RESEARCH ARTICLE
Open Access

One Health in practice: Benefits and challenges of multisectoral coordination and collaboration in managing public health risks: A meta-analysis

Valentina Thobias Sanga[1,2], Esron D. Karimuribo[2], and Abubakar S. Hoza[3]

1. Prime Minister's Office, Department of Disaster Management, One Health Section, Dodoma, Tanzania; 2. Department of Veterinary Medicine and Public Health, Sokoine University of Agriculture, College of Veterinary Medicine and Biomedical Sciences, Morogoro, Tanzania; 3. Department of Veterinary Microbiology, Parasitology and Biotechnology, Sokoine University of Agriculture, College of Veterinary Medicine and Biomedical Sciences, Morogoro, Tanzania.
Corresponding author: Valentina Thobias Sanga, e-mail: sangavalentina2@gmail.com
Co-authors: EDK: karimuribo@sua.ac.tz, ASH: abshoza@gmail.com
Received: 19-10-2023, **Accepted:** 05-01-2024, **Published online:** 24-01-2024

doi: www.doi.org/10.14202/IJOH.2024.26-36 **How to cite this article:** Sanga VT, Karimuribo ED, and Hoza AS (2024) One Health in practice: Benefits and challenges of multisectoral coordination and collaboration in managing public health risks: A meta-analysis, *Int. J. One Health*, 10(1): 26–36.

Abstract

Background: One Health (OH) approach is crucial for the effective management of emerging and re-emerging infectious diseases and other public health threats. A meta-analysis was conducted to explore the benefits and challenges encountered in the practical implementation of multisectoral coordination in the fight against public health threats and to identify similarities between countries in the practical implementation of multisectoral coordination and cooperation across sectors in OH.

Materials and Methods: To identify relevant studies published globally between 2010 and 2023, a literature search was conducted online using Google Scholar and PubMed search engines. Inclusion criteria were adopted based on key search terms "One Health," "multisectoral coordination," "One Health framework," and related terms "multisectoral collaboration" and "multidisciplinary." Unpublished manuscripts, dissertations, and conference reports were excluded from the review. A total of 307 articles were retrieved. Titles, abstracts, and keywords were screened for inclusion criteria. We extracted and analyzed 46 full-text articles published in English. Unpublished manuscripts, dissertations, and conference reports were excluded from the study.

Results: This study found that most countries have similar challenges that hamper the coordination of OH activities implementation. Of the 46 articles reviewed, 69.6% (n = 32) focused on the benefits of adopting the OH approach and 73.9% (n = 34) focused on multisectoral coordination and collaboration among sectors. In addition, 58.7% (n = 27) of the articles indicated that governments need to invest more resources in OH implementation, and 50% (n = 23) proposed that policies, guidelines, and plans should be integrated to facilitate multisectoral coordination and collaboration. In addition to inadequate coordination and funding, other reported challenges were limited knowledge (34.8%) (n = 16) and inadequate resources (32.6%) (n = 15). In addition, 21.7% (n = 10) highlighted different sectoral priorities and interests as obstacles to effective coordination in the implementation of OH activities.

Conclusion: Multisectoral coordination plays a key role in the effective management of public health threats through OH. The creation of mechanisms for regular communication, the promotion of mutual trust, and the strengthening of relations between sectors will enhance cooperation. The similarity in challenges across regions observed in this study calls for countries across regions to prioritize OH operationalization and collaboration among sectors, strengthen collaboration, and synergize activities to enhance future changes in the mitigation of public health threats.

Keywords: multisectoral collaboration and multidisciplinary, multisectoral coordination, One Health, One Health framework.

Introduction

Over the decades, there has been an increase in the occurrence of re-emerging and emerging infectious diseases (REIDs) that have affected countries' livelihoods, socioeconomic status, security, and political strength [1, 2]. Such an increase in REIDs may be linked to an increase in the interaction between humans and animals and their environment [3]. Easiness of travel across the globe has also contributed to the surge of public health threats, such as severe acute respiratory syndrome, Ebola virus disease outbreak, highly pathogenic avian influenza, and recently COVID-19 pandemic [4–7]. The emergence of other public health threats, such as antimicrobial resistance (AMR) and climate change, is further fueling the problem due to their negative impact on human life, aquatic animals, and terrestrial plants [8]. Due to the negative effects of climate change and variability on wildlife ecosystems, wild animals invade human settlements and *vice versa*. Due to spillover and spread of pathogens at the human–animal (wildlife, domestic)-environment interface [9], the transmission of zoonotic diseases is

also escalating. Moreover, human activities such as farming, hunting, mining, and agriculture are among the important social determinants of disease spread [10]. It is now clear that such public health threats are complex, and solutions to them are also complex since the relationship between human health and biodiversity and consequently land-use changes are complex, numerous, and often dispersed in space and time [11, 12]. Considering the landscape approach to public health, raising awareness about land-use, wildlife, livestock, and public health challenges is essential [13, 14]. To curb this ever-increasing complexity, countries require effective multisectoral coordination, collaboration, and communication across multisectoral, inter-sectoral, and multi-discipline areas through the One Health (OH) approach [4, 15, 16].

Global, regional, and national public health measures require multisectoral action to improve early detection, prevention preparedness, and response to emerging health problems [17]. The OH concept became noteworthy after the subsequent increase in health risks at human, animal, and environmental interfaces [18]. The Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO), and the World Organization for Animal Health (formerly the Office International des Épizooties [OIE]) recognized OH as a tactic for multisectoral coordination and collaboration [19, 20]. This approach focuses on fostering and sustaining effective collaboration, coordination, communication, and capacity development of the OH workforce to improve OH actions [4, 16]. Some countries around the world, including Tanzania, have developed and established national OH platforms, strategic plans, and guidelines to ensure the implementation of OH. The aim of these instruments is to create and maintain active cooperation between sectors in the prevention and control of zoonotic diseases and other public health events to ensure preparedness and timely and coordinated responses. However, despite establishing OH platforms and developing guiding documents to operationalize the OHA, multisectoral coordination and collaboration in many countries, including Tanzania, remains a challenge [17]. Many sectors continue to work in a siloed approach, and donor support continues to be project- or program-oriented [21, 22].

This study aims to identify the strengths and weaknesses of the existing multisectoral coordination mechanisms for OH and to identify similarities between countries in the practical implementation of OH across sectors. The identified best practices and challenges will contribute to strengthening the OH coordination platform in Tanzania and other countries worldwide.

Materials and Methods

Ethical approval

Ethical approval was not required because the study was based on a literature review. Reporting was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 Statement [23].

Study period and location

The data were extracted, analyzed, and interpreted from 8th May, 2023 to 31st July, 2023at Sokoine University of Agriculture.,

Search strategy

To identify relevant studies published globally from 2010 to 2023, a literature search was conducted online using electronic databases including Google Scholar and PubMed search engines. To review the context of OH multisectoral coordination, we retrieved published papers that addressed OH, multisectoral coordination, and related keywords. The search was based on key search terms "One Health," "multisectoral coordination," "One Health framework," and "multidisciplinary collaboration." A total of 307 articles were identified and retrieved, of which 107 (34.9%) were retrieved from PubMed and 200 (65.1%) from Google Scholar. A total of 78 (25.4%) duplicates were removed and 183 (59.6%) articles were excluded after screening the abstracts and key terms used for literature search because they did not address OH, multisectoral coordination, or collaboration. The remaining 46 (15%) articles were included in the review (Figure-1).

