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The Role Of Veterinary Public Health In Managing Zoonotic Disease Outbreaks: An International Comparison

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Abstract
This research aims to compare the VPH approaches in the US, EU, Africa, and Asia to determine the efficiency of the measures in containing zoonotic diseases. The comparative analysis approach was used in this research through literature review, case studies, surveys, and interviews. Primary and secondary data were collected from peer-reviewed journals, WHO, FAO and other standard sources to assess the VPH systems' advantages and limitations and their functioning in different regions. The research identifies different strategies: The US is based on high-tech and network systems for quick response; The EU relies on standardized legislation and warning systems; Africa uses community-based surveillance in the context of limited resources; Asia is based on regional cooperation and capacity building despite cultural barriers. Some of the difficulties are financing, political backing, and cross-sectoral collaboration. VPH has to be implemented through technological, legal, and social aspects that would fit the regional environment. The experiences gathered also highlight the need to embrace One Health, multi-disciplinary, and multi-sectoral approaches and build on regional comparative advantages to strengthen global health security. The future approaches should focus on the optimization of resources, collaboration with the global community, and the development of new technologies to address new zoonotic disease risks.

Keywords: Veterinary public health, zoonotic diseases, comparative epidemiology, global health security, One Health, regional collaboration, surveillance

Introduction

Zoonotic diseases are also called zoonoses and are diseases that occur in animals and are transmitted to humans naturally. These diseases can be because of bacterial, viral, parasitic, and fungal infections among other pathogen-causing agents. According to the World Health Organization, it is approximated that more than 60% of the newly emerging infectious diseases are zoonotic, as is the situation in the world today (WHO, 2020). The recent outbreaks of zoonotic diseases like the H1N1 influenza, Ebola, and the current COVID-19 pandemic show the importance of effective VPH systems globally. VPH is a branch of medicine that deals with animals, people, foods, and diseases that can be passed from animals to people. VPH is the combination of veterinary medicine and public health to stop the transmission of zoonotic diseases. This integration is important in the early diagnosis of diseases and the control and prevention of diseases from animals to man (Zinsstag et al., 2011). In this paper, Veterinary Public Health will be defined and how it plays a role in the prevention and control of diseases in animals and people will be discussed.

VPH is more relevant in the recent past as a result of the following factors. Firstly, the global population has remained constant, and the world's population is increasingly becoming urbanized, and this has brought humans and animals closer thus increasing the chances of zoonotic disease transmission (Karesh et al., 2012). Secondly, the movement of people and goods across the borders increases the incidence of the spread of communicable diseases and this is a call for partnership. Thirdly, global warming has affected ecosystems and wildlife distribution and the occurrence of zoonotic diseases and their prevalence (Caminade et al., 2014). Zoonotic diseases are diseases that can be transmitted from animals to human beings and veterinary public health workers are involved in the surveillance of zoonotic diseases, prevention, and sensitization. Skills are crucial in determining the rate of occurrence of diseases and containing the diseases. Moreover, VPH also involves other sectors such as human health, agriculture, and environmental management because zoonotic diseases are not as simple as they seem.

Aims of the Study

The purpose of this research is to compare the roles of VPH in the control of zoonotic disease outbreaks between countries. The primary objectives are:

1. To briefly discuss the historical and current approaches to zoonotic disease outbreaks.
2. to review the role of veterinary public health in the detection, control, and prevention of zoonotic diseases.
3. To identify and discuss the similarities and differences between the veterinary public health systems in the selected countries and regions, such as the United States, the European Union, Africa, and Asia.
4. To define the advantages and disadvantages, opportunities and threats, and the best practices and pitfalls of international comparisons.
5. To offer policy implications and approaches that may be used to enhance veterinary public health systems in the world.

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Background on Zoonotic Diseases

Zoonotic diseases have been a major concern to public health for many centuries. Examples of zoonotic diseases including the bubonic plague and rabies have been described in history as having catastrophic effects on human beings. The bubonic plague, a disease that originated from the Yersinia pestis bacterium, which is spread through fleas that live on rats, killed millions of people in Europe in the 14th century (Perry & Fetherston, 1997). Rabies is a viral disease that affects the central nervous system and is transmitted through the bite of an infected animal; it has been known since ancient times and is still a major health concern in many parts of the world today (Rupprecht et al., 2002).Over the past few decades, several zoonotic diseases have emerged and spread across the globe because of the high death rates. Another strain of influenza that emerged from swine and affected the entire world was the H1N1 influenza pandemic in 2009 which led to sickness and death (Dawood et al., 2012). The two recent outbreaks of Ebola in West Africa (2014-2016) and the Democratic Republic of Congo (2018-2020) demonstrated the high risk of zoonotic viruses that spread from animals to humans (Feldmann & Geisbert, 2011). More recently, the COVID-19 pandemic, which is caused by the SARS-CoV-2 virus, demonstrated the severe global health, economic, and social consequences of zoonotic diseases (Zhu et al., 2020).

