Review Article
DOI: https://doi.org/10.62418/ijvph.10.2.2024.1-17

The One Health Approach is Transforming Global Health by Integrating Health with the Ecosystem

Purnendu Ghosh, Samit Kumar Nandi*

Department of Veterinary Surgery & Radiology, West Bengal University of Animal and Fishery Sciences, Kolkata

(Received: 18th August 2024 | Accepted: 29th November 2024)

Abstract

The multidisciplinary One Health approach aims to attain the best possible health outcomes via teamwork by acknowledging the interdependence of environmental, animal, and human health. The importance of this viewpoint has been highlighted by recent global health emergencies, such as the COVID-19 pandemic. Zoonotic diseases, make up a significant percentage of newly discovered infectious diseases that can be transferred from animals to humans. Factors including international trade, climate change, and increasing interactions between humans and animals further exacerbate these health hazards. One Health promotes collaborative efforts from several sectors, such as human health care, animal healthcare, and the environment to create sustainable solutions and interventions that improve all aspects of health. To reduce health risks at the interface of humans, animals, and the environment, the cooperative framework encourages information exchange, surveillance systems, and efficient governance. As the population increases and ecosystems undergo changes, the One Health concept is growing increasingly which is important for preserving food safety, addressing emerging health risks, and promoting environmental conservation. One Health improves public health outcomes and fosters a sustainable future for all living beings by combining efforts from different sectors. This article reviews the origins, significant turning points, difficulties, and potential future directions of the multidisciplinary One Health concept.

Key Words: One Health, Zoonotic Diseases, Interdisciplinary approach, Environmental health, Antimicrobial resistance, Global health security

Introduction:

In our globalized world, we are all interdependent. Hence our health is also interconnected. The animal diseases can affect the health of people and also the diseases of humans can harm animal health. The newly emerging 75% of human diseases are zoonotic. Animals are the source of 60% of infectious diseases that currently exist. (Lee, 2022) . In addition, the health of the environment is also linked to our health in several aspects. The idea of "One Health" has emerged as a crucial paradigm for addressing the connections between environmental, animal, and human health. The evolution of global health problems, such as antibiotic resistance and zoonotic diseases, highlights the vital need for a thorough understanding of these interactions. Since its beginning, the One Health concept has undergone substantial development, going from early observations of disease transmission to a comprehensive, cooperative framework that is essential for tackling issues related to global health. The One Health concept is crucial as the world grows more interconnected and faces new disease outbreaks and environmental problems. By adopting and putting this principle into reality as Figure 1 highlights the intricate connection between the environment and all living organisms, we may create a sustainable future in which the health of humans, animals, and the environment is regarded as crucial components of a larger, interconnected system.

Figure 1: One Health Approach is the Future of Global Health Security (Leonardo.ai)

The environment, animal welfare, and human health are more closely linked than ever in our globalized world. The One Health concept presents itself as a revolutionary paradigm intended to tackle these interrelated health issues comprehensively. This holistic viewpoint acknowledges that every component such as human, animal, and environment has an impact on others and that

controlling and preventing health problems that cross numerous domains requires a concerted effort (Otto et al., 2014).

The earliest research on the links between animal diseases and human health occurred when the concept of One Health first emerged. The complicated interactions that occur between many species were previously highlighted by the emergence of zoonotic diseases, such as rabies and tuberculosis, especially pulmonary tuberculosis and drug-resistant tuberculosis, which may infect humans from animals. The foundation for comprehending these connections was built by scientists such as Louis Pasteur and Robert Koch in the late 19th and early 20th centuries.

The phrase "One Medicine" was first used in a veterinary medical textbook named "Veterinary Medicine and Human Health" in 1964 by public health-trained veterinarian Calvin Schwabe. It was meant to emphasize the links between human and animal medicine and the importance of veterinarians and physicians working together to address global health concerns (Schwabe, 1964). The World Health Organization (WHO), the World Organization for Animal Health (OIE), and the Food and Agriculture Organization (FAO) (Lubroth, 2012) have all approved the One Health concept. This is because the organizations understand that health issues cannot be effectively handled in isolation. Taking this perspective into account, certain areas have been identified to constitute the foundation of the One Health concepts.

The Three Pillars of One Health

Three fundamental pillars depicted in Figure 2, support the One Health approach: environmental health, animal health, and human health (Prata et al., 2022). Since these domains are interrelated, problems in one can have a big effect on the others.

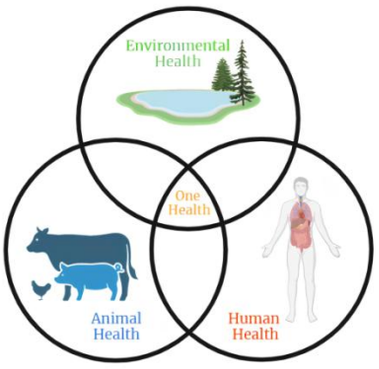

Figure 2: Three Pillars of One-health (the image was prepared using Canva)

1. Human Health

Numerous factors, such as genetics, lifestyle, and environmental exposures have an impact on human health. However, the importance of environmental factors and animal health is sometimes overlooked. Zoonotic diseases, including COVID-19 (Yoo and Yoo, 2020), SARS, and Ebola, have shown how quickly infections can transcend species boundaries and result in serious health emergencies worldwide. A thorough approach that considers interactions with animals and the environment is necessary to comprehend the human health dimension. This includes everything from direct contact with wildlife to the effects of environmental changes on health (Prata et al., 2022; Mishra et al., 2021).

2. Animal Health

One of the most important aspects of the One Health concept is the health of animals including both domestic and wild animals. Zoonotic diseases can be carried by animals, which help in the transmission of pathogens from animals to humans. Furthermore, environmental variables like pollution, climate change, and habitat degradation have a direct effect on animal health. To address animal health, one must keep an eye on and manage diseases that affect companion animals, cattle, and wildlife populations (Mishra et al., 2021). Additionally, one must make sure that veterinary care is incorporated into larger health programs.

3. Environmental Health

Environmental health refers to how the environment, together with other biotic components like vegetation, plankton, algae etc. and abiotic factors like water, air, soil, glaciers, rainfall etc., affect the health of people and animals. Food security, water quality, and disease patterns can all be impacted by problems like pollution, climate change, and deforestation. The management of natural resources and the avoidance of ecosystem damage are also regarded as important aspects of environmental health. Through addressing the environmental issues, the One Health approach seeks to improve general well-being and reduce the probability of disease transmission by generating better habitats for both humans and animals (Mishra et al., 2021).

Many global health issues demonstrate how human, animal, and environmental health are intertwined. For example, the health of humans and animals is seriously threatened by the rise of microorganisms that are resistant to antibiotics. Resistant strains may arise from the excessive use of antibiotics in livestock farming, animal husbandry, and the public health sectors. These strains can subsequently infect humans through food or environmental exposure. To address this problem, different sectors, such as the animal health sector, public

health sector, and environmental sector must work together to develop responsible antibiotic use and put in place efficient infection control strategies. This collaborative approach is required to address numerous environmental problems such as climate change and mitigatetheir detrimental effects on the environment. The effects of climate change on health are another instance. Dengue fever and malaria are two examples of vector-borne diseases transmitted by *Aedes aegypti* (Hussain and Dhiman, 2022) and *Anopheles culicifacies* (Das et al., 2021) respectively, whose distribution might change due to extreme weather events conditions, changing weather patterns, and rising temperature (Rocklöv and Dubrow, 2020). These modifications affect ecosystems and animal populations in addition to human health. Through the integration of climate-environment science with health research and policy, a One Health approach facilitates the understanding and management of these intricate relationships.

Several advantages provided by the One Health concept are essential for tackling today's health issues. Greater efficacy in disease prevention, early diagnosis, and control methods may result from an integrated strategy. For example, a One Health approach made it easier for veterinarians, wildlife experts, and human health officials to work during the West African Ebola outbreak (Sikakulya et al., 2020), as humans, chimps, gorillas, and monkeys are the primary hosts of the Ebola virus. The Pteropodidae family of fruit bats is thought to be a natural reservoir of the Ebola virus. The Ebola virus is thought to use duikers, nonhuman primates, cats, foxes, hogs, antelopes, porcupines, and rodents as intermediate or unintentional hosts. Inter-species immunization may be advantageous to both species (Capps and Lederman, 2015). This concerted effort assisted in identifying the animal reservoirs of the virus and putting preventative measures in place to stop the infection from spreading to people. In a similar vein, the COVID-19 pandemic brought to light how crucial One Health principles are to controlling zoonotic infectious diseases and comprehending their effects on global health (Mishra et al., 2021). Several strategies can be adopted to mitigate the COVID-19 disease. One such strategy is integrating surveillance systems improving monitoring in the environmental, animal, and human domains to identify and track possible epidemics in advance. This involves keeping an eye on human cases of zoonotic diseases as well as monitoring the diseases in livestock and wildlife. Coordinating immunization programs that take into account the health of both humans and animals, such as immunizing livestock and pets to lower the risk of disease transmission is another way to apply the One Health approach to combat COVID-19.

