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REVIEW ARTICLE

Prioritizing Zoonotic Diseases in a One Health Framework: Oman Perspectives

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Abstract

Many countries around the world have embraced the One Health strategy to give priority to zoonotic diseases. However, the lack of information on the impact of these diseases and the lack of cooperation between the public and private sectors are hindering the effective implementation of One Health. In Oman, there are protocols for collaboration, but zoonotic diseases continue to be a problem, possibly because these collaborations are not backed by scientific data. There is a pressing need for a systematic approach to prioritize zoonotic diseases in order to guide research and public health initiatives. This study offers a comprehensive and innovative model for prioritizing zoonotic diseases in a country that is experiencing rapid economic development, urbanization, and a largely traditional way of life. By recognizing the interconnectedness of human, animal, and environmental health, this model can effectively direct research and investments in public and animal health. Furthermore, it emphasizes the importance of data-driven decision making and calls for enhanced cooperation among all stakeholders involved. With this evidence-based approach, Oman can proactively address the challenges posed by zoonotic diseases and pave the way for a healthier future.

Keywords

Brucellosis, One Health, Oman, Zoonotic diseases

Introduction

Zoonotic diseases, those transmitted from animals to people, have become an increasing area of focus for research, policy, and practice as a result of global trends. Zoonotic diseases account for approximately 60% of all communicable diseases and 75% of emerging infectious diseases globally (Awaidy SA et al.). In the Eastern Mediterranean Region and particularly in Oman, where humans, animals, and the environment are interlinked and in close contact in a wide variety of disease ecosystems, the One Health approach has become increasingly important [1-2]. In 2018, ten zoonotic diseases were listed as priorities; diseases that either are present in or have the potential to emerge in Oman are among them, such as MERS - CoV, brucellosis, rabies, and Rift Valley Fever, in addition to a few listed in the priority research areas [3-4]. This paper aims to provide an overview of both the One Health applicable frameworks and a situation analysis of zoonotic diseases in Oman. It also introduces how these perspectives fit into Oman's health policies and plans for various sectors. Four zoonotic diseases are addressed: Middle East Respiratory Syndrome, brucellosis, rabies, and Crimean Congo Hemorrhagic Fever. Finally, the paper details how other countries have utilized prioritization to shape health policy and practice. Emerging infectious diseases are an increasing area of concern, with zoonotic diseases contributing a significant component of EIDs. Accordingly, there has been an increasing interest in zoonotic diseases, particularly in relation to public and animal health and environmental security [1,5]. Grand challenges have been proposed in One Health reports because of the interconnectedness that perpetuates the occurrence of zoonotic health threats. There is an emerging worldwide trend in which different sectors are increasingly building mechanisms and common frameworks for operational collaboration

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in the prevention and control of zoonotic diseases that cross the human-animal-environmental interface [6-7].

Understanding Zoonotic Diseases

Zoonotic diseases are diseases and infections that are naturally transmitted between vertebrate animals and humans. The mode of transmission may be healthy carriers or may be transmitted through direct contact or indirectly via contaminated environments. The occurrence of zoonotic diseases is triggered by various factors, either intrinsic or extrinsic, of which the causative agents are mainly bacteria, fungi, parasites, viruses, and/or pathogenic agents [8-10]. Besides, a type of disease may have different strains within the same species or a different species of animals and has the potential to be transmitted to humans with variable morbidity or mortality rates. The spectrum of global and local public health, including developing, emerging, and unpredictable zoonotic diseases, is acknowledged [11-13]. Zoonotic diseases are characterized by a number of mechanisms underlying their occurrence and may involve a single or multi-host sharing a complex ecosystem. Besides, disease emergence shows the clinical aspects of epizoonosis and epizootics phenomena [14-15]. The health of animals is closely related to humans and has laid one of the foundations of the One Health principles, which share the philosophical concept between public health practices and veterinary health in its management. Maintaining or monitoring the One Health concept can lead to greater awareness and offset the socio-economic implications of public health and animal sectors, particularly for animal husbandry and related industries [16-17]. Several strategies promote partnerships and collaboration between veterinarians in obvious ways, including animal husbandry, shelter teams, wildlife protection, technical staff, health administrators, government officials, and ministries responsible for planning to be prepared by both veterinarians and medical associations, easing the transition for newly diagnosed zoonoses or the re-emergence of unusual zoonotic diseases [18-20]. Fifty to seventy percent of emerging infectious diseases and zoonotic diseases occur at the wild animal interface in harmony with environmental dynamics. After the 20th century, zoonotic diseases became a global concern, caused inter alia by rapid globalization and urbanization, favorable climatic conditions, increasing volume of tourists traveling to new endemic areas, and increased transboundary animal diseases [1]. Mammals are known to be responsible for 33% of all zoonotic viruses. The most common zoonotic diseases are caused by pathogens inherited from the pink quadrant, including the genera *Brucella spp, Erysipelothrix spp, Leptospira spp, Mycobacterium spp, and Toxoplasma spp* [9-10]. Human anthrax has a lower zoonotic index but is widely distributed in nature. Canine rabies in Oman is classified as a negatively affected disease caused by non-infecting viruses and local strains reported, and it has a negative effect on human health. The same facility routinely reported human inhalation brucellosis, the most common zoonotic disease in southern border regions [3, 21-22]. The increased number of human brucellosis cases was noted in 1881, approximately 10 years before the eradication of animal control brucellosis, mainly occurring via human consumption of red meat and dairy products. Zoonotic tuberculosis is endemic in Oman on dairy farms in the region of Al Batinah North, in fertile soils with heavy rain crops and water buffalo, and has a human infection rate of 15-20% due to animal linkage. There is also documentation of human alveolar echinococcosis disease due to wild carnivore hydatid tapeworm eggs infesting the soil and water, leading to the spread of parasitic eggs, which are the only source of human infection [23].