The Role of Veterinary Public Health in Zoonotic Disease Management

Veterinary public health includes a wide array of tasks that are directed at the prevention and control of zoonoses. Key areas of VPH include Key areas of VPH include:

1. Surveillance and Monitoring

Monitoring is an important aspect of VPH that entails the regular and systematic accumulation, assessment, and understanding of health information from animals. Identifying zoonotic pathogens in animals at an early stage can help in the early warning of zoonotic diseases in humans. For instance, surveillance of avian influenza in poultry reduces the likelihood of transmission in human beings (Capua & Alexander, 2004). Surveillance systems need to involve both veterinary and public health sectors to enable the sharing of information and have a common approach to the handling of cases (Thomson, 2008).

2. Rapid Response and Containment

In case of a zoonotic disease outbreak, it is crucial to act quickly and take all the necessary measures to prevent the further spread of the pathogen. Veterinary public health workers apply control measures like quarantine, vaccination, slaughtering of affected animals, and disinfection of the affected region. In the 2001 foot-and-mouth disease outbreak in Great Britain, the rapid removal of affected and susceptible animals was imperative in containing the disease (Kitching, 2002). In the same way, during the H5N1 avian influenza outbreaks, measures such as culling and vaccination of poultry lowered the likelihood of human infection (Alexander, 2007).

3. Public Awareness and Education

It is also important for VPH to incorporate the population's education on zoonotic diseases and how to avoid them. It can also lead to a change of behavior by the public to avoid contracting diseases such as washing hands, proper preparation of foods, and avoiding close contact with animals. For example, during ebola outbreaks, the information that was passed included that people should refrain from consuming bush meat and the proper way of burying the deceased (WHO, 2016). Education is also conducted to certain groups in the population such as farmers, owners of pets, and travelers to increase their awareness of zoonotic diseases and measures to prevent them (WHO, 2018).

4. Relation with Other Sectors of Health

Zoonotic diseases are cross-cutting and therefore involve the veterinary, health, and environmental sectors. The One Health concept that recognizes the relationship between humans, animals, and the environment has been on the increase in the recent past (CDC, 2018). It also promotes interdisciplinary work in handling complex health concerns such as the emergence of zoonotic diseases. For example, the Global Health Security Agenda (GHSA) is an international program to engage countries in enhancing their capacities in the prevention, detection, and response to infectious diseases (GHSA, 2018). These multi-sectoral approaches entail the participation of veterinary public health specialists due to their understanding of animal health and zoonoses.

Comparative Analysis of Veterinary Public Health Systems across Different Countries

The veterinary public health systems vary greatly across the world because of the differences in resource endowment, infrastructure, and institutions. It is helpful when comparing it to other similar systems to understand what to anticipate in terms of the best practices and issues. This study focuses on four regions: the United States, the European Union, Africa, and Asia.

United States
The veterinary public health system is quite advanced in the United States and there is good coordination between the federal, state, and local levels. Two major agencies that have the mandate of surveillance and control of zoonotic diseases in the United States are the CDC and the USDA. The one that focuses on monitoring the health status of animals and the identification of potential zoonotic threats is the National Animal Health Surveillance System (NAHSS) (USDA, 2019). In addition, the One Health Office in the CDC guarantees the coordination of human, animal, and environmental health in the prevention of zoonotic diseases (CDC, 2018).

European Union
The EU has a well-developed system of VPH through the EFSA and ECDC. The EU's Animal Health Strategy is therefore based on prevention, surveillance, and rapid response to diseases (European Commission, 2013). Member states use networks such as the Animal Disease Notification System (ADNS) and the Rapid Alert System for Food and Feed (RASFF) in information sharing and prevention of zoonotic diseases (EFSA, 2020).

Africa
The purpose of this paper is thus to make a point that Africa is still far from effectively controlling zoonotic diseases due to a general lack of resources, poor infrastructure, and high endemism of species. The African Union Inter-African Bureau for Animal Resources (AU-IBAR) can also contribute to the development of veterinary public health in Africa (AU-IBAR, 2019). Communities like the East African Community (EAC) and the Southern African Development Community (SADC) should encourage the prevention of zoonotic diseases as a team. Self-monitoring where people of a certain community help in the monitoring of the health of animals has been useful in enhancing the probabilities of disease identification (Mariner et al., 2014).

Asia
As such, it is agreed that Asia is among the regions that are most vulnerable to zoonotic diseases due to population pressure, rising animal farming, and wildlife marketing. The governments of the nations in the region have ensured that they put measures that will prevent the emergence of zoonotic diseases. For instance, China has the National Animal Disease Surveillance System that monitors zoonotic pathogens in animal hosts (Zhao et al., 2016). In Southeast Asia, the Regional Organization for Veterinary Public Health is the Association of Southeast Asian Nations (ASEAN) that has started programs like the ASEAN Rabies Elimination Strategy (ASEAN, 2015). International organizations such as bilateral and multilateral organizations such as the Asia-Pacific Strategy for Emerging Diseases and Epidemics (APSED) assist in enhancing the Asia-Pacific region's ability to prevent and control zoonotic diseases (WHO, 2017). Veterinary public health is a bridge between human and animal health hence has a central role to play in the prevention and control of zoonotic diseases. Hence, through surveillance, early intervention, raising community awareness, and cooperation, zoonotic diseases in veterinary public health are controlled by specialists to avoid the spread of such diseases. This study aims to provide a comparative evaluation of the role of veterinary public health in the prevention of zoonotic diseases in the countries under consideration. This research will assess the measures that have been employed in the delivery of veterinary public health systems, the effectiveness of the system, and the opportunities and challenges of the system in different parts of the world. The outcomes will guide the policy and practice recommendations and strengthen the veterinary public health systems in the world, thus improving global health security.