The 'One Health concept' presents a potential framework for addressing health issues, but putting it into practice is not without its share of difficulties. Among the challenges are securing sufficient funding, integrating data from many sources, and coordinating activities across different industries. But these difficulties also offer chances for creativity and cooperation. Technological and data analytics advances, for example, can facilitate the creation of integrated surveillance systems that track health indicators in the environmental, animal, and human domains. Similarly, strategies that facilitate interdisciplinary collaboration and address health determinants can be implemented to increase the effectiveness of the One Health Project. The One Health approach will become more crucial in tackling global health issues as they continue to change. The interconnectedness of health is emphasized, offering a holistic framework for comprehending and handling complicated health challenges. Improving health outcomes and preserving the welfare of people, animals, and the environment will require the ongoing development and improvement of One Health methods, backed by research, cooperation, and legislation.

2. History and Evolution of One Health Concept

Early Observations

One Health's historical roots can be discovered in the late 1800s when important developments in our knowledge of how diseases spread began to take shape. Paul-Louis Simond first connected the dots between animal health and human diseases in 1894, when he discovered a correlation between rat populations and the bubonic plague outbreak in India (Lynteris, 2022). This early discovery paved the way for further research into the connection between human and animal health (Mumford et al., 2023). It quickly became apparent that animals are the source of several major human diseases.

The Advent of Zoonotic Disease Research

Studies that were more methodical and concentrated on zoonotic diseases, diseases that people can contract from animals, started to appear in the early to mid-1900s. The significance of veterinary medicine in public health was acknowledged with the founding of animal health organizations and an expanding corpus of research (Dharmarajan et al., 2022). The World Health Organization (WHO) was established in 1948, which made cooperation between the various health sectors even more important. As per the definition coined by WHO zoonotic diseases are infections that can spread from animals to humans and have a major global influence on food supply and public health. WHO promotes efficient preventive measures like hygienic practices and safe animal husbandry while collaborating with partners to set international standards for pathogen identification and

risk management. The organization places a strong emphasis on the need to overcome antimicrobial resistance, which makes controlling these diseases more difficult because antibiotics are frequently used on food for animals. The World Health Organization uses targeted initiatives and education to successfully minimize the risks associated with zoonoses (Horefti, 2023). In light of zoonotic disease studies, the notion of One Health increasingly took shape.

The Birth of the One Health Concept

The term "zoonosis" was coined by Rudolf Virchow and William Osler, who also promoted veterinary medical education and recognized a connection between human and animal health. In North America, Canadian physician William Osler is considered the founder of veterinary pathology. Osler's interest in the connections between veterinary and human medicine was profound. Dr. Virchow was among the many renowned medical professionals and veterinarians with whom he trained. His initial work, "The Relation of Animals to Man," highlights the connection between the development of diseases in humans and animals (Fasina et al., 2021). The zoonotic disease epidemiology has been greatly advanced by James Steele, who established the Veterinary Public Health Division at the Centers for Disease Control and Prevention (CDC) in 1947. He has significantly contributed to our understanding of the epidemiology of these diseases. A scientist named Calvin Schwabe, who first used the term "one medicine" in 1964, conducted more research to establish the one health concept (Fasina et al., 2021). There has been a considerable desire from other work to be associated with the development of one health concept. Leopold's ideas have played a significant role in shaping the concept of "one health." Aldo Leopold contended that morality has to go beyond humankind and animals, placing a premium on the survival of ecosystems over that of individual members. He made the case that human activity has the same potential to harm ecosystems as disease (van Herten et al., 2019).

After that, The Brundtland Report, formerly titled "Our Common Future," (Burton, 1987) highlighted the connection between health and the environment and the significance of sustainable development in 1987. This extensive study established the notion of sustainability and paved the way for multidisciplinary methods that would help people see health as a shared obligation between people, animals, and the environment.

Recently experts from throughout the world in a variety of professions have adopted a novel approach in this millennium to protect global health. The Wildlife Conservation Society (WCS) convened a conference in September 2004 at Rockefeller University that brought together international health specialists to discuss the potential and existing spread of diseases among domestic animals, wildlife, and human populations. Twelve recommendations are included in The Manhattan Principles, the output of the symposium, for framing a more comprehensive strategy for stopping epidemics and epizootic diseases and preserving ecosystem integrity for the benefit of human beings, their domesticated animals, and the fundamental biodiversity. These Principles call on international leaders, the scientific community, civil society, and the global health community. This symposium strengthened the concept of "One Health" more (Su et al., 2024). Another organization called the Society of Environmental Toxicology and Chemistry (SETAC) is continuously improvising the "One Health" concept. SETAC depends on One Health, and One Health depends on SETAC for optimal efficacy. The chance to protect humans, animals, and plants, against activities that have been introduced in an era marked by infectious diseases, climate change, chemical pollution, and biodiversity losses is provided by SETAC's positive involvement in One Health (Aguirre et al., 2016).

The term "One Health"

The term “One Health” became popular in the early 2000s, particularly in public health and veterinary care. New zoonotic infections like the West Nile Virus (1999) and the Severe Acute Respiratory Syndrome (SARS) in 2002–2003 brought attention to the connection between animal and human health (Loeb, 2009). A symposium held in 2004 by the Centers for Disease Control and Prevention (CDC) and the American Veterinary Medical Association (AVMA) helped popularize the term “One Health” (Hristovski et al., 2010). To effectively prevent disease and promote health, stakeholders from a variety of disciplines needed to work together and share knowledge, and this event marked a turning point in that regard.

The Initiative for One Health

As a cooperative endeavor including experts from human medicine, veterinary medicine, and environmental sciences, the One Health Initiative was founded in 2008. In 2007, Roger K. Mahr of the American Veterinary Medical Association, Jay H. Glasser of the American Public Health Association, and Ronald M. Davis of the American Medical Association joined together to establish a task force and scheduled a teleconference to address One Health. Additionally, they acted as an interface of contact for scholars, students, government workers, industry experts, and other health science professionals. (Bas, 2024). The objective of this endeavor was to foster the integration of different interrelated sectors and to advance the idea of One Health on a worldwide scale. The One Health Commission was established in 2009 to organize, create, and carry out One

Health outreach and education, thus strengthening the cause. To promote research and improve cooperation, the Commission also assembled a wide range of partners, including educational institutions, governmental bodies, and nonprofit groups.

Agenda for Global Health Security

The One Health strategy became increasingly important as a component of global health security policies as risks to global health increased. To properly prepare for and respond to pandemics and outbreaks, cross-sectoral collaboration is crucial, as highlighted by the Global Health Security Agenda (GHSA) (Katz et al., 2014) which was introduced in 2014. The Global Health Security Agenda (GHSA) seeks to improve the capacities of nations to stop, identify, and address risks from infectious diseases to promote global health security. Its main goals are to promote international cooperation while enhancing emergency response systems, diagnostic capabilities, and surveillance. The GHSA places a strong emphasis on developing robust health systems and organizing initiatives to successfully manage and contain outbreaks. One such outbreak that the entire world faced recently is the COVID-19 pandemic.

The COVID-19 Pandemic Response

The COVID-19 epidemic highlighted the One Health framework's global significance and urgency. With the global community struggling to contain cross-species zoonotic viruses, interdisciplinary cooperation and proactive surveillance strategies were more important than ever. As a result, many governments and health organizations across the globe started stepping up their One Health initiatives, realizing that solving health issues necessitates a thorough comprehension of the relationships between people, animals, and the environment (Mishra et al., 2021).

3. Key Features of One Health

One health strategy is a quite new idea in combating the enemies of human beings, animals, and the environment. An environment that promotes health is necessary for one to be healthy. In addition to many other advantages, a well-balanced, well-organized, and healthy environment helps prevent disease, provides food security and safety, generates wealth for the community, and provides protection against natural calamities. One Health adds to the security of global health by tackling health issues all at once. It supports the detection and mitigation of possible health hazards and thus shouts for global health security. The One Health concept recognizes the influence of social determinants of health-on-health outcomes, including socioeconomic status and community practices. It promotes just solutions that are advantageous to a range of people (Kayunze et al., 2012). If this concept is effectively put into practice, it may prevent the emergence of new diseases, stop the spread of pandemics, and protect the environment. The three pillars are kept safe by the one health concept in several ways; however, certain key aspects are covered here.

Health Interconnectedness

"One Health" highlights how environmental, animal, and human health are intertwined and that successful initiatives necessitate collaboration across several areas (Abbaspour and Sorooshian, 2024). To address health challenges across many professions, it places a strong emphasis on teamwork as well as enhanced risk assessment, surveillance, and interdisciplinary response. It is often seen that adjustments or crises in one sector can affect others (Pitt and Gunn, 2024). Even though the integrated health strategy covers numerous sectors the primary concern of this integrated health concept is disease prevention, which is consistently emphasized by the approach.

