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Popular Article

One Health and Global Health Security: Bridging Human, Animal and Environmental Health

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Abstract

The One Health concept emphasizes the interconnected relationship between human, animal, and environmental health. The growing incidence of zoonotic diseases, the emergence of antimicrobial resistance, concerns regarding food safety, and the impacts of climate change underscore the importance of adopting coordinated and multidisciplinary health management strategies. Human activities such as urbanization, deforestation, intensive farming, and global trade have increased the risk of disease emergence and spread. One Health promotes collaboration among medical, veterinary, and environmental professionals to improve disease prevention, surveillance, and response. However, challenges such as limited data sharing, weak coordination, and lack of trained workforce hinder effective implementation. Strengthening interdisciplinary cooperation and global policies is essential to improve health security and ensure sustainable development for future generations.

Introduction

Anthropogenic activities, such as changes in ecosystems and land use pattern, intensification of agriculture, rapid urbanization, expansion of international travel and trade, climate variability, unsustainable farming practices, globalization, and wildlife trade, have all become major factors in the emergence of zoonotic diseases over the past three decades. These



factors have created ecological and evolutionary conditions that allow pathogens to adapt, diversify, and increase the frequency of animal-to-human spillover events. A substantial proportion of emerging infectious diseases originate from animal sources, particularly wildlife. This trend underscores the increasingly complex and dynamic interactions between human populations, animals, and their surrounding environments. The growing prevalence of zoonotic illnesses, such as Ebola, Avian influenza, and COVID-19, emphasizes the importance of an integrated and collaborative approach that brings together animal health, human health, and environmental sciences. Such coordination is essential for effective risk assessment, preparedness planning, and for understanding the ecological drivers behind disease emergence (Zhang et al., 2024).

Concept of One Health

One Health is an approach to infectious diseases investigation that recognizes the interdependence of people, animals, plants, and the natural environment (CDC,2023). During the mid-twentieth century, the American veterinary epidemiologist Calvin W. Schwabe examined the parallels between human and veterinary medical practices and introduced the concept of “One Medicine,” emphasizing the shared foundations of human and animal health. He emphasized that animal and human health are closely connected and should be addressed through a collaborative, multidisciplinary approach. He also emphasized the significance of integrating social sciences and improving communication with communities in order to effectively manage infectious diseases (Schwabe,1969).

In the 21st century, the concept was expanded to include the health of the entire ecosystem, covering plants, wildlife, and the environment. The Manhattan Principles, released in 2004, emphasized the importance of a more comprehensive understanding of the relationships between humans and animals. The pandemic of severe acute respiratory syndrome (SARS) further emphasized the serious threat that zoonotic diseases pose to human health. Around this period, the term “One Health” was introduced, recognizing the interconnectedness of human health, animal health, behaviour, and the environment (Pitt and Gunn, 2024).

In 2021, the One Health High-Level Expert Panel (OHHLEP) was established as a scientific and strategic advisory group for the Quadripartite collaboration—World Health Organization, Food and Agriculture Organization, United Nations Environment Programme, and World Organisation for Animal Health. The panel was assigned the responsibility of formulating a clear and comprehensive definition of the One Health concept. This definition highlights the interconnected roles of sectors, disciplines, and societies, and is built on four



key pillars: communication, collaboration, coordination, and capacity building. These four global organizations formally united as the One Health Quadripartite to strengthen cross-disciplinary and multinational cooperation (WHO, 2023).

One Health High-Level Expert Panel (OHHLEP) define “One Health as an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems”. It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent. The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development. By integrating the health of humans, animals, and the environment, the One Health framework supports a comprehensive approach to disease management, encompassing prevention, early detection, preparedness, response, and control. This integrated strategy strengthens global health security. Furthermore, One Health emphasizes the critical role of interdisciplinary collaboration and coordination across multiple sectors in addressing complex health challenges. This framework is essential for managing zoonotic infections, antimicrobial resistance (AMR), vector-borne illnesses, food safety concerns, and environmental health problems. Looking ahead, One Health is regarded as a transformative framework that provides an integrated approach to strengthening global health security by addressing the underlying drivers of emerging diseases and environmental degradation (Rabinowitz et al., 2013).

