Health approach emphasises the integration of surveillance data from human, animal, wildlife, and environmental sectors to generate a comprehensive understanding of disease transmission and emerging health threats.[17,28] Integrated surveillance allows the identification of unusual disease patterns at the human-animal-environment interface before widespread transmission occurs, thereby enabling timely implementation of preventive and control measures.[29]

Rapid advances in digital health technologies have further strengthened surveillance systems. Electronic health records, Geographic Information Systems (GIS), mobile-based reporting platforms, electronic laboratory reporting systems, and real-time dashboards facilitate rapid collection, analysis, and dissemination of surveillance data across multiple sectors.[31] The use of digital platforms improves data quality, enables predictive modelling of disease trends, supports geospatial mapping of outbreaks, and facilitates early warning systems for public health emergencies.[32] More recently, genomic surveillance and artificial intelligence-assisted data analysis have enhanced the identification of novel pathogens, monitoring of pathogen evolution, and prediction of outbreak patterns, thereby strengthening preparedness and response capacities.[33,34]

India has made considerable progress in strengthening integrated surveillance through several national initiatives. The Integrated Disease Surveillance Programme (IDSP), coordinated by the National Centre for Disease Control (NCDC), serves as the country's primary surveillance system for epidemic-prone diseases by integrating information from districts and states for early detection and rapid response.[20] The Integrated Health Information Platform (IHIP) has further modernised surveillance by enabling near real-

time reporting, electronic case-based surveillance, and improved interoperability between health facilities.[21] In the animal health sector, the National Animal Disease Reporting System (NADRS) supports systematic reporting and monitoring of livestock diseases, facilitating information sharing between veterinary and public health authorities.[22] Strengthening collaboration among these surveillance platforms is essential for achieving an effective One Health surveillance system capable of detecting threats at the human-animal-environment interface.[17,24]

Surveillance systems often continue to function independently, resulting in fragmented databases, limited interoperability, inconsistent reporting standards, and inadequate information sharing among sectors.[15,30] Variations in laboratory capacity, shortages of trained epidemiologists, delayed reporting from peripheral health facilities, and insufficient integration of environmental surveillance further limit the effectiveness of surveillance systems, particularly in resource-constrained settings.[26,27] Addressing these gaps requires strengthening laboratory networks, improving digital infrastructure, standardising reporting mechanisms, promoting routine data sharing across sectors, and investing in a skilled multidisciplinary workforce.[25,27]

Public health institutions are uniquely positioned to coordinate these efforts. By integrating surveillance across human, animal, and environmental health sectors and leveraging advances in digital technologies, genomic surveillance, and data analytics, they can substantially improve early detection of emerging health threats, strengthen outbreak preparedness, and enhance national and global health security. Continued investment in integrated surveillance systems will therefore remain essential for the successful operationalisation of the One Health approach.

Policy Development and Governance

Public health institutions play a central role in developing, implementing, and evaluating policies that address complex health challenges within the One Health framework. These policies extend beyond conventional disease control and encompass zoonotic disease prevention, antimicrobial resistance (AMR), food safety, environmental protection, biodiversity conservation, and climate-sensitive health risks. Effective policy development provides a structured framework for coordinated action across multiple sectors and ensures that interventions are aligned with national and global public health priorities.[17,28]

Governance forms the foundation for successful implementation of the One Health approach. Public health institutions work closely with government ministries, veterinary and environmental agencies, academic institutions, research organisations, international agencies, and civil society to ensure coordinated planning and implementation of public health interventions. Strong governance mechanisms facilitate effective resource allocation, establish accountability, strengthen regulatory oversight, and support continuous monitoring and evaluation of programmes. Such coordination is essential for translating policy into practice and ensuring long-term sustainability of One Health initiatives.[15,35]

The WHO Global Action Plan on Antimicrobial Resistance and the United Nations Sustainable Development Goals have highlighted the importance of multisectoral collaboration in addressing emerging public health threats.[36,37] More recently, the One Health Joint Plan of Action (2022-2026) developed by WHO, FAO, WOAH, and UNEP has provided a comprehensive roadmap for strengthening governance, surveillance, workforce development, food safety, environmental health, and pandemic preparedness through coordinated action across sectors.[17] These international frameworks encourage countries to integrate human, animal, and environmental health into national public health planning.[37]