Prevention of Diseases and its Transmission

We are all aware of the phrase "prevention is better than cure." Under the One Health approach, illness and disease prevention are given more importance than only treating medical emergencies. It encourages preventative measures including better planning, surveillance, and education to decrease potential threats (Robbiati et al., 2023). In addition to the risks associated with animal-to-human transmission, there are also risks associated with reverse transmission. An outbreak in the Republic of Congo in 2010 was attributed, according to one study, to wild poliovirus type 1 (WPV-1), an enterovirus of the Picornaviridae family that causes paralysis in humans. The same virus was observed to have infected a chimpanzee after a month of this occurrence (Mombo et al., 2015) in a conservation center. Strategies were taken to restrict the spread of diseases from humans to non-human primates in their natural environments. The wildlife biologists and infected persons of the center who were found to be infected were isolated first and then treated properly. These strategies have been developed to reduce this form of disease transmission (Wallis and Rick Lee, 1999). Another disease called Toxoplasmosis, caused by *Toxoplasma gondii*, is an intracellular protozoan infection distributed worldwide and becoming a global threat (Aguirre et al., 2019). It transmits to humans from cats which are often asymptomatic. Sometimes domestic dogs act as a career of the parasite. Continuous monitoring of domestic animals and treating them properly can prevent the transmission of the disease. *Toxoplasma gondii* is a parasite that requires multiple hosts to complete its life cycle. Rat is one of its hosts. The chain of its life cycle can be broken down by eliminating house rats by adopting proper pest control.

Thus, the transmission can be prevented. In addition, vaccination is another way to prevent disease transmission. Immunization against infections can be induced by vaccinations. Vaccines protect not only vaccinated individuals but also the community by producing "herd immunity," which occurs when a large number of people become immune to a specific virus. Mass vaccination reduces unvaccinated people's exposure to pathogens and breaks or shortens the chain of disease transmission. Many vaccines such as vaccines against West Nile virus, rabies virus, Japanese encephalitis, *Bacillus anthracis*, Avian influenza, Hepatitis E, *Toxoplasma*, etc. have been developed for animals, humans, or both which can prevent disease transmission from animals to humans and vice-versa (Monath, 2013). To stop the disease from spreading, vaccination against coronaviruses is found to be crucial for domestic animals according to a report (Tizard, 2020). The availability of proper diagnostic tools and techniques can also be helpful for disease prevention in both animals and humans. Moreover, many diseases are becoming more common at the moment due to climate change and global warming. Epidemiological outbreaks can be prevented by addressing these two key issues. Hence preference should be given to environmental health as a measure of disease prevention to get a better healthier life for all.

Prioritizing Environmental Health

One Health draws attention to the connection between environmental factors such as pollution, climate change, habitat destruction, and health problems. For health treatments to be generally effective, these environmental health issues must be addressed (Ogunseitan, 2022). For instance, deforestation reduces biodiversity and threatens the extinction of species by destroying habitats. Numerous species shift from their native environments to unfamiliar ones as a result of deforestation, which is linked to the spread of diseases among people. Three distinct species of bats – *Hypsignathus monstrosus*, *Myonycteris torquate* and *Epomops franqueti* have been identified as Ebola Virus Disease (EVD) reservoirs. Deforestation has been associated with a higher likelihood of EVD outbreaks because it disrupts the natural habitats of those bat species, causing them to migrate into places they had not previously visited and increasing human contact with these zoonotic viruses (Olivero et al., 2017). Deterioration of the ecosystem through deforestation may have an impact on the services provided by the environment, such as pest control, pollination, food chain balance, etc. Pollinators play crucial roles in maintaining forest ecosystems as well as crop production. Habitat loss leads to interspecific competition for space, food, and other resources which in turn may eradicate pollinators. According to one study, it was found that deforestation can influence and shift the functional composition of pollinator communities. The study was conducted on *Heliconia tortuosa*, a tropical herb pollinated by species such as *Campylopterus hemileucurus*, *Phaethornis guy*, and *Phaethornis longirostris* which are hummingbirds (Torres-Vanegas et al., 2021). The harmful effects on pollinators can significantly reduce global food production and resource allocation for both humans and animals. The incidences of pest attacks on crops are increasing due to the habitat loss for those pest species.

In addition to destroying habitats, deforestation has numerous other negative effects on the environment's health. A larger amount of greenhouse gas emissions due to various industrial and anthropogenic activities are continuously increasing the average temperature of the atmosphere. The forests around the world are getting smaller as a result of cutting down excessive trees, which makes it difficult to filter greenhouse gases and increases their negative effects on the ecosystem which leads to climate change, especially global warming. These ever-changing climatic conditions are associated with human health, including the spread of vector-borne diseases (Purse et al., 2023) and diseases triggered by excessive heat. It was found that when incubation temperatures rose to 34°C, the development rates of juvenile *Aedes aegypti* normally increased. 90% of organisms survived through all stages of growth at a maximal temperature of 27°C, whereas lower temperatures are particularly harmful to life. Additionally, it was noted that the development rates of *Aedes aegypti* eggs, larvae, and pupae increased at higher incubation temperatures and stopped at lower temperatures (Morin et al., 2013). Thus, increasing temperature may raise the risk of the development of vector-borne diseases. Another study has reported that due to the rise in global sea surface temperature *Vibrio*-related infections are becoming so common in humans and aquatic animals (Vezzulli et al., 2015). The elevated temperature is not only responsible for developing infectious diseases but it also increases the risk of introducing noncommunicable health issues in both animals and humans. Animals exposed to high temperatures in the environment typically produce reactive oxygen species (ROS) unintentionally, which leads to an increase in the oxidation of lipids, proteins, and nucleic acids by ROS. Oxidative stress (OS) is a situation caused by an increase in biomolecule oxidation. Animals with increased temperatures experience abnormalities in their physiology due to an increase in OS condition (Paital et al., 2016). Another study reported that elevated atmospheric temperature is directly related to cardiovascular diseases in humans (Khraishah et al., 2022). Climate change often causes heavy and untimely rainfall. For instance, high rainfall circumstances are directly linked to Rift Valley fever (RVF), a mosquito-borne zoonotic viral disease that is spreading throughout

Africa and the Middle East, affecting both humans and livestock (Linthicum et al., 2016).

Deforestation can cause fertility issues and soil erosion, which can lower agricultural output and result in food insecurity, which is dangerous for public health. When forests are lost, rainfall patterns and water availability are changed. This can result in droughts or flooding. Both these conditions significantly lower the food production destroying the crops which have badly impacted on animal and human populations. Additionally, this condition lowers the amount of food available for wildlife. Wild animals suffer from habitat loss and food scarcity as a result of deforestation, which causes conflict between humans and wildlife (Mekonen, 2020). The impact of this battle on animal and human life is profound. Conflicts between humans and wild animals frequently result in crop destruction (Ogra, 2008), which has a detrimental impact on food production. Loss of forest area raises the possibility of contracting zoonotic infections (Morand and Lajaunie, 2021) that can spread from animals to humans.

On the other hand, afforestation increases forest cover, recreating habitats for various species. This promotes biodiversity, which is essential to the health of ecosystems and the services they offer, such as pest control and pollination. To slow down climate change, trees take up carbon dioxide from the atmosphere. Biologically sound ecosystems control the temperature, which is critical to both animal and human health. One study revealed that rising global temperature due to deforestation is promoting vector-borne diseases like viral, bacterial, and parasitic diseases (Ortiz et al., 2022). On the other hand, a vital part of the water cycle is played by forests. Cleaner water sources for people and wildlife are the result of their ability to filter pollutants, lessen soil erosion, and maintain the health of watersheds. Reforestation improves soil fertility and structure, which increases agricultural output and lessens the demand for chemical fertilizers, which are hazardous to the environment and public health. By offering leisure activities and lowering stress, green spaces improve human well-being and can improve overall health results.

A healthy ecology is necessary for good health. Environmental manipulation creates several circumstances that are harmful to human and animal health. As a consequence of changes in environmental health, the *Borrelia burgdorferi* bacteria is the primary cause of Lyme disease, an infectious disease that usually occurs in humans from the bite of an infected black-legged tick, sometimes referred to as a deer tick. Tick populations and their habitats are impacted by changes in land use, urbanization, and climate change, which impacts the dynamics of transmission (Simon et al., 2014). To implement effective preventative and control measures, it is essential to comprehend the ecology of tick reservoirs and their interactions with human populations.

In this regard, a healthy environment is important for the good health of both animals and humans. By providing conservation and protection to our environment, one health can be ensured. By supporting actions that preserve ecosystem health, which in turn supports the health of people and animals, One Health fosters sustainable development.

