

An Overview of One Health Concept and Preventable Outbreaks

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Abstract

Emerging and re-emerging diseases are the major public health challenges that are currently leading in terms of outbreaks of preventable diseases. These diseases are associated with significant morbidity and mortality, unfortunately, a key strategic intervention of one health is not receiving the desired attention, due to the paucity of knowledge and practice of the concept. Similarly, limited studies were conducted on one health. This paper is a narrative review of one health concept and preventable outbreaks. The outbreaks of communicable diseases linked to humans and animals in most cases extend to involve other countries beyond the source due to trade, travel, and tourism resulting in pandemics and in some cases Public Health Emergencies of International concern. One health strategy was identified as an important approach for partners and critical stakeholders' engagement, collaboration and coordination to ensure prevention, early detection, and prompt management of potential outbreaks of diseases that could emerge along human, animal and environmental interfaces. The detection and response entails quality surveillance for diseases among humans and animals, ensuring availability of outbreak preparedness and response plan, providing and maintaining an environment free from infectious diseases for both humans and animals, and promptly responding to suspected outbreaks of diseases among humans and animals.

Keywords: One health, epidemics, preparedness, response, emerging and re-emerging diseases

INTRODUCTION

In the second half of the 20th century, the understanding increased that collaborations between the human health sector and the veterinary sector are needed to prevent and control zoonotic diseases and antimicrobial resistance (AMR) (Sikkema *et al.*, 2016). Worldwide, the identification of the potential threat of emerging and re-emerging zoonosis resulted in advocacy for the adoption of a One Health (OH) approach at the country level aimed at strengthening monitoring and response to zoonotic disease risks through a multisectoral, trans-disciplinary collaboration (Munyua *et al.*, 2019). One Health is a concept that has gained

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popularity during the last years, especially since the Tripartite engagement of the World Health Organization (WHO), the Food and Agriculture Organization (FAO) and the World Organization for Animal Health (OIE) in 2010 (Humboldt-Dachroeden *et al.*, 2021).

OH is an integrated, unifying approach that sustainably balances and optimizes the health of people, animals, and the environment or ecosystems (Onyango *et al.*, 2023). The concept appreciates the intricate connection between people's health and that of animals, including their shared environment (Onyango *et al.*, 2023). The critical objective is to design and implement programs, policies, legislation, and research in which multiple sectors communicate and work as a team to achieve better health outcomes (Onyango *et al.*, 2023). Nigeria is one of the countries ranked globally top the charts for the countries with the most burden endemic diseases (Lucero-Prisno *et al.*, 2023). It was linked to increased poverty, and lack of quality development of the country's health care system (Lucero-Prisno *et al.*, 2023). In an effort to successfully meet the emerging health challenges, promptly identify and manage epidemic outbreaks, and ensure synergy response across relevant ministries, departments and agencies, Nigeria became one of the first countries in Africa to launch the concept of "One Health plan" signed by the ministers of Health, Agriculture and Environment (Lucero-Prisno *et al.*, 2023). The aim was to strengthen multi-sectoral collaboration for health security (Lucero-Prisno *et al.*, 2023). This resulted in an increase in awareness and collaboration among professionals in the recent "One Health" strategic plan vested by NCDC, a step further from the Nigeria Federal Ministry of Agriculture and Federal Ministry of Health developed strategy (Lucero-Prisno *et al.*, 2023).

ONE HEALTH

Today, the world faces huge complex problems, such as emerging infections, that a single discipline, institution or country cannot respond to alone (El Zowalaty *et al.*, 2020). More than 75% of emerging and re-emerging infectious diseases are of zoonotic origin (Munyua *et al.*, 2019). These can cause explosive global outbreaks resulting in substantial economic and public health burden (Munyua *et al.*, 2019). In addition, various cultural norms in some communities promote the consumption of unprocessed live-stock products such as unpasteurized milk and uninspected meat (Munyua *et al.*, 2019). The exponential population growth, and movement into new geographic areas lead to climatic changes and land utilization. The pathogens that can be spread through poor OH coordination can spread rapidly and globally across borders because of the rapid migration and movement of people, animals, and their products due to increased international tourism, trade and travel (Onyango *et al.*, 2023).