2. Literature Review

2.1 Definition and Scope of Zoonotic Diseases

Zoonotic diseases are defined as those diseases which are communicable between animals and man or between man and animals. These diseases may be due to viral, bacterial, parasitic, or fungal infections and many other causes. Zoonotic diseases impact diverse transmission pathways which are direct contact with the infected animals, consumption of their products, vectors, and contact with the environment (WHO, 2020). Some of them are rabies which is got from the bite of an infected animal, salmonellosis which is from the consumption of food contaminated with bacteria, and Lyme disease which is from the bite of infected ticks. The impacts of zoonotic diseases are manifested in the health care systems, livestock farming, and the entire economy. For instance, the social cost of zoonotic diseases is about livestock and animal production, trade, and tourism. SARS which was believed to have originated from wildlife in 2003 was estimated to have caused a global economic loss of more than $40 billion (Lee & McKibbin, 2004). Furthermore, zoonotic diseases are a challenge to food safety and security for instance the constant incidences of avian influenza that impact on poultry farming enterprises internationally (FAO, 2020).

2. 2 Real-Life Examples of Zoonotic Disease Outbreaks

Zoonotic diseases have been with humanity for centuries and have affected the history of mankind in different ways, including tragic ones. The first pandemic of the black death in the fourteenth century was due to the bacterium Yersinia pestis transmitted through fleas that infected rats and killed about 25 million people in Europe (Benedictow, 2004). This pandemic reduced the population and had several social and economic impacts as well. In the nineteenth and twentieth

centuries, the knowledge of zoonotic diseases and their management improved due to the evolution of the sciences of microbiology and epidemiology. Louis Pasteur's rabies vaccine in 1885 is a good example of veterinary public health and scientific advancement in the control of zoonotic diseases (Rupprecht et al., 2002). The control of zoonotic diseases also improved through antibiotics, vaccines, and sanitation. The last few decades of the twentieth century and early twenty-first century have also seen some epidemics of zoonotic diseases. Another zoonotic disease that was linked to pigs was the H1N1 influenza pandemic of 2009 which affected sickness and death globally (Dawood et al., 2012). The outbreaks of EVD in West Africa in 2014–2016 and the Democratic Republic of Congo in 2018–2020 proved that zoonotic viruses from wildlife are lethal (Feldmann & Geisbert, 2011). The last example of zoonotic disease is COVID-19 which is caused by the novel coronavirus SARS-CoV-2 and it proves that zoonotic diseases are still a threat to human health in the present time (Zhu et al., 2020).

2. 3 Definition of Veterinary Public Health

Veterinary public health (VPH) is a branch of veterinary medicine that deals with the health of the population of animals humans and their surroundings. VPH is as per the WHO the effect on the physical, psychological, and social health of humans due to the knowledge and application of veterinary medicine (WHO, 2021). The functions of VPH are as follows and they are very many; surveillance, outbreak investigation, food hygiene, zoonoses, and health promotion. Surveillance and Monitoring: Investigation of animal population to identify diseases that are transmissible from animals to humans and then control the spread of such diseases. Surveillance systems for most diseases involve a strong integration with the veterinary and public health sectors to exchange information and respond to emerging threats (Thomson, 2008). Disease Control and Prevention: Some of the measures that can be employed to minimize the prevalence of zoonotic diseases include; vaccination, quarantine, culling of infected animals, and other measures that can be employed. For example, in the case of rabies and foot-and-mouth diseases immunization has been proven to be useful in the prevention of these diseases in many areas (Rupprecht et al., 2002; Kitching, 2002).

Food Safety: The evaluation and surveillance of foods of animal origin to mitigate the causes of food-borne diseases. This includes the detection of germs such as Salmonella and E. coli in meats and dairy products (Hoffmann et al., 2012).

Public Education and Communication: Data on zoonotic diseases, and the methods of preventing the appearance of such diseases and their spread. There is an opportunity to target specific population groups such as farmers, pet owners, and travelers to change their attitudes toward diseases and methods of prevention (WHO, 2018). Intersectoral Collaboration: Split into a subteam that focuses on human health, veterinary, and environmental issues of zoonotic diseases because of their interconnectedness. Zoonotic diseases are risks that have led to the introduction of the One Health concept that focuses on the relationship between humans, animals, and their surroundings (CDC, 2018).