4. Current Status of One Health

A primary goal of every living being is to accumulate food to survive and continue existing. Ever since humans began cultivating to produce food, nature has been altered. Agriculture is a century-old activity, but food production techniques have advanced significantly in recent years there with increased use of pesticides, herbicides, and fertilizers. Fertilizers contain those elements or compounds that are necessary for the growth of plants. Numerous studies have shown that while certain metals, such as copper, iron, zinc, and others, are necessary for plant growth, their high quantities can cause plant toxicity and put people at risk for disease development (Brevik et al., 2020). Elevated levels of heavy metals in the body can impact multiple organ systems, such as the brain, kidneys, liver, blood, and lungs. Long-term exposure to heavy metals, even at low concentrations, increases the chance of developing cancer and neurological diseases including Parkinson's and Alzheimer's diseases (Järup, 2003). In addition, the use of pesticides releases organic contaminants into the environment. These organic contaminants can cause various diseases. An American study found a strong positive correlation between early menopause and the level of organic contaminants in urine (Grindler et al., 2015). The excessive and uncontrolled use of pesticides, fertilizers, and synthetic foods has resulted in environmental toxicity that has directly affected several ecosystems. They are connected to the loss of biodiversity and the extinction of many species, resulting in a precipitous drop in pollinators, natural enemies of pests, biologically significant and medicinally important organisms, and others. Practices aimed at boosting agricultural productivity are destroying the food production chain. A global food emergency will occur in the coming decades (Mojeed et al., 2024).

Furthermore, many human activities constantly disrupt nature and natural processes. Many pathogens are becoming resistant as a result of the overuse of medications. Drug-resistant diseases were expected to account for 4.95 million deaths annually, while bacterial pathogens resistant to existing antibiotics were expected to cause 1.27 million deaths (Okeke et al., 2024).

Antibiotic-resistant microbes are expected to cause over 10 million deaths by 2050 worldwide (Ahmed et al., 2024). Already, more than one million people died from this exact reason in this decade. On the other hand, the risk of landslides is increased by excessive and unorganized mining practices. Over-tourism ultimately destroys authentic natural ascents because it causes deforestation and landscape devastation in the name of ecotourism. All of these are identified as current links for ecosystems and health, as all living species' health is tied to their environment.

Everything that harms the environment has a direct or indirect connection to health risks. Therefore, we have to pay careful and conscious attention to ensure that any inventions or actions we do for the advancement of civilization do not hurt the environment. As of right now, it is understood how critical it is to protect the health of people and animals by maintaining a beautiful, healthy, and pollution-free environment. A healthy environment is necessary for good health.

5. Challenges in Implementing One Health

The One Health strategy provides a viable framework for tackling intricate health issues across the environmental, animal, and human realms. However, there are many obstacles in the way of its implementation, necessitating thoughtful attention and calculated action.

Health and diseases have an inverse relationship with one another. Human and animal health, as well as population and environmental health, are all included in this context of health. These areas are all connected, and one parameter influences the others. The investigation of disease causation, epidemiology, and control is the main goal of the One Health approach. A single health strategy encompasses all aspects of the development and course of a disease, as well as its etiology, epidemiology, control, and prevention. Finding the cause of a disease and all of its contributing variables is often challenging. However, to prevent and treat a specific health problem, all of its contributing components must be identified about the health of the population, animals, and environment. It has been found that the preferred drug for treating malaria is quinine. Primaquine and chloroquine are effective treatments for *Plasmodium vivax* malaria as well as all other forms of malaria. On the other hand, falciparum malaria resistant to chloroquine is treated with sulfadoxine-pyrimethamine in a single dosage (Ashley and Phyo, 2018). This protozoal disease can be managed and cured with drugs. However, *Anopheles* mosquitoes are the vector of the disease. Treating the patient alone will not be enough to combat malaria. Controlling the mosquito population is crucial to limiting the spread of the disease, and this can be done by studying the life cycle of the mosquito. It is the job of a biologist. To manage the mosquito population, it must be understood the ideal ecological circumstances for mosquito reproduction. Eliminating clear, stagnant water is linked to a decrease in mosquito breeding sites, allowing for the control of the mosquito population. Developing targeted drugs is not the only approach to combat the disease. The disease epidemic will not be stopped until biologists, ecologists, pharmacologists, biomedical scientists, and epidemiologists work together on drug development, behavioral study, ecological research, vector biology, and epidemiological research. Integrating all aspects of a disease from its emergence to development, spread, severity, epidemiology, and etiology for combating and preventing the disease is a challenging task and often it is so laborious, time-consuming, and expensive. Several factors and all the above-mentioned aspects behind many diseases are still unclear. There are other diseases, like influenza, that are distinct due to the variety of host species they affect (Short et al., 2015). These viruses are some of the most difficult viruses that can harm the health of humans and animals. Different species have varying rates of disease onset. Diverse hosts experience diverse viral expressions. Furthermore, they are remarkable in their ability to adapt and evolve within their hosts. Comprehending the various interactions that viruses conduct with their hosts can be challenging. Multi-secretor research is required to address this kind of health issue. The strategy necessitates the combination of several disciplines, including public health, environmental science, veterinary medicine, and medicine. Encouraging successful interdisciplinary collaboration is one of the main obstacles to achieving One Health. The absence of connection among autonomous government agencies, research centers, and non-governmental groups may result in inconsistent responses to health concerns because of irregular departmental communication.

Another challenge often One Health approach faces is the integration of data from several areas. One Health must be implemented effectively. Data compatibility is a major concern. It can be challenging to combine and evaluate data from environmental monitoring systems, veterinary records, and human health databases as they sometimes exist in different formats. All of the data generated by the sectors supporting One Health must be stored and organized coherently. Due to the lack of a specialized system for data collection and storage, a lot of data gets lost. A common database is needed to aggregate the data generated by different sectors. Additionally, specific data analysis techniques like algorithms and statistical tools are required to help anticipate control actions for diseases or epidemics in advance. In addition to generating analytical tools, building, maintaining, and utilizing a thorough and well-organized multi-sectoral database is a significant and challenging task.

An additional obstacle is combating zoonotic disease. One of the biggest challenges in the fight against many zoonoses is the difficulty, cost, and requirement for high-quality, consistent medical care for both animal and human cases. While the need for improvements in diagnostics and healthcare is urgent. Early detection of diseases helps to stop epidemiological outbreaks by providing plenty of time to plan and formulate strategies to fight against disease. It was reported that in the Netherlands, an outbreak detection mechanism was put in place to stop a potential Legionnaires' disease (LD) outbreak at its earliest stages. Targeting control measures was made easier by quick genotyping, sampling, and cluster detection. Two minor outbreaks were simply stopped once the water system was renewed (Den Boer et al., 2007). Another study revealed that Hepatitis A was reported in September 2012 in the northeastern part of Thailand. The outbreak of the hepatitis A virus (HAV) has been controlled through a gradual decrease in the number of infected patients, as a result of health education, cleanliness campaigns, fast and early detection of the virus using anti-hepatitis A virus (HAV) IgM, and/or HAV-RNA based assay, and voluntary vaccination (Poovorawan et al., 2013). Early disease detection necessitates well-equipped laboratories, knowledgeable and qualified workers, and continuous monitoring. These demand a significant financial commitment and enormous funding.

The funds can be provided by State initiatives. Personal investment is perhaps an impossible task. Governments of various nations and multinational initiatives cooperation are the way to generate more funds to make the One Health concept strong.

It is also recommended that the Govt. should ensure a handsome per capita income for all of its citizens so that people can avail all the benefits to live a healthy lifestyle and take personal initiatives to protect surrounding animal health as we as the environment. Without food, shelter, clothing, and all the basic needs expecting social duties from an individual to protect human health, animal health, and our environment is a rubbish idea. For instance, a study on a woman's experiences getting fever treatment in a poor urban community in Tanzania brought to light the feeling of powerlessness these women had when negotiating the healthcare system, she said;

"I have a fear of the payment, and not of the sickness. Treatment exists, a good treatment that will cure quickly, but you worry you will not be able to find the money in time because a fever does not wait for you. You worry if you will be able to find the money to get treatment before the patient dies (Laurie, 2014)".

In addition to government activities, community, and environmental health depend heavily on public awareness. One potential remedy is community education. Community education can foster the development of new health-maintaining behaviors and cultures among people, which will ultimately reinforce the One Health idea. Antibiotic-resistant microbial strains are becoming a growing risk to public health in India due to the overuse of antibiotics in animal husbandry, veterinary medicine, and human health. The majority of the time, consumers use antibiotics without having the appropriate medical understanding and their uses and without authorized prescriptions. There are no such sales restrictions in our society. Many medical practitioners prescribe antibiotics excessively, and their uses and sales are frequently considered from a profit-making perspective, ignoring the potential future threats. This behavior needs to be stopped immediately, and community-wide public awareness is necessary.

So, in brief, the key challenges are veterinary manpower shortage along with the shortage of manpower in public health sectors, lack of information sharing between human and animal health institutions, and inadequate coordination on food safety such as processing, distribution, and retail facilities.