Inclusion and exclusion criteria

The titles, abstracts, and keywords were screened for inclusion criteria. Articles describing the One Health and multisectoral collaboration were included in the review. Only full-text articles published in the English language were extracted; unpublished manuscripts, dissertations, conference reports, and articles that do not contain explanations of one health and multisectoral collaboration were excluded from this review. Preferred Reporting Items for Systematic Reviews and Meta-analyses was used during selection of the articles for the study as indicated in the flow diagram.

Data extraction and analysis

Reviewed papers were screened by collecting, identifying, and analyzing relevant information through content analysis that was reported to influence multisectoral coordination and collaboration in the management of public health risks using OH. All reviewed articles were stratified according to the regions and countries where the study was conducted. The advantages of OH; challenges in multisectoral coordination; capacity, skills and awareness of OH; policies and regulations to support the implementation of OH; and sectoral priorities and availability of resources were identified and analyzed.

Results

Benefits of implementing OHA

The OHA recognizes the interconnectedness of human, animal, and environmental health. A holistic and collaborative approach offers a number of benefits

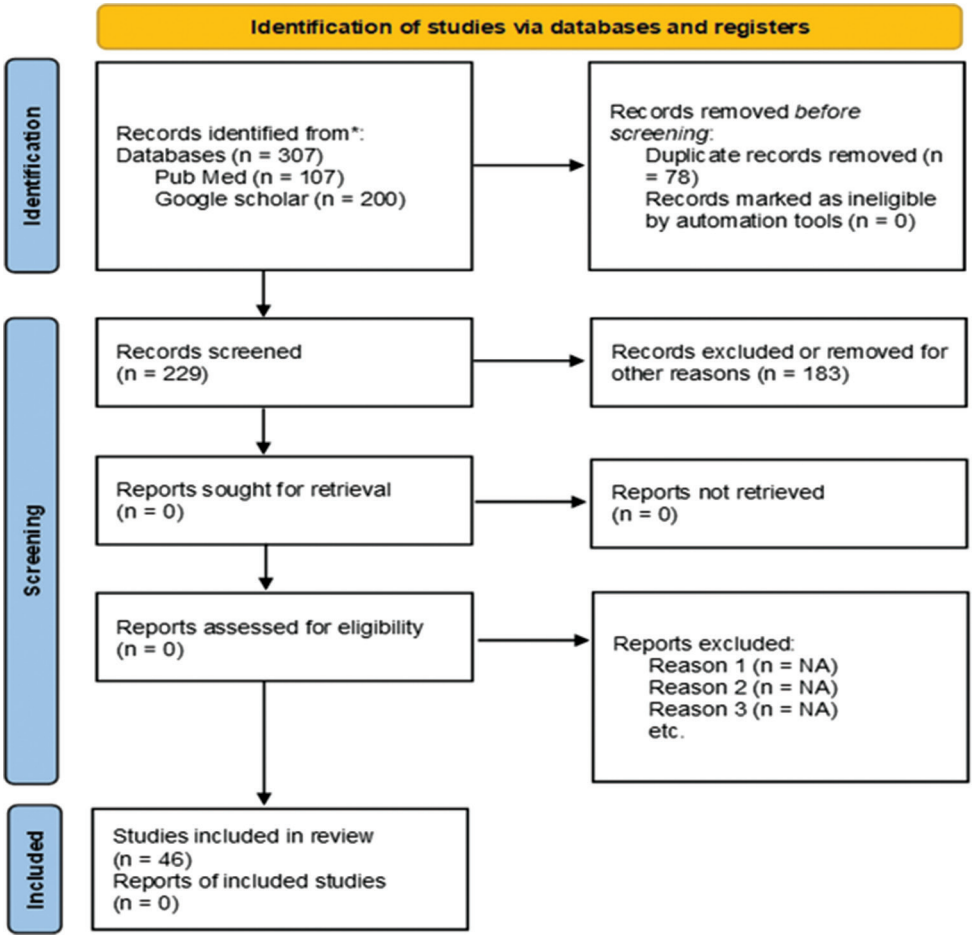

Figure-1: A flow diagram indicating selection of articles for the study.

in addressing complex health problems. Most studies have highlighted the importance of applying the OHA to address public health risks that affect humans and animals in their shared environment.

In this study, 32 (69.6%) out of 46 articles reviewed focused on the benefits of adopting an OHA to enhance early detection, prevention, preparedness, and response to outbreaks and other health threats through institutionalization of OH. For example, studies conducted in Asia (Yemen), the Middle East, and Australia have highlighted the importance of applying the OHA in promoting early detection, rapid response, and coordinated actions, as well as enhancing the ability to manage outbreaks, pandemics, and other health crises [24, 25]. Similarly, 34 (73.9%) articles highlighted the importance of multisectoral coordination of OH and cooperation between sectors in addressing health risks. For example, Tanzania promotes collaborative efforts between different sectors and other implementing partners in response to zoonotic disease events through the OH platform, which is under the Prime Minister's Office. In addition, it has facilitated the development of strategies and guidelines for priority zoonotic disease prevention, such as the National Strategy for Prevention and Control of Anthrax in Humans and Animals 2018–2023, the Prevention and Control of Brucellosis in Humans and Animals 2018–2023, and the National Rabies Control Strategy 2019 that need to be implemented by different sectors.

Similarly, studies conducted in Africa have asserted a multisectoral and transdisciplinary approach in addressing REIDs in Ghana, Kenya, and Tanzania [26]. For example, studies conducted in Kenya encourage collaboration and cooperation in various disciplines, including human medicine, veterinary medicine, environmental science, ecology, and public health. This multidisciplinary approach enables experts from different fields to share knowledge, resources, and expertise, leading to more effective and comprehensive solutions to health problems [1, 26]. They also emphasized strengthening multisectoral coordination in conducting research and surveillance on zoonoses and emerging diseases such as COVID-19.

Although OH has globally adopted its implementation, countries still need more efforts to commit resources. A total of 58.7% (n = 27) of articles reviewed indicated a need for governments to invest more resources in the implementation of OH activities. For example, studies conducted in Egypt, Tanzania, Kenya, East Asia, and Qatar, among other countries, emphasized investing more resources in the prevention and control of emerging and endemic zoonoses [10, 21, 27–29]. Furthermore, it was found that OHA helps to avoid duplication of efforts, share knowledge and expertise, facilitate data sharing, and encourage joint research and surveillance

activities [30]. This collaborative approach leads to cost savings and the optimal use of resources in disease prevention, control, and research, yielding effective and comprehensive solutions to health challenges [1, 26, 31, 32].

