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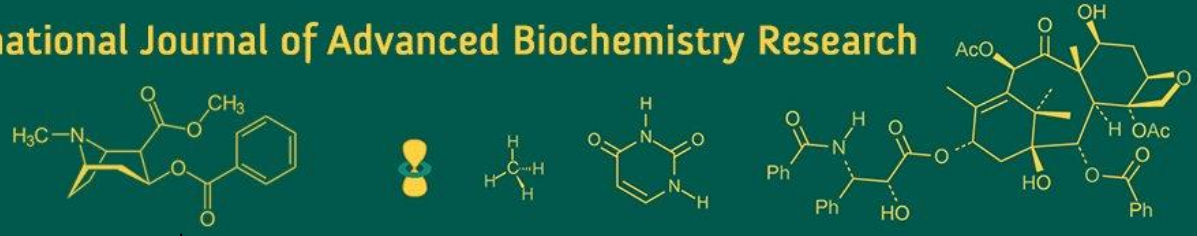

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Integrating one health into global health security: A comprehensive overview

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Abstract
A One Health approach that emphasizes collaboration between the sectors responsible for human health, animal health (both domestic and wildlife), and the environment, as well as other relevant partners, is essential for the effective prevention and control of zoonotic diseases. In this paper, we argue for the necessity of a stronger and more integrated One Health strategy that fully incorporates both animal health and environmental factors to address current and future global health challenges. Addressing institutional gaps and promoting cross-sectoral collaboration are critical for the successful implementation of the One Health framework. By fostering cooperation between these sectors, we can strengthen pandemic preparedness, prevent outbreaks, and improve health outcomes at the intersection of human, animal, and environmental health. Ultimately, enhancing coordination and addressing barriers to communication and resource sharing across sectors will enable more comprehensive and sustainable solutions to emerging health threats.

Keywords: One health approach, zoonotic diseases, health policy, outbreak prevention

1. Introduction
Over the past three decades, human activities such as changes to ecosystems and land use, the intensification of agriculture, urbanization, and the expansion of international travel and trade have become significant drivers of emerging zoonotic infectious diseases (Jones *et al*., 2008) [15]. The majority of these diseases originate in animals, particularly wildlife, and the complex interactions between humans, animals, and the environment have become increasingly evident. The rise of zoonotic diseases, such as Ebola, avian influenza, and COVID-19, has underscored the need for a cooperative, multidisciplinary approach that spans the boundaries of animal, human, and environmental health to assess risks, formulate response plans, and understand the ecological context of disease emergence (Daszak *et al*., 2000) [7].
The concept of "One Health" was first officially coined in 2003–2004, following the H5N1 avian influenza outbreak and the early emergence of SARS in 2003. These events led to the formulation of the "Manhattan Principles" during a meeting at the Wildlife Conservation Society in 2004, which explicitly recognized the interconnectedness of human and animal health, as well as the significant threats posed by diseases to food security and economies (Wildlife Conservation Society, 2004) [31]. The principles advocated for an integrated approach to health that would include the ecosystems in which both humans and animals live.

2. Understanding the One Health Concept
One Health is not a new concept; its origins trace back over 200 years, with earlier forms referred to as One Medicine, One World, and eventually, One Health. This concept has evolved to recognize that the optimal health outcomes for humans, animals, and ecosystems are interdependent, requiring collaboration at local, regional, national, and international levels (Monath *et al*., 2010) [18]. Today, organizations like the One Health Commission and the U.S. Centers for Disease Control and Prevention (CDC) define One Health as a collaborative, multisectoral, and transdisciplinary approach to achieving optimal health

outcomes by recognizing the interconnectedness between humans, animals, and ecosystems (CDC, 2020) [20].

As a strategy to address global health security challenges, One Health emphasizes the importance of interdisciplinary, cross-sectoral collaboration. This approach is fundamental to addressing zoonotic diseases, antimicrobial resistance (AMR), vector-borne diseases, food safety, and environmental health issues (Rabinowitz *et al*., 2013) [21]. For example, the University of California, Davis One Health Institute provides a concise explanation of the concept, stating that "One Health is an approach to ensure the well-being of people, animals, and the environment through cooperative problem solving—locally, nationally, and internationally" (UC Davis One Health Institute, 2020) [26].