India has taken several important policy initiatives to operationalise the One Health approach. The National Action Plan on Antimicrobial Resistance (NAP-AMR) recognises antimicrobial resistance as a major public health challenge and promotes a

multisectoral strategy involving the health, animal husbandry, agriculture, fisheries, pharmaceutical, and environmental sectors. The plan emphasises integrated surveillance, antimicrobial stewardship, infection prevention and control, research, capacity building, and public awareness as key components for combating AMR.[18]

Another major milestone has been the establishment of the National One Health Mission, coordinated through the Office of the Principal Scientific Adviser to the Government of India. The Mission aims to institutionalise collaboration among the Ministry of Health and Family Welfare, Department of Animal Husbandry and Dairying, Department of Biotechnology, Indian Council of Medical Research (ICMR), Indian Council of Agricultural Research (ICAR), National Centre for Disease Control (NCDC), and several other stakeholders.[19] Its objectives include strengthening integrated surveillance systems, improving laboratory networking, promoting interdisciplinary research, enhancing outbreak preparedness, and developing coordinated policy responses for zoonotic diseases and other emerging health threats.

The Indian Council of Medical Research (ICMR) has further strengthened the One Health agenda through collaborative research programmes, laboratory networks, and surveillance initiatives focused on zoonotic diseases, antimicrobial resistance, and emerging infections.[23] Similarly, the Department of Biotechnology has supported multidisciplinary research programmes and innovation platforms aimed at strengthening diagnostic capacity, pathogen discovery, genomic surveillance, and translational research under the One Health framework.[30]

Public health institutions therefore remain central to the governance of the One Health approach. Through evidence-informed policymaking, coordinated leadership, effective regulation, and multisectoral collaboration, they provide the institutional framework necessary to strengthen health systems, improve preparedness for emerging public health threats, and advance national and global health security.[17,35]

Intersectoral Coordination

Intersectoral coordination is the cornerstone of the One Health approach, recognising that effective prevention and control of public health threats require collaboration among the human health, animal health, environmental, agricultural, wildlife, and allied sectors. Public health institutions serve as the central coordinating agencies that facilitate communication, information sharing, joint planning, and implementation of interventions across these diverse sectors.[16,35]

Effective coordination relies on well-defined governance mechanisms, regular communication, and institutional partnerships. Public health institutions facilitate collaboration through multidisciplinary technical committees, joint surveillance activities, shared databases, interdepartmental meetings, and coordinated outbreak response plans. These mechanisms reduce duplication of efforts, optimise the utilisation of available resources, improve laboratory coordination, and enable timely implementation of evidence-based interventions.[15,35]

At the global level the One Health Joint Plan of Action promotes collaboration among governments, research institutions, veterinary services, environmental agencies, and international partners to strengthen surveillance, antimicrobial resistance containment, food safety, workforce development, and pandemic preparedness.[17] Similarly, the Tripartite Guide to Addressing Zoonotic Diseases in Countries (TZG) provides practical guidance for establishing sustainable multisectoral coordination mechanisms at the national and sub-national levels.[16]

India has increasingly adopted intersectoral collaboration as an essential component of its One Health strategy. The IDSP facilitates coordination between district surveillance units, public health laboratories, veterinary authorities, and state health departments for the early detection and reporting of epidemic-prone diseases.[20] The IHIP has further strengthened communication by enabling electronic reporting and real-time information sharing across healthcare facilities.[21] Coordination between the NCDC, ICMR,

Department of Animal Husbandry and Dairying, Department of Biotechnology, and other national agencies has also improved surveillance and preparedness for zoonotic diseases and antimicrobial resistance.[19,23,26]

The response to the Nipah virus outbreaks in Kerala demonstrates the importance of intersectoral collaboration in disease control. Rapid coordination among the state health department, NCDC, ICMR, National Institute of Virology (NIV), Pune, veterinary authorities, local administration, and community stakeholders facilitated early case detection, laboratory confirmation, contact tracing, risk communication, infection prevention measures, and containment of the outbreak.[38,39] Similar multisectoral coordination has been observed during India's response to avian influenza, where collaboration among human health, veterinary, wildlife, and environmental agencies has been critical for surveillance, outbreak investigation, culling operations, laboratory confirmation, and implementation of public health measures.[40]

Despite these achievements, several barriers continue to hinder effective intersectoral coordination. Institutional silos, overlapping administrative responsibilities, fragmented information systems, differences in reporting mechanisms, limited sharing of surveillance data, and disparities in technical and financial capacities often restrict collaboration between sectors.[15] Strengthening intersectoral coordination requires clearly defined governance structures, formal mechanisms for information sharing, interoperable surveillance systems, joint training programmes, multidisciplinary simulation exercises, and sustained political commitment.