The One Health Approach

The emergence of the One Health concept in the early 2000s marked a crucial step towards addressing zoonotic diseases. One Health is the integrative effort of multiple disciplines to achieve optimal health for people, animals, and the environment. It is an approach that targets and promotes the collaboration and cooperation of various sectors in health and represents the mutual goals of human, animal, and environmental health [24-25]. The close interconnection between the health of people, animals, and their environment was increasingly recognized not only as a crucial issue for developing countries but also in developed countries. The threats of novel zoonotic diseases and bioterrorism exerted additional pressure on the establishment of One Health. There have been successful models of implementation of the One Health approach in different parts of the world and across multiple levels of stakeholders involved [16, 26-27]. While the global adoption of One Health as the most practical pathway for improving and effectively preventing zoonoses is promoted by a few advocates, it is also critical that there is policy encouragement. One Health has been a dominant issue internationally and has the potential to identify where it can potentially be applied in Oman with the likely associated benefits [24]. In Oman, a holistic dimension of health is implicitly achieved through the Ministry of Agriculture and Fisheries' Department of Animal Health, which is responsible for implementing programs for controlling animal diseases, animal welfare, breeding programs, and controlling livestock feed quality. However, the concept of One Health is only explicitly achieved by the Ministry of Health in the proposed Oman One Health initiative involving two key sectors, the Ministry of Health and the Ministry of Agriculture and Fisheries, and one collaborating agency, the Public Authority for Consumer Protection [28].

Zoonotic Diseases in Oman

Oman is currently facing a wide range of zoonotic diseases, which are diseases of animals that can be transmitted to humans. Zoonotic diseases pose a problem in Oman due to existing favorable conditions for the transmission of these diseases. Oman has a varied and unique topography and climate, with diverse and complex patterns of precipitation and temperature, all of which contribute to attracting high numbers of migratory birds [3-4,29]. Such conditions increase the risk of exogenous zoonotic infections resulting from contact with wildlife, including diseases such as avian influenza. The human-wildlife interface is also influenced by cultural and ecological conditions. Hunting wild animals and carrying out livestock husbandry and cultivation are important sources of income and forms of relaxation in Oman [30-32]. The handling, slaughtering, transportation, preparation, and consumption of wildlife and livestock carry an associated increase in risk. Many Omani families also keep non-domesticated animals as pets, such as houbara bustards, cats, and camels. These animals interact with humans and can be infected with infectious diseases [1,32]. Pathogens that are transmitted between animals can also have a significant effect on human health in the form of zoonotic diseases. Not only can zoonotic diseases infect humans, resulting in high morbidity and mortality rates among the country's citizens and tourists, but they also contribute to economic loss. Zoonotic diseases can, either directly or indirectly, infect uninfected livestock, wildlife, farmworkers, tour operators, etc [9,12,33]. The implementation of zoonotic disease control and elimination strategies in countries can benefit their citizens and the country by reducing the health and economic impact of infectious diseases. People living in close contact with wild animals can become infected with zoonotic pathogens. Some traditional human practices in the Arabian Peninsula can be predisposing factors for contracting zoonotic diseases in humans. For example, many people in the Arabian Peninsula have close relationships with camels and consume their products. These infections might be underreported in humans living at the animal–human interface through community practices or occupational exposure [3-4,21,30].