Some of the emergent diseases include Severe Acute Respiratory Syndrome (SARS), West Nile fever, avian influenza, hantavirus disease, Rift Valley fever (RVF), Marburg virus disease, influenza A, Middle East Respiratory Syndrome (MERS), Ebola Virus Disease, Zika fever, and recently, COVID-19 (Bloom *et al.*, 2017). The global economic burden due to zoonotic diseases is very high (Gebreyes *et al.*, 2014). According to a recent World Bank estimate, the economic burden due to six of the zoonotic diseases was huge (Gebreyes *et al.*, 2014).

Since One Health's inception, it has gained significant attention due to its integrated and holistic approaches, which fit well with the current disease trends involving humans, animals and the environment (Yopa *et al.*, 2023). Several interventions have been developed in many regions and countries worldwide to tackle complex health problems, including epidemics and pandemics (Yopa *et al.*, 2023). The similarities and relationship between human and animal diseases and the relations between animals and humans in contact with them have already been recognized in ancient times (Sikkema *et al.*, 2016).

In 1952, the Food and Agricultural Organization (FAO) and the World Health Organization (WHO) already published a joint report on 'advances in the control of zoonoses' (Sikkema *et al.*, 2016). Infectious diseases are transmitted between humans and animals by a variety of routes (Nyatanyi *et al.*, 2017). While zoonotic diseases are a major concern globally, their impact in less developed countries is disproportionately high because of the occurrence of risk factors such as a high rate of population growth, lack of infrastructure and skilled manpower capacity to tackle disease outbreaks, a high proportion of people with compromised immunity due to comorbidities such as HIV / AIDS or parasitic diseases, and lifestyles in which daily life depends on animals (Gebreyes *et al.*, 2014). The increasing occurrence of zoonoses, and recently the COVID-19 crisis highlighted the importance of having close links established between surveillance programmes in humans and animals to guide operational decision-making and serve appropriate risk management. (Bourély *et al.*, 2023). Although principally associated with EID prevention and control, OH is also relevant to the prevention and control of endemic and zoonotic animal diseases, as well as securing food safety (Degeling *et al.*, 2015). Moreover, multiple environmental factors affect host-pathogen interactions and disease dynamics (He *et al.*, 2022), demonstrating the need for a holistic and collaborative approach with consideration of animal health and environmental quality when tackling zoonosis issues and achieving optimal human health (He *et al.*, 2022).

Evolution Of One Health Approach

Emerging and re-emerging zoonotic diseases are of significant public health concern and pose a growing threat to global health, global security, and the global economy. Six out of the seven Public Health Emergencies of International Concern (PHEICs) are zoonotic namely: the Influenza A virus subtype H1N1 (H1N1) H1N1 pandemic in 2009, Ebola outbreaks in West Africa in 2014- 16, Zika virus outbreaks in 2015–16, Kivu Ebola epidemic in the 2018–20, the COVID-19 pandemic, and M pox outbreaks in 2022. These events and other zoonotic outbreaks have resulted in several billions of dollars lost and indirect losses affecting lives and economies (Alimi *et al.*, 2023). A One Health approach will improve the ability to efficiently prevent, detect, and respond to emerging and re-emerging zoonotic diseases at the human–animal–environment interface, therefore, operationalization of a One Health approach involves the effective collaboration between human, animal, and environmental health and all relevant stakeholders in the related sectors to address shared health threats (Alimi *et al.*, 2023).

The Guinea Pig Era

The Federal *Food, Drug, and Cosmetic Act* (1938) and the *Nuremberg Code* (1947) gave rise to the "Guinea Pig Era," i.e., extensive animal testing. The 1938 *Act* required animal testing to demonstrate improved clinical outcomes and safety before pharmaceuticals were marketed and required comparative medicine to inform human studies. Biomedical scientists pivoted towards a narrow range of lab animals and focused exclusively on human health (Bresalier *et al.*, 2015).