Challenges in multisectoral coordination

Multisectoral coordination and collaboration is not a new term. It has been used globally by various institutions, agencies, and political structures in many countries, but it is still not clearly understood [18, 33]. At the global level, countries in different regions have adopted an OHA, but its implementation remains a challenge. Many countries have made significant efforts to operationalize and institutionalize OH at a national level, leaving lower levels behind [34]. For example, a study conducted in Tanzania and Nigeria on the operationalization of OH showed limited cooperation and integration of OH into routine disease control and national health security programs [35, 36]. Similarly, a study conducted in Tanzania identified key factors hindering the implementation of OH as well as multisectoral coordination and collaboration [30, 37].

However, multisectoral coordination is still a challenge for many countries, as highlighted in studies conducted by different countries around the world on how countries fail to integrate and translate policies into action, for example, in the Middle East [24], Kenya [26], Qatar [28], the Sub-Saharan region [35], Nigeria [36], South Africa [38], Indonesia [39], Western Asia [40], and China [41]. Reviewed articles n = 23 (50%) indicated that policies, guidelines, and plans need to be integrated to facilitate the implementation of OH activities and multisectoral coordination and collaboration. The integration of policies could improve OH implementation and ease coordination [16, 21, 31, 42].

Countries such as Kenya, Rwanda, and Tanzania have developed OH strategic plan (OHSP) to facilitate coordination, communication, and implementation between sectors. Despite the remarkable strength of OH implementation, a situational analysis conducted during a review of countries' OHSP found that awareness of OH is still limited [43, 44]. In this study, 16 (34.8%) of the reviewed articles demonstrated a lack of inadequate knowledge of OH and a lack of institutionalization and governance structures of OH, among the key factors hindering implementation and coordination of OH in many countries [4]. In Kenya, for example, the zoonotic disease unit is an independent structure with a mandate to coordinate OH between human and animal sectors. The main focus is on zoonotic diseases, leaving other health concerns to be coordinated by separate coordination mechanisms such as AMR [45]. Similarly, in Tanzania, OH activities are coordinated by the OH Section under the Disaster Management Department of the Prime Minister's Office. The Prime Minister's Office has a mandate to control and coordinate the implementation of all sector ministries and organizations. However, interministerial and institutional coordination remains a challenge, particularly at a sub-national level.

Different studies have shown that sectoral priorities and silo mentality in resource sharing pose a major challenge. Of the 46 articles reviewed, 15 (32.6%) insisted on resource and information sharing. Different sectors often operate independently, resulting in fragmented efforts and insufficient information sharing [21, 46, 47]. For example, in Tanzania, an "after action review" report on rabies and anthrax outbreaks revealed challenges in coordination during response to frequent outbreaks. Delayed information sharing hinders early detection, prevention, and response to such outbreaks [27, 48].

Globally, different sectors have different priorities, interests, and incentives, which contribute to coordination difficulties [21, 22, 35, 49]. The reviewed articles show that 21.7% (n = 10 out of 46 articles) of different countries reported different sectoral priorities and interests that hinder effective coordination. The priorities of different sectors in the implementation of OH differ. For example, studies conducted in Kenya, Tanzania, Egypt, India, and the United States have identified different priorities for different sectors. The public health sector may differ from the animal sector in terms of its impact on productivity, social economy, politics, and trade [21]. Diverse sector priorities and inadequate allocation of finances and resources to key OH implementation sectors hinder effective cooperation and operationalization of OH [1, 39].

Similarly, limited funding for certain sectors is a significant challenge for coordinated responses since many OH activities are *ad hoc* and donor-dependent [50]. The experience observed in most African countries, which may also apply to Tanzania, suggests that there is insufficient or lack of financial resources for the implementation of OH activities [36, 49]. For example, in Tanzania, efforts to control rabies and anthrax, which are among the priority zoonotic diseases, continue to be challenging due to the lack of resources and funding allocated by the Ministry of Livestock and Fisheries [51, 52].

Prevention of health risk determinants remains a challenge because it requires a wider involvement of multiple sectors rather than a single sector, such as the Ministry of Health [53–55]. Through this study, we found that most countries have similar challenges that hamper the coordination of OH implementation. However, most country policies and legal frameworks do not address issues related to OH, thus creating difficulties for coordinated action and informed decision-making [35, 56, 57], as summarized in Table-1 [1, 4, 10, 16, 21–33, 35–39, 44, 49–53, 55–64].

Discussion

Countries continue to face a number of health risks due to social determinants of health, such as REIDs that affect both humans and animals, as well as their interactive environment [65], due to the effects

Table-1: Summary of similarities of benefits and challenges on one health multisectoral coordination among different countries.

Reference	Region/ country	Add value of adopting OH in addressing complex health threats	Improve collaboration, communication and coordination among sectors	Need to invest more resources among sectors	Strengthen OH capacity, skills and awareness	Lack of data sharing and management	Lack of policy integration and regulation reinforcement among sectors	Competing sectoral priorities and interest
Gongal, 2013 [21]	East Asia	Yes	Yes	Yes	Yes			
Li *et al*., 2019 [58]	China	Yes			Yes	Yes	Yes	
Kimani *et al*., 2019 [26]	Kenya	Yes	Yes	Yes		No	Yes	Yes
Munyua *et al*., 2019 [10]	Kenya	Yes	Yes	Yes		Yes		Yes
Mremi *et al*., 2022 [27]	Tanzania	Yes	Yes	Yes	Yes	Yes		No
Mtui-Malamsha *et al*., 2020 [47]	Tanzania	Yes	Yes	Yes	Yes	Yes		Yes
Kitua *et al*., 2019 [30]	Tanzania	Yes	Yes	Yes				Yes
Mbugi *et al*., 2012 [37]	Tanzania	Yes		No				No
Lebov *et al*., 2017 [31]	United States	Yes	Yes	Yes	Yes			Yes
Sinclair, 2019 [1]	Globally	Yes		Yes	Yes	Yes		Yes
Errecaborde *et al*., 2019 [56]	Globally	Yes	Yes	Yes				
Kayunze *et al*., 2014 [62]	Tanzania	Yes	Yes	Yes	Yes		Yes	
Mackenzie, 2019 [61]	Sweden	Yes						
Zinsstag *et al*., 2016 [81]		Yes	Yes					
Bansal *et al*., 2023 [28]	Qatar	Yes	Yes	Yes		Yes	Yes	
Zakham *et al*., 2019 [24]	Middle East	Yes	Yes		Yes		Yes	
Bresalier *et al*., 2021 [18]	worldwide	Yes						
Stephen *et al*., 2022 [48]	Tanzania	Yes	Yes	Yes	Yes		Yes	
Ayobami *et al*., 2021 [35]	Sub Saharan region	Yes				Yes	Yes	
Lokossou *et al*., 2021 [36]	Nigeria	Yes	Yes	Yes	Yes		Yes	
Kingsley and Taylor, 2017 [33]	Globally	Yes		Yes		Yes	Yes	
Amri *et al*., 2022 [16]	Globally		Yes				Yes	
Muhanga *et al*., 2020 [43]	Tanzania				Yes	Yes	Yes	
Onyango *et al*., 2023 [44]	Kenya	Yes	Yes	Yes			Yes	
Cunningham *et al*., 2017 [4]	Globally	Yes		Yes	Yes		Yes	
Mouiche *et al*., 2019 [47]	Cameroon					Yes		
Reid *et al*., 2016 [22]	Australia and New Zealand		Yes					
Kelly *et al*., 2020 [50]	Globally	Yes		Yes			Yes	
United Republic of Tanzania, 2018 [51]	Tanzania		Yes	Yes				
United Republic of Tanzania, 2019 [52]	Tanzania		Yes	Yes				
Kakkar *et al*., 2019 [53]	Globally	Yes	Yes	Yes		Yes	Yes	
MOHCDGEC. (2021) [54]	Tanzania		Yes			Yes		
Mshana *et al*., 2013 [59]	Zambia		Yes			Yes		
Reid *et al*., 2017 [60]	West Asia		Yes					
Ng *et al*., 2020 [25]	Yemen	Yes						
Phelps *et al*., 2019 [40]	Western Asia		Yes	Yes			Yes	
Ahmed *et al*., 2023 [55]	Globally	Yes	Yes	Yes	Yes			Yes