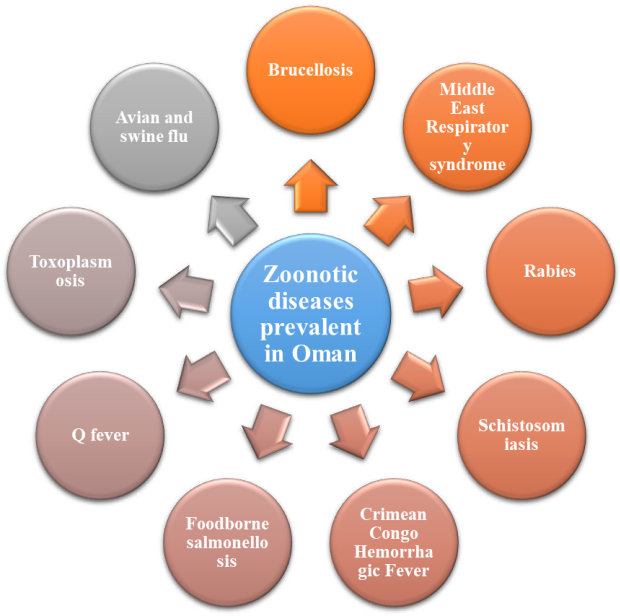

Figure 1. Common zoonotic diseases recognized under One Health framework in Oman.

Epidemiology and Impact

Oman, located in the southeastern corner of the Arabian Peninsula, is characterized by a unique combination of a hot desert climate in the interior region and a semi-humid to hot and humid climate in coastal areas. There were expected to be 303.36 cases of zoonotic diseases per 100,000 populations in Oman [34]. Zoonotic diseases do occur in humans in Oman every year, with brucellosis, rose rosette, and Crimean Congo hemorrhagic fever virus being zoonotic agents with the highest incidence rates [4]. Humans cohabit with millions of animals, including exotic and companion animals, in different ecological systems. An outbreak of a zoonosis can have significant economic and socio-political implications on both public health and livestock production systems [3-4, 21]. The severe consequences are often the result of the enormous losses associated with the destruction of animals in affected areas, which could decrease the income and livelihood of large rural areas and lead to an unemployment crisis. In addition, diseases cause an enormous economic burden and seriously damage the output value of Omani agricultural production [35-37]. Previous studies conducted in Oman have reported human, animal, and sociodemographic factors associated with the epidemiology of brucellosis, Q fever, and severe enterovirus D68 outbreaks. Rainfall and per capita income have been identified as independent determinant factors. Animals support livelihoods and play crucial roles in many areas of need, including the provision of food, clothing, and employment opportunities among participants [4,38-39]. Zoonotic diseases can be common and significantly impact human, animal, and environmental health systems. In addition to the general public, the management of these diseases can severely affect Oman's relevant populations such as animal handlers, forest herders, and guests visiting rural and natural areas. Such incidents can result in the need for extensive monitoring and disease control actions and can be a significant drain on healthcare resources [29, 40-41]. Additionally, the necessity for a complete understanding of the ecological systems, including the diseases that affect them, is essential to effectively implement human welfare programs in this area. Getting a systematic detection of the development and occurrence of the diseases may allow early warning and quick treatment, thus preventing chronic disability.

Outbreaks of exotic zoonotic diseases are commonly observed in countries such as Oman, and livestock populations in some instances help in damping the spread of such diseases to the international community [4,41-42]. Furthermore, Oman is not exempt from the cyclical re-emergence of previously controlled diseases due to the global link between the Omani market and those of the world. This perspective also covers the infectious zoonotic agents and their causative diseases, particularly those subclinical forms seen in animals. Understanding the progression of zoonotic diseases inside Oman will necessitate a thorough examination of the social factors that coincide with their expansion. Climatic factors, including changes brought about by the changing climate, should also be more closely studied to understand the progression of the diseases [4,39-40].

Key Zoonotic Diseases in Oman

A range of bacterial, viral, and parasitic zoonotic diseases prevail in Oman, which are of major public health concern. Animal-associated foodborne diseases such as brucellosis, cystic hydatid disease, and leptospirosis are of considerable health and economic importance [43-46]. The bacterial agents responsible for these diseases are very commonly present among livestock populations in the country, and they are also implicated in abortions and stillbirths in animals. Cameroon sheep and goats are important sources of meat and milk in Oman; therefore, diseases endemic in these animals may be transmitted to consumers [47-50]. The consumption of raw camel milk and undercooked camel meat parts also facilitates the transmission of bovine tuberculosis, brucellosis, and cystic hydatid disease from animals to humans. Furthermore, the role of wildlife as potential zoonotic pathogen reservoirs in Oman is largely unknown [51-54]. Brucellosis is widespread, affecting multiple production animal species in Oman, and it has also been reported in humans. Bovine tuberculosis is a major livestock problem in Oman. Leptospirosis continues to be reported in animals in Oman, and human cases of leptospirosis are sporadic in countries like Oman due to a lack of diagnostic facilities [3-4,39,41]. Rabies has emerged as an important zoonotic viral encephalitis in Oman. There is very little information available on the epidemiology and public health impact of other zoonotic agents in Oman, such as *Rift Valley fever virus, Alkhurma hemorrhagic fever virus, Coxiella burnetii*, and *Middle East respiratory syndrome coronavirus* [3-4,21,55- 56]. Therefore, due to the limited resource facilities, these are not investigated by researchers. Livestock is an important economic asset and plays a vital role in daily human consumption patterns and customs in Oman. Animal husbandry is not a commercial activity in rural areas among nomadic and semi-nomadic populations; rather, the animals are used to fulfill the basic social, cultural, and religious needs of society [3-4,57-58].