Creation of the Center for Disease Control

The CDC was established in 1946 (King *et al.*, 2006), by the United States Congress to provide a platform for technical support for malaria prevention and control (Tsacker *et al.*, 2011). From its inception, the CDC was different from the National Board of Health (NBH) by providing technical support through laboratory expertise, consulting with state public health officials, and participating in epidemic control (Tsacker *et al.*, 2011). In 1947, the CDC acquired the Public Health Service Plague Suppressive Lab which became its epidemiology division. In the same year, the CDC also established a Veterinary Public Health (VPH) division, which aimed to protect human and animal health and recognized the importance of environmental health

as an extension of VPH (CDC., 2011). Like Friedrich Meyer's observations, the CDC noted that land use and expansion into wild areas created public health risks for humans and animals (King *et al.*, 2006). With these 2 divisions and recognition of environmental health, the CDC was already adopting foundational ideas implemented by Lonnie King to create a One Health office (King *et al.*, 2006).

One Medicine

The CDC's Epi-Aids and VPH divisions influenced how disease and health were approached in the United States. In 1984, the term "One Medicine" was coined by Calvin Schwabe in the 3rd edition of *Veterinary Medicine and Human Health*. Schwabe was a veterinarian, epidemiologist, and public health advocate who saw human medicine as focused on treating disease and advocated for veterinary medicine as defining health in terms of the population (herd) and focused on disease prevention. With the One Medicine approach, Schwabe imagined that reconciling human and veterinary medicine's views of health would benefit both human and animal populations. One Medicine grew from previous ideas and events and merged One Health components (Ancheta *et al.*, 2011).

Improved Collaboration on One Health

In 2004, the Wildlife Conservation Society (WCS) identified the environment, including wildlife and ecological systems, as under-recognized yet critical components of complex emerging health issues in humans and animals. Sparked by global health crises in the late 1990s and early 2000s, the concept of addressing health issues at the human-animal-environment interface was widely promoted by the international agencies responsible for health (e.g., World Health Organization/WHO, World Organization for Animal Health/WOAH, Food and Agriculture Organization/FAO, United Nations System. The Influenza Coordination/UNSIC, United Nations Environment Program/UNEP, Convention on Biological Diversity/CBD), as well as by government and academic stakeholders in countries and regions worldwide. Through wider application, the concept developed into what is now called "One Health," which is currently widely recognized as a useful approach to addressing complex health issues (Mumford *et al.*, 2023).

The One Health approach has been used in research, education, and policymaking to address complex health concerns at different levels and with different scopes, with slow yet steady progress in working more collaboratively across health sectors. Tools and guidance are available to support.

One Health activities in countries (WHO., 2019), and many countries have national One Health mechanisms responsible for health policy, strategy, and action (Allal *et al.*, 2019).

KNOWLEDGE, ATTITUDE, AND PRACTICES TOWARD ONE HEALTH

Knowledge of One Health Approach

A descriptive mixed-methods study among 74 doctors and 221 veterinarians was carried out in Turkey. The data were collected through a questionnaire sent by email to members of the Ankara Chambers of Medicine and the Ankara Chambers of Veterinary Medicine. Qualitative data were obtained through focus group discussions with boards of directors of both chambers. Recordings were transcribed and the data were categorized in line with the questionnaire. Few (6.3%) of the veterinarians had not heard about One Health while the majority of the physicians (63.5%) had not heard about it ($P < 0.001$). Most of the physicians (95.9%) and veterinarians (71.5%) had not received training on One Health; significantly more veterinarians had received training ($P < 0.001$). Most of the veterinarians (73.3%) and a few physicians (35.1%) had applied One Health in their work ($P < 0.001$). Although participants

mentioned other disciplines related to One Health, they had not been involved in any cooperative or collaborative work relating to these disciplines (Özgüler *et al.*, 2023).

A cross-sectional study targeted all interns of the Ege University Faculty of Medicine, Turkey of the 2019–2020 academic year (n=356). The study group included a fair gender distribution (47.8% female), and the average age was 23.6 ± 1.2 . Out of the 316 participants, 40.2% had not heard of the One Health concept before (Akpınar *et al.*, 2022).

In a study conducted in China examined the level and distribution of One Health awareness among the general public using a survey conducted in Beijing ($n = 1820$). Awareness of the term “One Health” versus awareness of the core set of ideas – the interconnection between the health of people, animals, and the environment was distinguished. The result revealed that 40% of respondents reported that they have heard of the term, but more than double the number indicated that they recognize the core idea of interconnection between people, animals, and the environment. Up to 83% of the respondents said that they believe people's health is closely connected to animal health and 86% believe people's health is closely connected to plant and environmental health (Wu *et al.*, 2023).

