THE ONE HEALTH APPROACH: CONCEPTS, APPLICATIONS, FUTURE DIRECTIONS, AND THE IMPORTANCE OF THE 'ONE WORLD–ONE HEALTH' FRAMEWORK

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ABSTRACT

The One Health approach is a holistic and transdisciplinary framework that recognizes the intrinsic interconnections between human, animal, and environmental health. Emerging global health threats such as antimicrobial resistance (AMR), zoonotic and vector-borne diseases, food insecurity, and the impacts of climate change illustrate the urgent need for coordinated action across disciplines and sectors. More than 60% of emerging infectious diseases are zoonotic in origin, with wildlife playing a major role in their transmission, underscoring the importance of integrated surveillance, prevention, and response strategies. Climate change further intensifies risks by altering ecosystems, expanding the geographical range of disease vectors, and increasing the frequency of extreme events, which compromise food, water, and air quality. Additionally, neglected tropical diseases (NTDs) and foodborne illnesses continue to disproportionately affect vulnerable populations, demanding innovative cross-sectoral interventions that extend beyond traditional biomedical approaches.International organizations, including WHO, FAO, WOAH, and UNEP, have highlighted the One Health paradigm as critical for building global health security, promoting sustainable food systems, and combating the escalating threat of AMR. Key strategies include genomic tools, integrated vector management, risk communication, and capacity development across human and veterinary health systems. Despite these advances, challenges persist, including fragmented governance, limited engagement from the medical community, and the absence of a unified definition of One Health.The role of One Health as a transformative model for addressing contemporary health challenges, advocating for stronger interdisciplinary education, enhanced research collaborations, and investment in preventive strategies. Adoption of this approach at local, national, and international levels offers a pathway to improved resilience, equity, and sustainability, ensuring a healthier future for humans, animals, and the environment alike.

KEYWORDS: One Health, zoonotic diseases, antimicrobial resistance, climate change, food safety, neglected tropical diseases, global health security, interdisciplinary collaboration

INTRODUCTION

The 'One Health' concept emphasizes the interconnectedness of human, animal, and environmental health, highlighting how threats to one domain inevitably affect the others. Issues such as antimicrobial resistance, zoonotic and vector-borne diseases, food insecurity, and climate-driven health risks demonstrate this interdependence. For example, multidrug-resistant pathogens spread rapidly through food systems, trade, and the environment; rising temperatures expand the range of disease vectors; animal diseases threaten economies and livelihoods; human–animal interactions contribute to mental well-being; and contaminated water poses risks to both humans and animals. the fundamental basis of the One Health approach lies in fostering interaction, coordination, collaboration, and capacity development among human, animal,

and environmental health sectors, along with other relevant stakeholders (Mettenleiter *et al.,* 2023)

ONE HEALTH PARADIGM

The One Health Initiative is a global effort that encourages cooperation among doctors, veterinarians, dentists, and environmental health experts to improve the wellbeing of people, animals, plants, and the environment. It highlights the natural connection between ecological, animal, and human health, aiming to protect all species. More than 985 well-known scientists, doctors, and veterinarians support this initiative. The World Health Organization (WHO) has also launched its own One Health Initiative to coordinate efforts across human, animal, and environmental health. WHO works with partner organizations to promote this concept through leadership, strategies, capacity building, and disease monitoring. This approach is increasingly recognized for effectively controlling zoonotic diseases at both national and international levels.

Climate Change and the Epidemiology of Vector-Borne Diseases

Rising global temperatures strongly affect human health, safety, and wellbeing, mainly through environmental changes (McMichae *et al.,* 2008). Climate change increases the frequency of extreme events such as floods, heat waves, and wildfires, which not only cause direct harm but also worsen air quality, spread infectious diseases, and threaten food and water security. Vulnerable groups such as children, older adults, and people of colour are especially at risk of malnutrition and vector-borne illnesses. In the U.S., rising temperatures and unpredictable rainfall patterns disrupt crop yields, leading to poor nutrition and diet-related diseases. Since climate change has multiple interconnected causes, it requires broad, long-term solutions from both governments and private agencies, rather than quick fixes. Linking its impacts with familiar health issues like asthma, allergies, and infections can increase public understanding and encourage community action (Maibach *et al.,* 2010). Overall, climate change is a serious public health threat, and addressing it demands prevention, awareness, and comprehensive strategies.