Outbreak Investigation and Response

Public health institutions play a pivotal role in the investigation and control of disease outbreaks by coordinating surveillance, laboratory confirmation, epidemiological investigations, risk assessment, and implementation of timely public health interventions. Within the One Health framework, outbreak investigation extends beyond the traditional focus on human disease to include animal health, wildlife surveillance, environmental assessment, and ecological risk factors. This integrated approach facilitates a comprehensive understanding of disease transmission dynamics and enables early identification of the source of infection, transmission pathways, and populations at risk.[17,41]

The investigation of outbreaks typically involves systematic case detection, verification of diagnosis, confirmation of outbreaks, descriptive and analytical epidemiological investigations, environmental assessments, laboratory confirmation, and implementation of appropriate control measures. Public health institutions coordinate multidisciplinary rapid response teams comprising epidemiologists, microbiologists, clinicians, veterinarians, environmental scientists, entomologists, and public health officials. Such multidisciplinary investigations enable identification of disease reservoirs, vectors, environmental risk factors, and opportunities for interrupting disease transmission.[42,43]

In India, several institutions contribute significantly to One Health-oriented outbreak response. The NCDC coordinates surveillance, epidemiological investigations, and rapid response activities for epidemic-prone diseases across the country.[20] The ICMR supports laboratory diagnosis, operational research, and development of evidence-based public health strategies through its network of research institutions.[23] The NIV, Pune, together with State Public Health Laboratories and VRDLs, provides specialised laboratory support for confirmation of emerging viral infections and genomic surveillance.[44] These institutions work in close collaboration with state health departments, veterinary services, wildlife authorities, and environmental agencies to facilitate coordinated outbreak response.[19,23]

The response to the Nipah virus outbreaks in Kerala represents one of India's most successful examples of the One Health approach in practice. Rapid coordination among the Kerala Department of Health, NCDC, ICMR, National Institute of Virology, veterinary authorities, wildlife experts, district administration, and community stakeholders

enabled prompt laboratory confirmation, comprehensive contact tracing, isolation of cases, infection prevention and control measures, risk communication, and surveillance of bat populations to identify the probable animal reservoir.[38,39]

Similarly, India's response to avian influenza has relied on close collaboration between the Ministry of Health and Family Welfare, Department of Animal Husbandry and Dairying, NCDC, state veterinary departments, wildlife authorities, and local administrations. Integrated surveillance of poultry, migratory birds, and human populations at risk, combined with laboratory confirmation, culling operations, movement restrictions, risk communication, and continuous monitoring, has contributed to the early detection and containment of outbreaks.[40] These experiences illustrate the practical application of One Health principles in strengthening preparedness and minimising the public health impact of zoonotic diseases.

Despite these achievements, outbreak investigation and response continue to face several challenges. Delays in reporting, fragmented surveillance systems, inadequate laboratory capacity in some regions, limited integration of animal and environmental surveillance, shortages of trained epidemiologists, and constraints in real-time data sharing may reduce the effectiveness of outbreak response.[15,27] Strengthening laboratory infrastructure, expanding genomic surveillance, promoting interoperability between surveillance systems, conducting regular simulation exercises, and institutionalising multisectoral rapid response mechanisms will be essential for improving preparedness against future public health emergencies.[33,45]

Research and Evidence Generation

Research and evidence generation constitute one of the core functions of public health institutions in operationalising the One Health approach. The increasing complexity of emerging infectious diseases, antimicrobial resistance, environmental degradation, and climate-sensitive health threats requires robust scientific evidence to guide policy formulation, programme implementation, and public health decision-making. Public health institutions play a vital role in generating, synthesising, and translating evidence into practical interventions by promoting multidisciplinary research that integrates human, animal, and environmental health.[2,46]

