



REVIEW ARTICLE

# One Health Approach for the Control of Zoonotic Diseases

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## Abstract

Zoonoses are infectious diseases that can be transmitted from animals to humans and/or from humans to animals. Approximately 75% of new emerging and re-emerging disease pathogens are zoonotic: 60% spread from domestic and wild animals, and 80% are of concern regarding bioterrorism. For the past 20 years, the world has faced several zoonotic disease outbreaks. Some zoonoses can cause recurring outbreaks, such as Ebola virus disease, salmonellosis, Marburg disease, rabies and anthrax. Still others, such as the novel coronavirus causing COVID-19, have the potential to cause worldwide pandemics. The high risk of emerging and reemerging disease spillover and burden has been increased by extensive interactions among animals, humans and ecosystems. Hence, this complex health threat strongly requires a multi-sectoral collaboration known as the One Health approach. This article discusses recent scientific policies, initiatives, best practices, systems and challenges in One Health. The critical rapid review method was used, with a particular emphasis on available and recent global information. Literature found in Google Scholar and PubMed, and data publicly available on the websites of major global, regional and national organizations were included. The aim of this article is to provide compiled information and increase awareness.

**Key words:** awareness, collaboration, emerging and reemerging, infectious diseases, multi-sectoral, one health approaches, zoonotic diseases

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## INTRODUCTION

Zoonoses are infectious diseases that can be transmitted from animals to humans and/or from humans to animals [1,2]. More than 75% of emerging disease pathogens are zoonotic: 60% of them spread from domestic or wild animals to humans, and 80% are of concern regarding bioterrorism. Worldwide, these emerging zoonoses account for 2.5 billion cases and 2.7 billion death each year [3,4,5]. These zoonotic diseases are becoming growing health threats worldwide and, in the past 20 years, have been reported to cause billions of US dollars of economic damage in many local and

global multi-sectoral economies [6]. In the past decade, zoonotic diseases have cost more than 20 billion US dollars in direct costs and 200 billion US dollars in indirect costs [7]. Worldwide, more than 25% of the original forest cover has been lost due to frequent encounters of humans and domestic animals with wildlife. Human activities have severely destroyed or altered more than 75% of terrestrial environments and 66% of marine environments. Consequently, infectious disease transmission has been exacerbated, thus causing as much as 20% global animal production loss and severely affecting food security [3].

For the past 20 years, the world has faced several zoonotic disease outbreaks, such as the viral diseases of Ebola virus disease, hantavirus disease, the highly pathogenic avian influenza, West Nile disease, Rift Valley fever, severe acute respiratory syndrome, Marburg disease, rabies, Middle East respiratory syndrome, monkeypox disease, and the COVID-19 pandemic, as well as the bacterial diseases of anthrax, brucellosis, tuberculosis, salmonellosis, and *Escherichia coli* (O157:H7) and *Yersinia pestis* infections. Some zoonoses can cause recurring outbreaks, whereas others may cause potential worldwide pandemics and have been declared public health emergencies of international concern by the World Health Organization (WHO) [3,8,9]

Because of the world's interconnectedness, the threat of a given disease somewhere is a threat everywhere. The high risk of emerging and reemerging disease spillover and burden has been increased by the extensive interactions among animals, humans and ecosystems, as a result of exponential growth of livestock and human populations; rapidly increasing urbanization and changing farming systems; close interactions between wildlife and domestic animals (followed by forest encroachment, habitat destruction and ecosystem changes); globalization in the trade of animal and animal products; antimicrobial resistance; and climate change [4,10]. Land use changes due to improper use and overuse of natural resources, together with the effects of climate change (such as floods, drought, forest fires and the heat island effect) have led to severe degradation and/or destruction of entire ecosystems, thus resulting in a loss of natural protection against disease emergence. In contrast, wildlife habitat fragmentation because of infrastructure development, urbanization and unregulated exploitation (through extensive hunting, trade and consumption) has contributed to decreasing biodiversity; increasing disease vector and host interaction; and exacerbating disease spillover across wild animals, domestic animals and humans [11]. Antimicrobial resistance due to the misuse of antibiotics and other medicines, particularly in animal rearing, hinder the treatment of diseases and resistant microorganisms. Environmental pollution has also facilitated the spread of disease via water, air and soil [12]. In addition, foodborne pathogens such as bacteria, viruses and parasites have increased the worldwide burden of diseases. Currently, food safety is affected by several challenges (such as population growth and migration, changes in food production and distribution systems, globalization of the food trade, growth in meat consumption and frequent consumption of meat by humans), which can result in continual contamination and the occurrence of food-borne disease [13]. Consumption of contaminated food causes foodborne illness and death of 600 million and 400,000 people, respectively, each year. The sources of these foodborne illnesses are products of animal origin, fruits, vegetables and contaminated water. Therefore, food safety should be assured through an integrated multi-disciplinary approach [8,3,14].

This complex and interconnected health threat based on animal–human–environment interactions strongly requires inter-sectoral integration and/or collaboration not only to decrease the burden, but also to enable future effective prevention and control of all zoonotic diseases [3,15]. This goal can be achieved through the One Health approach and its coordination mechanisms. The One Health approach is an effective platform organizing all relevant stakeholders (in animal, human, environmental and other relevant sectors), which also can provide substantial benefits for health sectors and their development goals through convening relevant governmental agencies [16,17]. However, the implementation mechanisms of the One Health approach to decrease and prevent zoonotic diseases remain poorly understood and have received little attention worldwide, particularly in low income countries. Moreover, the dynamics, and the economic and epidemiological mechanisms of preventing and controlling the persistence and emergence of zoonoses are unclear [8].