One Health Strategies for Zoonotic Disease Prioritization

While neglecting zoonotic diseases is easy with many pressing public health issues, addressing key zoonotic diseases and disruptive challenges is crucial to guide decision-making about resource allocation and strategic implementation. Notably, within a One Health framework, a multidisciplinary approach involving public health, animal health, wildlife, ecology, epidemiology, laboratory reporting and diagnostics, policy formulation and legislation, and the environment would be useful for reducing the burden of zoonotic diseases [2,6]. This requires close federal, inter-ministerial, national, regional, and global coordination across several government departments since response prioritization, risk assessments, and threat assessments must involve a flow of information between government ministries and departments as they play a part in maintaining competing activities necessary to prevent and respond [59-60]. A 'One Health' system is important to maximize the use of resources, achieve 'co-benefits' from combined zoonotic surveillance, recognize linkages more easily, pool resources, enhance surveillance and detection, and carry out more integrated analysis. As detailed, other methods should be supported in the same way, such as the integrative assessment of scenarios, integrated surveillance and response plan development including risk management, scenario planning, improved risk management in the medical and veterinary communities, and a co-designed, integrated prioritization of research. There is also a need to develop and sustain a capacity for action across the whole of government and society as early as possible after an outbreak or when a disease is considered a threat, explicitly including scenario development, disease prioritization, and risk management [61-62]. Development, validation, and data-sharing of transdisciplinary, multi-stakeholder strategic frameworks would be useful as well. In planning the strategies described, the involvement and influence of industries and their associated interests will be important [63-64]. The strategy has also noted the importance of raising public awareness about One Health approaches. Community engagement is fundamental to enabling sustainable management in disease and disaster response, achieving trust in official responses, and thus ultimately advancing the implementation of best-practice emergency and biosecurity management principles. In general, the capability of a country to respond effectively to a sudden event and/or potential requirement should also be examined, given that each country has a limited capacity to respond to disasters, emergencies, and outbreaks. Deploying strategies to minimize negative impacts from these events is vital. In the long term, a One Health approach may help reduce these diseases in animal and human populations through integrated monitoring and preparedness [65-67].

Surveillance and Early Detection

A comprehensive integrated surveillance system integrating the information and experienced eyes linked with modern technologies and data analytics on the pattern of diseases in humans, animals, and the environment is the priority in prioritizing the PDs in One Health. This systemic link would form the surveillance system that would help identify the threats at various points before reaching humans [68-69]. The mainstay of the ZDs prioritization should lie in establishing a system that strengthens prevention and preparedness. In many of the works, taking the One Health approach translates to the rest of the working packages for further directed work. Such linkages would provide the evidence needed for transdisciplinary workers to propose prioritization and therefore investments at national levels. The knowledge generated at the grassroots levels of the human health surveillance system, including diseases with decades-old reporting in particular areas, needs to be collected, compiled, and disseminated systematically so that appropriate guidance on reporting and response is initiated [70-72]. The surveillance systems might be the result of carefully crafted robust methods or the found data that actually provide a shot in the arm for health professionals thinking about that particular area. Data could be collected through passive or reactive as well as through active surveillance methods in both humans and animals. A number of disease control strategies often rely on early detection and therefore case finding in the community and also in primary health centers, which represent a central focus of the field programs [73-75]. An active integrated human health surveillance system, including rudimentary auxiliary long-term personnel, is more likely to detect unknown circulation while dealing with endemics and identifying new or reemerging diseases; whereas passive methods may only observe increases in known diseases. Detection of an infection will provide an advance opportunity to possibly isolate the sick animal to control its spread. Treatment of the case will contribute to speeding up recovery, reducing the number of animals shedding the organism, and reducing the risk to humans [76-78]. Detection, treatment, and control will also help to reduce the economic impact of diseases on animal production. In many cases, natural outbreaks of ZDs could be viewed as large-scale uncontrolled experiments that can be used for learning. The surveillance systems to detect these diseases should be based on a strong partnership between veterinary services and human healthcare providers. The partnership should extend to training, research, and cooperation in the development of optimized diagnostic methods and the prioritization of diseases as surveillance focus [79-81].