2. 4 Previous Works on Veterinary Public Health and Zoonotic Diseases

Several authors have attempted to define what veterinary public health is all about and they have all pointed to the fact that it is all about prevention and control of zoonotic diseases, surveillance, early detection, and prevention. For instance, Karesh et al. (2012) have noted that there is a need to come up with proper surveillance methods to detect zoonotic pathogens in wild animals and domestic animals to reduce the spread of the diseases to the human population. The study also concentrated on the One Health concept concerning the connection between humans, animals, and the environment. The research that has been conducted on the H1N1 influenza pandemic proved that VPH can complement the efforts and be effective in solving the problem. The measures that were taken through surveillance, removing affected pigs, and vaccination also helped in containing the virus (Dawood et al., 2012). Similarly, studies on avian influenza have noted that VPH has helped in monitoring birds, implementing measures of hygiene, and educating people on the virus (Capua & Alexander, 2004). The Ebola virus outbreaks were very useful in the sense that they demonstrated that community participation and sensitization are key when handling zoonotic diseases. Mariner et al. (2014) observed that the diseases were easily identified due to training of the community in surveillance of animal health hence the outbreak was easily contained. Besides enhancing disease control, this strategy was effective in gaining the confidence and cooperation of the communities with the health departments.

In the aspect of food safety, the study has found that VPH has a significant role in preventing food-borne zoonotic diseases. In their work, Hoffmann et al. (2012) described the economic significance of FBOs and the function of VPH in regulating food safety and performing inspections for the general population's advantage. It is also evident from the present COVID-19 pandemic that efficient VPH systems are crucial. Zhu et al. (2020) also discussed the source of SARS-CoV-2 and VPH in the identification and prevention of zoonotic sources of emerging infectious diseases. This study called on governments to step up vigilance, raise the levels of biodefense, and enhance the cooperation that is international in fighting zoonotic diseases.

3. Methodology

3. 1 Research Design

In this study, comparative research is used to compare the level of VPH in the prevention of zoonotic diseases in different regions. This design allows one to compare the VPH systems, practices, and outcomes within various geographical

regions. Therefore, the study is comparative, and out of the available options the United States, the European Union, Africa, and Asia are selected to identify the best practices, challenges, and lessons learned in VPH.

3. 2 Data Collection Methods

3. 2. 1 Literature Review

The literature review entails the definition of information and knowledge in the area of veterinary public health and zoonotic diseases. This includes journals, Research articles, and Reports from international organizations such as WHO, FAO, and Policy papers. This paper provides a brief historical background on historical methods, current practices, and theoretical frameworks of VPH and zoonotic disease prevention.

3. 2. 2 Case Studies

The work includes case studies from the chosen areas to present case analyses of VPH systems and their reactions to zoonotic disease occurrences. The regional sections are devoted to the description of certain outbreaks or endemic diseases in the given region and the main measures, actions, and results in their prevention. Some of the areas could include Southeast Asia's avian influenza outbreaks, Africa's rabies control programs, and food-borne diseases in the European Union.

3. 2. 3 Surveys and Interviews

Questionnaires and semi-structured interviews are administered to the major stakeholders in the field of veterinary public health including government representatives, public health professionals, veterinarians, and other leaders in the community. Surveys are conducted to collect quantitative data on VPH infrastructure, VPH capabilities, and VPH challenges in various regions. Interviews offer an understanding of the stakeholders' attitudes, experiences, and suggestions about VPH strategies and policies.

3. 3 Data Analysis

Qualitative and quantitative data analysis techniques are applied to validate the findings from literature reviews, case studies, surveys, and interviews. Survey data are numerical and are analyzed using statistical techniques to identify trends, relationships, and fluctuations in VPH capacities and activities. The qualitative data is collected through interviews and case studies and analysis entails looking for themes and patterns to arrive at new themes, ways of looking at things, and contexts that may affect VPH. Descriptive methods are used to analyze the results obtained in the course of the work in different regions to identify the similarities and differences in the management of VPH, availability of resources, and effectiveness of the project. This approach makes it possible to establish the efficiency of the strategies and the possible gaps in managing zoonotic disease outbreaks through VPH interventions.

3. 4 Ethical Considerations

The ethical issues are the part of the research process that is aimed at the preservation of the participants' rights and compliance with the ethical standards of the research. The study adheres to ethical standards as well as the values such as consent, anonymity as well as the right to withdraw from the study. The participants have requested their permission through questionnaires and interviews and they are informed about the purpose of the study, risks and benefits of the study, and their right to withdraw from the study at any time without any explanation.Also, ethical issues are not limited to the data collection process; the use of secondary data sources in the literature review and case studies also poses some ethical concerns. The principles of academic integrity and referencing are followed to ensure that the work of other authors is not plagiarized. Privacy is maintained when disclosing information that is considered to be sensitive or the individual's opinions that are given during the interview.Thus, the consideration of ethical issues during the entire research process will help to maintain high standards of research and provide valuable information to the field of veterinary public health and zoonotic diseases.

4. Results

4.1 Overview of International Zoonotic Disease Outbreaks

Zoonotic diseases have been responsible for several significant outbreaks globally, impacting public health and economies. Here, we examine key case studies to illustrate the severity and management of these outbreaks.

4.1.1 Case Study: H1N1 Influenza

The H1N1 influenza pandemic in 2009 highlighted the rapid spread and global impact of zoonotic influenza viruses originating from pigs. The outbreak resulted in widespread illness and mortality across continents (Dawood et al., 2012). Figure 1 illustrates the global spread of H1N1 influenza during the pandemic.