Realizing the full potential of One Health requires removing obstacles to public awareness, monitoring, policy formulation, data integration, coordination, resource allocation, and cultural considerations. Through joint endeavors, inventive resolutions, and unwavering dedication, concerned parties might strive towards a more comprehensive and efficient strategy for worldwide health.

Figure 3: The best way to protect Global Health, the picture is adopted from CDC

6. Strategies to Overcome Challenges

The One Health approach provides a comprehensive framework for addressing complicated health issues by integrating the health of humans, animals, and the environment. Figure 3 is a useful approach that the CDC has presented to protect global health. However, as discussed earlier, there are several obstacles to overcome to put this strategy into practice, such as discrepancies in resources, coordination problems, and data integration

problems. Customized strategies are required to overcome these challenges.

Strategy to understand a disease

The world is home to various types of diseases. Some are infectious, some are hereditary, and others arise from lifestyle preferences. For example, malaria, dengue, influenza, typhoid, COVID-19, filariasis, ascariasis, chlamydia, and trichomoniasis are all infectious diseases. On the other hand, diseases like thalassemia, color blindness, muscular dystrophy, myopia, and Down syndrome are hereditary. Additionally, obesity, diabetes, hypertension, depression, and anxiety are some examples of lifestyle-associated diseases. There are also autoimmune diseases, such as rheumatoid arthritis, and some diseases like cancer and others are quite concerning. Among all these diseases, infectious diseases are particularly terrifying. They are alarming because they are caused by pathogens that can spread rapidly from one host species to another. These diseases frequently reach epidemic levels, endangering the lives of a large part of the population. For example, the mortality rate since 2002 was found to be 52% for ebola in Europe (Granata et al., 2024). The transmission of these pathogens must be stopped rapidly as soon as they are detected otherwise a large number of people will be affected by the disease within a short period. To restrict disease transmission the associated factors, need to be pointed out. Sometimes, these pathogens reside in a specific organism known scientifically as a reservoir host. From this reservoir, they can spread to one or more communities and cause diseases, which is referred to as zoonosis. Currently, zoonosis is a major threat, necessitating special measures to combat it. Drug discovery for rapid treatment of diseases is essential. This requires understanding the biology of pathogens, and collaborative efforts and joint research among parasitologists, microbiologists, and pharmacologists are crucial for developing effective treatments.

It is often observed that these pathogens spread through vectors. Therefore, the development of drugs for the disease is not a complete solution. In today's era of the One Health concept, understanding the biology of vectors is particularly important for controlling the spread of diseases. Additionally, it is necessary to know what types of environments these vectors and pathogens prefer for growth, including temperature, pH, humidity, and other environmental factors. This type of research necessitates collaborative studies between biologists and environmental scientists. To confront any disease, it is essential to understand all these factors, as only then can we effectively target the disease. Thus, to fully comprehend a disease, it is vital to study all these aspects together under one roof, involving experts from various fields in combined research. This approach significantly increases the likelihood of achieving effective results in a shorter time. In this regard Department of Animal Husbandry and Dairying (DAHD) has been launching several schemes to mitigate the prevalence of animal disease since 2015 and soon will establish a One Health unit. Moreover, such collaborative researches generate vast amounts of data, which can be integrated to play an important role in disease control.

Strategy for the development of a common database

Collecting all the data arising from collaborative research is not an easy task; it is extremely challenging. To preserve this vast amount of information, a specialized database is necessary. This database must be a common one, allowing for the easy storage of disease-related research data from various fields and enabling unrestricted access to this information as needed. The National Animal Disease Reporting System (NADRS), the National Animal Disease Referral Expert System (NADRES) for animals under the Department of Animal Husbandry & Dairying (DAHD), and the Integrated Disease Surveillance Programme (IDSP) for humans under the Ministry of Health and Family Welfare (MoHFW) are examples of initiatives in India that have been launched to develop databases in this regard. In Gujarat, a One Health Surveillance (OHS) system is about to commence on a mission to provide early warning and response for newly emerging and reemerging zoonoses like the Global Early Warning and Response System for Animal Diseases including Zoonoses (GLEWS) (Yasobant et al., 2023). Additionally, suitable methods or tools for analyzing this data are required.

Another significant advantage of this database is that by using bioinformatics tools, we can easily predict whether a disease is likely to take on epidemic proportions in the future, identify regions where the disease is more prevalent, and determine where it might spread shortly. We can also explore potential treatments for the disease and assess whether mutations in the pathogen could lead to the emergence of new diseases. Bioinformatics can even help identify potential resistance to the disease.

Furthermore, bioinformatics can analyze all this data rapidly, allowing for the processing of a large volume of information in a shorter time, which reduces costs for making various predictions about the disease. Therefore, creating, maintaining, and improving a common database is an extremely important strategy within the One Health approach.

The strategy of developing early diagnosis systems to detect zoonosis and prevent the outbreak

Using bioinformatics, we can make many predictions about diseases in a shorter time and at a lower cost. These predictions are quite helpful in guiding future directions.

However, it is not possible to make significant health decisions or treat diseases solely based on predictions. This is only achievable when predictions made using bioinformatics are validated through laboratory tests.

Establishing good health and determining effective disease control strategies often depend on early disease diagnosis and identifying zoonosis. Early diagnosis has the potential to prevent epidemics. For this, advanced and high-quality laboratories and groundbreaking research are essential.

Strategy to combat antibiotic resistance

Currently, antibiotic resistance in disease prevention is particularly important. Many bacterial infections are becoming difficult to treat due to antibiotic resistance. Sometimes, diseases caused by these resistant bacteria even result in death. Today, antibiotic resistance is creating a new epidemic. Therefore, in addition to early disease diagnosis, there is a need for extensive, advanced, and world-class research to find alternative methods to combat antibiotic-resistant bacteria.

Strategy for fund allocation

Any world-class research, whether for early disease diagnosis or for combating antibiotic-resistant bacteria, requires substantial funding in every field. Therefore, continuous research necessitates dedicated research funding. Establishing special funds for such research is one of the key strategies of the One Health approach. Like many other countries taking initiatives in this regard has already been started in India. Funds were sanctioned in 1980, by the National Standing Committee on Zoonosis for setting up a Centre for One Health at Nagpur. It is essential for the government and intergovernmental organizations to jointly increase the approval and allocation of resources for these types of research projects. In addition, more strategies are needed to enrich the One Health vision. These include:

Establish suitable risk management policies based on research, capacity building for qualified staff members, certified diagnostic centers for public health and veterinary medicine with a common database, enhanced execution, and utilization of currently available natural resources.

7. Future Directions and Opportunities

According to the 2004 Manhattan Principle, "It is clear that no one discipline or sector of society possesses sufficient knowledge and resources to prevent the emergence or resurgence of diseases in today's globalized world." The trends of habitat loss and extinction, which threaten the health of people and animals, cannot be stopped by a single nation. The only way we may unleash the innovation and understanding needed to address all the serious issues affecting the well-being of people, domestic animals, wildlife, and the integrity of ecosystems is by tearing down barriers across organizations, disciplines, individuals, specializations, and sectors."

Figure 4: Different strategies to overcome the challenges in implementing the One Health Approach (Leonardo.ai)

To effectively address complex health concerns, the One Health approach which acknowledges the interdependence of human, animal, and environmental health has become more and more important as shown in Figure 4. The One Health framework presents many potentials to improve global health, control new dangers, and develop long-term solutions as we look to the future.

The aspiration to solve contemporary problems determines what methods will be adopted in the future to address these difficulties. In other words, the direction for the future is set by looking at the problems of the present. As it is, the One Health idea needs several long-term strategies and regulations to address numerous issues. Determining the future course of One Health research is essential for applying the concept to put policies in place that deal with such concerns. Therefore, several very important aspects regarding the future direction of One Health research are discussed here.

The Use of Bioinformatics

In the battle against zoonoses, One Health is vital. As previously mentioned, coordinated research involving specialists from diverse domains is vital to reduce the spread and effect of zoonoses. It has also been discussed that the enormous amount of data produced by this collaboration needs to be stored in a common shared database. But is information storage the only use for this database? This database is capable of much more than merely storing data. For instance, we can predict whether a disease will spread to epidemic proportions by employing bioinformatics techniques to examine the data kept in this database. We are therefore able to adopt various precautions and necessary measures in advance. The bioinformatics tool Nextstrain, for example, consists of viral genome databases and interactive visualization

platforms and helps to identify the evolution and transmission of different viral diseases (Hadfield et al., 2018). Predicting disease outbreaks, like the West African ebola pandemic, has also been made easier by mathematical modeling (Chretien et al., 2015). We are currently in the early stages of developing bioinformatics methods to forecast these kinds of outbreaks. In this regard, future research should concentrate on developing more sophisticated bioinformatics techniques for epidemic prediction.

