***Review Article***

**One Health Approach: Integrating Human, Animal, and Environmental Health to Control Infectious Diseases**

# **ABSTRACT**

Infectious diseases have been a public health problem and over the years, the world has witnessed several disease outbreaks and many have lost their lives to such outbreaks. In the quest for a solution to disease outbreaks many attempts have been made globally and within nations of which the One Health approach is one of them. One Health is a health model that recognizes the interconnectedness of health of human, animal and environment which makeup the ecosystems, thereby factoring this interconnectedness in the prevention, control and management of infectious diseases through collaboration and transdisciplinary efforts.

One Health is a holistic strategy that is crucial in addressing infectious diseases, especially zoonotic diseases, which are diseases transmissible across animals, humans, and the environment as well as emerging and reemerging infectious illnesses like COVID-19, Ebola, and Zika. The frequent emergence of these pandemics highlights the deficiencies in existing public health strategies, in which there are fragmented efforts across human, animal, and environmental health domains, which are usually inadequate for prevention, control and management of outbreaks. With One Health, addressing these outbreaks becomes easier as it fosters collaboration among public health experts, veterinarians, environmental scientists, and policymakers thereby facilitating optimal resource allocation and utilization, improving disease surveillance systems, and enabling early detection. In this review, we evaluated the One Health approach and its significance in illness prevention, control and management of infectious diseases. We also provide insights into its effective implementation strategies and offer future directions that will optimize its benefit and foster its adoption.

**Keywords:** One Health, Infectious diseases, Zoonotic diseases, Emerging diseases, Public health, Global health

# **1. INTRODUCTION**

One Health, according to the Centres for Disease Control and Prevention (CDC), is a model of health that promotes the implementation of collaborative, multisectoral, and transdisciplinary approaches to achieve the best health for humans and environment by acknowledging the interdependence of humans, animals, plants and their shared environment in addressing the transmission and control of infectious diseases in all levels of health (local, regional, national, and global), locally and globally (CDC, 2024). However, the World Health Organisation (WHO) referred to One Health as a holistic concept developed to advocate for improvement in the health of people, animals and ecosystems (WHO, n.d.). The health model uses a multi-disciplinary approach involving several different professionals including physicians, veterinarians, statisticians and laboratory scientists.

In the context of emerging infectious diseases proliferating in both humans and animals, this same model has been extremely useful on a global scale (Zinsstag et al., 2011, Danasekaran, 2024). Zoonotic diseases (zoonosis), which are diseases that can be transmitted from animals to humans, have become more popular more recently, therefore it becomes increasingly important to use a more strategic approach to tackle such diseases of public health concern (WHO, 2017). With One Health approach, the close interdependence of human, animal and environmental health is well evaluated which is valued universally in responding to zoonotic diseases and control and surveillance of other infectious diseases well as attaining equitable and sustainable health of all components of the ecosystem.

The concept of One Health has its roots in the early 20th century when scientists began to study the connections between human and animal health. The first term used in describing the concept was "One Medicine" which was coined by a public health veterinarian, Calvin Schwabe, in 1964 to reflect the connection between animal and human medicine and highlight the need for collaboration between veterinarians and physicians in addressing [global health issues](https://en.m.wikipedia.org/wiki/Global_health) (Cardiff et al., 2008).

However in 2004, the Wildlife Conservation Society conference on "One World, One Health" was held at Rockefeller University in New York in which the twelve Manhattan principles which are hallmarks of One Health model were developed to describe a unified approach in the control of infectious diseases (Riley, 2021, Gibbs, 2014). Then in 2007, the American Veterinary Medical Association (AVMA) officially established a One Health Initiative through the formation of a One Health Initiative Task Force (OHITF) (One Health Commission, n.d.). Since its inception, One Health has been very instrumental in responding to a number of major zoonotic disease outbreaks like the 2002 SARS pandemic (Cherry & Krogstad, 2004, WHO, n.d.), avian influenza outbreaks in 2006 (WHO, n.d.) and the 2009 H1N1 influenza pandemic (CDC, n.d.), and in more recent times, the COVID-19 pandemic.