(*Contd*...)

Table-1: (*Continued*)

Reference	Region/ country	Add value of adopting OH in addressing complex health threats	Improve collaboration, communication and coordination among sectors	Need to invest more resources among sectors	Strengthen OH capacity, skills and awareness	Lack of data sharing and management	Lack of policy integration and regulation reinforcement among sectors	Competing sectoral priorities and interest
Karamoy *et al.*, 2023 [39]	Indonesia	yes	Yes	Yes			Yes	
Taaffe *et al.*, 2023 [71]	India	Yes	Yes	Yes		Yes		Yes
Liu *et al.*, 2023 [41]	China	yes			Yes		Yes	
Mor, 2023 [32]	India	Yes	Yes				Yes	Yes
Allal, 2019 [29]	Egypt	Yes		Yes	Yes			Yes
Wu *et al.*, 2023 [57]	China			Yes	Yes	Yes	Yes	
Shanks *et al.*, 2022 [63]	Globally		Yes				Yes	
Mahlangu *et al.*, 2019 [38]	South Africa		Yes				Yes	
Gooding *et al.*, 2022 [64]	Globally		Yes	Yes			Yes	

OH=One Health

of climate change, population growth, and urbanization, as well as increasing human–animal interaction with their ecosystem. However, health outcomes depend on the social, economic, political, and physical environment in which humans and animals live and grow [17]. Although access to healthcare services has improved, health outcomes of the population are not met due to illiteracy concerning zoonotic diseases and their transmission [58, 66].

In this review, it has been noted that the benefits and challenges are similar across regions. In this context, countries need to promote OH to enhance disease prevention, early detection, and control at their source. Strengthen cooperation and synergies between sectors to prevent, control, and respond to public health threats. This process of mitigating health risks requires systems thinking and a holistic approach through community engagement, involving multiple sectors, and a multidisciplinary approach over and above the efforts made by the Ministry of Health [25]. A holistic and collaborative OHA promotes sustainable practices and addresses environmental issues, such as pollution, deforestation, and climate change, with a view to protecting ecosystems and biodiversity, thereby contributing to improved human and animal health [59–61]. Given the importance of animal health and well-being, it is necessary to promote animal health practices, including vaccination programs, disease monitoring, and antimicrobial use, to improve human well-being. Therefore, through this study, countries are recommended to efficiently allocate resources to help prevent the spread of diseases among animals and humans [67, 68].

OH operationalization

Since ancient times, OH has been used to promote a collaborative approach to health issues that link humans, animals, and the environment [11]. Calvin W. Schwabe, the father of veterinary epidemiology, introduced the concept of "one medicine" involving veterinary medicine and human health. This requires an integrated human and veterinary approach in the fight against zoonotic diseases, thus providing a modern foundation for OH [69]. Due to the interconnectedness between human and veterinary medicine, collaboration was emphasized to effectively cure, prevent, and control illnesses that affect both humans and animals [18].

In view of increasing health risks, an agenda for innovative multisectoral cooperation to address public health risks was given a global priority in 2003 [70]. Understanding the links between human, animal, and environmental health allows countries to proactively plan measures to prevent the emergence and spread of diseases, including zoonotic diseases, through multisectoral coordination [61, 71]. The FAO–OIE–WHO Tripartite, which has recently joined the UNEP to form a quadripartite, has established a multisectoral coordination mechanism in which relevant OH sectors

work harmoniously together to prevent and respond to health risks at human, animal, and environmental interfaces [19, 72].

The OHA has become an important tactic for addressing public health risks worldwide [16], as observed in this study. To effectively respond to emerging and re-emerging threats [31, 73], it guides and directs the development of coordination, collaboration, communication, and capacity among humans, animals, agriculture, and the environment. The international ministerial conference on avian and pandemic influenza (2007), held in New Delhi, encouraged governments to improve the OH concept and coordination by strengthening the links between human and animal health systems for pandemic preparedness and human security, as well as to involve a high political level and the sharing of resources in response to pandemics [64, 74]. At international, regional, and national levels, it is important to strengthen OH and coordination mechanisms to prevent the impact of outbreaks, such as the COVID-19 pandemic, the Ebola outbreak in West Africa, the recent Marburg disease outbreak in Uganda and Tanzania, and other public health concerns. Prevention and control of zoonotic diseases, AMR, food safety, climate change, and its contributing social determinants of health require an integrative effort of sectors beyond the health sector as 60% of infectious agents originate from animals [11, 28, 35].

Establishing mechanisms for regular communication, strengthening mutual trust, and building relations between sectors enhance cooperation [62]. Promoting interdisciplinary training programs, such as short courses, will also improve the understanding of OH and build capacity across sectors to respond to public health risks [35, 49]. Operationalization of OH requires the engagement of professionals and other stakeholders, including policy and decision-makers, as well as the community, for effective prevention, mitigation, and response actions [16]. In particular, creating awareness among these groups will make them think, advocate, and commit efforts to the application of OH in addressing public health risks [75].

Despite having technical competencies, a change of mindset is a key component for improving multisectoral coordination and collaboration between government sectors and other stakeholders at all levels [21, 26]. That means a transformational change in the usual ways of performing activities (business-as-usual mindset) and a transformation by new knowledge based on evidence-based practice is mandatory for professionals [76]. In addition, countries must make efforts to bridge professional silos by promoting cooperation between stakeholders in a bottom-up manner. However, building capacities and social accountability in surveillance, early detection, data sharing, and responding to health threats that are currently missing or limited are very important [16, 53].