Cross-Sectoral Collaboration

Effective collaboration is essential to comprehensively manage the risks posed by zoonotic diseases and should be framed within the constraints of current national public health systems. It has long been recognized that public health and veterinary authorities and environmental agencies are natural partners in dealing with zoonotic diseases. When these sectors work together, they can draw on each other's resources, skills, and expertise to develop more meaningful and robust responses [2,6]. Examples of effective partnerships with different areas of One Health in Oman include conducting wildlife surveys and investigations on wildlife ecology and host-pathogen interactions. The Ministry of Health, Agriculture and Fisheries, and Environment and Climate Affairs in Oman is willing to share their knowledge and resources with each other to try and gain insight into the interrelatedness of the causality and effects of the transmission of multihost and multidrug parasites [82-85]. There may be many stumbling blocks to effective cross-sectoral and multidisciplinary working, not least of which are strong traditions built up over many years in donor funding agencies, followed in turn by public health and veterinary services themselves, and higher-level, ministerial budget allocations for one or other of the various components of disease surveillance and response [7,86] .There may also be significant differences in the management culture, ability, and aspirations of the leaders of the colliding or competing low or higher-level national health portfolios. This compartmentalization extends in hierarchical fashion also down to the health professionals and services and to their patients and clientele. These and other issues are recognized as a main barrier to improving collaboration between Central and Local Government, between health and local government, and between the health of humans and of animals, domestic and wild [87-88] much is being written about this issue at present, but no easy solutions are forthcoming, given the ingrained and structural nature of the barriers. The key role of good communication and the need to raise awareness of the potential impacts of zoonotic diseases on people, animals, and the environment is highlighted [6,89]. Community involvement may encourage and foster collaborations at the grassroots level. Diverse views from and between these actors are to be considered in the responses to zoonotic diseases that are, after all, sited very close to local people in many cases where traditional, bushmeat hunting or related practices continue, including meat processing and consumption, modern or salacious practice, or simply through environmental pathways into homes and gardens, for example. Encouraging and sowing the seeds of dialogue between these sectors as a matter of policy and at the very local level not only brings local responses but increases understanding at many levels and is a way of assisting, for mutual benefit and for building the essential trust, in longer-term responses to zoonotic disease at the global level [6,90-91].

Implementation of One Health in Oman

A full One Health approach in Oman has been discussed in several case studies, such as outbreaks and management, surveillance of zoonotic diseases in abattoirs and in livestock, control of zoonotic parasites, and One Health capacity building and education in the country [4,30]. Zoonotic diseases, including zoonotic parasites, have been adequately addressed for the past decade in Oman, despite several limitations due to a lack of intersectoral awareness and collaboration at the beginning. Several interventions and programs to address zoonotic diseases in animals and humans have been successfully implemented in the country. The research into zoonotic diseases and surveillance systems to detect zoonotic disease outbreaks in animals and humans was initiated at the start of a One Health approach in 2010 [4,92]. Subsequently, a number of governmental and non-governmental organizations, along with private sector organizations, pioneered by governmental organizations, have successfully implemented a number of zoonoses and other zoonotic intervention programs. However, the implementation of the One Health concept in Oman is still a work in progress [4]. In this study, we investigated the status of and limitations observed in implementing such programs in Oman. Challenges and recommendations from stakeholders who worked in the field have also been considered and are discussed here. The success of a One Health approach in Oman depends mainly on the real motivation and commitment of all stakeholders who are working in public health, animal health, and environmental services. Providing the required resources for the identified programs and monitoring and evaluation are very important for sustainability.