The One Health approach encourages collaboration among epidemiologists, clinicians, veterinarians, microbiologists, environmental scientists, ecologists, social scientists, and policymakers to better understand disease transmission dynamics and identify effective prevention and control strategies. Such interdisciplinary research contributes to the development of improved diagnostic tools, vaccines, surveillance systems, risk assessment models, and evidence-based public health policies.[9,35]

The National One Health Mission promotes collaborative research among ICMR, DBT, ICAR, NCDC, and academic institutions to strengthen preparedness for emerging and re-emerging diseases. It supports research networks, data sharing, and standardized methodologies to generate evidence for policymaking and outbreak response.[19]

International initiatives such as the One Health Joint Plan of Action (2022-2026) identify research and innovation as key to strengthening surveillance, antimicrobial resistance control, risk assessment, and pandemic preparedness. Advances in genomics, artificial intelligence, geospatial analysis, and digital health have further enhanced the prediction, detection, and response to emerging health threats.[31,33,34]

Research gaps, including limited funding, fragmented data, and poor intersectoral coordination, continue to hinder effective One Health implementation, particularly in low- and middle-income countries.[30,47]

Capacity Building

Public health institutions play a central role in developing human resources by providing education, training, mentorship, and continuing professional development for professionals working in human health, veterinary sciences, environmental sciences,

wildlife management, and public health laboratories.[24,25]

Capacity building under One Health includes multidisciplinary training in surveillance, diagnostics, outbreak investigation, antimicrobial stewardship, and emergency preparedness. Joint training, simulation exercises, and cross-sectoral collaboration strengthen coordination and improve preparedness for emerging health threats.[17,48]

India has undertaken several initiatives to strengthen the workforce required for implementing the One Health approach. The India Epidemic Intelligence Service (EIS) Programme and the Field Epidemiology Training Programme (FETP-India) have significantly enhanced national epidemiological capacity by training public health professionals in surveillance, outbreak investigation, data analysis, and emergency response.[49] Similarly ICMR and NCDC regularly conduct training programmes on laboratory diagnostics, integrated disease surveillance, antimicrobial resistance, biosafety, and emerging infectious diseases.[20,23] These programmes have contributed substantially to strengthening India's public health workforce and improving preparedness for epidemic-prone diseases.

The veterinary sector, led by ICAR and its institutes, strengthens One Health through training in veterinary epidemiology, zoonotic disease surveillance, diagnostics, and animal health management. These initiatives have enhanced multidisciplinary collaboration and built a skilled veterinary workforce for One Health implementation.[50]

Organizations such as WHO-SEARO, FAO, and WOAH support One Health through technical guidance, training, workshops, and simulation exercises. These initiatives strengthen surveillance, laboratory quality, risk communication, and coordinated outbreak response across countries.[16, 24,51]

Despite these efforts, shortages of skilled professionals and limited multidisciplinary training continue to hinder One Health implementation, particularly in resource-constrained settings. Unequal workforce distribution and inadequate continuing professional development further limit effective cross-sectoral collaboration.[26,47] Strengthening One Health requires sustained investment in interdisciplinary education, workforce development, and institutional partnerships. Integrating One Health into health curricula and continuing professional training is essential for improving surveillance, outbreak preparedness, and effective implementation.[24,25]

Community Engagement

Community engagement is central to One Health, as effective disease prevention and control depend on active public participation alongside institutional efforts. Empowering communities to recognize, report, and prevent health risks enables early detection of zoonotic diseases and strengthens surveillance.[29] Public health institutions promote community engagement through health education, risk communication, behaviour change initiatives, and community-based surveillance. Culturally appropriate awareness programmes on zoonotic diseases, hygiene, vaccination, and antimicrobial stewardship encourage preventive behaviours and improve public participation.[48]

In India, frontline health workers such as Accredited Social Health Activists (ASHAs), Auxiliary Nurse Midwives (ANMs), and Multipurpose Health Workers (MPHWs) contribute significantly to community-based surveillance and health promotion. These workers maintain close contact with communities and facilitate early identification and reporting of unusual health events, support outbreak investigations, promote immunisation, encourage infection prevention practices, and disseminate health education messages. Their active participation has been particularly valuable during outbreaks of vector-borne and zoonotic diseases, and the COVID-19 pandemic, where community engagement played a crucial role in surveillance, contact tracing, and risk communication.[52,53]