Multisectoral coordination

Multisectoral coordination brings together experts from different sectors, agencies, and disciplines to address complex challenges at the human–animal–environmental interface [3]. These integrative efforts increase the sharing of scarce resources and expertise, reduce duplication of efforts, and thus create new innovative solutions to complex challenges [38]. However, the achievement of the sustainable development agenda by 2030 focuses on a holistic approach to understanding and addressing health risk and its social determinants. Therefore, countries and sectors must apply system thinking to improve human, animal, plant, environment, and ecosystem health [77].

In addition, countries have been failing to solve health threats, including health risk determinants [8, 78] due to the siloed mentality of addressing issues and rigidity in adopting changes [3]. In many countries, working independently has delayed the early detection and response to health challenges. Breaking the boundaries of a siloed working mentality between sectors will transform countries in terms of preventing health risks and sustaining life [79]. In addition, countries need to harmonize vertical (disease-focused) and horizontal (systems-focused) programs to ensure consistency of agreed objectives and interests in health outcomes, not only for disease-specific but also for addressing social determinants [78].

OH institutionalization and policy integration

In addition to strengthening coordination and the OHA, countries need to adequately balance priorities and policies and build mutual trust in resource sharing between sectoral ministries with cross-cutting issues that require political influence [80, 81]. The involvement of decision-makers and policymakers can also support future changes in government policies and systems [62, 82, 83]. Joint OH priority activities in developing countries can improve disease control efficiency. For example, different priorities have been observed in the livestock sector compared to the human sector in the control of rabies diseases, which have less impact on livestock production but a high impact on human health [21]. In fact, an effective coordination mechanism depends on how sectors adopt change and apply policies available to strengthen governance structures and systems. Non-health sectors play a significant role in improving health for sustainable development [38, 66]. However, mutual agreement on resource allocation and coordination efforts is needed to reduce duplication of efforts in the same geographic area or sector [11, 65].

Conclusion

OHA is important for responding to public health threats around the world. Therefore, this study calls on countries to prioritize operationalization of OH and collaboration among sectors. It is time for countries to strengthen the OHA to promote early disease detection and prevention. It improves public health, improves animal health and well-being, promotes environmental

protection, promotes interdisciplinarity optimizes resource allocation, and strengthens resilience to emerging health threats. In addition, multisectoral coordination plays a crucial role in the effective management of public health threats through the OHA. Countries need to create effective means of regular communication, promote mutual trust, and strengthen relations between sectors. Promoting interdisciplinary OH training programs to improve understanding and facilitate effective communication and sharing of information across sectors will also improve the implementation of OH.

To better operationalize OH, countries need to involve policy and decision-makers, institutionalize OH, and develop integrated guidelines and policies to enhance future mitigation of zoonoses and infectious disease pandemics [44]. This will, however, help break the boundaries of siloed working mentality between sectors and transform countries into better ways of sharing information and early detection and prevention. Therefore, it is necessary to strengthen the commitment of governments to promote adequate funding and resource allocation to support prevention activities and coordinated responses not only in the health sector but also in the animal sector, where pathogenic agents originate. Investing more knowledge in the community on social determinants of health will contribute to the prevention of health threats, which will start at the grassroots. In view of the similarities of challenges across the globe, a high level of government commitment to support potential solutions to the challenges faced in their practical implementation is, therefore, crucial to improve the overall response to public health threats, thus ensuring human, animal, and environmental health.

Authors' Contributions

VTS: Designed and conceptualized the study, analyzed the data, and writing of the manuscript. EDK and ASH: Conceptualized and designed the study and reviewed and edited the manuscript. All authors have read, reviewed, and approved the final manuscript paper for submission.

Acknowledgments

The authors are thankful to experts from the Sokoine University of Agriculture for their comments and suggestions. Further, we extend our acknowledgment to the Prime Minister's Office, Disaster Management Department, for granting time to conduct this study. No funding was received for this study from any grant or funding agencies in the public, commercial, or non-profit sectors.

Competing Interests

The authors declare that they have no competing interests.

Publisher's Note

Veterinary World (Publisher of International Journal of One Health) remains neutral with regard to jurisdictional claims in published institutional affiliation.

References

1. Sinclair, J.R. (2019) Importance of a one health approach in advancing global health security and the sustainable development goals. *Rev. Sci. Tech*., 38(1): 145–154.
2. Mohan, B.S. and Nambiar, V. (2020) COVID-19: An insight into SARS-CoV-2 pandemic originated at Wuhan City in Hubei province of China coronaviruses. *J. Infect. Dis. Epidemiol*., 6(4): 146.
3. Ladbury, G., Allan, K.J., Cleaveland, S., Davis, A., de Glanville, W.A., Forde, T.L., Halliday, J.E.B., Haydon, D.T., Kibiki, G., Kiwelu, I., Lembo, T., Maro, V., Mmbaga, B.T., Ndyetabura, T., Sharp, J., Thomas, K. and Zadoksa, R.N. (2017) One health research in Northern Tanzania - challenges and progress. *East Afr. Health Res. J*., 1(1): 8–18.
4. Cunningham, A.A., Daszak, P. and Wood, J.L.N. (2017) One Health, emerging infectious diseases and wildlife: Two decades of progress? *Philos. Trans. R. Soc. B Biol. Sci.*, 372(1725): 20160167.
5. Coltart, C.E.M., Lindsey, B., Ghinai, I., Johnson, A.M. and Heymann, D.L. (2017) The Ebola outbreak, 2013–2016: Old lessons for new epidemics. *Philos. Trans. R. Soc. B Biol. Sci*., 372(1721): 20160297.
6. Peters, L., Greene, C., Azziz-Baumgartner, E., Zhou, S., Lupisan, S., Dayan, W., Hammond, A., Claes, F., Mumford, E. and Dueger, E. (2018) Strategies for combating avian influenza in the Asia-Pacific. *Western Pac. Surveill. Response J*., 9(5 Suppl 1): 8–10.
7. The World Bank. (2018) Operational Framework for Strengthening Human, Animal, and Environmental Public Health Systems at their Interface. World Bank Report Number: 122980-GLB International Bank for Reconstruction and Development/The World Bank, p1–152. Available from: https://documents.worldbank.org/curated/en/703711517234402168/operational-framework-forstrengthening-human-animal-and-environmental-public-health-systems-at-their-interface. Retrieved on 12-10-2023.
8. Nzietchueng, S., Kitua, A., Nyatanyi, T. and Rwego, I.B (2023) Facilitating implementation of the one health approach: A definition of a one health intervention. *One Health*, 16: 100491.
9. Humboldt-Dachroeden, S.M. and Mantovani, A. (2021) Assessing environmental factors within the one health approach. *Medicina* (*Kaunas*), 57(3): 240.
10. Munyua, P.M., Njenga, M.K., Osoro, E.M., Onyango, C.O., Bitek, A.O., Mwatondo, A., Muturi, M.K., Musee, N., Bigogo, G., Otiang, E., Ade, F., Lowther, S.A., Breiman, R.F., Neatherlin, J., Montgomery, J. and Marc-Alain Widdowson, M. (2019) Successes and challenges of the One Health approach in Kenya over the last decade. *BMC Public Health*, 19(Suppl 3): 465.
11. Lee, K. and Brumme, Z.L. (2013) Operationalizing the One Health approach: The global governance challenges. *Health Policy Plan*., 28(7): 778–785.
12. Romanelli, C., Cooper, D., Campbell-Lendrum, D., Maiero, M., Karesh, W.B., Hunter, D. and Golden, C.D. (2015) Connecting global Priorities: Biodiversity and Human Health, a State of Knowledge Review. World Health Organization and Secretariat for the Convention on Biological Diversity. World Health Organization, Geneva, p360.
13. Fasina, F.O., Fasanmi, O.G., Makonnen, Y.J., Bebay, C., Bett, B. and Roesel, K. (2021) The one health landscape in Sub-Saharan African countries. *One Health*, 13: 100325.
14. Romanelli, C., Cooper, H.D. and Dias, B.F.D.S. (2014) The integration of biodiversity into One Health. *Rev. Sci. Tech*., 33(2): 487–496.
15. Acharya, K.P., Subramanya, S.H. and Neupane, D. (2021)