This has underscored the importance of a coordinated and interdisciplinary approach in tackling disease outbreaks owing to the fact that these disease outbreaks emerged from an animal reservoir. These outbreaks justify the claim of interconnection of humans, animals and environmental health, and these interconnections must be factored into strategies aimed at addressing infectious disease transmission and control.

The prevalence of zoonotic illnesses has increased. According to the World Health Organisation (WHO), more than 60% of infectious diseases impacting humans are of animal origin, with zoonotic diseases constituting over 75% of new infectious diseases (WHO, n.d.). The onset of these illnesses is linked to several factors, including environmental factors and human activities such as agricultural practices (Esposito et al., 2023, Zubair et al., 2024). These elements provide the interaction points among people, animals, and the environment, enabling the transmission of infectious agents (pathogens) between species (Sharan et al., 2023).

Historically, human health and veterinary health professionals have functioned independently, with minimal communication between the two sectors. Environmental health has also garnered less attention and is frequently addressed in isolation, despite its evident connections to the establishment of infectious illnesses (Johnson et al., 2018). The restricted integration of these three sectors has impeded effective disease preventive and response efforts. Nonetheless, as awareness of the One Health approach grows, propelled by the advocacy of international organisations such as the WHO, the World Organisation for Animal Health (WOAH), and the Food and Agriculture Organisation (FAO) (WOAH, n.d., FAO United Nations, n.d., Mackenzie & Jeggo, 2019) and the integrative strategies that span these sectors are gaining ground.

In order to achieve this integration, good communication and data sharing between sectors are critical and the monitoring of disease spread between species and of factors which potentially influence disease transmission is indispensable for effective disease control (Madhav et al., 2017). In recent years, artificial intelligence, digital health platform, and GIS technologies have been utilized to improve disease surveillance systems and have contributed to information sharing across domains (Zhang et al., 2024).

Despite its promising potential, the implementation of the One Health approach has faced various challenges such as inadequate funding, limited infrastructure, political challenges, and lack of knowledge and expertise among professionals (Yopa et al., 2023). Policymakers must prioritise the integration of health sectors within the One Health framework, allocate sufficient funding for its implementation, and establish educational and training programs to equip the healthcare system with professionals possessing essential skills for combating infectious diseases. The significance of this matter lies in the fact that infectious diseases are progressively transcending borders, making international collaboration essential for the prevention and management of disease outbreaks (Mohamed, 2024, Elnaiem et al., 2023). Furthermore, each nation must be always prepared, as most events occur without prior notification to any country. The COVID-19 pandemic has demonstrated the significance of preparedness, global solidarity, and collaboration in tackling issues of health that are beyond national boundaries.

# **2. THE ONE HEALTH TRIAD: HUMAN, ANIMAL AND ENVIRONMENTAL HEALTH**

# The complex interconnections among human, animal, and environmental health, as illustrated in Figure 1, are essential for comprehending the dynamics of infectious disease transmission. The One Health concept acknowledges the interconnection of these three components, wherein problems affecting one domain can profoundly impact the others. The connections among these domains are further explored under the subsequent headings.