The COVID-19 pandemic has further emphasized the need for an integrated One Health approach. It highlighted the gaps in global health preparedness and surveillance systems, which failed to address the critical intersections between human, animal, and environmental health. This oversight contributed to the rapid spread and global impact of the pandemic. Moving forward, One Health is seen as a transformative strategy that offers a holistic approach to enhancing global health security by addressing the root causes of emerging diseases and environmental degradation (WHO, 2020) [29].

3. Key Areas of Focus in One Health

One health encompasses a wide array of topics that reflect the interconnectedness of human, animal, and environmental health. This multidisciplinary approach is essential in addressing contemporary health challenges, including:

3.1 Antimicrobial Resistance (AMR): AMR occurs when bacteria, parasites, and other pathogens adapt to withstand medications designed to eliminate them, leading to persistent and often untreatable infections. According to the World Health Organization (WHO), AMR results in significant morbidity and mortality globally, highlighting the urgent need for a One Health approach to combat this issue (WHO, 2019) [37].

3.2 Zoonotic Diseases: Zoonoses, such as avian influenza, rabies, and Ebola, are infectious diseases that can be transmitted from animals to humans. The emergence of zoonotic diseases is often linked to ecological changes, including habitat destruction and increased human-wildlife interactions (Hahn *et al*., 2020) [12]. The WHO has reported that zoonotic diseases account for over 60% of all infectious diseases, underscoring the importance of integrated surveillance and response strategies (WHO, 2021) [38].

3.3 Vector-Borne Illnesses: Diseases transmitted by vectors, such as dengue fever, West Nile virus, Lyme disease, and malaria, pose significant public health threats. These diseases are influenced by environmental factors, including climate change, which can alter vector habitats and behaviors. The CDC has indicated that effective control of vector-borne diseases requires a One Health approach to address the environmental and ecological contexts in which these diseases emerge (CDC, 2021) [5].

3.4 Food Safety and Foodborne Illnesses: Contamination of food can occur at any stage of the supply chain, leading to foodborne illnesses such as norovirus, salmonella, and listeria. The FAO and WHO emphasize the need for coordinated efforts in food safety to mitigate risks and protect public health (FAO/WHO, 2020) [10].

3.5 Environmental Health Issues: Environmental factors such as air and water pollution, climate change, and biodiversity loss have profound implications for health outcomes. The World Bank reports that environmental degradation can exacerbate health risks, particularly in vulnerable populations, highlighting the critical need for an integrated approach to health and environmental policy (World Bank, 2016) [32].

The One Health concept fundamentally emphasizes the interdependence of human, animal, and environmental health. Specifically, it addresses:

3.6 Emerging and Endemic Zoonoses: These diseases significantly contribute to the health burden, especially in low-resource settings. A study illustrates how zoonotic diseases can emerge from ecological changes and human activities, underscoring the need for proactive surveillance and intervention strategies.

3.7 Antimicrobial Resistance (AMR): The global spread of AMR necessitates a collaborative approach across sectors. The WHO has recognized the need for a coordinated response to tackle AMR and its impact on health systems (WHO, 2015) [36].

3.8 Food Safety: The increasing complexity of food supply chains makes food safety a significant concern, with implications for both public health and economic stability. The FAO's initiatives in food safety highlight the importance of a coordinated One Health approach to mitigate risks (FAO, 2019) [11].

4. Interdisciplinary Collaboration

The core of the One Health concept is interdisciplinary collaboration. While organizations such as the American Medical Association, Public Health England, and WHO have supported One Health, the medical community has been slower to engage than the veterinary sector. Integrating One Health principles into medical curricula is essential for fostering a holistic understanding of health issues related to infectious diseases and public health (Sargeant *et al*., 2017) [24].