To obtain compiled information for better understanding effective systems for controlling zoonotic diseases, reviewing and framing the One Health approaches, policies and available global best practices is critical. Therefore, this article discusses recent scientific policies, initiatives, best practices, systems and challenges. The critical rapid review system was applied to major studies gathered by searching peer-review databases for One Health related terms, and the findings are discussed with particular emphasis on all available and recent global information. Studies found in Google Scholar and PubMed, and data publicly available on the websites of major international, global, regional and national organizations were included. This review differs from previous reviews in its attempt to include major and recent scientific policies, initiatives, best practices, systems and challenges and solutions of the One Health approach. The aim of this article is to increase community awareness of One Health.

## ONE HEALTH: DEFINITION, HISTORICAL ADVANCEMENT AND IMPORTANCE

### Definition

One Health an interdisciplinary, multi-sectoral and collaborative approach that can function at global, regional, national and local levels, with the objective of ensuring optimal health through the recognition of connections among environment, humans, animals and plants [18]. This integrated and unifying approach can mitigate and prevent health threats at the interface of the environment, humans, animals and plants, with the objective of achieving and sustainably balancing or optimizing public and animal health, food and nutritional security, sustainable ecosystems and fair trade [19]. The One Health approach mobilizes several disciplines and sectors as well as communities at different levels in working together to combat health and ecosystem threats. It is aimed at addressing the collective need for clean water, energy and air, safe

and nutritious food, taking action on climate change and contributing to sustainable development. One Health is a global paradigm for challenge driven teamwork that forges co-equal and all-inclusive collaboration across human, animal, plant and environmental health areas [20]. In terms of legislation and policy, the One Health approach can be enforced to implement programs, policies and legislation through communication across several sectors working together to achieve better health [21].

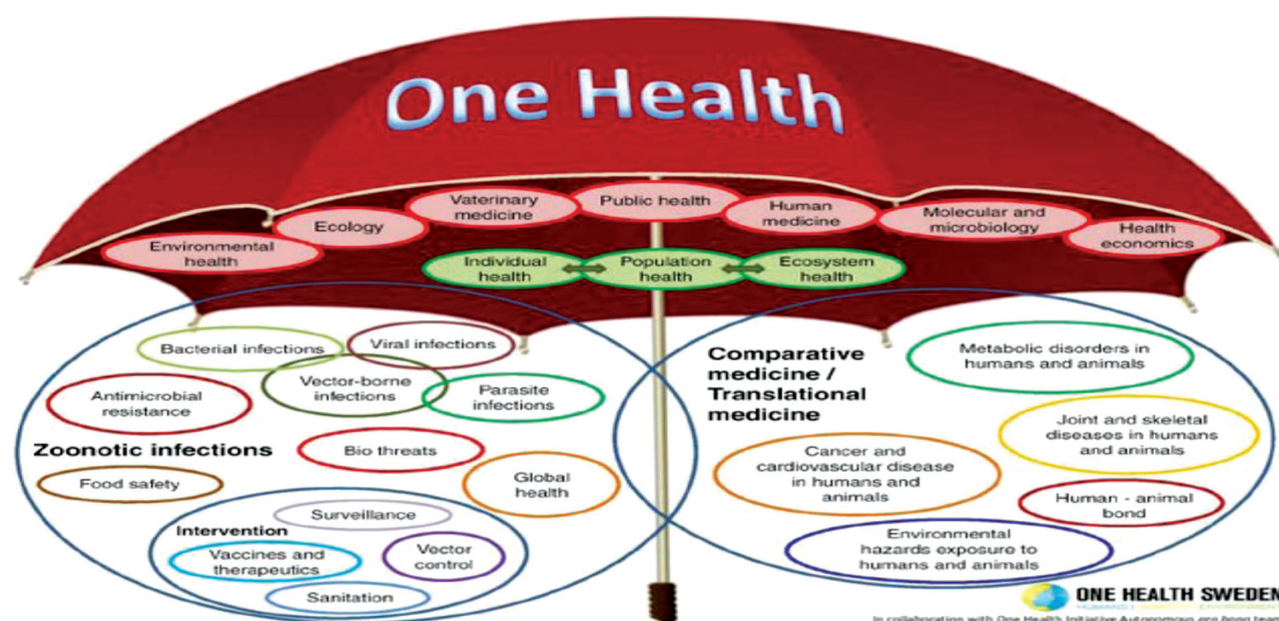
### Historical advancement of the One Health approach

The One Health approach concept was launched in 19<sup>th</sup> century by Rudolf Virchow (1821–1902) after he incorporated veterinary medicine into human health and asserted the absence of a dividing line between them. Subsequently, the One Health concept grew worldwide, and at the start of the first of 21<sup>st</sup> century showed a paradigm shift; since then, interdisciplinary collaboration has expanded [22]. The Wildlife Conservation Society formulated the One World-One Health concept, in 2004, by establishing a cross-sectional approach to prevent epizootic or epidemic diseases and maintain ecosystem integrity. The United Nations Food and Agriculture Organization (FAO), World Organization of Animal Health (OIE), United Nations Children’s Fund, World Bank and United Nations System Influenza Coordinator documented a strategic framework for decreasing risks of infectious diseases at the human–animal–environment interface, entitled “Contributing to One World, One Health,” in 2008. In the same year, this strategic framework was supported by World Medical Association (WMA) through a resolution on the collaboration between human and veterinary medicine, including joint educational efforts

between veterinary and human medical schools [23,24]. The Global Conference on One Health, held in May 2015 by the World Veterinary Association (WVA) and World Medical Association (WMA), was also one of the most important actions that expanded the One Health platform by recommending an increase in interdisciplinary collaboration between veterinary and medical professionals to improve animal and human health. Since then, the One Health concept has become more accepted, and its initiatives have rapidly been gaining a wider platform [25].