Human-animal interface

The human-animal interface is a key part of the One Health approach, which promotes collaboration across different sectors to improve health by recognizing the close links between humans, animals, and the environment. It refers to the many ways humans and animals interact, which can lead to the spread of infectious diseases. Through this framework, One Health supports global health security by focusing on prevention, detection, and response to disease outbreaks. This approach involves public health, veterinary, and environmental sectors. Many zoonotic diseases, such as rabies, Ebola, and avian influenza, spread through this interface, and it can also increase risks of chronic diseases in both humans and animals (Rabinowitz *et al.,* 2013). One Health further plays an important role in food and water safety, disease prevention, nutrition, and combating antibiotic resistance. Its successful application at local to global levels depends on effective governance, coordination, and teamwork. Thus, managing the human-animal interface is essential for controlling diseases and protecting public health.

One Health approach

The One Health approach recognizes the strong link between human, animal, and environmental health, aiming to protect both ecosystems and living beings (de Macedo Couto and Brandespim, 2020). Neglected Tropical Diseases (NTDs) are long-lasting illnesses that cause disability and suffering, mostly affecting poor and marginalized populations. WHO identifies more than 20 such diseases, including parasitic, viral, bacterial, and fungal infections, which contribute to high morbidity and mortality but receive limited funding and attention compared to their impact. Zoonotic NTDs are especially difficult to eliminate because animals act as reservoirs for re-infection,

making population-level control the most realistic goal (Casulli, 2021). Addressing NTDs requires moving beyond traditional methods toward cross-disciplinary and multisectoral approaches that consider social, economic, and environmental factors (Laing *et al.,* 2021). Preventing diseases like rabies, guinea worm, and Chagas disease requires collaboration between human and veterinary health, clean water access, hygiene practices, and environmental protection (Peterson *et al.,* 2020). The WHO NTD Road Map emphasizes the importance of One Health in achieving elimination targets by investing in new strategies such as genomic tools, integrated vector control, better disease management, and improved sanitation (Engels and Zhou, 2020).

Nutrition and Food Safety

The concept of "One Medicine," later known as One Health, was introduced by Dr. C. Schwabe in 1964, who highlighted the shared treatment of humans and animals and the importance of clean water, safe food, and sanitation for public health. This idea now guides the development of international food safety standards through the FAO/WHO Codex Alimentarius, promoting cooperation and investment to strengthen food systems. The International Food Safety Authorities Network also provides support during food safety emergencies. Unsafe food is a major health threat, causing over 200 diseases, from mild diarrhoea to fatal cancers, making access to safe and nutritious food essential. Common foodborne pathogens include *Salmonella, Campylobacter, and E. coli,* which infect millions through contaminated meat, eggs, produce, and milk. *Listeria* is especially dangerous for pregnant women, infants, and the elderly, while *Vibrio cholerae* from unsafe water or seafood can cause severe dehydration and death. Viruses such as *Norovirus* and *Hepatitis A,* and prions causing diseases like mad cow disease, also spread through unsafe food. To reduce risks, the WHO promotes the "Five Keys to Safer Food"—keeping food hygienic, separating raw and cooked, thorough cooking, safe storage, and using safe water and raw materials (Garcia *et al.,* 2019). Each year, one in ten people become ill from unsafe food, making it vital for both food workers and consumers to follow safe practices.

Antimicrobial Resistance

Challenges, Surveillance, and Strategic Interventions- Antimicrobial resistance (AMR) is one of the most serious global health threats, affecting humans, animals, plants, and ecosystems. It arises mainly from the overuse and misuse of antimicrobials in medicine, agriculture, and livestock production, and it undermines progress toward the Sustainable Development Goals (SDGs) . Drug-resistant bacteria are spreading worldwide, making some infections untreatable, which proves that single-sector strategies are not enough requiring a One Health approach (Adisasmito *et al.,* 2022). Recognizing this, the UN included AMR in SDG 3: Good health and wellbeing, and in 2015, WHO members adopted the Global Action Plan on AMR, along with the GLASS surveillance system to monitor resistance. India has also launched its National Action Plan to combat AMR. Four major organizations WOAH, FAO, UNEP, and WHO are leading global research and surveillance, focusing on antimicrobial use and resistance across humans, animals, and the environment. Environmental factors like excessive antibiotic use, pesticides, fertilizers, pharmaceutical waste, hospital effluents, and aquaculture further drive resistance. To tackle AMR, more research is needed on how resistant genes spread across species and ecosystems, and how different conditions fuel resistance. With strong global cooperation, the One Health approach offers the most effective way to fight AMR (Taneja and Sharma, 2019; Velazquez-Meza *et al.,* 2022)

The One Health Approach & Importance

Over the last 30 years, most new zoonotic diseases have been found to originate in animals, especially wildlife, and their emergence is largely driven by human activities such as land-use change, agriculture, urbanisation, and global travel. This highlights

the need for a One Health approach, which integrates human, animal, and environmental health to better understand, assess, and control these diseases (Jones *et al.,* 2013).