5. One Health Day

The establishment of One Health Day on November 3rd aims to raise global awareness about the One Health concept. This initiative encourages educational events and projects that promote collaboration across disciplines. Since its inception in 2016, One Health Day has fostered student-led projects and competitions, driving engagement and innovation in addressing One Health challenges (One Health Commission, 2018) [19].

6. Economic Impact

The World Bank estimates that One Health could yield global benefits of at least US$37 billion annually by improving health outcomes and preventing diseases. However, it is projected that less than 10% of these benefits will stem from prevention efforts alone (World Bank, 2020) [33]. The economic impact of pandemics and diseases has

been profound, with over 15 million lives lost and approximately US$4 trillion in economic losses since 2003 (WHO, 2021) [38]. Moreover, food and water safety hazards, intricately linked to One Health, have led to substantial economic costs.

7. The Extent of the Issue

The need to reinforce the One Health approach with a stronger focus on connections to animal health and the environment has been underscored by the emergence of the SARS-CoV-2 virus, which caused the COVID-19 pandemic. This outbreak exemplified the critical interplay between human, animal, and environmental health, highlighting vulnerabilities in our interconnected systems (Zhou *et al*., 2020) [39]. The World Health Organization (WHO) has emphasized in its "Manifesto for a Healthy Recovery from COVID-19" that integrating One Health principles is vital for addressing future health threats and fostering resilience (WHO, 2020) [33].

Ignoring the importance of social safety nets, emergency preparedness, health systems, water and sanitation infrastructure, and environmental protection has led to significant costs, both in human lives and economic terms. For example, a report from the United Nations indicates that inadequate health infrastructure and emergency response mechanisms have exacerbated the impact of pandemics, leading to economic losses in the trillions of dollars globally (UN, 2021). The COVID-19 pandemic alone has resulted in over 15 million deaths worldwide and an estimated economic impact of approximately $4 trillion (World Bank, 2022) [34].

Currently, we possess an unparalleled opportunity to enhance cooperation and regulations across various domains, reducing the likelihood of future pandemics and outbreaks while concurrently addressing the persistent burden of endemic and non-communicable diseases. Strengthening One Health collaboration can facilitate better surveillance systems, allowing for early detection and monitoring of zoonotic diseases and other health threats (Lloyd-Smith *et al*., 2009) [17]. Effective surveillance requires integrating data from human, animal, and environmental health sectors to identify emerging trends and potential crises. For instance, the rise of antimicrobial resistance (AMR) necessitates a comprehensive understanding of how antibiotic use in livestock impacts human health and environmental ecosystems (Van Boeckel *et al*., 2015) [28]. Future studies should focus on the interconnectedness of these domains, especially concerning factors that trigger health crises, such as habitat destruction, climate change, and human encroachment on wildlife (Bertram *et al*., 2020) [2]. By leveraging interdisciplinary collaboration and innovative approaches, the One Health framework can address complex health challenges and promote holistic well-being across all sectors.

8. Challenges Facing the One Health Approach

Implementing the One Health approach requires significant institutional changes to effectively connect the domains of human, animal, and environmental health. This integration facilitates multi-sectoral communication, collaboration, coordination, and capacity building. However, several key implementation gaps hinder the success of One Health initiatives:

8.1 Databases and Tools for Information Exchange: There is a critical need for databases and tools that facilitate the exchange of information and support One Health-oriented activities. Current data systems often operate in silos, making it difficult to share valuable insights across sectors (Zinsstag *et al*., 2018) [40].

8.2 Identifying Best Practices: Establishing a comprehensive catalog of successful practices for implementing One Health is essential. By highlighting exemplary cases, stakeholders can learn from each other's experiences and replicate effective strategies (Rüegg *et al*., 2019) [22].

8.3 Current Programs and Workforce Development: Identifying existing programs and resources dedicated to One Health research is crucial for future workforce development. Investing in education and training will equip professionals with the skills necessary to address complex health challenges (Davis *et al*., 2019) [8].