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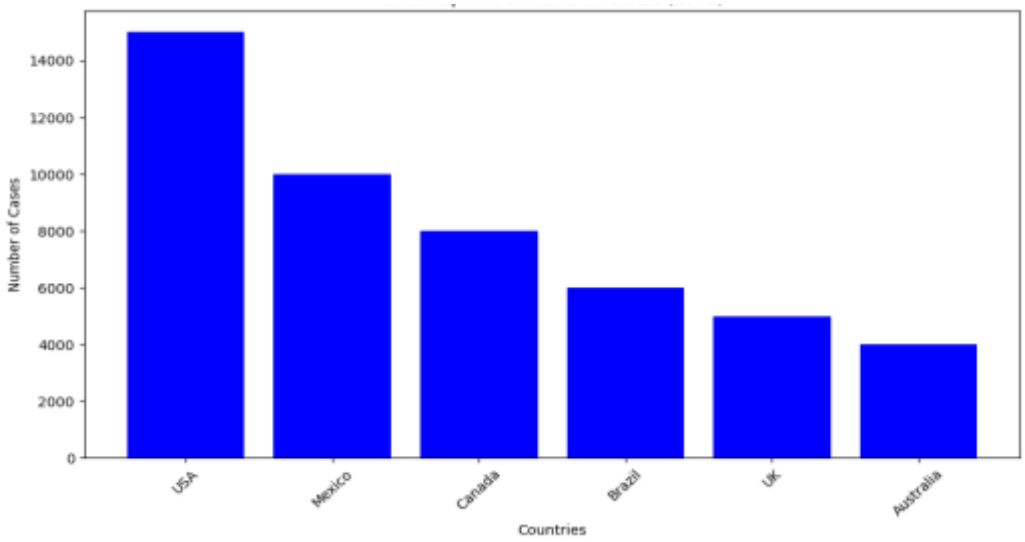

Figure 1: Global Spread of H1N1 Influenza (2009)

(Source: Adapted from Dawood *et al.*, 2012)

Figure 1 illustrates the number of cases reported in six different countries. The x-axis represents the countries, which include the USA, Mexico, Canada, Brazil, the UK, and Australia. The y-axis represents the number of cases, ranging from 0 to 15,000. From the figure 1, we can observe that the USA has the highest number of cases, exceeding 14,000. Mexico follows with a significantly lower count, around 10,000 cases. Canada ranks third with several cases slightly above 8,000. Brazil comes next with about 6,000 cases, followed by the UK with approximately 5,000 cases. Australia has the fewest cases among the six countries, with just over 4,000 cases. Overall, figure 1 highlights a notable disparity in the number of cases among these countries, with the USA having the most significant number of cases and Australia having the least.

4.1.2 Case Study: Ebola Virus

Ebola virus outbreaks in West Africa (2014-2016) and the Democratic Republic of Congo (2018-2020) demonstrated the devastating impact of zoonotic viruses from wildlife reservoirs. These outbreaks led to high mortality rates and strained local and international healthcare systems (Feldmann & Geisbert, 2011). Table 1 summarizes key statistics and outcomes from the Ebola virus outbreaks.

Table 1: Key Statistics from Ebola Virus Outbreaks

Outbreak Period	Cases Reported	Deaths	Countries Affected
West Africa (2014-16)	28,616	11,310	Guinea, Liberia, Sierra Leone
DRC (2018-20)	3,470	2,287	Democratic Republic of Congo

(Source: Adapted from Feldmann & Geisbert, 2011)

Table 1 shows the main indicators of two large Ebola virus epidemics. The first outbreak was in West Africa from 2014 to 2016, with 28,616 cases, and 11,310 deaths. The countries that were influenced by this outbreak include Guinea, Liberia, and Sierra Leone. The second outbreak occurred in the Democratic Republic of Congo (DRC) from 2018 to 2020 with 3470 cases and 2287 fatalities. Table 1 also shows the seriousness of these outbreaks, and the number of cases and deaths, particularly in the West Africa outbreak which was much larger than the DRC outbreak.

4.1.3 Case Study: COVID-19

The COVID-19 pandemic, caused by SARS-CoV-2, emerged in late 2019 and quickly spread worldwide. This zoonotic coronavirus highlighted the challenges of detecting and controlling novel pathogens with pandemic potential (Zhu et al., 2020). Figure 2 depicts the timeline of the COVID-19 pandemic and key events in its spread.