Emerging pandemics: Lesson for one-health approach. *Vet. Med. Sci*., 7(1): 273–275.
16. Amri, M., Chatur, A. and O'Campo, P. (2022) Intersectoral and multisectoral approaches to health policy: An umbrella review protocol. *Health Res. Policy Syst*., 20(1): 21.
17. Ssennyonjo, A., Van Belle, S., Titeca, K., Criel, B. and Ssengooba, F. (2021) Multisectoral action for health in low-income and middle- income settings: How can insights from social science theories inform intragovernmental coordination efforts? *BMJ Glob. Health*, 6(5): e004064.
18. Bresalier, M., Cassidy, A. and Woods, A. (2021) One Health in History. One Health: The Theory and Practice of Integrated Health Approaches. 2nd ed. CAB International, United Kingdom, p 1–14.
19. OIE, WHO, FAO. (2019) A Tripartite Guide to Addressing Zoonotic Diseases in Countries Taking a Multisectoral, One Health Approach. OIE, Paris.
20. WOAH, WHO, FAO and UNEP, (2022) One Health Joint Plan of Action (2022-2026). WOAH, Paris.
21. Gongal, G. (2013) One Health Approach in the South East Asia Region: Opportunities and Challenges. *Curr. Top. Microbiol. Immunol*., 366: 113–122.
22. Reid, S.A., Mckenzie, J. and Woldeyohannes, S.M. (2016) One Health research and training in Australia and New Zealand. *Infect. Ecol. Epidemiol.*, 6: 1–9.
23. Page, M.J., McKenzie, J.E., Bossuyt, P.M., Boutron, I., Hoffmann, T.C., Mulrow, C.D., Shamseer, L., Tetzlaff, J.M., Akl, E.A., Brennan, S.E., Chou, R., Glanville, J., Grimshaw, J.M., Hróbjartsson, A., Lalu, M.M., Li, T., Loder, E.W., Mayo-Wilson, E., McDonald, S., McGuinness, L.A., Stewart, L.A., Thomas, J., Tricco, A.C., Welch, V.A., Whiting, P. and Moher, D. (2021) The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372(71): n71.
24. Zakham, F., Alaloui, A., Levanov, L. and Vapalahti, O. (2019) Viral haemorrhagic fevers in the Middle East. *Rev. Sci. Tech*., 38(1): 185–198.
25. Ng, Q.X., Lee, M., Qing, Z., Loke, W. and Yeo, W.S. (2020) Yemen' s cholera epidemic is a one health issue. *J. Prev. Med. Public Health*, 53(4): 289–292.
26. Kimani, T., Kiambi, S., Eckford, S., Njuguna, J., Makonnen, Y., Rugalema, G., Morzaria, S.P., Lubroth, J. and Fasina, F.O. (2019) Expanding beyond zoonoses: The benefits of a national One Health coordination mechanism to address antimicrobial resistance and other shared health threats at the human - animal - environment interface in Kenya. *Rev. Sci. Tech*., 38(1): 155–171.
27. Mremi, I.R., Rumisha, S.F., Sindato, C., Kimera, S.I. and Mboera, L.E.G. (2022) Comparative assessment of the human and animal health surveillance systems in Tanzania: Opportunities for an integrated one health surveillance platform comparative assessment of the human and animal health one health surveillance platform. *Glob. Public Health*, 18(1): 2110921.
28. Bansal, D., Jaffrey, S., Al-Emadi, N.A., Hassan, M., Md. Islam, M., Al-Baker, W.A.A., Radwan, E., Hamdani, D., Haroun, M.I., Enan, K., Nour, M., Coyle, P.V., Al Marri, A., Al-Zeyara, A.A., Younus, N.M., Yassine, H.M., Al Thani, A.A., Darkhshan, F., Khalid, M., Marhous, H., Tibbo, M., Alhosani, M., Taha, T., Wannous, C., Al Hajri, M., Bertollini, R., Abdullatif Al Khal, M.A.A., Eid Al Romaihi, H., Sheikh Al Thani, M.H.J., El Idrissi, A. and Abd Farag, E. (2023) A new One Health Framework in Qatar for future emerging and re-emerging zoonotic diseases preparedness and response. *One Health*, 16: 100487.
29. Allal, L., Mahrous, H., Saad, A., Refaei, S., Attia, M., Mahrous, I., Fahim, M., Elfadaly, S. and Abdelnabi, A. (2019) From four-way linking to a one health platform in Egypt: Institutionalisation of a multidisciplinary and multisectoral one health system the four-Way Linking Framework in Egypt. *Rev. Sci. Tech*., 38(1): 261–270.
30. Kitua, A.Y., Scribne, S., Rasmuson, M., Kambarage, D., Mghamba, J., Mwakapeje, E.R., Chinyuka, H., Bernard, J., Zimmerman, K., Duale, S. and Mutonga, D. (2019) Building a functional national One Health platform: the case of Tanzania. *One Health Outlook*, 1: 3.
31. Lebov, J., Grieger, K., Womack, D., Zaccaro, D., Whitehead, N., Kowalcyk, B. and MacDonald, P.D.M. (2017) A framework for One Health research. *One Health*, 3: 44–50.
32. Mor, N. (2023) Organising for One Health in a developing country. *One Health*, 17: 100611.
33. Kingsley, P. and Taylor, E.M. (2017) One health: Competing perspectives in an emerging field. *Parasitology*, 144(1): 7–14.
34. Alimi, Y. and Wabacha, J. (2023) Strengthening coordination and collaboration of one health approach for zoonotic diseases in Africa. *One Health Outlook*, 5(1): 10.
35. Ayobami, O., Mark, G., Kadri-Alabi, Z., Achi, C.R. and Jacob, J.C. (2021) COVID-19: An opportunity to re-evaluate the implementation of a One Health approach to tackling emerging infections in Nigeria and other sub-Saharan African countries. *J. Egypt. Public Health Assoc*., 96: 26.
36. Lokossou V.K., Atama, N.C., Nzietchueng, S., Koffi, B.Y., Iwar, V., Oussayef, N., Umeokonkwo, C.D., Behravesh, C.B., Sombie, I., Okolo, S. and Ouendo, E.M. (2021) Operationalizing the ECOWAS regional one health coordination mechanism (2016–2019): Scoping review on progress, challenges and way forward. *One Health*, 13: 100291.
37. Mbugi, E.V., Kayunze, K.A., Katale, B. Z., Kendall, S., Good, L., Kibik, G.S., Keyyu, J.D., Godfrey-Faussett, P., van Helden, P. and Matee, M.I. (2012) "One Health" infectious diseases surveillance in Tanzania: Are we all on board the same flight? *Onderstepoort J. Vet. Res*., 79(2): 500.
38. Mahlangu, P., Goudge, J. and Vearey, J. (2019) Towards a framework for multisector and multilevel collaboration: Case of HIV and AIDS governance in South Africa. *Glob. Health Action*, 12(1): 1617393.
39. Karamoy, A.S. Kalesaran, A.F.C. and Mantjoro, E.M. (2023) Implementation of the One Health approach in controlling rabies in Minahasa Regency, Indonesia. *Int. J. One Health*, 9(1): 32–42.
40. Phelps, K.L., Hamel, L., Alhmoud, N., Ali, S., Bilgin, R., Sidamonidze, K., Urushadze, L., Karesh, W., Kevin, J. and Olival, K.J. (2019) Gaps and opportunities in Western Asia. *Viruses*, 11(3): 240.
41. Liu, J., Li, X., Zhang, Q., Han, L., Xia, S., Kassegne, K., Zhu, Y., Yin, K., Hu, Q., Xiu, L., Wang, X., Li, O.Y., Li, M., Zhou, Z., Dong, K., He, L., Shu-Xun Wang, S., Yang, X., Zhang, Y., Guo, X., Li, S., Zhou, X. and Zhang, X. (2023) China' s application of the One Health approach in addressing public health threats at the human-animal-environment interface: Advances and challenges. *One Health*, 17: 100607.
42. Gongal, G., Ofrin, R.H., de Balogh, K., Oh, Y., Kugita, H. and Dukpa, K. (2020) Operationalization of One Health and tripartite collaboration in the Asia-Pacific region. *WHO South East Asia J. Public Health*, 9(1): 21–25.
43. Muhanga, M.I., Malungo, J.R.S. and Kimario, K.A. (2020) One Health Approach (OHA) in Selected Urban Settings in Tanzania: Knowledge, attitudes, awareness and practices one health approach (OHA) in selected urban settings in Tanzania: Knowledge, attitudes, awareness, and practices. *Tanzania Vet. J.*, 37: 64–74.
44. Onyango, N.D., Onguru, D.O. and Atieno, O.A. (2023) Effectiveness of multisectoral collaboration in implementation of One Health Approach for control of zoonoses in Kisumu, Kenya. *One Health Implement Res*., 3: 30–41.
45. Mbabu, M., Njeru, I., File, S., Osoro, E., Kiambi, S., Bitek, A., Ithondeka, P., Kairu-Wanyoike, S., Sharif, S., Gogstad, E., Gakuya, F., Sandhaus, K., Munyua, P., Montgomery, J., Breiman, R., Rubin, C. and Njenga, K. (2014) Establishing a One Health office in Kenya. *Pan Afr.*