### The scope of One Health

The following areas requiring the One Health approach at all levels of academia, government, industry, policy and research, because of the interconnectedness of human, animal, environmental, plant and whole planet health: agricultural production and land use; animals (as sentinels for environmental agent and contamination detection and response); antimicrobial resistance mitigation; biodiversity (conservation medicine); climate change and its effects on humans, animals and ecosystems; clinical medicine; sector of information communication and outreach; comparative medicine; disaster preparedness and response; disease surveillance and prevention of both infectious (zoonoses) and chronic diseases; economics; environmental health; food safety and security; global trade; the human–livestock bond; natural resource conservation; occupational health risks; plant and soil health; professional education and training; public policy and regulation; research; water safety; and the welfare/well-being of animals, humans, ecosystems and the planet [5,26,27]. A One Health Umbrella formulated by One Health Initiative and One Health Sweden to demonstrate the scope of the One Health approach (Fig 1) is the best example of collaboration among One Health stakeholders.



**FIGURE 1** | The ‘One Health Umbrella’ developed by the networks ‘One Health Sweden’ and ‘One Health Initiative’ to illustrate the scope of the ‘One Health concept’. Available on [www.onehealthinitiative.com](http://www.onehealthinitiative.com) and previously published in Ref. [28].

### Why the One Health approach?

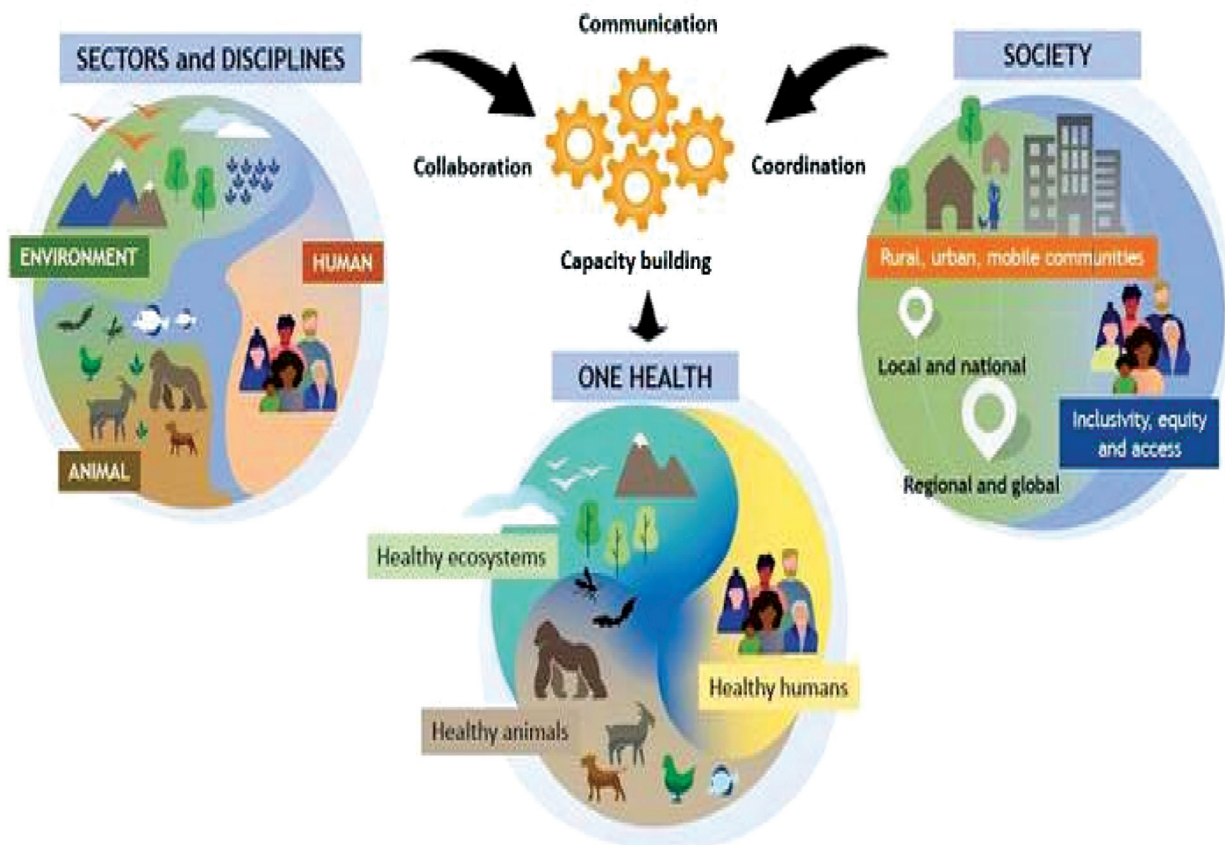
Animals and humans are infected by many of the same microorganisms because they live in a shared ecosystem. For example, most zoonotic diseases, such as rabies, anthrax and brucellosis, can be effectively prevented in humans by controlling an animal source of the causative agents. Drug resistant microorganisms can be transmitted between humans and animals through contaminated food and direct contact. Environmental pollution, ecosystem destruction, antimicrobial resistance (due to misuse of antibiotics) and consumption of contaminated food (causing foodborne illness due to consumption of products of animal origin, fruits, vegetables and contaminated water) are also among the relevant problems in which they cannot be controlled and eliminated by one sector alone. Therefore, to effectively address these issues, a well-coordinated One Health approach in the human–animal–environment sectors is required [10,17,29]. Moreover, advancing the Sustainable Development Goals (SDGs), particularly SDG-3 (“Ensure healthy lives and promote well-being for all at all stages”) and SDG-15 (“Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss”), provides a unique opportunity for relevant sectors to work in a collaborate manner [30,31].