**Figure 1: One Health Triad**

## **2.1 Human Health and Infectious diseases**

The global human population is estimated to have exceeded eight billion, with health and population dynamics significantly impacted by infectious diseases, including common bacterial, viral, and parasitic infections, alongside emerging and reemerging diseases (United States Census Bureau, 2023). In the early history of healthcare, the approach to managing infectious diseases was focused on medical and epidemiological interventions that prioritised human health (Dobson & Carper, 1996). This has resulted in poor success rates in addressing infectious diseases that arise from animals and the environment. Researchers are actively investigating the origins of infectious diseases, evaluating factors like urbanisation, migration, agriculture, and wildlife consumption, and their impacts on disease transmission (Institute of Medicine (US) Committee for the Study of the Future of Public Health, 1988). The swift rise in urban populations is linked to a heightened rate of disease transmission, driven by elements like overcrowding, lack of sanitation, subpar hygiene practices, and inadequate vaccination initiatives (Institute of Medicine (US) Forum on Microbial Threats, 2009, Bedford et al., 2019, Piot et al., 2019). Furthermore, as people interact with wildlife habitats through various agricultural methods, they encounter both domesticated animals and wildlife, which heightens the risk of zoonotic disease transmission (Esposito et al., 2023). This mode of transmission is observed in the Ebola virus, a zoonotic disease typically passed from animals to humans via contact with infected animal carcasses or bodily fluids (CDC, 2024). The details of common zoonotic diseases, causative agents, animal hosts and their mode of transmission are shown in Table 1.

### **Table 1: Common Zoonotic Diseases, Their Causative Agents, Animal Hosts and Mode of Transmission**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Zoonotic Disease | Causative Agent | Animal Host | Mode of Transmission | Impact on Human Health |
| Rabies | Rabies virus | Dogs, Bats | Bite, scratch, saliva | Encephalitis, death |
| Avian Influenza | Influenza A virus | Birds (esp. poultry) | Airborne, direct contact | Respiratory issues, death |
| Ebola | Ebolavirus | Bats, Primates | Direct contact, bodily fluids | Hemorrhagic fever, death |
| Zika Virus | Zika virus | Mosquitoes, Primates | Mosquito bites | Birth defects (microcephaly), fever |
| Tuberculosis | Mycobacterium tuberculosis | Cattle, Goats | Airborne (inhalation) | Lung disease, systemic spread |
| Brucellosis | Brucella species | Cattle, Sheep, Goats | Direct contact, consumption of unpasteurized milk | Fever, arthritis, chronic fatigue |

## **2.2 Animal Health and Infectious diseases**

Animals act as reservoirs for zoonotic diseases, which can be transmitted to humans via multiple routes, including direct contact and consumption (Elsohaby & Villa, 2023). The influence of animal husbandry practices, particularly intensive farming, on disease transmission is considerable (Zhang et al., 2024). Additionally, wildlife significantly influences disease ecology, and fluctuations in wildlife populations can markedly affect both human and animal health. The global wildlife trade intensifies this issue by facilitating the introduction of novel pathogens into new regions, thereby heightening the risk of cross-species transmission (Hilderink & de Winter, 2021).

Furthermoree, the incorporation of animal health within the One Health framework is essential, as diseases originating from animals frequently serve as the catalyst for global pandemics and prevalent infectious diseases affecting both humans and animals. For example, foot-and-mouth disease (FMD) mainly infects animals, but can also affect humans and its transmission to human is by direct contact with infected animals and consumption of FMD-contaminated products (Paton et al., 2018).

**2.33 Environmental Health and Infectious diseases**

The environment is where all lives including pathogenic organisms thrive and from the lens of One Health approach, environmental conditions critically affect the emergence and spread of infectious diseases among humans and animals. For that reason it is crucial to understand how factors like climate change, environmental pollution of all kinds, deforestation and biodiversity change affect the spread and proliferation of diseases. However, the importance of One Health in addressing infectious diseases cannot be overemphasized. For example, changes in climate, such as temperature and precipitation changes, have effects on breeding of disease vectors like ticks and mosquitoes. Thus, the distribution of infectious diseases such as malaria, dengue fever or Lyme disease is affected by climate and environmental factors (Ellwanger et al., 2020).

In addition, biodiversity loss which includes the loss of natural ecosystems, has an important impact on the transmission and dissemination of infectious diseases. Disruptions of ecosystems such as deforestation, urbanisation and agriculture expansion create opportunities for pathogen proliferation in the environment through alteration of the natural habitats of wildlife leading to an increased probability of cross-species transmission (zoonoses) to human (Gibb et al., 2020).