Conclusion

Combining the disciplines to reduce infection transmission from animals to humans may become essential in Oman to prevent potential emerging infectious diseases. Addressing these at the community and technical level is consequently important as we work towards a One Health approach for society, inclusive of the effect of potential future connectedness through programs to the west, coupled with an increase in the movement of illegal immigrants across international borders. They suggest the need for a coherent, cooperative, collaborative, and coordinated action involving multiple sectors and partners as paramount. We conclude that prioritizing and working toward a One Health approach to those zoonoses in Oman that are considered a priority will better position the Sultanate in managing the risk of zoonotic disease. Recommendations: Policymakers should seek to improve the surveillance and prioritization of zoonotic diseases in an integrated, One Health approach. Progressive education and awareness programs that embrace health, wild and domestic fauna management sectors of the community can educate and inform, building knowledge around organism habits which reduce potential spillover. Research addressing the gaps in managing zoonotic infection dynamics in the region should be a priority. Other research questions include capacity building and response analyses relevant for the region, including factors that affect zoonosis transmission. Future research into this field should be intersectoral in nature. A more integrated approach to the prevention of human exposure to zoonoses in the Sultanate of Oman is needed. Building on and enhancing public health and the principles of One Health, we need to strengthen interdisciplinary theory and develop practical infrastructure and governance at the regional level. We conclude that working towards a One Health approach will better position the Sultanate in managing zoonotic disease. Ongoing national surveillance campaigns among the principal reservoirs will assist in our understanding of the actual threat to the human population, but reporting should be directed toward the collection of early warning information from local health systems in order to facilitate an appropriate response. Public health programs need to be established favoring awareness raising, information, correction, and communication in order to reduce the risks from zoonotic disease.

Key Findings and Recommendations

This paper has discussed zoonotic diseases and the One Health framework. The review of the epidemiological data and the strategic frameworks of One Health are rare subjects, mainly discussed from the Gulf and the Arabian Peninsula, and are entirely new in Oman. Based on the strengths, results, and gaps reflected in the discussions, the following key findings and recommendations emerged. The overall findings of the FGDs using the five principles of the One Health framework and FGD cross-cutting findings are key elements to reach a broad understanding of zoonotic disease prevention and management.

Based on the analysis of the data in the preceding section, the following findings and recommendations are formulated:

Findings One Health helps health experts understand the complex interconnectedness of human, animal, and environmental health, the determination of zoonosis, and enhances health security involving different stakeholders. However, in terms of zoonoses, Oman has no collaborative area between human, animal, and environmental sectors to prevent and control. Recommendations Set up mechanisms to improve surveillance and reporting to understand the real burden and trends of zoonotic diseases in humans and animals. Develop tools and measures to integrate One Health principles into the national health strategies at the clinical and environmental levels. Link all research work that requires multidisciplinary partnerships to

conduct comprehensive approaches to the diagnosis, prevention, and control of zoonoses. Improve the training of health workers in order to understand all the ways zoonotic infections spread, where they occur, and to assist with integrated responses to disease outbreak investigations.