### The Importance of the One Health approach

The One Health approach is used to conduct joint disease surveillance; control and prevent zoonotic diseases outbreaks; improve food safety and security; and decrease antimicrobial resistant infections to improve human and animal health. By promoting strong collaboration among relevant sectors, the One Health approach strengthens the disease surveillance system, the data sharing mechanism with all stakeholders, diagnostic laboratory systems, and the network for early response and detection of zoonoses. This approach clearly enhances the zoonotic disease prevention and control workforce and ensures effective and coordinated public health emergency preparedness, in which all strategies contribute to the effective reduction of zoonotic diseases. Generally, the One Health approach strongly supports international health security through its effective multi-sectoral collaboration, coordination and information communication at the interface between relevant sectors by addressing common health threats, such as zoonoses, antimicrobial resistance, food safety and security issues [18,32,33].

### How can work contribute to One Health?

The One Health approach promotes collaboration, coordination and communication across all sectors (Fig 2) among animal, human, environmental and other relevant disciplines. Consequently, anyone can contribute to the



**FIGURE 2** | The collaboration, coordination and communicating system of One Health across all sectors [34].



actual implementation of One Health strategies through participating in human, animal/wildlife and environmental health. Professionals (human and veterinary medicine and environmental health cares) can greatly contribute by applying this approach to regular practice [18,34].

### **Initiatives driving the One Health approach**

Several global One Health initiatives have been used and developed to assist countries by facilitating and increasing the capacity of the One Health approach, together with designing strategies, implementation programs, policies, legislation and studies to improve global health security, achieve SDGs, comply with the international health regulations and handle common health threats [35,36].

#### ***International ministerial conference on avian and pandemic influenza***

Representatives from 29 international organizations and 111 countries, in December 2007, convened in New Delhi, India, and promoted the idea of One Health by creating linkages between animal and human health systems for pandemic preparedness. At the time, the meeting representatives clearly recommended the One Health approach for effective preparedness [18].

#### ***The world medical association resolution***

In 2008, the World Medical Association made a resolution for real collaboration among veterinary and human medicine. The Association recommends collaboration, and strongly supports joint education between human and veterinary schools [37].

#### ***A collaboration of FAO, WOA, WHO, United Nations International Children Emergency Fund (UNICEF) World Bank and UNESCO***

In 2007, these major international organizations meet in India and developed a joint strategic framework to respond to emerging and reemerging infectious diseases, particularly avian influenza. This Joint Strategic Framework was entitled “Contributing to One World, One Health” and built on the lessons of the One Health concept [18].

#### ***Tripartite agreement among three international organizations***

The World Organization for Animal Health (WOAH), FAO of The United Nations and WHO have agreed to a tripartite agreement in April 2010 for working together on antimicrobial resistance, tuberculosis, rabies, and Middle East respiratory syndrome–coronavirus. This agreement proposes and advances a long term strategic direction for international collaboration, with the aim of sharing responsibilities and coordinating global health activities at the interface of humans, animals and ecosystems [16].

#### ***The first one health congress***

In 2011, an international One Health Congress was held in Melbourne, Australia, by representatives from 60 nations.

The conference discussed the importance of working together to promote a One Health approach; awareness of the interdependence of animal, human and environmental health; and the necessity of involving other disciplines, such as economics, social behavior, food security and safety [38].

#### ***The world medical and veterinary association one health collaboration***

In 2012, these two organizations signed a memorandum of understanding to integrate a unified approach for addressing common health threats and working effectively to improve global health. Their agreement focuses on zoonoses such as rabies control, antimicrobial resistance and education [39].

#### ***The one health global conference***

The World Medical and Veterinary Associations held a conference in May 2015 (Spain) and strongly agreed on the need for increasing multidisciplinary collaboration among human and veterinary professionals to improve common wellbeing [40].

#### ***Operational framework of One Health for strengthening animal, human and environmental health systems***

The World Bank was developed this framework in order to provide One Health orientation and support one health sectors in terms of implementing and understanding the approach. The framework provides important initiatives and tools for supporting One Health by strengthen in the animal, human and environment sectors. Generally, the framework was established to provide a generalized overview of the concept of One Health and application guidance [6].