Additionally, data analysis and the application of bioinformatics technologies can be used to predict whether a medicine will be effective against a harmful microbe. Enough research has already been done in this field to find novel drugs to treat diseases and also many researches are going on. Research has been conducted using molecular docking and molecular dynamic simulation to develop drugs that prevent *Babesia microti* and the monkeypox virus (Akash et al., 2023). It was also reported that by using molecular docking technologies, new drug-like compounds were found to fight against the Nipah virus (Naeem et al., 2023). Additionally, gene sequences of pathogens can be analyzed using bioinformatics techniques to search for mutations. This can assist in anticipating the emergence of new diseases brought on by these mutated pathogens. In this context, one report stated that whole genome sequencing and bioinformatics analysis were used to identify the salmonellosis outbreak (Taylor et al., 2015). In Germany generation sequencing was proven helpful in predicting a Shiga toxin-producing *Escherichia coli* outbreak (Mellmann et al., 2011).

Food safety is the next issue to be addressed. Using a One Health approach, efficient steps must be put in place to guarantee food safety at all levels, down to the areas. In some cases, it's necessary to build publicly available databases where people may find a variety of One Health-related information. For example, the public could be informed by a food safety database as to whether the animal they plan to eat is diseased, if it has been vaccinated, and if so, which immunizations it has received. In addition, animals utilized as food must be given unique codes that allow different information to be retrieved from the databases. These kinds of databases will be especially helpful for animals that are connected to slaughterhouses. Other animal husbandry sectors, including dairy, apiculture, aquaculture, sericulture, and poultry, also require similar databases. A steady stream of data must be added to the information repository to maintain its richness. As a result, to coordinate the numerous data sets acquired from diverse sectors, a specialized team of researchers is required. In addition, it takes ongoing observation, investigation, and approval of numerous associated programs to guarantee a consistent flow of information. To reinforce the One Health concept, additional studies in several different fields must be done in addition to data-related research. One such domain is antibiotic resistance.

Alternative Antibiotic-Free Treatment

The worldwide health situation is becoming worse due to the rise of several germs that are resistant to antibiotics. Antibiotic-resistant bacteria are continuously being produced by the excessive, uncontrolled, and arbitrary applications of antibiotics in both human and veterinary medicine. The detrimental effects of which are already being felt. Reducing the indiscriminate use of antibiotics and simultaneously looking for other treatments is one strategy for combating this problem. Antibiotics can be substituted with probiotics. By actively competing with other harmful bacteria, these probiotics drastically lower their population and lessen the severity of diseases. Furthermore, these probiotics occasionally secrete different antimicrobial substances that eradicate additional dangerous microorganisms. Numerous alternative techniques can lessen the negative effects of antibiotics besides using bacteria to eradicate other bacteria, such as controlling bacteria with bacteriophage viruses. Furthermore, different kinds of antimicrobial peptides are secreted by different animals. These peptides have the potential to replace antibiotics in some situations. Not all infections in humans and animals are caused by bacteria. However, one of the main factors contributing to the development of diseases that have the potential to spread globally is viruses. In contrast to antiviral therapies, vaccinations are the recommended course of treatment for viral diseases. Nevertheless, vaccinations can also be used to effectively treat some bacterial diseases. To anticipate and understand the evolution and emergence of antimicrobial-resistant strains and to give appropriate therapy, the Center for Genomic Epidemiology (CGE-tools) was established. One such tool is Res Finder (Florensa et al., 2022).

Vaccination

Every year, vaccines avert almost 2.5 million deaths (Olshansky and Hayflick, 2017). Currently, 26 infectious diseases have vaccinations available internationally (Excler et al., 2021). Smallpox was declared extinct in the globe in the 1970s as a result of concerted vaccination campaigns led by The World Health Organization, following roughly 400 million deaths from the disease in the 20th century. Vaccines shield the community as well as those who receive them. Through a mechanism known as "herd immunity," this is characterized by the presence of many people immunized against a particular pathogen. Widespread immunization lowers the exposure of non-vaccinated persons to pathogens and stops or slows the chain of disease transmission.

The effectiveness of One Health depends on the immunization being administered to a variety of animals in addition to humans. As previously said, there are still a lot of diseases for which vaccines are needed. Therefore, to rapidly develop vaccines for many types of infectious diseases, more funds and research are required. This funding is essential not only for vaccine research but also for diagnostic research. Promoting diagnostic research is essential because the early detection of diseases enables early planning, which can stop many epidemics. This means that additional labs are needed to diagnose diseases in livestock, wildlife, and animal husbandry in addition to human diseases. Alongside research for disease diagnosis and vaccine development, specific research is also needed for vector control. Worldwide, diseases transmitted by vectors caused many deaths and also killed a lot of animals.

Vector Control, Urban Planning, Infectious Disease Surveillance, and Hygienic Health Practices

Unplanned urbanization and vector-borne diseases are correlated. Pollution is produced by unplanned urbanization. The problem of stagnant water is common in unplanned cities and suburbs. Inadequate drainage infrastructure contributes to the amount of standing water in cities, providing mosquitoes with a breeding environment. The lack of a proper waste disposal system and accumulation of wastes attracts flies which are home to a variety of disease-causing organisms. Thus, planned urbanization, appropriate waste disposal mechanisms, and cleanliness are necessary for effective vector control. Keeping surroundings clean helps stop a lot of diseases from spreading. Infectious disease surveillance and the promotion and implementation of hygienic health practices are also essential to stop the spread of infections.

Conclusion:

The One Health concept has gained popularity in the last few years. Governments, organizations, and institutions are using this integrated approach increasingly to address the complexity of health-related challenges. Global efforts to close gaps in the sectors of environmental, animal, and human health are demonstrated. Initiatives like the Global Health Security Agenda and the Sustainable Development Goals of the United Nations highlight the importance of a well-coordinated approach. Regardless of these advancements, the implementation of the One Health approach is still inconsistent. There exist significant variations in the application of this concept across various contexts and economic sectors, resulting in discrepancies in readiness and health results. One Health is not being widely adopted due to health system issues, insufficient money, poor coordination, and differences in professional cultures, goals, and communication styles. These problems impede the efficacy of treatment and delay responses to new threats. Despite these difficulties, interdisciplinary approaches and teamwork may help in overcoming the challenges. More studies are being conducted on the development of novel vaccines and alternate tactics to counteract antibiotic resistance to control a variety of diseases. Since it is known that the environment plays a significant role in the emergence, transmission, and outbreak of diseases, efforts are made constantly to prevent infections at the same time protecting the natural environment.

In brief, the One Health concept offers a comprehensive framework for addressing the complex and interrelated issues affecting modern health. The current situation with One Health shows great progress, but it also highlights persistent challenges that call for increased funding, collaboration, and coordination. By making use of technological breakthroughs and integrating One Health principles into community initiatives and policy, we may be able to get closer to a stronger and integrated global health system. It will be necessary to make use of these opportunities to build a healthier future where the health of humans, animals, and the environment is all carefully assessed and maintained.

Conflict of interest:

There was no conflict of interest among the authors.

Contribution of authors:

All the authors contributed equally in the preparation of the manuscript.

Acknowledgement:

This paper is dedicated to all the scientists who made significant and pioneer contribution in the field of One Health.

References:

Abbaspour A, Sorooshian S. Multidisciplinary Collaboration Mitigating Health Crises Rooted in Wildlife-Human Interaction. Public Health Reviews. 2024; 45: 1607266.

Aguirre AA, Beasley VR, Augspurger T, Benson WH, Whaley J, Basu N. One health-Transdisciplinary opportunities for SETAC leadership in integrating and improving the health of people, animals, and the environment. Environmental Toxicology and Chemistry. 2016; 35(10): 2383–2391. https://doi.org/10.1002/etc.3557.

Aguirre AA, Longcore T, Barbieri M, Dabritz H, Hill D, Klein PN, Lepczyk C, Lilly EL, McLeod R, Milcarsky J, Murphy CE, Su C, VanWormer E, Yolken R, Sizemore GC.The One Health Approach

to Toxoplasmosis: Epidemiology, Control, and Prevention Strategies. Eco Health. 2019; 16(2): 378-390. https://doi.org/10.1007/s10393-019-01405-7.

Ahmed SK, Hussein S, Qurbani K, Ibrahim RH, Fareeq A, Mahmood KA, Mohamed MG.Antimicrobial resistance: Impacts, challenges, and prospects. Journal of Medicine, Surgery, and Public Health. 2024; 2: 100081.

Akash S, Mir SA, Mahmood S, Hossain S, Islam MR, Mukherjee N, Nayak B, Nafidi HA, Bin Jardan YA, Mekonnen A. Novel computational and drug design strategies for inhibition of monkeypox virus and Babesia microti: Molecular docking, molecular dynamic simulation and drug design approach by natural compounds. Frontiers in Microbiology. 2023; 14: 1206816.