The term One Health gained prominence during the outbreaks of SARS (2003) and avian influenza H5N1, leading to the Manhattan Principles (2004) that stressed cross-disciplinary collaboration and the inclusion of wildlife health. These outbreaks showed the urgent need for global cooperation, rapid surveillance, and response systems to tackle pandemics (Mackenzie *et al.,* 2014). The concept of One Health dates back over 200 years (Atlas, 2013) and is now widely defined as a collaborative, multisectoral, and transdisciplinary approach for achieving optimal health across people, animals, plants, and the environment. Various organizations (CDC, One Health Commission, One Health Global Network, UC Davis) provide slightly different but similar definitions, all emphasizing interconnectedness.

One Health focuses on major challenges such as:

1. **Emerging and endemic zoonotic diseases** with high impact in developing countries.
2. **Antimicrobial resistance (AMR),** which spreads across humans, animals, and environments.
3. **Food safety** as a global public health issue.

The scope also includes biodiversity, land use, ecology, and social sciences, though engagement from the medical community remains slower than that from veterinarians. Incorporating One Health into medical education is suggested to strengthen involvement (Rabinowitz *et al.,* 2017).

To raise awareness, One Health Day (November 3rd) was established in 2016, promoting global education and student-led projects. today's health issues are complex and cross-species, requiring collaborative and transdisciplinary solutions rather than isolated medical or veterinary approaches. Research published in *Tropical Medicine and Infectious Disease* highlights how One Health provides innovative and effective ways to address global health threats, AMR, and zoonotic diseases (Mackenzie and Jeggo, 2019).

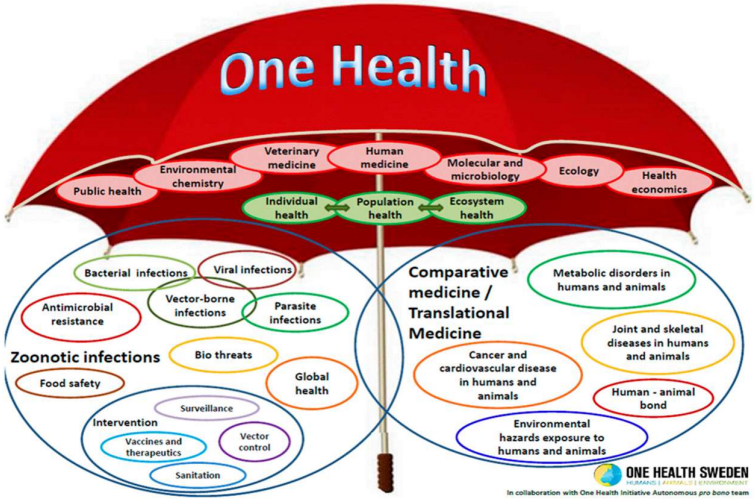

Fig. 1. The One Health Umbrella, developed by One Health Sweden and the One Health Initiative Autonomous pro bono team.

THE COMPONENTS OF 'ONE WORLD – ONE HEALTH' APPROACH

The interaction between humans, animals, and pathogens can be explained through four components: geographical, ecological, human activities, and food-agricultural. The geographical component highlights how global trade of animals and animal products has accelerated the spread of diseases, such as FMD and Rift Valley fever

(RVF). Climate change, especially global warming, is altering ecosystems and shifting the distribution of disease-carrying vectors like those of RVF, dengue, and malaria. Increasing human and animal population densities, along with intensified poultry production in countries like China, have contributed to outbreaks like H5N1. International travel has also facilitated the rapid spread of diseases such as SARS and H1N1 influenza. Vector-borne diseases can cross regions with similar ecological conditions, as seen with bluetongue virus spread in the Mediterranean Basin [Calistri *et al.,* 2004]. To address these risks, organizations like WHO, FAO, and OIE have strengthened collaboration to support capacity building in developing countries. Many governments, fearing pandemics like avian influenza, have stockpiled antiviral drugs, though developing nations face greater challenges from endemic diseases such as HIV/AIDS, tuberculosis, malaria, and diarrhoeal illnesses. Since countries are highly interconnected, efficient traceability systems for animal products and real-time data exchange are essential for disease control. Emerging tools like Infodemiology and Infoveillance use internet-based data for monitoring health-related trends [Eysenbach, 2011]. Similarly, social network analysis of livestock movements helps understand and prevent disease spread effectively [Dube *et al.,* 2009; Natale *et al.,* 2009].