Foundational Areas of Action in One Health

The One Health framework addresses numerous issues that reflect the close interrelationship between human, animal, and environmental health. Key priority areas include strengthening laboratory systems, managing zoonotic and neglected tropical diseases, combating antimicrobial resistance, ensuring food safety and control of foodborne diseases, and promoting environmental health.

Laboratory investigations play a crucial role in the diagnosis, surveillance, and reporting of infectious diseases, particularly because many infections present with non-specific symptoms. Accurate identification of pathogens is essential for appropriate treatment and for determining whether diseases are zoonotic in origin. The One Health strategy encourages collaboration between medical and veterinary laboratory professionals to develop shared testing protocols and strengthen disease surveillance systems (Bessler et al., 2024).



Zoonotic diseases arise when humans have direct or indirect interaction with wild or domestic animals that carry transmissible pathogens. Effective control requires understanding the nature of these interactions and the factors that maintain the infections within animal reservoirs (CDC, 2023). The One Health framework promotes a cautious and comprehensive approach, recognizing the risk of unintended outcomes. Human-focused strategies, including reducing exposure to animal reservoirs and vectors through education, treatment, and preventive measures, have shown limited success when applied in isolation. A broader One Health perspective, acknowledging global interconnectedness and the ecological drivers of zoonotic transmission, is thus crucial for effective disease prevention (Reynolds et al.,2019).

WHO identifies 20 neglected tropical diseases (NTDs) that primarily affect impoverished populations, especially women and children (WHO,2023). These diseases are caused by variety of pathogens, including viruses, bacteria, parasites, and fungi, and are closely linked to environmental and social determinants of health. Zoonotic NTDs, such as rabies and echinococcosis involve animal reservoirs, whereas parasitic diseases like schistosomiasis and lymphatic filariasis require intermediate hosts or mosquito vectors. Chagas disease, caused by *Trypanosoma cruzi*, is mainly transmitted by triatomine bugs but may also spread via blood transfusion, organ transplantation, or congenitally. Dengue and chikungunya, transmitted by *Aedes aegypti* mosquitoes, are increasing due to climate change and urbanization (Magalhaes, 2023). The One Health approach integrates surveillance, vector control, sanitation, and environmental management to enhance sustainable NTD prevention and control.

Antimicrobial resistance (AMR) represents a major global public health concern, as it undermines the effectiveness of existing therapies and complicates the management of infectious diseases. Pathogens such as *Mycobacterium tuberculosis* and *Staphylococcus aureus* are increasingly resistant to existing drugs (NHS,2023). Although antimicrobial resistance can arise naturally, its accelerated emergence and dissemination are primarily associated with the inappropriate and excessive use of antimicrobial agents in both human and veterinary medicine. Overprescription, incomplete treatment, and inadequate diagnostic testing accelerate resistance. Significant quantities of antibiotics enter sewage and soil through excretion and improper disposal, contributing to environmental contamination. Microplastics may further support the persistence and transfer of resistant bacteria within ecosystems and the food chain (Wang, 2021).

Agriculture accounts for a substantial share of antibiotic consumption, sometimes up to 80% with large volumes entering the environment annually. The administration of antimicrobials



for purposes such as growth enhancement and routine disease prevention contributes to increased selective pressure that promotes the development of resistant microorganisms. Effective control of AMR requires stricter regulation, rational prescribing, improved diagnostics, and a coordinated One Health approach integrating human, animal, and environmental health sectors (Pitt and Gunn, 2024).