#### ***Quadripartite memorandum of understanding for the One Health collaboration***

On March 17, 2022, the FAO, WOA and WHO updated their former tripartite agreement to a new quadripartite agreement by incorporating the United Nations Environmental Programme as an equal partner working on One Health in collaboration. Accordingly, the Directors General of the four organizations signed a memorandum of understanding agreeing to increase collaboration to maximize and optimize the health of animals, humans, the environment and plants. The agreement not only provides a legal framework for those organizations to combat challenges at the ecosystem–animal–human interface, but also enhances the reinforcement of international, regional, national and local health services [41].

#### ***One Health approach actions for the control of zoonotic diseases***

Globally, neglected tropical diseases have greatly affected more than 1 billion people in disadvantaged and marginalized communities. Acting quickly to efficiently control the burden of zoonoses through One Health is critical

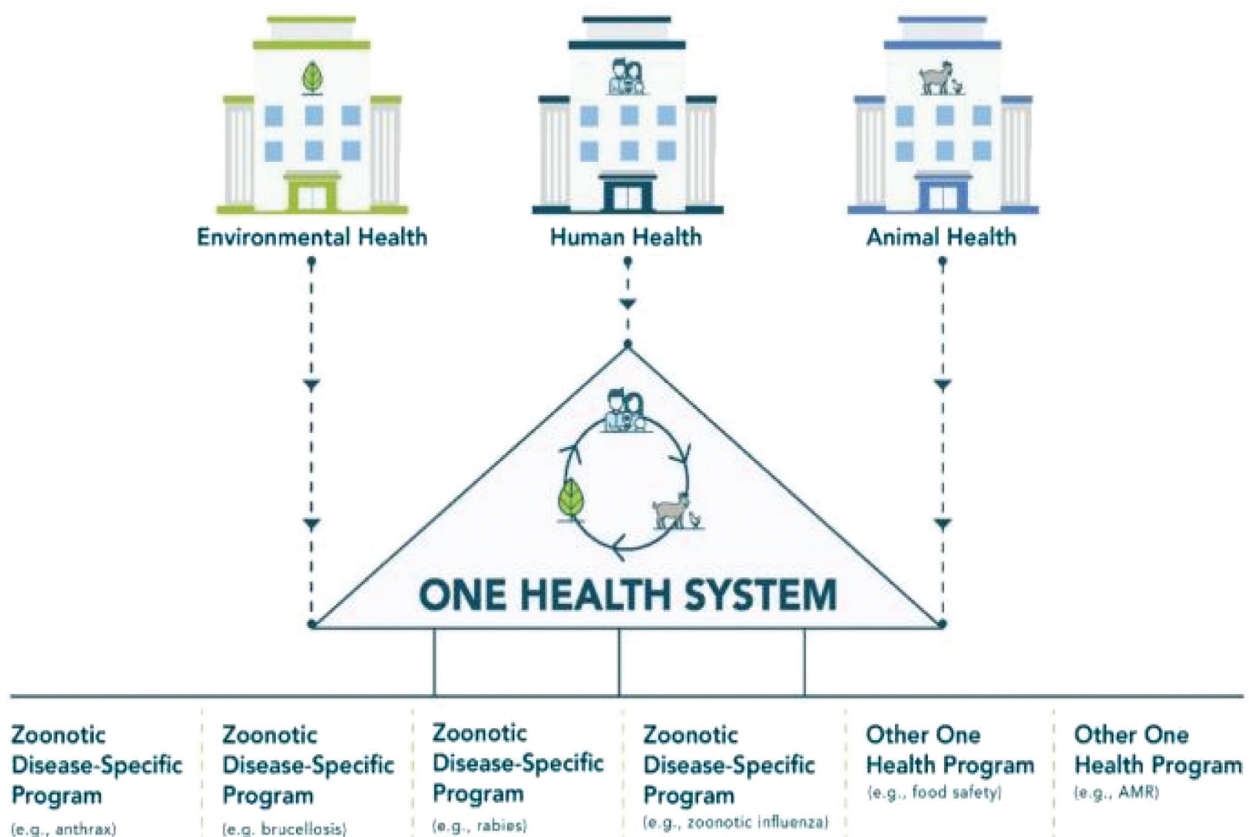
[42]. Currently, several global One Health initiatives have been used and developed to assist countries by facilitating and increasing the capacity of One Health approach, together with designing strategies, implementation program, policies, legislation and studies to improve global health security, attain SDGs, comply with International Health Regulations and handle common health threats. For example, the WHO, FAO, WOA and United Nations Environmental Programme have collaborated on using the One Health approach to predict, detect, respond to and prevent global health threats, as well as to promote sustainable development, [43].

The WHO has launched a historical One Health approach action companion document to combat neglected tropical diseases through a 2021–2030 roadmap, with the aim of supporting countries, international organizations stakeholders and non-state actors in achieving the goals through a trans-disciplinary, cross-cutting approach. The document intended three main priorities or roadmap pillars to be achieved by each group. The first pillar is accelerating programmatic action by integrating the One Health system for neglected tropical diseases and achieving targeted actions, such as technical progress (through guidance and evidence based intervention), service and strategy delivery (surveillance and joint risk assessment), and integrating funding, advocacy collaboration and multi-sectoral action. The second

priority intensifies cross-cutting approaches through coordination and integration actions in key sectors, and is implemented by targeted actions such as enhancing common delivery working platforms on animals and humans; prioritizing neglected tropical diseases within human–animal–environmental health systems; and coordinating with other sectors in neglected tropical disease interventions, such as strengthening cross-sectoral coordination mechanisms. The other pillar is changing culture and operating models to facilitate country mandate by nurturing and sustaining a country-led One Health action. This pillar is achieved through targeted action, such as creating ownership at national and sub-national levels (through responding to specific needs of the population and global health security agenda), defining stakeholder roles (by managing priorities across nations and sectors), and aligning organizational setup, operating models and philosophy [42].