The ecological component highlights how wildlife is often seen as reservoirs of dangerous infections, such as migratory birds spreading HPAI (Shafir *et al.,* 2012) or bush meat contributing to Ebola transmission (Eves *et al.,* 2008; Nkoghe *et al.,* 2011). Pathogens and hosts evolve together, and many diseases can infect multiple species, making them harder to control (Woolhouse *et al.,* 2001). The concept of "reservoirs" is sometimes misused, as not all wild animals sustain infections long-term (Thrusfield, 1995). Humans are often "dead-end" hosts for zoonoses like Rift Valley fever and hydatidosis, where cultural practices can influence disease spread (Macpherson, 1983). Urban and peri-urban environments also play a major role, with poor hygiene and high population density making cities hotspots for water-borne and person-to-person infections.

The human activities component shows that close collaboration between medicine and veterinary science, first promoted through Veterinary Public Health, is vital. In countries like Italy, integrated health services facilitated joint disease prevention after World War II, and similar approaches were later adopted by the EU (Mantovani, 2008). However, gaps remain for instance, the EU still collects human and animal disease data through separate systems (ECDC and EFSA). Since Veterinary Public Health is multidisciplinary, it requires cooperation between veterinarians, physicians, food technologists, and environmental experts. Stronger research networks and effective risk communication with the public are essential for successful prevention and control (Green *et al.,* 1999).

The food-agricultural component emphasizes the *"farm to fork"* approach, where food safety and quality are ensured across the entire production chain, from animal feed to final consumption (Caporale *et al.,* 2001). Producers, retailers, and control authorities share responsibility, with traceability systems and risk assessments playing a key role. Quality goes beyond safety, covering all characteristics that meet consumer needs. Preventive actions must begin early, even with feed, since contamination by toxins like dioxin or mycotoxins has caused health risks (Bernard *et al.,* 2002). However, dividing pre- and post-harvest responsibilities often hinders success, so a multidisciplinary, integrated system is needed for effective food safety and public health.

FUTURE OF ONE HEALTH

The development of One Health faces challenges, including a lack of consensus on its definition (Zinsstag *et al.,*2011) describe it as collaboration between human and

veterinary medicine to improve health and save costs, while the One Health Commission defines it as a global, multidisciplinary effort to optimize health for humans, animals, plants, and the environment. The One Health Initiative emphasizes expanding interdisciplinary communication and research to advance public health, biomedical discoveries, and medical education. However, some physicians resist the term "holistic," and silos in research and practice make cross-sector collaboration difficult. One Health is especially valuable in resource-limited settings, addressing the "triple threat" of infectious diseases that can spread between animals, humans, and the environment. Since over 60% of emerging infectious diseases are zoonotic, with 75% originating from wildlife, a systematic One Health approach is critical for global health, disease prevention, and enhancing public health and medical care (King, 2008; Atlas *et al.,* 2010; Atlas, 2012).

CONCLUSION

The One Health framework provides a comprehensive and collaborative pathway to address complex health challenges that transcend species and environmental boundaries. By linking human, animal, and environmental health, this approach enables early detection, effective control, and sustainable prevention of global threats, ranging from zoonotic outbreaks to antimicrobial resistance. The evidence underscores that siloed, sector-specific strategies are insufficient in the face of rising climate-driven risks, intensifying food insecurity, and the growing burden of infectious and chronic diseases. Despite its clear benefits, barriers such as fragmented governance, inconsistent definitions, and limited medical engagement continue to hinder its full realization. Strengthening interdisciplinary education, enhancing global surveillance, and investing in integrated research are essential to operationalize One Health. Ultimately, its adoption at local, national, and international levels can foster resilience, reduce health inequities, and ensure a safer, healthier future for humans, animals, and the environment alike.

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