Food contamination can occur at any stage of the supply chain, leading to foodborne illnesses such as norovirus, salmonellosis, and listeriosis. Ensuring food safety and food security is essential for protecting both human and animal health. Hazards such as toxins, pollutants, and pathogens are often not visibly detectable, highlighting the need for regular testing, proper storage, and safe transportation to meet established standards (Pitt and Gunn, 2024). The Food and Agriculture Organization (FAO) and World Health Organization (WHO) stress coordinated global efforts to strengthen food safety systems and protect public health. A One Health approach recognizes that environmental contamination, animal health status, and agricultural practices directly influence both the safety and availability of food, thereby linking food security with public health. Interactions among humans, animals, and the environment determine contamination risks and food production stability, emphasizing the need for integrated surveillance, regulation, and multidisciplinary collaboration to ensure sustainable and safe food systems (Mukhtar et al., 2023).

Climate change is an escalating public health challenge affecting all regions, though impacts are more severe in low- and middle-income countries. Rising temperatures, sea-level increase, ocean acidification, and extreme weather events such as floods and heatwaves disrupt infrastructure, reduce food production, and drive migration. Environmental changes alter infectious disease patterns through interconnected human, animal, and ecological systems, supporting the need for a One Health approach. Higher temperatures can accelerate parasite and vector life cycles; for example, mosquito populations may expand geographically, increasing the risk of diseases such as malaria and dengue. Heat stress and food scarcity may also weaken immunity, increasing susceptibility to infections. Flooding can contaminate water sources, raising the risk of waterborne diseases such as cholera (Malikzai, 2023). However, disease outcomes are shaped not only by climate but also by land use, socioeconomic conditions, public health infrastructure, and surveillance systems. In some settings, environmental shifts may even reduce certain infections (Pitt and Gunn, 2024). Addressing these complex interactions requires integrated, multidisciplinary strategies.



Constraints affecting the implementation of the One Health framework

Implementing the One Health approach requires significant institutional and structural changes to effectively integrate human, animal, and environmental health sectors. Although the framework encourages multisectoral coordination and collective responsibility, several challenges and gaps in implementation continue to restrict its overall effectiveness.

A major barrier is the absence of interoperable databases and digital tools that enable seamless cross-sectoral data exchange. Surveillance systems frequently function independently, restricting timely access to epidemiological and environmental data. Strengthening integrated information platforms is critical for early warning and coordinated response. There is limited systematic documentation of successful One Health interventions. Establishing a global repository of evidence-based practices would facilitate knowledge transfer and replication across regions. Sustainable implementation requires investment in interdisciplinary education and workforce development. Many health professionals are trained within discipline-specific silos, limiting cross-sector collaboration. Developing comprehensive monitoring frameworks that combine human, veterinary, and environmental data is essential for detecting emerging threats and antimicrobial resistance patterns (Velazquez-Meza et al., 2022).

Clear governance structures and emergency coordination protocols remain inadequate in many settings. Effective communication pathways and defined institutional roles are necessary during outbreaks and environmental crises. Rapid urbanization, global trade, agricultural intensification, and habitat disruption increase zoonotic spillover risks. Understanding these interconnected drivers is fundamental to prevention strategies. Harmonized methodologies for assessing zoonotic and food-chain risks are lacking. Standardization would improve comparability, policy development, and preventive planning. One Health policies must evaluate ecological, economic, and social trade-offs while maximizing shared benefits across sectors (Mukhtar et al., 2023). Integrating health with sustainable development goals remains an ongoing challenge.

5. Conclusion

The growing threats of antimicrobial resistance, climate change, food insecurity, and emerging zoonotic diseases demonstrate that human, animal, and environmental health are deeply interconnected. Fragmented approaches are no longer sufficient to address these complex global challenges. The One Health framework provides a comprehensive strategy that integrates surveillance, risk assessment, food safety systems, environmental monitoring, and antimicrobial stewardship across sectors. However, effective implementation requires



overcoming institutional silos, strengthening data-sharing systems, improving workforce capacity, standardizing risk assessment methods, and enhancing global coordination. Guidance from the One Health High-Level Expert Panel (OHHLEP) is instrumental in promoting evidence-based, collaborative policies. By embracing interdisciplinary cooperation and sustainable practices, the One Health approach not only improves preparedness and response to infectious diseases but also supports resilient food systems, environmental protection, and long-term global health security. Sustained political commitment and international collaboration are essential to translate the One Health vision into measurable public health impact.

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