Community engagement is particularly important in rural, tribal, and geographically remote areas where close interaction between humans, domestic animals, and wildlife increases the risk of zoonotic disease

transmission. In such settings, involving local leaders, Village Health, Sanitation and Nutrition Committees (VHSNCs), self-help groups, farmers, livestock owners, forest personnel, and community-based organisations in surveillance and health promotion activities improves trust, encourages timely reporting of disease events, and enhances acceptance of public health interventions.[54]

Limited health literacy, misinformation, cultural beliefs, social stigma, inadequate access to healthcare services, and weak communication systems may reduce community participation in surveillance and disease control activities. Addressing these barriers requires sustained investment in health education, community mobilisation, transparent risk communication, and regular engagement with local stakeholders.[29,48]

Strengthening Health Systems

A strong and resilient health system is capable of preventing, detecting, responding to, and recovering from public health emergencies while ensuring the continuity of essential health services. Effective collaboration between human health, veterinary, environmental, agricultural, and wildlife sectors enhances the ability of health systems to detect emerging threats early, coordinate responses efficiently, and minimise the impact of outbreaks. Strengthening linkages among these sectors also facilitates efficient resource utilisation, reduces duplication of efforts, and improves the overall effectiveness of public health interventions.[17,35]

In India, initiatives such as the Integrated Health Information Platform (IHIP) and the Ayushman Bharat Digital Mission (ABDM) are strengthening digital health infrastructure by improving electronic health records, interoperability, and real-time reporting.[21,32] These initiatives have the potential to facilitate better integration of surveillance data within the One Health framework and support more effective public health planning.

Well-equipped laboratories strengthen disease diagnosis, antimicrobial resistance surveillance, and outbreak investigations. Investment in laboratory infrastructure and advanced diagnostics is essential for timely detection and preparedness against emerging infectious diseases.[33] A skilled multidisciplinary workforce is essential for implementing the One Health approach through effective collaboration across human, animal, and environmental health sectors. Interdisciplinary training and continuous professional development strengthen workforce capacity and improve coordinated public health responses.[24,25]

Limited financial resources, unequal distribution of healthcare infrastructure, shortages of skilled personnel, fragmented information systems, and inadequate coordination between sectors remain major barriers to effective One Health implementation.[26,55] Addressing these challenges requires sustained political commitment, strategic investments, strengthened governance mechanisms, and long-term integration of One Health principles into national health policies and programmes.[27,32]

Challenges in Implementation

Fragmented institutional structures across human, animal, and environmental sectors hinder coordination, communication, and information sharing. This weakens integrated surveillance and delays effective responses to public health emergencies.[15] Poor integration of human, animal, wildlife, and environmental surveillance systems limits timely data sharing and coordinated risk assessment. This reduces opportunities for early detection and effective response to zoonotic disease outbreaks.[28,47]

Limited financial investment hinders the development of integrated surveillance systems, laboratory infrastructure, digital health platforms, and a skilled multidisciplinary workforce. In resource-constrained settings, competing healthcare priorities often reduce preparedness for emerging health threats.[26,30]

A shortage of trained multidisciplinary professionals and limited opportunities for interdisciplinary education hinder effective One Health implementation. Differences in institutional priorities and professional cultures further weaken collaboration and coordinated decision-making.[25]

Limited community awareness and public participation reduce the effectiveness of One Health interventions, particularly in preventing zoonotic diseases and antimicrobial resistance. Inadequate, culturally inappropriate risk communication further limits community engagement and timely disease reporting.[29,48]

In India, additional operational challenges include variations in public health infrastructure across states, unequal distribution of skilled human resources, limited integration between human and animal health surveillance systems, and differences in technical capacity at district and peripheral levels.[20,21,51]

Overcoming One Health implementation challenges requires sustained political commitment, adequate financing, stronger governance, integrated surveillance, and multisectoral collaboration. Strengthening public health systems, workforce capacity, community engagement, and digital infrastructure will improve preparedness and health system resilience.[17,27,35]