**One Health systems: best examples and practices**  
***Tripartite Zoonotic Guide (TZG)***

This system-based One Health approach (Fig 3) and/or multi-sectoral coordination mechanism was prepared by the FAO, WOA and WHO to address zoonotic diseases in various nations. This systematic guide provides a Generalized One Health Framework (Fig 4), achieved through five steps that describes a clear structure for the



**FIGURE 3** | System based program of One Health: zoonotic disease specific program compared with other areas [44].

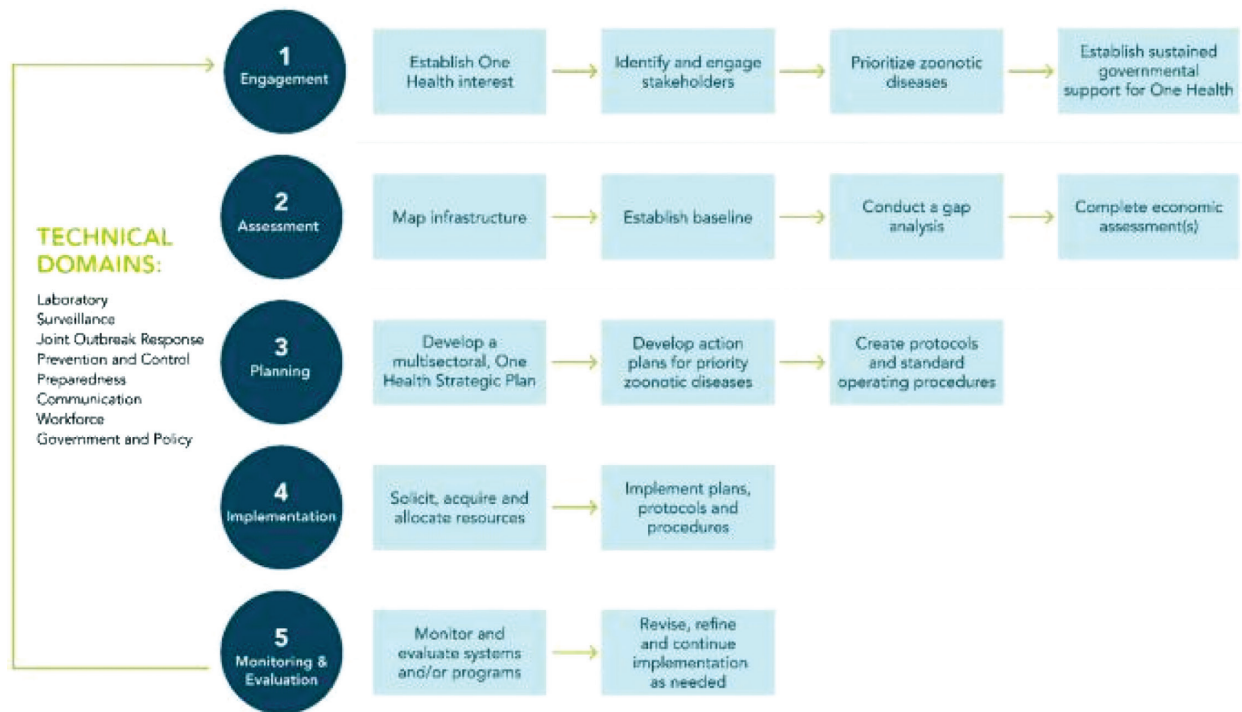


FIGURE 4 | Generalized One Health Framework achieved through five steps [44].

One Health approach in the prevention of zoonotic diseases [44].

**Clinical Project in One Health**

This One Health approach implementation clinical project (Fig 5) in Malawi offers a crucial lifeline to victims

of wildlife crimes and human-wildlife conflict. This project was mandated by the government of Malawi to secure and rehabilitate wildlife and injured animals, and work with communities to promote peaceful co-existence with wildlife, capacity building among wildlife professionals and research to inform the country’s conservation