Furthermore, the quality of water supply available in the environment that all lives (including humans and animals) depend on greatly impacts the transmission of infectious diseases, in particular water-borne diseases such as cholera, typhoid fever, and dysentery (Shayo et al., 2023). It also affects certain neglected tropical diseases, including schistosomiasis, Guinea worm disease (dracunculiasis), trachoma, and lymphatic filariasis (Nwokedi et al., 2025). The availability and quality of water significantly influence practices like sanitation and waste management, which are crucial strategies in the control of infectious diseases (Okesanya et al., 2024). Furthermore, the recurrent incidents of flooding linked to climate change result in water contamination, consequently increasing the risk of transmission and spread of infectious diseases across various regions (Olanrewaju et al., 2019, Okaka & Odhiambo, 2018). Thus, it is essential to implement effective water management systems, ensure sanitation, and regulate environmental pollution.

Nevertheless, air pollutants such as particulate matter (PM), nitrogen oxides, and sulphur dioxide have been shown to enhance the transmission of infectious diseases, especially respiratory infections like influenza, tuberculosis, and pneumonia. This occurs through the impairment of the respiratory and immune systems, which increases individuals' susceptibility to infections (Domingo & Rovira, 2020). However, the summary of how environmental factors contribute to spread of infectious diseases are shown in Table 2.

**Table 2: Environmental Factors Contributing to the Emergence of Infectious Diseases**

|  |  |  |  |
| --- | --- | --- | --- |
| Environmental Factor | Diseases Affected | Impact | Example |
| Climate Change | Malaria, Dengue, Lyme | Increased range of disease vectors | Warming temperatures increase the range of mosquitoes carrying malaria and dengue virus |
| Deforestation | Ebola, Zika | Increased human-wildlife interaction, leading to pathogen spillover | Deforestation in Central Africa has been linked to Ebola outbreaks |
| Water Pollution | Cholera, Typhoid | Contamination of water supplies | Polluted water sources increase the risk of waterborne diseases |
| Biodiversity Loss | Malaria, Lyme, Zika | Loss of natural predators, which increases vector populations | Loss of biodiversity can increase vector populations like ticks and mosquitoes |

# **3. APPLICATIONS OF ONE HEALTH FRAMEWORK**

# The One Health framework as a holistic approach in addressing issues of infectious diseases which takes into account all lives within the environment and the environment in which they thrive has been found applicable in the following ways:

**I.) Control of Zoonotic Diseases**

In the prevention and control of zoonotic diseases, One Health is a useful mode as its concepts are applied in the design and implementation of disease surveillance systems. For comprehensive disease surveillance, One Health approach is factored to ensure all data from various sectors, such as human health, animal health, and environmental health are taken into consideration. With comprehensive data derived from One Health surveillance model, authorities easily detect disease threats at an early stage and can swiftly respond with greater efficacy.

**II.) Food Safety**

All humans and animals depend on food for survival and these foods are sourced from the environment. This further justifies the interconnected nature of humans and animals and the environment they inhabit. Within One Health Model, food safety is one of the important sectors. According to Rabia Shabir Ahmad et al (2023), food safety refers to all measures put in place to ensure that food products are without contaminations of all kinds and safe for human consumption. Food Safety is of public health concern as in has a significant burden on the lives of humans and animals such as reported cases of deaths as a result of food contamination induced outbreaks as well as loss in farm produce which possess economic threat to farms and hazards to humans when the consume from the farm produce from the affected farms.

The WHO estimates that 600 million people worldwide—nearly one in ten—get sick after consuming foods that have been contaminated, and that 420 000 people die each year as a result of consumption of contaminated food.. For this reason, policies like One Health must be implemented to guarantee food safety (WHO, 2024). The One Health paradigm tackles food-borne zoonotic illnesses patterning to food handling and processing (King, 2012). Its integrated approach helps in drawing insights from food production and health sectors to ensure that preventative measures are taken into consideration at every stage of the production-to-consumption continuum.