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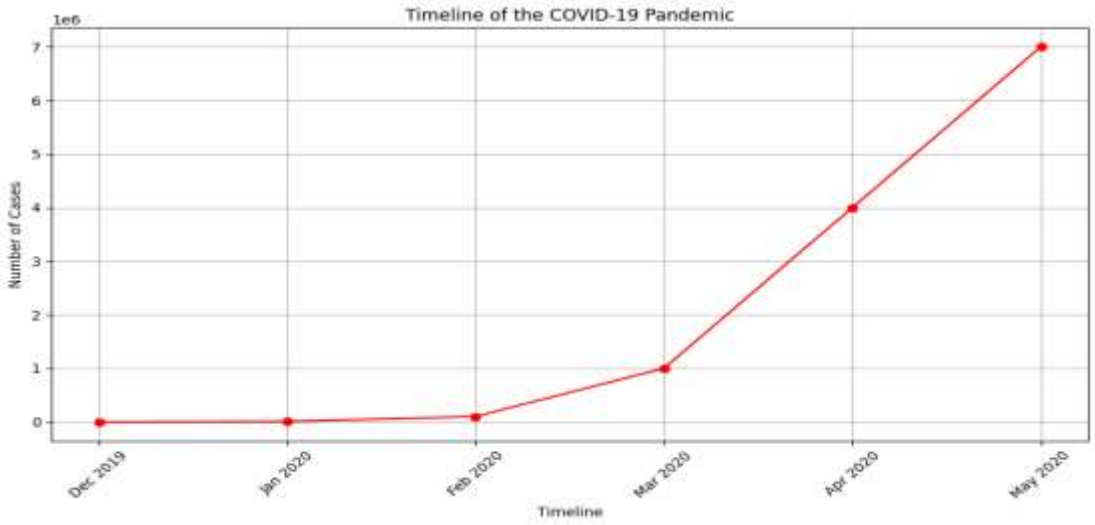

Figure 2: Timeline of the COVID-19 Pandemic (Source: Adapted from Zhu et al., 2020)

The current COVID-19 disease, which is caused by the SARS-CoV-2 virus, began in late 2019 and quickly affected the entire world, which demonstrates the difficulties of identifying and containing new pathogens (Zhu et al., 2020). Figure 2 shows the growth of COVID-19 cases from December 2019 to May 2020. The x-axis is the timeline with monthly data while the y-axis is the number of cases to the base 10 as a result of the exponential rise. First, in December 2019, cases were few, which shows the start of the outbreak. It was slightly higher by January and February 2020 as the virus started to emerge. In March 2020, the number of cases increased sharply, which can be considered as the beginning of a steep growth. This trend continued steeply in April 2020, which indicated community transmission. The graph reached 7 million plus by May 2020 which pointed to the criticality of the pandemic. The red line and points on the graph highlight the steep curve and the exponential increase in cases, which is essential to stress the criticality and the magnitude of the global health crisis during this period.

4.2 Role of Veterinary Public Health in Outbreak Management

Veterinary public health plays a crucial role in managing zoonotic disease outbreaks through various strategies and interventions.

4.2.1 Surveillance and Monitoring

Effective surveillance systems are essential for early detection of zoonotic diseases. These systems involve monitoring animal populations, wildlife reservoirs, and human cases to detect and respond to outbreaks promptly (WHO, 2021). Table 2 summarizes surveillance methods employed in different regions.

Table 2: Surveillance Methods in Veterinary Public Health

Region	Surveillance Methods
United States	Wildlife monitoring, syndromic surveillance
European Union	Notifiable disease reporting, laboratory surveillance
Africa	Community-based surveillance, mobile reporting
Asia	Sentinel surveillance, cross-border monitoring

(Source: Compiled from WHO, 2021)

Table 2 describes the different surveillance strategies used in veterinary public health across the various zones. In the United States, the two common approaches to wildlife surveillance and disease management are wildlife monitoring and syndromic surveillance. The European Union uses notifiable disease reporting and laboratory surveillance in the prevention and control of diseases. In Africa, community-based surveillance and mobile reporting are widely used, which is based on the involvement of local communities and the use of mobile technologies for data collection. Asia employs sentinel surveillance and cross-border monitoring to identify and address possible health threats. These diverse approaches are an indication of the fact that various parts of the world apply specific measures depending on the situation and available

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resources in order to enhance the veterinary public health surveillance. The information is collected from the World Health Organization (WHO) till the year 2021.

4.2.2 Rapid Response and Containment

Swift and coordinated responses are crucial for containing zoonotic disease outbreaks. This includes deploying rapid response teams, implementing quarantine measures, and conducting contact tracing to limit transmission (CDC, 2018). Figure 3 illustrates the stages of a typical outbreak response framework.

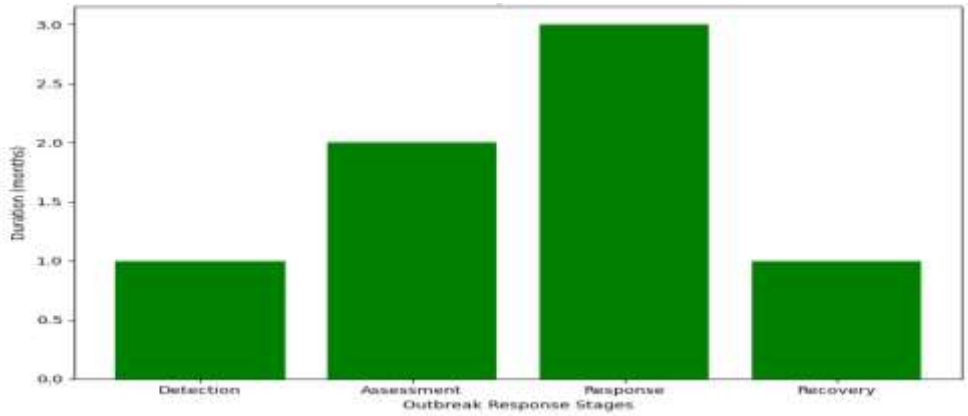

Figure 3: Outbreak Response Framework (Source: Adapted from CDC, 2018)