A quasi-experimental design was employed to evaluate the effect of the One Health training program in the Philippines with an online questionnaire based on the content of the training modules administered to the participants before and after the training program. The attendees who accomplished both the pre-and post-training assessment questionnaire were included as study participants; of the 225 attendees, 119 respondents qualified. The difference between the pre-and post-training mean A-KAP scores of participants was determined using a paired t-test. Findings showed that the Awareness of the participants ($P < 0.001$) across the topics discussed significantly increased after taking part in the training program. In the Knowledge aspect, however, there was no significant improvement in the general knowledge items score of the participants ($P = 0.06$). The study conducted in the Philippines found improvements were observed in all the modules included in the training ($P < 0.05$) (Vigilla-Montecillo *et al.*, 2023).

A study conducted in Ibadan, Nigeria utilized multiple choice questions covering various One Health topics to evaluate their level of Knowledge, Attitude and Practices of One Health. An independent t-test was performed to relate the knowledge of respondents in both Veterinary Medicine and Human Medicine students. Virtually all the students had One Health knowledge, although most did not have detailed knowledge. Of the Veterinary Students, 65% had a good idea compared to 31.7% Medical Students. Veterinary students had more knowledge of One Health especially the 600-level students who had excellent knowledge (Terrigbade *et al.*, 2021).

Attitude towards One Health

The study conducted among interns of the Ege University Faculty of Medicine, Turkey reported that 85.4% of respondents had declared a positive attitude toward the concept (Akpınar *et al.*, 2022). In students' responses to the attitude questionnaire items, the epidemic sub-dimension had the highest level at 86.1%, and the antibiotic resistance sub-dimension had the lowest level at 77.2% (Akpınar *et al.*, 2022). The study conducted in PinesPhilippines reported that there was no significant improvement in the attitude scores of the participants ($P > 0.05$) after taking part in the training (Vigilla-Montecillo *et al.*, 2023). The Veterinary students who studied in Ibadan Nigeria had excellent attitudes towards One Health Concept while Medical Students had an averagely very good attitude (Terrigbade *et al.*, 2021).

Practices of One Health

The Practice scores of the participants for the study conducted in the Philippines reported, that no significant improvements were observed ($P>0.05$) after taking part in the training (Vigilla-Montecillo *et al.*, 2023). The study conducted among students in Ibadan, Nigeria revealed that most Veterinary Students (56.7%) were eager to learn more about One Health compared to 23.3% of Medical Students (Terrigbade *et al.*, 2021).

Factors associated with knowledge, attitude, and practice towards one health

The study conducted among interns of the Ege University Faculty of Medicine, Turkey reported the probability of high attitude to be 5.03 times (95% CI 1.10–23.12) higher in those with above-average success status and 4.08 times (95% CI 1.15– 14.52) higher in those who had kept animals. In students' responses to the attitude questionnaire items, the epidemic sub-dimension had the highest level at 86.1%, and the antibiotic resistance sub-dimension had the lowest level at 77.2% (Akpınar *et al.*, 2022).

The study conducted in China revealed that women, younger people, and individuals with a higher level of education show higher levels of One Health awareness than their counterparts. Being aware of the term was also associated with higher recognition of the core ideas (Wu *et al.*, 2023).

Conceptual Framework

The preparedness–prevention continuum OH-based framework provides for the detection of threats at the human–animal–environment interface, assessing potential risks for pandemics, evaluating possible impacts at system levels and providing back strategies to improve and strengthen prevention. It addresses priorities for action to be considered at the national (by governments) and international (by international organizations and agencies) level as shown in Figure 1 (Agrimi *et al.*, 2021).