**III.) Control of Antimicrobial Resistance**

Misuse of antibiotics is common among humans and farmers also misuse antibiotics in their animals with intentions such as prophylaxis against infectious diseases, improve yield. This misuse is of public health concern as it contributes to the issue of antimicrobial resistance (AMR) (WHO, 2023). AMR issue also impacts on the management of many health conditions as comorbid infections worsen AMR by initiating complex interactions among pathogens, this can complicate disease conditions and negatively affect treatment outcomes (Ayomide et al., 2024). Hence there is a need to take into account the usage of antibiotics in both human and animal populations as supported by the One Health framework. It has been reported that misuse of antibiotics in animals can lead to the development of strains of pathogens that are resistant to antibiotics and their resistant strains can lead to cross resistance as such pathogens get transmitted to humans (Economou & Gousia, 2015, Chang et al., 2015). One Health encourages several approaches that can help address this issue of antimicrobial resistance which includes: immunization, microbiota modification, and hygiene practices, the One Health approach promotes the rational use of antibiotics in both humans and animals through regulation and surveillance (Cella et al., 2023, Maller et al., 2008).

**IV.) Ecosystem Conservation**

Environmental factors such as climate change, deforestation, extensive agricultural practices, and poor water quality can impact human health and contribute to the spread of infectious diseases. In order to prevent and control emerging and reemerging zoonotic diseases within the ecosystem, there is a need to observe One Health approaches that foster protection and continuous restoration of natural ecosystems as well as the regulation and application of laws to support sustainable agriculture practices.

**V.) Promotion of Research and Collaboration**

One Health approach encourages collaboration by bringing in experts from public health agencies, veterinary services, environmental authorities, and agricultural sectors under one umbrella to address infectious diseases issues. Therefore One Health fosters interdisciplinary collaboration and also organizes collaborative training programs that facilitate data-sharing across disciplines. Furthermore, such interdisciplinary cooperation has been recognized to be impactful via a joint research approach among numerous stakeholders, NGOs and governments.

**VI.) Integration of Digital Technologies in Disease Surveillance**

Digital technologies have been found to be very instrumental in revolutionizing the health sector. Modern tools including mobile applications, cloud computing technologies, geographic information systems (GIS), big data analytics and remote monitoring have been instrumental in disease monitoring. Under the One Health approach, they have been useful in disease surveillance and fostering collaboration among professionals as it makes communication and data sharing easy. Moreover, in monitoring the environment factors as well as activities of humans and animals and how the interaction among humans and animals within the ecosystem impact their health, digital technologies are highly instrumental. For instance, GIS can help monitor the transmission of vector-borne diseases predisposed by climate change and other environmental factors.

Some researchers have investigated the influence of the environment on disease transmission and spread. For example, Javaidetal. (2023) (Javaid et al., 2023), explored the use of GIS in disease surveillance and showed that temperature, precipitation, and specific humidity are the most important environmental factors for vector-borne diseases (VBD) like dengue, malaria, and leishmaniasis.

**4. CHALLENGES ASSOCIATED WITH IMPLEMENTATION OF ONE HEALTH**

Despite the fact that the One Health paradigm has been recognized as an integral approach to the prevention, detection, and control of infectious diseases, it is confronted with a wide range of challenges that seriously obstruct its implementation. These challenges including lack of data sharing and collaboration among involved sectors, financial limitations and cultural/perception issues need to be addressed to implement One Health effectively.

Fragmented healthcare systems in public health, veterinary and environmental sectors exist in many countries around the world, and very little or no collaboration among these sectors. This fragmentation has resulted in disjointed efforts in combating health threats and thus limiting data sharing especially in developing Countries where adoption of technology in communication and collaboration is an issue.