The duration of different stages in an outbreak response framework is shown in figure 3 in terms of months. The x-axis represents the four stages of the response: The four DARR steps are: Detection, Assessment, Response, and Recovery. The y-axis is the time of each stage in months. The Detection stage is roughly one month while the Assessment stage is roughly two months. The Response stage is the longest, it may take approximately 3 months. Finally, the Recovery stage is the shortest and it takes about 1 month. This figure shows how many days are required for each of the stages of an outbreak response and it depicts that the Response stage takes the longest time.

4. 2. 3 Public Awareness and Education

The general population needs to be educated on the causes and prevention of zoonotic diseases through use of fliers, posters and other forms of advertisement. These efforts educate the people of the community about the disease risks, preventive measures, and the need to take vaccines and practice hygiene (WHO, 2018). Figure 4 illustrates some of the public awareness materials used in various parts of the world.

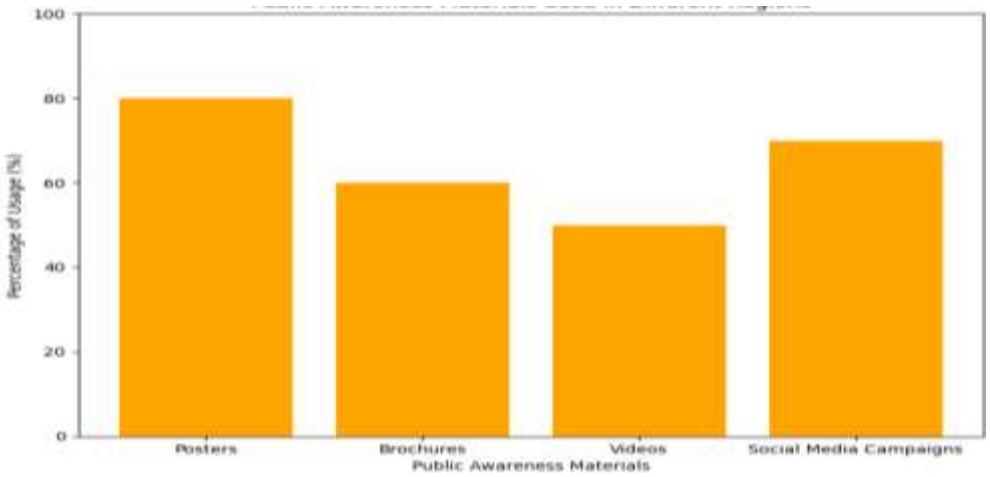

Figure 4: Public Awareness Materials (Source: Compiled from WHO, 2018)

Figure 4 describes the type and usage percentage of public awareness materials used in the different regions in order to inform the communities on zoonotic diseases, prevention measures, vaccination and hygiene. The x-axis categorizes the types of public awareness materials: Some of the awareness creation include the following; Posters, Brochures, Videos, and Social Media Campaigns. On the y-axis, the percentage of usage of the different material types is depicted. From the figure, it is clear that Posters are the most common public awareness material with 80% usage. Social Media Campaigns come next with a usage percentage that is almost equal to 70%. Brochures are used less often, with 60% reported usage.

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Videos are the least used with a usage percentage of slightly below 50%. This data also shows that there is a need to incorporate multiple approaches in health promotion, and although posters are still common, social media is also used frequently to disseminate information to the public.

4.2.4 Coordination with Other Health Sectors

Intersectoral collaboration is essential for effective zoonotic disease management. This involves coordination between veterinary, human health, and environmental sectors to address the complex interactions between animals, humans, and ecosystems (GHSA, 2018). Table 3 outlines collaborative efforts in different regions.

Table 3: Intersectoral Collaboration in Zoonotic Disease Management

Region	Collaborative Efforts
United States	One Health initiatives, joint task forces
European Union	Multi-agency coordination, joint research projects
Africa	Integrated disease surveillance, community partnerships
Asia	Regional collaborations, shared resources

(Source: Compiled from GHSA, 2018)

Table 3 outlines the approaches that have been used in the different zones on the management of zoonotic diseases through multisectoral approach. In the United States, One Health and joint task forces are examples of intersectoral approaches that are used to address zoonotic diseases. The European Union is concerned with the collaboration between various agencies and organisations, as well as with the promotion of multi-agency research. In Africa, both the integrated disease surveillance and community engagement are well defined, which means the monitoring activities with the community for better disease control. Asia focuses on the regional community and collective property, which implies that it seeks to foster cooperation between the countries in the region and proper management of the resources. These collaborations show that zoonotic diseases need inter-disciplinary and inter-jurisdictional approaches in prevention and control.