Ashley EA, Phyo AP. Drugs in Development for Malaria. Drugs. 2018; 78(9): 861–79. https://doi.org/10.1007/s40265-018-0911-9.

Bas IM. One World One Health The Basis: Holistic Economics. *Farkli Boyutlariyla Yaşam Kalitesi*. https://books.google.com/books?hl=en&lr=&id=_jzsEAAAQBAJ&oi=fnd&pg=PA151&dq=+One+Health+Initiative+Task+Force+Members+Roger+K.+Mahr,+Jay+H.+Glasser+,+Ronald+M.+Davis+&ots=ps5ntpSC-6&sigTmjBD8WM_R6dN5uLyPXgeXSButA. 2024.

Brevik EC, Slaughter L, Singh BR, Steffan JJ, Collier D, Barnhart P,Pereira P. Soil and Human Health: Current Status and Future Needs. Air, Soil, and Water Research. 2020; 13: 117862212093444. https://doi.org/10.1177/1178622120934441.

Burton I. Report on Reports: Our Common Future: The World Commission on Environment and Development. Environment: Science and Policy for Sustainable Development. 1987;29(5): 25–9. https://doi.org/10.1080/00139157.1987.9928891.

Capps B, Lederman Z. One Health, Vaccines, and Ebola: The Opportunities for Shared Benefits. Journal of Agricultural and Environmental Ethics. 2015;28(6): 1011–1032.https://doi.org/10.1007/s10806-015-9574-7.

Chretien JP, Riley S, George DB. Mathematical modeling of the West Africa Ebola epidemic. Elife. 2015; 4: e09186.

Das MK, Rahi M., Dhiman RC, Raghavendra K.Insecticide susceptibility status of malaria vectors, Anopheles culicifacies, Anopheles fluviatilis, and Anopheles minimus in the tribal districts of Jharkhand state of India. Journal of Vector-Borne Diseases. 2021; 58(4): 374–82.

Den Boer JW, Verhoef L, Bencini MA, Bruin JP, Jansen R,Yzerman EP. Outbreak detection and secondary prevention of Legionnaires' disease: A national approach. International Journal of Hygiene and Environmental Health. 2007; 210(1): 1–7.

Dharmarajan G, Li R, Chanda E, Dean KR, Dirzo R, Jakobsen KS, KhanI, Leirs H, Shi ZL, Wolfe ND. The animal origin of major human infectious diseases: What can past epidemics teach us about preventing the next pandemic? Zoonoses. 2022; 2(1): 989.

Excler JL, Saville M, Berkley S, Kim JH.Vaccine development for emerging infectious diseases. Nature Medicine. 2021; 27(4): 591–600.

Fasina FO, Fasanmi OG, Makonnen YJ, Bebay C, Bett B, Roesel K. The one health landscape in Sub-Saharan African countries. One Health. 2021;13: 100325. https://doi.org/10.1016/j.onehlt.2021.100325

Florensa AF, Kaas RS, Clausen PTLC, Aytan-Aktug D, Aarestrup FM. ResFinder – an open online resource for identification of antimicrobial resistance genes in next-generation sequencing data and prediction of phenotypes from genotypes. Microbial Genomics. 2022; 8(1). https://doi.org/10.1099/mgen.0.000748.

Granata G, Simonsen L, Petrosillo N,Petersen E. Mortality of H5N1 human infections might be due to H5N1 virus pneumonia and could decrease by switching receptors. The Lancet Infectious Diseases. 2024; 24(9): e544–e545.

Grindler NM, Allsworth JE, Macones GA, Kannan K, Roehl KA, Cooper AR. Persistent organic pollutants and early menopause in US women. PloS One. 2015; 10(1): e0116057.

Hadfield J, Megill C, Bell SM, Huddleston J, Potter B, Callender C, Sagulenko P, Bedford T, Neher RA. Next strain: Real-time tracking of pathogen evolution. Bioinformatics. 2018; 34(23): 4121–3.

Horefti E. The Importance of the One Health Concept in Combating Zoonoses. Pathogens. 2023; 12(8): 977.

Hristovski M, Cvetkovik A, Cvetkovik I, Dukoska V. Concept of one health-a new professional imperative. 2010; http://www.mjms.mk/Online/MJMS201033/MJMS.1857-5773.2010-0131.pdf

Hussain SSA, Dhiman RC. Distribution expansion of dengue vectors and climate change in India. Geohealth. 2022; 6(6): e2021GH000477.

Järup L. Hazards of heavy metal contamination. British Medical Bulletin. 2003; 68(1): 167–82.

Katz R, Sorrell EM, Kornblet SA, Fischer JE. Global Health Security Agenda and the International Health Regulations: Moving Forward. Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science. 2014; 12(5): 231–238. https://doi.org/10.1089/bsp.2014.0038.

Kayunze KA, Kambarage DM, Rweyemamu MM, Kiwara AD, Lyamuya E, Rushton J, Kock R, Coker R. A socio-economic approach to One Health policy research in southern Africa: Proceeding. Onderstepoort Journal of Veterinary Research. 2012; 79(2): 1–8.

Khraishah H, Alahmad B, Ostergard Jr RL, AlAshqar A, Albaghdadi M, Vellanki N, Chowdhury MM, Al-Kindi SG, Zanobetti A, Gasparrini A. Climate change and cardiovascular disease: Implications for global health. Nature Reviews Cardiology. 2022; 19(12): 798–812.

Laurie EW. The embodied politics of health in Dar Es Salaam, Tanzania. Ph.D. Thesis, University of Glasgow. 2014; https://theses.gla.ac.uk/6380.

Lee K. The Global Governance of Emerging Zoonotic Diseases: Challenges and Proposed Reforms. Council on Foreign Relations. 2022. https://cdn.cfr.org/sites/default/files/report_pdf/The%20Global%20Governance%20of%20Emerging%20Zoonotic%20Diseases%20%20Challenges%20and%20Proposed%20Reforms_0.pdf.

Linthicum KJ, Britch SC,Anyamba A. Rift Valley Fever: An Emerging Mosquito-Borne Disease. Annual Review of Entomology. 2016; 61(1): 395–415. https://doi.org/10.1146/annurev-ento-010715023819.

Loeb MB. SARS and West Nile Virus. Infectious Disease in the Aging: A Clinical Handbook. 2009; 497–506.

Lubroth J. FAO and the One Health Approach. In J. S. Mackenzie, M. Jeggo, P. Daszak, & J. A. Richt (Eds.), One Health: The Human-Animal-Environment Interfaces in Emerging Infectious Diseases. 2012; 366: 65–72. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-662-45791-7_262.

Lynteris C. In search of lost fleas: Reconsidering Paul-Louis Simond's contribution to the study of the propagation of plague. Medical History. 2022; 66(3): 242–63.

Mekonen S. Coexistence between human and wildlife: The nature, causes and mitigations of human wildlife conflict around Bale Mountains National Park, Southeast Ethiopia. BMC Ecology. 2020; 20(1): 51. https://doi.org/10.1186/s12898-020-00319-1

Mellmann A, Harmsen D, Cummings CA, Zentz EB, Leopold SR, Rico A, Prior K, Szczepanowski R, Ji Y, Zhang W, McLaughlin SF, Henkhaus JK, Leopold B, Bielaszewska M, Prager R, Brzoska PM, Moore RL, Guenther S, Rothberg JM, Karch H. Prospective Genomic Characterization of the German Enterohemorrhagic *Escherichia coli* O104:H4 Outbreak by Rapid Next Generation Sequencing Technology. PLoS ONE. 2011; 6(7): e22751. https://doi.org/10.1371/journal.pone.0022751.

Mishra J, Mishra P, Arora NK.Linkages between environmental issues and zoonotic diseases: With reference to COVID-19 pandemic. Environmental Sustainability. 2021; 4(3): 455–67. https://doi.org/10.1007/s42398-021-00165-x

Mojeed A, Misiekaba-Kia P, dos Anjos V. Climate change, extreme weather & conflict exacerbate global food crisis. Premium Times. 2024; 19.https://news.mongabay.com/2024/02/climate-change-extreme-weather-conflict-exacerbate-global-food-crisis/

Mombo IM, Berthet N, Lukashev AN, Bleicker T, Brünink S, Léger L, Atencia R, Cox D, Bouchier C, Durand P, Arnathau C, Brazier L, Fair JN, Schneider BS, Drexler JF, Prugnolle F, Drosten C, Renaud F, Leroy EM, Rougeron V. First Detection of an Enterovirus C99 in a Captive Chimpanzee with Acute Flaccid Paralysis, from the Tchimpounga Chimpanzee Rehabilitation Center, Republic of Congo. PLoS ONE. 2015; 10(8): e0136700.https://doi.org/10.1371/journal.pone.0136700.

Monath TP. Vaccines against diseases transmitted from animals to humans: A one health paradigm. Vaccine. 2013; 31(46): 5321–38. https://doi.org/10.1016/j.vaccine.2013.09.029.