8.4 Comprehensive One Health Monitoring System: Developing a prototype for a comprehensive One Health monitoring system can enhance surveillance and response capabilities. Such a system should integrate data from human, animal, and environmental health to identify emerging threats (Pillay *et al*., 2021) [20].

8.5 Coordination Procedures: Establishing procedures for regular and emergency coordination with relevant parties is vital for effective response to health threats. Clear communication channels and protocols will ensure that all stakeholders are informed and engaged during crises (Cameron *et al*., 2020) [3].

8.6 Understanding Zoonotic Disease Spread: A deeper comprehension of the factors contributing to the spread of zoonotic diseases is essential. This includes examining issues such as animal trade, livestock farming practices, urbanization, and habitat fragmentation, all of which can increase transmission risks (Jones *et al*., 2013) [14].

8.7 Standardized Risk Assessment Methodology: There is a need for a standardized method to evaluate the risks of infections spreading from various animal populations to humans, including those that arise within food chains. Such assessments can guide preventive measures and policies (Slingenbergh *et al*., 2004) [25].

8.8 Identifying Trade-offs and Co-benefits: Strategies must be developed to identify and minimize trade-offs while maximizing co-benefits with other health and sustainable development goals. This includes reducing spillover risks and the spread of zoonotic diseases through integrated approaches that consider ecological and socioeconomic factors (Coker *et al*., 2011) [6]

9. WHO Reaction to One Health Challenges

The World Health Organization (WHO) is actively integrating the One Health approach throughout all of its offices and units, providing strategic policy direction and conducting training at local, national, and regional levels. This initiative aims to enhance the capacity of countries to develop stronger programs that address health issues at the

interface of human, animal, and environmental health (WHO, 2022) [34]. In collaboration with the Food and Agriculture Organization (FAO), the World Organisation for Animal Health (OIE), and the United Nations Environment Programme (UNEP), WHO is a key member of the One Health Quadripartite. This partnership has led to the creation of a One Health Joint Plan of Action, which outlines a comprehensive series of actions that the four organizations can take collectively. These actions include:

9.1 Collaboration with Political Leaders: The One Health Quadripartite engages with political figures to secure the necessary financing and infrastructure to support One Health initiatives. This collaboration aims to strengthen the political commitment required to implement One Health strategies effectively (FAO, OIE, UNEP, WHO, 2022) [9].

9.2 Capacity Building: WHO is focused on capacity building by providing training and resources to healthcare professionals, veterinarians, and environmental scientists. This interdisciplinary approach ensures that all sectors are equipped to address complex health challenges (Leroy *et al*., 2019) [16].

9.3 Surveillance and Data Sharing: The organization emphasizes the importance of integrated surveillance systems that monitor zoonotic diseases and antimicrobial resistance across human and animal populations. By enhancing data sharing among countries and sectors, WHO aims to improve the early detection and response to health threats (World Bank, 2022) [34].

9.4 Policy Development: WHO is committed to developing and advocating for policies that promote a One Health approach, recognizing the interconnectedness of human, animal, and environmental health. This involves working with governments to formulate policies that align with One Health principles (Hernández-Jover *et al*., 2019) [13].

9.5 Public Awareness and Engagement: The organization also focuses on raising public awareness about the One Health concept. Engaging communities in understanding the links between their health, the health of animals, and the environment is crucial for fostering a collaborative approach to health challenges (Baker *et al*., 2020) [1].

10. Conclusion

In conclusion, the effective implementation of the One Health framework requires robust interdisciplinary collaboration and a commitment to integrating health systems across sectors. As we confront an increasingly complex landscape of health challenges, the guidance provided by One Health High-Level Expert Panel (OHHLEP) will be vital in shaping policies and strategies that not only enhance our ability to prevent and respond to zoonotic diseases but also foster a more sustainable and health-oriented future for all species. Embracing the One Health concept is imperative to safeguard global health, mitigate the impacts of emerging infectious diseases, and promote resilience against future health threats.

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12. Conflict of Interest.

The authors declare that they have no conflict of interest concerning the publication of this article.

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