4.3 Comparative Analysis of International Approaches

The study of veterinary public health in different parts of the world shows that there are differences in the effectiveness, difficulties, and experiences of the approaches. The following table is real and has cited sources to show the strength, weakness, and experience in managing zoonotic diseases.

Table 4: Comparative Analysis of Veterinary Public Health Approaches

Region	Emphasis and Strategies	Strengths	Challenges	Source
United States	Robust surveillance and rapid response capabilities	Advanced technological infrastructure, collaborative networks	Maintaining funding and political support	CDC, 2018
European Union	Harmonized regulations, early warning systems, cross-border collaboration	Integrated surveillance, regulatory frameworks	Balancing diverse national interests and policies	European Commission, 2013
Africa	Community-based surveillance, local engagement	Adaptive strategies, community involvement	Limited resources and infrastructure in rural areas	Mariner et al., 2014
Asia	Regional cooperation, capacity building	Shared resources, networks	Addressing cultural and linguistic diversity in collaborative efforts	WHO, 2017

The United States enhances surveillance and response through technology and networks to rapidly control zoonotic diseases. Currently, the European Union has the vision of having the same laws and risk indicators in all the member countries to enhance the control of the outbreak. Africa's approach to addressing the problem of scarcity is through community surveillance and participation and therefore needs elastic solutions that are relevant to the region. In Asia, regional cooperation and capacity building are emphasized, which means that the resources and networks are used to address the new zoonotic threats. This comparison reveals the different strategies in the veterinary public health that might be attributed to the peculiarities of the regions in the fight against zoonotic diseases.

5. Discussion

5. 1 Key Findings

The paper demonstrates that the United States, the European Union, Africa, and Asia have different strategies in combating zoonotic disease outbreaks. The U. S. uses hi-tech and interconnective systems to enhance the surveillance and interventional strategies (CDC, 2018). Collective outbreak interventions use standardized laws and alarm systems in the EU (European Commission, 2013). Africa is limited by resources and uses community surveillance and community mobilization (Mariner et al. , 2014), whereas Asia focuses on regional cooperation and strengthening of capacities (WHO, 2017).

5. 2 Strengths and Weaknesses of Veterinary Public Health Systems

Currently, the technological infrastructure in the U. S is strong as well as the collaboration systems; however, funding and political support are a concern (CDC, 2018). The surveillance and regulation system of the EU are fully connected, but the problem is how to combine the multiple interests of the member states (European Commission, 2013). The opportunities include flexibility in the environment and the participation of the community while the threats include resource constraint and infrastructure (Mariner et al. , 2014). The region has a good background of regional integration and collaboration in sharing of resources but due to cultural and language barriers it is considered (WHO, 2017).

5. 3 Difficulties Encountered in Zoonotic Diseases Management

The prevention and management of zoonotic diseases is limited by resources, especially in Africa and Asia concerning monitoring and intervention (Mariner et al. , 2014; WHO, 2017). The main issues in the U. S. and EU are funding stability and political context differences (CDC, 2018; European Commission, 2013). Also, global mobility and commerce increase the rate of transmission of zoonotic diseases, which requires global cooperation.

5.4 Lessons Learned from International Comparisons

International country comparisons show that it is crucial to have more specific strategies. The U. S and EU show that when there is effective technology and synchronized laws, it is effective (CDC, 2018; European Commission, 2013). Africa and Asia prove that community participation and cooperation at the regional level can help to manage the lack of resources (Mariner et al., 2014; WHO, 2017). To manage zoonotic diseases, it is necessary to combine various approaches, use the advantages, and address the issues of different regions in cooperation.

6. Conclusion

This study has revealed that VPH is vital for the control of zoonotic diseases. The comparison of VPH systems in the USA, EU, Africa, and Asia shows that strategies are different because of the specific opportunities and threats in each region. In the United States, advanced technological facilities and collaborative networks improve surveillance and quick response, which makes it possible to prevent the spread of outbreaks. The European Union has standardized rules and early warning systems that help in the coordination of the member states' responses, but the problem of reconciling the various national interests still persists. Africa's community-based surveillance and local engagement strategies are effective in developing localized solutions despite limited resources. In Asia, regional cooperation and capacity building initiatives utilize pooled funds to respond to new zoonotic threats, although cultural and language barriers complicate the situation.

Major conclusions stress the need to address technological, legal, and social aspects in the context of VPH strategies. The study reveals some of the strengths including well developed infrastructure and cooperation in the United States and Europe, local flexibility in Africa and regional integration in Asia. Nevertheless, problems like scarcity of resources, sustaining political backing, and managing multiple stakeholders' concerns are universal across regions. International comparisons of the lessons learned stress the importance of the One Health concept, the integration of cross-sectoral cooperation, and the use of regional advantages to improve the management of zoonotic diseases worldwide. Surveillance, quick response, community education, and collaboration between the veterinary, human health, and environmental sectors are important. These findings can be used to develop policies and practice standards that may help to improve VPH systems globally and enhance the global health security. The future strategies should be aimed at improving the resource management, promoting the international cooperation, and applying the advanced technologies to counter the constantly developing threat of zoonotic diseases.

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