Financial constraints is also a limiting factor for One Health implementation. Full implementation of One Health requires investment in infrastructure needed for robust surveillance systems as well as research, and training of professionals. Moreover, distribution of available finances is limited due to insufficient and inequitable budget allocations. The health sector typically possesses a greater allocation of human and financial resources for disease control initiatives compared to agencies focused on environmental or animal health.

Last but not the least, implementing One Health faces cultural and perception issues which must be continuously addressed. Cultural shifts within agencies are frequently necessary, alongside the development of new systems and capacities, as well as changes in the attitudinal relationships among various professions, including veterinarians, doctors, extension workers, biologists, and those involved in environmental and natural resource sectors (FAO, WHO, OEI, UNICEF, 2008).

# **5. STRATEGIES FOR STRENGTHENING THE ONE HEALTH APPROACH**

# Control of infectious diseases requires effective implementation of One Health approaches through strategic implementation in all health sectors and at all levels of health. For successful implementation, structural and functional strategies that foster collaboration among human, animal, and environmental health sectors must be embraced. Some of these strategies are discussed under the following heading:

**I.) Development of Joint Surveillance Systems**

In most countries of the world, human, animal, and environmental health surveillance systems often operate in silos (Hayman et al., 2023), and such systems can not efficiently detect and respond to health threats in these sectors collectively, hence the need for a joint surveillance system. Joint surveillance systems, facilitates sharing of data across sectors and timely detection of disease outbreaks thereby allows for coordinated responses to outbreaks.

**II.) Educational Initiatives**

For successful implementation of One Health approach, professionals from all the sectors within the framework of One Health must be properly equipped with skills and knowledge needed in execution of their duties as well as understand how health challenges are interconnected based on One Health concepts and the significance of working across disciplines. This can be achieved through professional training, public awareness campaigns, incorporation of One Health principles into educational curriculum particularly at the university level.

**III.) Legislative Involvement**

Effective policy frameworks and fostering multisectoral governance are essential elements of the One Health strategy and It is essential to develop and enact legislation that fosters a One Health approach by enhancing disease reporting and informing decision-making processes.

**IV.) Investments and Incentives**

Enhanced funding for the global health infrastructure for humans and animals is paramount, reflecting the critical urgency posed by emerging and re-emerging disease threats to humans, domestic animals, and wildlife. Moreover, there is a need to establish a framework for incentives, including the creation of joint budgets for services and the implementation of specialized grant mechanisms for One Health initiatives.

**V.) Promotion of Collaboration**

It is essential to establish institutional frameworks that promote improved cooperation and communication among agencies focused on human, animal, and ecosystem health.

# **6. CONCLUSION**

Infectious diseases pose serious risks to lives within the ecosystem globally particularly zoonotic diseases which are the major pandemics the world has ever witnessed. Several efforts have been made to address health issues relating to infectious disease and One Health which provides a critical strategy for managing these risks is one of such efforts. However these keep emerging and reemerging hence the need for continuous effort dedicated to control of infectious diseases.

One Health is a holistic model that takes into consideration the interconnectedness of human health, animal health as well as environmental health and fosters collaboration among experts across disciplines with the sole aim of finding solutions to managing diseases of public health concern.

The importance of the One Health approach can not be overemphasized as it has been found instrumental during COVID-19 pandemic, Ebola outbreaks, and other outbreaks. Its strategies are beneficial in prevention and control of zoonotic diseases, early disease outbreak detection, health research and development. It also fosters data and resources sharing and interdisciplinary collaboration.

While the One Health has been found promising, there are several challenges that impede its full adoption, such as lack of data sharing and collaboration among sectors involved, financial constraints as well as cultural and perception issues. However, there are strategies that can be used to address these challenges and facilitate its implementation which includes; establishment of institutional frameworks that promote improved cooperation and communication among agencies focused on human, animal, and ecosystem health, development of joint surveillance systems, educational initiatives, legislative involvement as well as provision of investments and incentives.

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