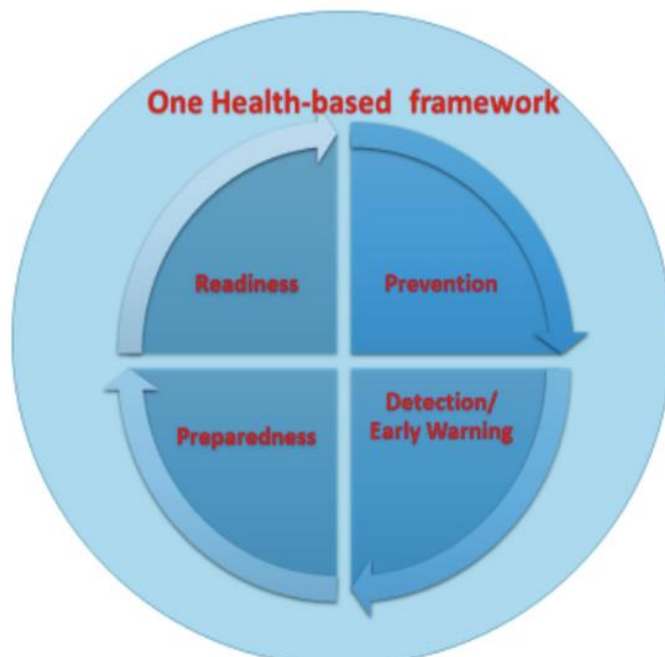


Figure 1: The preparedness–prevention continuum in the OH-based framework

Outbreak preparedness and readiness

Preparedness is defined as a continuous process of anticipating emergency events, taking steps to prevent or mitigate negative outcomes, and building the capacities and resources needed to promptly respond to and recover from such events (Christopher *et al.*, 2023). Some information in addition, specified various types of entities required to showcase these abilities or obtain resources for certain types of preparedness like within the public health systems, healthcare organizations, academic institutions, communities and individuals among others (Christopher *et al.*, 2023).

Outbreak preparedness, readiness, and response need cross-sector and timely coordination. An early and prompt response can not only minimize the impact of outbreaks, and, can also go a long way in preventing them from progressing into full-blown epidemics or pandemics (Moore *et al.*, 2023).

Preparedness activities may include strengthening systems for disease identification and investigation, developing timely and good response plans for the activities needed to minimize the negative consequences of an outbreak, and having a formidable structure to ensure equitable distribution of human, material, and financial resources to support outbreak prevention adequate response (Christopher *et al.*, 2023). Despite numerous preparedness and readiness frameworks and plans that were developed following earlier outbreaks like the 2009 H1N1 influenza pandemic, the SARS outbreak, several outbreaks of the Ebola virus, these plans drastically failed to translate into real-world interventions, with resulting consequences to human health and well-being (Moore *et al.*, 2023).

Outbreak detection

Previous epidemics showcased a strong link between timely detection and implementation of control measures implying that early detection is a key factor for the successful management of the disease in question and mitigating impacts on individuals' health, immediate families, communities and countries' social systems (Steele *et al.*, 2020). To ensure early and successful detection, a robust and competent surveillance system must be in place. Surveillance is a critical component under the IHR (2005) that mandated each Member State to have an event monitoring system and strengthened surveillance capabilities for rapid detection, prompt risk assessment, notification, and response to public health risks (Steele *et al.*, 2020).

Outbreak control

An outbreak can occur when the interaction between the agent (pathogen), population (hosts), and the environment create a suitable situation for spread (Ameli, 2015). Infectious agents multiply rapidly and can become resistant to drugs if not appropriately treated on time. Low vaccination coverage, poor nutrition, extreme age, and immunosuppression could contribute to infection and eventual development of the disease (Ameli, 2015). Overcrowding, poor design of houses and neighborhoods, poor hygiene due to poverty, unsafe drinking water, rapid climate changes, and natural disasters, could affect the host-agent and environment interface resulting in disease transmission. Therefore, once it has been established that an emergency condition exists, there must be a prompt and good response for control. The main goals are rapid assessment, prevention, surveillance, outbreak control, and disease management (Ameli, 2015).

CONCLUSION

Emerging and re-emerging diseases are currently the leading cause of outbreaks and Public Health Emergencies of International Concern (PHEOIC). The outbreak of these diseases is mostly associated with interaction along human, animal and environmental interfaces. The

one health concept is an important strategy that will go a long way in developing and preparedness and prevention plan, early warning and detection strategy, and prompt response to outbreaks along the interface. To achieve this important goal, there is a need for all the stakeholders from the Ministry of Health, agriculture, environment and all the relevant stakeholders to collaborate and ensure proper coordination and implementation of one health strategic intervention.

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