References

1. Magouras I, Brookes VJ, Jori F, Martin A, Pfeiffer DU, et al. (2020) Emerging zoonotic diseases: Should we rethink the animal-human interface? Front Vet Sci 7.
2. Erkyihun GA, Alemayehu MB (2022) One Health approach for the control of zoonotic diseases. Zoonoses 2.
3. Awladwadair ALI, Ahmed MS, Mahran E, Abdulkhalig Mohammed, Maha Alkarousi, et al. (2024) Emerging and re-emerging Zoonotic Viral Diseases Affecting Farm Animals in the Sultanate of Oman: A review of Current Situation. SVU-International Journal of Veterinary Sciences 7:18-33.
4. Awaidy SA, Hashami H (2020) Zoonotic Diseases in Oman: Successes, Challenges, and Future Directions. Vector-Borne and Zoonotic Diseases.
5. Haider N, Rothman-Ostrow P, Osman AY, Liã Bárbara Arruda, Laura Macfarlane-Berry, et al. (2020) COVID-19-zoonosis or emerging infectious disease? Front Public Health 8.
6. Sharan M, Vijay D, Yadav JP, Bedi JS, Dhaka P (2023) Surveillance and Response Strategies for Zoonotic Diseases: A Comprehensive Review. Science in One Health 2.
7. Asaaga FA, Young JC, Oommen MA, R. Chandarana, J. August, et al. (2021) Operationalising the 'One Health' approach in India: facilitators of and barriers to effective cross-sector convergence for zoonoses prevention and control. BMC Public Health 2.
8. Bauerfeind R, Von Graevenitz A, Kimmig P, Schiefer HG, Schwarz T, et al. (2020) Zoonoses: Infectious Diseases Transmissible from Animals to Humans. John Wiley & Sons
9. Shaheen MNF (2022) The Concept of One Health Applied to the Problem of Zoonotic Diseases. Reviews in Medical Virology
10. White RJ, Razgour O (2020) Emerging Zoonotic Diseases Originating in Mammals: A Systematic Review of Effects of Anthropogenic Land-Use Change. Mamm Rev.
11. Stephens PR, Gottdenker N, Schatz AM, Schmidt JP, Drake JM (2021) Characteristics of the 100 largest modern zoonotic disease outbreaks. Philos Trans R Soc Lond B Biol Sci.
12. Mishra J, Mishra P, Arora NK (2021) Linkages between Environmental Issues and Zoonotic Diseases: With Reference to COVID-19 Pandemic. Environmental Sustainability 4:455-467.
13. Ateudjieu J, Siewe Fodjo JN, Ambomatei C, Tchio-Nighie KH, Bissek AC (2023) Zoonotic Diseases in Sub-Saharan Africa: A Systematic Review and Meta-Analysis. Zoonotic Diseases 3:251-265.
14. Singh BB, Ward MP, Dhand NK (2023) Host Characteristics and Their Influence on Zoonosis, Disease Emergence and Multi-Host Pathogenicity. One Health 17:100596.
15. Gibb R, Redding D W, Chin K.Q, Donnelly C A, Blackburn T M, et al. (2020) Zoonotic host diversity increases in human-dominated ecosystems. Nature 584:398-402.
16. Overgaauw P. A, Vinke C. M, van Hagen M. A, Lipman L. J. (2020) A one health perspective on the human–companion animal relationship with emphasis on zoonotic aspects. Int. J. Environ. Res. Public Health 17:3789.
17. Gruetzmacher K, Karesh WB, Amuasi JH, Adnan Arshad e, Andrew Farlow, et al. (2021) The Berlin principles on one health-Bridging global health and conservation. Science of the Total Environment 764:142919.
18. Abbas SS, Shorten T, Rushton J (2022) Meanings and Mechanisms of One Health Partnerships: Insights from a Critical Review of Literature on Cross-Government Collaborations. Health Policy Plan 37:385–399.
19. Machalaba C, Raufman J, Anyamba A, Amanda M. Berrian, Franck C. J. Berthe, et al. (2021) Applying a One Health Approach in global health and medicine: Enhancing involvement of medical schools and Global Health Centers. Ann Glob Health 87:30.
20. Oppler SH, Palmer SD, Phu SN, Graham ML (2024) The role of behavioral management in enhancing clinical care and efficiency, minimizing social disruption, and promoting welfare in captive primates. Vet Sci 11:401.
21. El-Neweshy MS, Al Mayahi N, Al Mamari W, Al Rashdi Z, Al Mawly JH (2020) Animal rabies situation in Sultanate of Oman (2017-2019). Trop Anim Health Prod 52:3069-3076.
22. Islam MM, Farag E, Hassan MM (2023) Comment on Islam et al. Helminth Parasites among Rodents in the Middle East Countries: A Systematic Review and Meta-Analysis. Animals 13:3467.
23. Svetlana Tyaglova-Fayer (2023) The new reading of the 3D reconstruction of the Antikythera machine (30-day calendar).
24. Wilcox BA, Steele JA (2020) One Health and Emerging Zoonotic Diseases: Framework, Integration and Challenges. Handbook of Global Health
25. Ghai RR, Wallace RM, Kile JC, Trevor R. Shoemaker, Antonio R. Vieira, et al. (2022) A generalizable one health framework for the control of zoonotic diseases. Sci Rep 12:8588.
26. Marselle MR, Hartig T, Cox DTC, Siân de Bell, Sonja Knapp, et al. (2021) Pathways linking biodiversity to human health: A conceptual framework. Environ Int 150:106420.
27. Benis A, Tamburis O, Chronaki C, Moen A (2021) One Digital Health: A unified framework for future health ecosystems. J Med Internet Res 23: e22189.
28. Laith ALE, Sendyani S, Alnemri M (2023) Applications of the One Health concept: Current status in the Middle East. Journal of Biosafety and Biosecurity 5:21-31.
29. Khalafalla AI (2023) Zoonotic Diseases Transmitted from the Camels. Front Vet Sci 10:1244833.
30. Alwahaibi I, Dauletova V, Wels H (2023) Camels in the Bedouin community of Oman: Beyond the human–animal binary. Anthrozoos 36:1-14.
31. Dutton R W Updating agriculture and associated rural enterprises. Oman: Economic, Social and Strategic Developments
32. Ingram D J, Prideaux M, Hodgins N K, Frisch Nwakanma H, Avila I C, et al. (2022) Widespread use of migratory megafauna for aquatic wild meat in the tropics and subtropics. Frontiers in Marine Science 9: 837447.
33. Noguera Z, Charypkhan LP, Hartnack D, Torgerson S, Rüegg PR (2022) The dual burden of animal and human zoonoses: A systematic review. PLOS Neglected Tropical Diseases.

34. History and Geography, Sultanate of Oman.

35. Al-Risi S, Al-Subhi A, Al Hinai H, Zaki HEM, Shahid M (2024) Emerging threats of exotic viruses to the Oman agriculture: Diversity and management strategies. In: Molecular Dynamics of Plant Stress and Its Management. Springer Nature Singapore, 361-385.