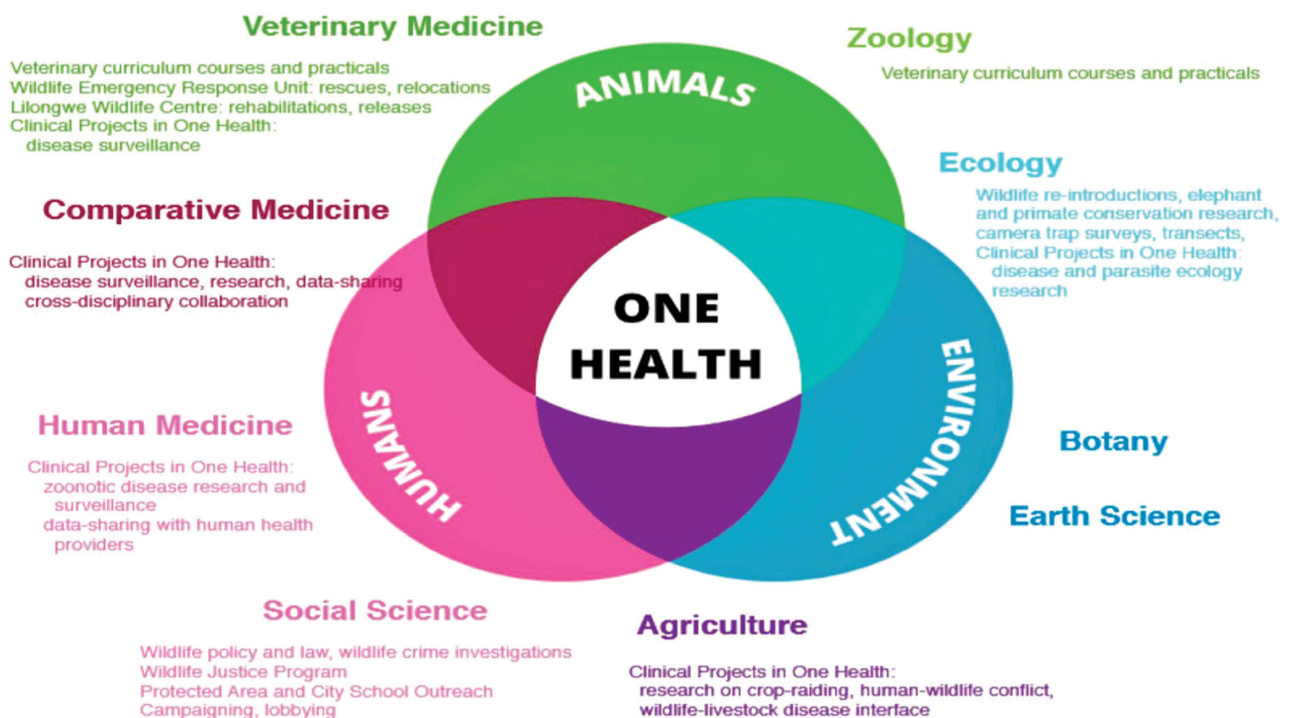


FIGURE 5 | The One Health Clinical Project in Malawi and the coordination of Lilongwe Wildlife Trust, Available on <https://www.lilongwewildlife.org/clinical-project-one-health> and previously published in Ref. [15].

management plan [45]. Some of the disciplines that are showed in Fig 5 are illustrated as follows.

### ***Veterinary medicine***

Human health can clearly be safeguarded by effectively promoting animal and environmental health, which is the responsibility of the veterinary profession, whose central mission is maintaining animal health and welfare and public health. Veterinary medicine is the main department in the One Health approach involved in securing food safety and wildlife care, disease surveillance and zoonosis prevention for farm and/or domestic animals [46].

### ***Comparative medicine***

This field examines similarities and differences between veterinary and human medicine, with an emphasis on the animal origin of human diseases together with the roles and responsibilities of veterinarians and animal resource centers. It plays a role in reduction, replacement and refinement of animal models in research and facilitates translation of knowledge, surveillance, data sharing, cross collaboration across multi-sectors [47].

### ***Human medicine***

In the One Health approach, human medicine plays a role in human health through the prevention and control of zoonotic diseases, disease surveillance, research, and data sharing among human health providers and related sectors [48].

### ***Agriculture and ecology***

An integrated comprehensive approach to health involves both living and nonliving components on the land, and links between ecological changes and human activity. It is concerned with land use changes due to improper use and overuse of natural resources; climate change, which leads to degradation of entire ecosystems; mining of domestic animals and wildlife habitat destruction; and disease spill-over at the wild animal–domestic animal–human interface. Generally, it addresses the effects of antimicrobial resistance, environmental contamination, climate change, biodiversity, habitat loss and human encroachment into wildlife areas [48].

### **Effective One Health approaches to reduce zoonotic diseases**

According to the Africa Center of Disease Communication, FAO, WOAHA, and United States Centre of Disease Control and Prevention, the most effective One Health approaches that are commonly used to combat zoonotic diseases include joint surveillance, increased laboratory capacity, emergency preparedness and response systems, workforce and technical working group establishment, prioritization of major zoonotic diseases, and effective communication and information sharing.

### ***Joint disease surveillance***

For early detection of zoonotic diseases, joint and/or coordinated surveillance systems should be considered by all relevant sectors. The main objective of joint surveillance for zoonotic diseases is to identify the disease events and support the application of coordinated response, prevention and mitigation measures. In addition to supporting research areas, the understanding of disease burden, monitoring and intervention is facilitated [49].

Joint surveillance of zoonotic diseases involves engagement of relevant sectors, and common data including identification numbers, time series data, sites of common exposure and/or geospatial data sources. These efforts require case definitions for surveillance, case detection methods and procedures for case confirmation, including laboratory results. The joint surveillance system also require the development of a specific technical group that can be involved at all One Health institutions as well as a strategic plan to prevent the disease [50,51].

### ***Increase the capacity of laboratories***

Laboratory capacity, and sector specific and multi-sectorial integration are highly important for the success of zoonosis prevention. In addition, conducting joint training and laboratory protocol sharing for One Health responsible sector laboratories is important to detect the same pathogens. Each laboratory should serve as a reference laboratory and create linked database networks over the relevant sectors to improve reporting, data sharing and early detection of zoonotic disease outbreaks [52,53].