Morand S, Lajaunie C. Outbreaks of vector-borne and zoonotic diseases are associated with changes in forest cover and oil palm expansion at global scale. Frontiers in Veterinary Science. 2021; 8: 661063.

Morin CW, Comrie AC, Ernst K. Climate and Dengue Transmission: Evidence and Implications. Environmental Health Perspectives. 2013; 121(11–12): 1264–72. https://doi.org/10.1289/ehp.1306556

Mumford E.L, Martinez DJ, Tyance-Hassell K, Cook A, Hansen GR, Labonté R, Mazet JA, Mumford EC, Rizzo DM, Togami E. Evolution and expansion of the One Health approach to promote sustainable and resilient health and well-being: A call to action. Frontiers in Public Health. 2023; 10: 1056459.

Naeem I, Mateen RM, Sibtul Hassan S, Tariq A, Parveen R, Saqib MAN, Fareed MI, Hussain M, Afzal MS. In silico identification of potential drug-like molecules against G glycoprotein of Nipah virus by molecular docking, DFT studies, and molecular dynamic simulation. Journal of Biomolecular Structure and Dynamics. 2023; 41(15): 7104–18. https://doi.org/10.1080/07391102.2022.2115557.

Ogra MV. Human-wildlife conflict and gender in protected area borderlands: A case study of costs, perceptions, and vulnerabilities from Uttarakhand (Uttaranchal), India. Geoforum. 2008; 39(3): 1408–22. https://doi.org/10.1016/j.geoforum.2007.12.004

Ogunseitan OA. One Health and the Environment: From Conceptual Framework to Implementation Science. Environment: Science and Policy for Sustainable Development. 2022; 64(2): 11–21. https://doi.org/10.1080/00139157.2022.2021792

Okeke IN, de Kraker ME, Van Boeckel TP, Kumar CK, Schmitt H, Gales AC, Bertagnolio S, Sharland M, Laxminarayan R. The scope of the antimicrobial resistance challenge. The Lancet. 2024, 403(10442):2426–38.

Olivero J, Fa JE, Real R, Márquez AL, Farfán MA, Vargas JM, Gaveau D, Salim MA, Park D, Suter J. Recent loss of closed forests is associated with Ebola virus disease outbreaks. Scientific Reports. 2017; 7(1): 1–9.

Olshansky SJ, Hayflick L. The role of the WI-38 cell strain in saving lives and reducing morbidity. AIMS Public Health. 2017; 4(2): 127.

Ortiz DI, Piche-Ovares M, Romero-Vega LM, Wagman J, Troyo A. The Impact of Deforestation, Urbanization, and Changing Land Use Patterns on the Ecology of Mosquito and Tick-Borne Diseases in Central America. Insects. 2022; 13(1): Article 1. https://doi.org/10.3390/insects13010020

Otto H, Knol Anne B, Matti J, Tek-Ang L, André C, Marianne R. Environmental Burden of Disease in Europe: Assessing Nine Risk Factors in Six Countries. Environ Health Perspect. 2014; 122(5): 439–46.

Paital B, Panda SK, Hati AK, Mohanty B, Mohapatra MK, Kanungo S, Chainy GBN. Longevity of animals under reactive oxygen species stress and disease susceptibility due to global warming. World Journal of Biological Chemistry. 2016; 7(1): 110–27. https://doi.org/10.4331/wjbc.v7.i1.110

Pitt SJ, Gunn A. The one health concept. British Journal of Biomedical Science. 2024; 81: 12366.

Poovorawan K, Chattakul P, Chattakul S, Thongmee T, Theamboonlers A, Komolmit P, Poovorawan Y. The important role of early diagnosis and preventive management during a large-scale outbreak of hepatitis A in Thailand. Pathogens and Global Health. 2013; 107(7): 367–72.https://doi.org/10.1179/2047773213Y.0000000116.

Prata JC, Ribeiro AI,Rocha-Santos T. An introduction to the concept of One Health. In One Health. 2022; pp. 1–31. Elsevier. https://www.sciencedirect.com/science/article/pii/B9780128227947000046.

Purse B, Burthe S, Narayanswamy D, Vanak A, Oomen M, Rahman M, Seshadri T, Srinivas P, Young J, Chanda M, Hoti SL, Schäfer S, Asaaga F. A One Health Ecosystem Approach for Understanding and Mitigating Spill-Over of Tick-Borne Diseases in India's Degraded Forests. One Health Cases. 2023; ohcs20230011.https://doi.org/10.1079/onehealthcases.2023.0011.

Robbiati C, Milano A, Declich S, Di Domenico K, Mancini L, Pizzarelli S, D'Angelo F, Riccardo F, Scavia G, Dente MG. One health adoption within prevention, preparedness and response to health threats: Highlights from a scoping review. One Health. 2023; 100613.

Rocklöv J, Dubrow R. Climate change: An enduring challenge for vector-borne disease prevention and control. Nature Immunology. 2020; 21(5): 479–83.

Schwabe CW. Veterinary medicine and human health. 1964; https://www.cabidigitallibrary.org/doi/full/10.5555/19662704978.

Short KR, Richard M, Verhagen JH, van Riel D, Schrauwen EJ, van den Brand JM, Mänz B, Bodewes R, Herfst S.One health, multiple challenges: The inter-species transmission of influenza A virus. One Health. 2015; 1: 1–13.

Sikakulya FK, Mulisya O, Munyambalu DK, Bunduki GK. Ebola in the Eastern Democratic Republic of Congo: One Health approach to infectious disease control. One Health. 2020; 9: 100117.

Simon JA, Marrotte RR, Desrosiers N, Fiset J, Gaitan J, Gonzalez A, KoffiJK, Lapointe FJ, Leighton PA, Lindsay LR, Logan T, Milord F, Ogden NH, Rogic A, Roy-Dufresne E, Suter D, Tessier N, Millien V. Climate change and habitat fragmentation drive the occurrence of Borrelia burgdorferi, the agent of Lyme disease, at the northeastern limit of its distribution. Evolutionary Applications. 2014; 7(7): 750–64. https://doi.org/10.1111/eva.12165.

Su Z, McDonnell D, Cheshmehzangi A, Bentley BL, Šegalo S, da Veiga CP, Xiang YT. Where should "Humans" be in "One Health"? Lessons from COVID-19 for One Health. Globalization and Health. 2024; 20(1): 24. https://doi.org/10.1186/s12992-024-01026-y

Taylor AJ, Lappi V, Wolfgang WJ, Lapierre P, Palumbo MJ, MedusC, Boxrud D.Characterization of Foodborne Outbreaks of Salmonella enterica Serovar Enteritidis with Whole-Genome Sequencing Single Nucleotide Polymorphism-Based Analysis for Surveillance and Outbreak Detection. Journal of Clinical Microbiology. 2015; 53(10): 3334–40. https://doi.org/10.1128/JCM.01280-15.

Tizard IR. Vaccination against coronaviruses in domestic animals. Vaccine. 2020; 38(33): 5123–30.

Torres-Vanegas F, Hadley AS, Kormann UG, Jones FA, Betts MG, Wagner HH. Tropical deforestation reduces plant mating quality by shifting the functional composition of pollinator communities. Journal of Ecology. 2021; 109(4): 1730–46. https://doi.org/10.1111/1365-2745.13594.

van Herten J, Bovenkerk B, Verweij M. One Health as a moral dilemma: Towards a socially responsible zoonotic disease control. Zoonoses and Public Health. 2019; 66(1): 26–34. https://doi.org/10.1111/zph.12536.

Vezzulli L, Pezzati E, Brettar I, Höfle M, Pruzzo C. Effects of Global Warming on *Vibrio* Ecology. Microbiology Spectrum. 2015; 3(3): 3.3.18. https://doi.org/10.1128/microbiolspec.VE-0004-2014

Wallis J, Rick Lee D.Primate Conservation: The Prevention of Disease Transmission. International Journal of Primatology. 1999; 20(6): 803–26. https://doi.org/10.1023/A:1020879700286

Yasobant S, Saxena D, Tadvi R, Syed ZQ. One Health Surveillance System in Gujarat, India: A Health Policy and Systems Research Protocol for Exploring the Cross-Sectoral Collaborations to Detect Emerging Threats at the Human-Animal–Environment Interface. Tropical Medicine and Infectious Disease. 2023; 8(9): 428.

Yoo HS, Yoo D. COVID-19 and veterinarians for one health, zoonotic-and reverse-zoonotic transmissions. Journal of Veterinary Science. 2020; 21(3). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7263917/

***Corresponding author's email ID: samitnandi1967@gmail.com**

Citation: Ghosh P, Nandi SK. The One Health Approach is Transforming Global Health by Integrating Health with the Ecosystem. Indian Journal of Veterinary Public Health. 2024; 10(2): 1-17.

DOI: https://doi.org/10.62418/ijvph.10.2.2024.1-17