Med. J., 19: 106.
46. Kayunze, K.A., Kiwara, A.D., Lyamuya, E., Kambarage, D.M., Rushton, J., Coker, R. and Kock, R. (2013) Utilisation of one health approaches in the surveillance and mitigation of risks of animal derived infections in Tanzania: Attitudinal profiles of human and animal health experts by and animal health experts. *Greener J. Med. Sci.*, 3(6): 233–239.
47. Mouiche, M.M.M., Moffo, F., Akoachere, J.T.K., Okah-Nnane, N.H., Mapiefou, N.P., Ndze, V.N., Wade, A., Djuikwo-Teukeng, F.F., Toghoua, D.G.T., Zambou, H.R., Feussom, J.M.K., LeBreton, M. and Awah-Ndukum, J. (2019) Antimicrobial resistance from a one health perspective in Cameroon: A systematic review and meta-analysis. *BMC Public Health*, 19(1): 1135.
48. Stephen, K.J., Assenga, J., Jubilate Bernard, J., Eblate, E., Mwakapeje, E., Mghamba, J., Chinyuka, H. and Kambarage, D. (2022) After-action review of rabies and anthrax outbreaks multi- sectoral response in Tanzania, challenges and lessons. *J. Public Health Afr*., 13(2): 2023.
49. Mtui-Malamsha, N., Assenga, J., Swai, E., Msemwa, F., Makungu, S., Chinyuka, H., Bernard, J., Sallu, R., OleNeselle, M., Ponsiano, E., Kazwala, R., Kimera, S., Nonga, H. and Fasina Folorunso, F. (2020) Subnational operationalization of One Health: Lessons from the establishment of One Health rapid response teams in Tanzania. *Trans. R. Soc. Trop. Med. Hyg*., 114(7): 538–540.
50. Kelly, T.R., Machalaba, C., Karesh, W.B., Crook, P.Z., Gilardi, K., Nziza, J., Uhart, M.M., Robles, E.A., Saylors , K., Joly, D.O., Monagin, C., Mangombo, P.M., Kingebeni, P.M., Kazwala, R., Wolking, D., Smith, W., PREDICT Consortium. and Mazet, J.A.K. (2020) Implementing One Health approaches to confront emerging and re-emerging zoonotic disease threats: Lessons from PREDICT. *One Health Outlook*, 2: 1.
51. United Republic of Tanzania. (2018) National Strategy for Prevention and Control of Anthrax in Humans and Animals 2018 - 2023. United Republic of Tanzania, Tanzania, p1–40.
52. United Republic of Tanzania. (2019) The National Rabies Control Strategy. United Republic of Tanzania, Tanzania, p1–84.
53. Kakkar, M., Chauhan, A.S., Bahl, T. and Rahi, M. (2019) Opportunities for One Health policies to reduce poverty. *Rev. Sci. Tech*., 38(1): 135–144.
54. MOHCDGEC. (2021) Health Sector Strategic Plan. United Republic of Tanzania, Tanzania, p1–98.
55. Ahmed, T., Tahir, F.M., Boden, L. and Kingston, T. (2023) Future directions for One Health research: Regional and sectoral gaps. *One Health*, 17: 100584.
56. Errecaborde, K.M., Macy, K.W., Pekol, A., Perez, S., O'Brien, M.K., Allen, I., Contadini, F., Lee, J.Y., Mumford, E., Bender, J.B. and Pelican, K. (2019) Factors that enable effective One Health collaborations - A scoping review of the literature. *PLoS One*, 14(12): e0224660.
57. Wu, C., Astbury, C.C., Lee, K.M., Gong, Z., Chen, S., Li, A., Tsasis, P. and Penney, T. (2023) Public awareness of One Health in China. *One Health*, 17: 100603.
58. Li, H., Chen, Y., Machalaba, C.C., Tang, H., Chmura, A.A., Fielder, M.D. and Daszak, P. (2021) Wild animal and zoonotic disease risk management and regulation in China: Examining gaps and One Health opportunities in scope, mandates, and monitoring systems. *One Health*, 13: 100301.
59. Mshana, S.E., Matee, M. and Rweyemamu, M. (2013) Antimicrobial resistance in human and animal pathogens in Zambia, Democratic Republic of Congo, Mozambique and Tanzania: An urgent need of a sustainable surveillance system. *Ann. Clin. Microbiol. Antimicrob*., 12: 28.
60. Reid, S.A., Rodney, A., Kama, M. and Hill, P.S. (2017) A process for developing multisectoral strategies for zoonoses: The case of leptospirosis in Fiji. *BMC Public Health*, 17(1): 671.
61. Mackenzie, J.S. (2019) The one health approach - why is it so important? *Trop. Med. Infect. Dis*., 4(2): 88.
62. Kayunze, K.A., Kiwara, A., Lyamuya, E., Kambarage, D.M., Rushton, J., Coker, R. and Kock, R. (2014) Practice of One Health approaches: Bridges and barriers in Tanzania. *Onderstepoort J. Vet. Res*., 81(2): E1–E8.
63. Shanks, S., Van Schalkwyk, C.I. and Cunningham, A.A. (2022) Viewpoint A call to prioritise prevention: Action is needed to reduce the risk of zoonotic disease emergence. *Lancet Reg. Health Eur*., 23: 100506.
64. Gooding, K., Bertone, M.P., Loffreda, G. and Witter, S. (2022) How can we strengthen partnership and coordination for health system emergency preparedness and response? Findings from a synthesis of experience across countries facing shocks. *BMC Health Serv. Res*., 22(1): 1441.
65. Salunke, S. and Lal, D.K. (2017) Multisectoral approach for promoting public health. *Indian J. Public Health*, 61(3): 163–168.
66. Mumford, E.L., Martinez, D.J., Tyance-Hassell, K., Cook, A., Hansen, G.R., Labonté, R., Mazet, J.A.K., Mumford, E.C., Rizzo, D.M., Togami, E., Vreedzaam, A. and Parrish-Sprowl, J. (2023) Evolution and expansion of the One Health approach to promote sustainable and resilient health and well-being: A call to action. *Front. Public Health*, 10: 1056459.
67. Barrett, M.A., Bouley, T.A., Stoertz, A.H. and Stoertz, R.W. (2011) Integrating a one health approach in education to address global health and sustainability challenges. *Front. Ecol. Environ*., 9(4): 239–245.
68. O'Brien, M.K., Macy, K.W., Pelican, K., Perez, A.M. and Errecaborde, K.M. (2019) Transforming the One Health workforce: Lessons learned from initiatives in Africa, Asia and Latin America What is One Health workforce development? *Rev. Sci. Tech*., 38(1): 239–250.
69. Schwabe, C.W. (1984) Veterinary Medicine and Human Health. 3rd ed. Williams and Wilkins, Baltimore.
70. United Republic of Tanzania. (2015) The United Republic of Tanzania One Health Strategic Plan 2015 – 2020, United Republic of Tanzania, Tanzania, p1–66.
71. Taaffe, J., Sharma, R., Parthiban, A.B.R., Singh, J., Kaur, P., Singh, B.B., Gill, J.P.S., Gopal, D.R., Dhand, N.K. Falgunee, K. and Parekh, F.K. (2023) One health activities to reinforce intersectoral coordination at local levels in India. *Front. Public Health,* 11: 1041447.
72. WOAH, UNEP, WHO, FAO. (2021) One Health High- Level Expert Panel, OHHLEP Annual Report. Available from: https://www.who.int/publications/m/item/one-health-high-level-expert-panel-annual-report-2021. Retrieved on 03-07-2023.
73. Järhult, J.D. (2018) Environmental resistance development to influenza antivirals: A case exemplifying the need for a multidisciplinary One Health approach including physicians. *Acta Vet. Scand.*, 60(1): 6.
74. Monto, A.S. and Whitley, R.J. (2008) Seasonal and pandemic influenza: A 2007 update on challenges and solutions. *Clin. Infect. Dis*., 46(7): 1024–1031.
75. Muhanga, M.I. and Malungo, J.R.S. (2018) Health literacy and its correlates in the context of one health approach in Tanzania. *J. Coop. Bus. Stud*., 1(1): 1.
76. Willingham, A.L., Cruz-Martinez, L., Scorpio, D.G. and Gallagher, C.A. (2016) Global solutions to regional challenges: Bridging the one health divide in the Caribbean. *One Health*, 2: 8–10.
77. Worsley-Tonks, K.E.L., Bender, J.B., Deem, S.L., Ferguson, A.W., Fèvre, E.M., Martins, D.J., Muloi, D.M., Murray, S., Mutinda, M., Ogada, D., Omondi, G.P., Prasad, S., Wild, H., Zimmerman, D.M. and Hassell, J.M. (2022) Viewpoint Strengthening global health security by improving disease surveillance in remote rural areas of low-income and middle- income countries. *Lancet Glob. Health*, 10(4): e579–e584.
78. Adeleye, O.A. and Ofili, A.N. (2010) Strengthening intersectoral collaboration for primary health care in developing