### ***Emergency preparedness and response***

Relevant sectors must be trained and coordinated to respond together to a given zoonotic disease outbreak through resource sharing and efficient cost associated with the outbreak control. Relevant sectors must prepare a sector specific emergency preparedness platform for their prioritized diseases and should support a participatory approach including preparedness and response activities, which might include joint risk assessment, simulation exercise and preparedness and contingency planning [16].

### ***Developing workforce***

Establishing a competent global, regional and national One Health workforce of public health, domestic animal, wildlife and environmental professionals is critical to respond to, prevent and control disease outbreaks. Countries should be prepared to detect, respond to, control and prevent any zoonoses by using a diverse workforce including experts such as physicians, veterinarians, laboratory technicians and epidemiologists. The workforce should be supported by education and legislation [36].

### ***Risk communication***

Each One Health approach should incorporate communication strategies including all stakeholders by considering how they can engage, communicate and share



information. The communication strategy includes formal channels of communication, programs and messaging, thus enabling sharing of resources and maximizing public support [16].

### ***Effective communication and information sharing***

On the basis of the information collected from all sources, data sharing for stakeholders aids in understanding of the existing disease burden. The systems can create data sharing platforms across relevant organizations and enable their timely integration [16].

### **One Health coordination mechanisms to combat zoonoses**

The most effective One Health coordination mechanisms to effectively combat zoonotic diseases are formulating operational frameworks with specific roles and responsibilities of stakeholders; establishing formal communication and collaboration systems that can be applied across all relevant sectors; capacity building, strengthening and institutionalization of the approach; addressing priorities, such as zoonoses, food safety and security, antimicrobial resistance and climate change); and developing local, national, regional and international strategies with inclusive goals, objectives and activities for relevant sectors, which describe how collaboration will be accomplished [16].

## **CHALLENGES OF THE ONE HEALTH APPROACH AND POSSIBLE SOLUTIONS**

### **Challenges**

Although considerable activities, effort and progress have strengthened the One Health approach in the past decades, its institutionalization and sustainable and/or regular operationalization within government institutions remain challenging, owing to various constraints that might contribute to weaknesses in effective coordination, such as differences in resource allocation among human, animal and environmental health programs, and disparities in education and training in various disciplines and fields. Owing to the lack of appropriate budgeting and coordination, occasional attempts to control and prevent zoonoses through One Health approach are not well integrated [28,54]. In most nations, poor coordination and integration across the human–animal–environmental health sectors persists in terms of information sharing; a lack of commitment of government officials in supporting One Health with financing and leadership (particularly in developing countries); competing priorities among zoonotic diseases prevention and control measures; limited diagnostic laboratory capacity to detect causative agents; and weak or absent legislation implementing the One Health approach, particularly through public private partnerships. Universities in most parts of the world cannot include One Health course curricula in human, veterinary medicine and other disciplines [21,55]. Moreover,

the main challenges of One Health include diverse emerging and reemerging zoonotic diseases; increased human–animal–ecosystem interaction because of the exponential growth of livestock and human populations; rapidly increasing urbanization and changing farming systems; very close interactions between wildlife and domestic animals that can result in forest encroachment (followed by habitat distraction and ecosystem change); globalization of trade in animal and animal products; antimicrobial resistance; and climate change [26].

### **Solutions**

Integrated activities are needed at multiple levels, including the grassroots national level, and regional and global levels. One Health must effectively operationalize, and the described lines of work require implementation through cooperation and intersectional dialogue. Research institutions must extensively cooperate in One Health issues through effective studies on emerging pathogens and mechanisms of disease spillover, and monitoring of risks of prevention and control strategies of zoonotic and/or infectious diseases [11]. Strong intersectional collaboration across the human and veterinary health, wildlife and environment sectors can enhance regular joint surveillance capacity, understanding of the dynamics of zoonotic disease emergencies and provision of an actual framework for effective implementation of health measures [56]. Every national public health institution and other relevant institution must be committed to ensuring the institutionalization of One Health in their regular plans and/or activities [54]. Countries worldwide must encourage higher education institutions to integrate One Health principles and philosophies into academic curricula and research areas. Moreover, diagnostic laboratory capacity must be increased, and government leadership must be advised or made aware of their commitment to the One Health approach [15]. To develop legal solutions for the implementation of One Health approach, identifying legal principles and institutional dynamics of relevant sectors beyond their sector specific legislation is important [21].

## **CONCLUSION AND RECOMMENDATION**

Re-emerging and emerging zoonoses are an increasing international threat. In the past 20 years, they have caused very high economic and public health damage in many local and global multi-sectoral economies. Over the past 20 years, several deadly zoonotic disease outbreaks have been reported worldwide. Because of global interconnectedness at the human–animal–environment interface, the threat of a given disease somewhere is a threat everywhere. Thus, zoonotic diseases may become the main public health and economic challenge globally in the coming decades. Hence, a strong multi-sectoral collaborative and institutional system (the One Health approach) is required to effectively reduce the burden of, prevent and control those zoonoses. Reviewing and compiling

available One Health approach mechanisms, policies and strategies is critical. In this review article, major globally available One Health policies, strategies, systems, coordination mechanisms, initiatives and best practices for developed and developing countries have been introduced and mapped out, together with challenges and solutions to improve understanding. On this basis, we recommend that all One Health stakeholders worldwide aggressively work toward the promotion, implementation and institutionalization of the One Health approach.

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#### CONFLICTS OF INTEREST

We confirm and declare that the manuscript was prepared without any conflicts of interest and financial relationships.

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