Opportunities and Future Directions

Public health institutions will play a pivotal role in translating these opportunities into sustainable and evidence-based public health action.[17]

Integration of digital health technologies, including Geographic Information Systems (GIS) and interoperable surveillance platforms, offers significant opportunities to strengthen the One Health approach. These technologies enhance early outbreak detection, real-time data sharing, risk assessment, and timely public health decision-making.[31] In India, further expansion of IHIP and ABDM provides an important opportunity for developing interoperable digital health systems that support the implementation of the One Health approach.[21,32]

Advances in artificial intelligence (AI), machine learning, and data analytics have strengthened integrated surveillance by improving outbreak prediction and risk assessment. Analysis of healthcare, veterinary, environmental, satellite, and climate data helps identify high-risk areas and supports timely preventive interventions.[34] Similarly, advances in genomic surveillance and whole genome sequencing provide valuable opportunities for monitoring pathogen evolution, identifying antimicrobial resistance patterns, detecting novel variants, and understanding transmission dynamics.[33,34]

Strengthening interdisciplinary research and innovation through collaboration among public health professionals, researchers, policymakers, and other sectors can advance diagnostics, vaccines, predictive models, and surveillance technologies. Partnerships between academia, government, international organizations, and the private sector facilitate knowledge sharing and translation of research into public health practice.[30,46]

Sustained investment in workforce development through interdisciplinary education, Field Epidemiology Training Programmes (FETPs), simulation exercises, and One Health curricula will strengthen capacity to address emerging public health challenges. Enhancing community engagement and health literacy will further improve surveillance, disease prevention, and public participation.[24,25,49]

CONCLUSION

The One Health approach has emerged as an essential framework for addressing the increasingly complex interactions between human, animal, and environmental health. The growing burden of zoonotic diseases, antimicrobial resistance, environmental degradation, and climate-sensitive health threats has highlighted the limitations of conventional sector-specific approaches and reinforced the need for integrated, multisectoral action. Public health institutions are central to translating the principles of One Health into practice through their roles in integrated surveillance, evidence-based policymaking, intersectoral coordination, outbreak preparedness and response, research, workforce development, environmental health monitoring, and community engagement.[17,35]

This review highlights that effective implementation of the One Health approach depends on strong institutional leadership, coordinated governance, robust surveillance systems, well-equipped laboratory networks,

interdisciplinary research, and meaningful collaboration among human health, veterinary, environmental, agricultural, and wildlife sectors. The experiences of national and international One Health initiatives demonstrate that sustained partnerships, timely information sharing, and integrated decision-making can substantially strengthen preparedness for emerging public health threats and improve health system resilience.[17,18-23,26]

India has made important progress towards operationalising the One Health approach through initiatives such as the National One Health Mission, the National Action Plan on Antimicrobial Resistance, the Integrated Disease Surveillance Programme, the Integrated Health Information Platform, and collaborative efforts led by institutions including the Indian Council of Medical Research, National Centre for Disease Control, Department of Biotechnology, and Department of Animal Husbandry and Dairying.[18-23] These initiatives provide a strong foundation for strengthening integrated surveillance, research, laboratory capacity, and multisectoral collaboration. Nevertheless, challenges such as fragmented governance, limited interoperability of surveillance systems, shortages of trained multidisciplinary professionals, and disparities in infrastructure continue to influence implementation, particularly in resource-constrained settings.[15,26,51]

Looking ahead, strengthening the One Health approach will require sustained political commitment, long-term financial investment, interdisciplinary capacity building, technological innovation, and greater integration of digital health, genomic surveillance, and environmental monitoring into routine public health practice. Equally important is the need to promote community participation, address the social and environmental determinants of health, and foster collaboration between government agencies, academic institutions, international organisations, and local communities.[29,31,33,34]

In conclusion, the One Health approach offers a practical and sustainable framework for strengthening health systems and improving preparedness for future public health emergencies. By fostering coordinated action across sectors and integrating human, animal, and environmental health into policy and practice, public health institutions can play a transformative role in enhancing national and global health security while contributing to the achievement of sustainable development goals.[17,37]

Authors Contribution

All authors have contributed equally.

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