countries: Can the health sector play broader roles? *J. Environ. Public Health*, 2010: 272896.

79. Belay, E.D., Kile, J.C., Hall, A.J., Barton-Behravesh, C., Parsons, M.B., Salyer, S. and Walke, H. (2017) Zoonotic disease programs for enhancing global health security. *Emerg. Infect. Dis*., 23(13): S65–S70.
80. Johnston, R.B. (2016) Transforming Our World: The 2030 Agenda for Sustainable Development. Arsenic Research and Global Sustainability. In: Proceedings of the 6th International Congress on Arsenic in the Environment, AS, p12–14.
81. Zinsstag, J., Abakar, M.F., Ibrahim, M., Tschopp, R. and Crump, L. (2016) Cost-effective control strategies for animal and zoonotic diseases in pastoralist populations. *Rev. Sci. Tech*., 35(2): 673–681.
82. Bardosh, K.L. Scoones, J.C., Grace, D., Kalema-Zikusoka, G., Jones, K.E., de Balogh, K., Waltner-Toews, D., Bett, B., Welburn, S.C., Mumford, E. and Dzingirai, V. (2017) Engaging research with policy and action: What are the challenges of responding to zoonotic disease in Africa? *Philos. Trans. R. Soc. Lond. B Biol. Sci.*, 372(1725): 20160172.
83. Pelican, K., Salyer, S.J., Barton Behravesh, C., Belot, G., Carron, M., Caya, F., De La Rocque, S., Errecaborde, K.M., Lamielle, G., Latronico, F., Macy, K.W., Mouille, B., Mumford, E., Shadomy, S., Sinclair, J.R., and Dutcher, T. (2019) Synergising tools for capacity assessment and One Health operationalisation. *Rev. Sci. Tech*., 38(1): 71–89.

****