36. Epoc FJ, Al-Siyabi M, Al-Kaabi R, Al-Omairi K, Al-Maqbali AS, et al. (2023) Issues and challenges faced by Omani farmers: Evidence from Mahadha Oasis area. Delhi Business Review 24:23-34.

37. Farooq M, Aman Ullah, Saleh Al Hinai, Saleem K Nadaf, Abdullah M Al Sadi, et al. (2022) Wheat production in Oman: experiences, challenges and opportunities. Journal of Agricultural and Marine Sciences 27:1-15.

38. Ibrahim M, Schelling E, Zinsstag J, Hattendorf J, Andargie E, et al. (2021) Sero-prevalence of brucellosis, Q-fever and Rift Valley fever in humans and livestock in Somali Region, Ethiopia. PLoS Negl Trop Dis 15: e0008100.

39. Dadar M, Omar SS, Shahali Y, Fakhri Y, Godfroid J, et al. (2022) The prevalence of camel brucellosis and associated risk factors: a global meta-epidemiological study. Quality Assurance and Safety of Crops & Foods 14:55-93.

40. Al Ani F, Al Ghenaimi S, Hussein E, Al Mawly J, Al MushaiKi K, et al. (2023) Human and animal brucellosis in the Sultanate of Oman: an epidemiological study. J Infect Dev Ctries 17:52-58.

41. Abuseir S (2021) Meat-borne parasites in the Arab world: a review in a One Health perspective. Parasitol Res 120:4153-4166.

42. Ashtiani ZT, Ahmadinezhad M, Amiri FB, Esmaeili S (2024) Geographical distribution of Bartonella spp in the countries of the WHO Eastern Mediterranean Region (WHO-EMRO). Journal of Infection and Public Health 17: 612-618.

43. Ismaila AA, Ahmad K, Siddique Y, Muhammad Aswad Abdul Wahab, Abdulaziz Bashir Kutawa, et al. (2023) Fusarium wilt of banana: Current update and sustainable disease control using classical and essential oils approaches. Hortic Plant J 9:1-28.

44. Perveen N, Muzaffar SB, Al Deeb MA (2021) Ticks and tick-borne diseases of livestock in the Middle East and North Africa: A review. Insects 12:83.

45. Meurens F, Dunoyer C, Fourichon C,Volker Gerdts, Nadia Haddad, et al. (2021) Animal board invited review: Risks of zoonotic disease emergence at the interface of wildlife and livestock systems. Animal 15:100241.

46. Almuzaini AM (2023) An epidemiological study of brucellosis in different animal species from the Al-Qassim region, Saudi Arabia. Vaccines 11:694.

47. Sawafi LA, Tai AA, Reesi MA, Mahmood Al Subhi, Muna Al Busaidi, et al. (2023) Brucellosis in Omani children: a multicenter experience over 15 years. Ann Saudi Med 43:380-385.

48. Hassan KS, Schuster H, Al Rawahi A, Balkhair A (2021) Clinical presentations of brucellosis over a four-year period at Sultan Qaboos University Hospital and Armed Forces Hospital, Muscat, Oman. Sultan Qaboos Univ Med J 21: e282-e288.

49. Gutema Wegi F (2020) Brucellosis in Cattle, Camel and Human: Seroprevalence and Associated Risk Factors in Amibara District of Afar Region, Ethiopia.

50. Elsohaby I, Elmoslemany A, El Sharnouby M, Mohamed Alkafafy, Mohammed Alorabi, et al. (2021) Flock management risk factors associated with Q fever infection in sheep in Saudi Arabia. Animals 11:1948.

51. Abdelazez A, Abd Elmotaal H, Abady G (2024) Exploring the Potential of Camel Milk as a Functional Food: Physicochemical Characteristics, Bioactive Components, Innovative Therapeutic Applications, and development opportunities analysis. Food Materials Research.

52. Duguma MF (2022) Review on the prevalence and economic importance of camel tuberculosis in Ethiopia. Journal of Food Science and Nutrition Therapy 8:048-053.

53. Abdullah HM, Sheikh A (2024) History of a Dairy Camel (NAQA) and Machine Milking in Saudi Arabia; Challenges and Prospective. Trop Anim Health Prod 56:352.

54. Holloway P, Gibson M, Nash S, Tanja Holloway, Jacqueline Cardwell, et al. (2023) A cross-sectional study of Q fever in Camels: Risk factors for infection, the role of small ruminants and public health implications for desert-dwelling pastoral communities. Zoonoses Public Health 70:238-247.

55. Dadar M, Omar SS, Shahali Y, Fakhri Y, Godfroid J, et al. (2022) The prevalence of camel brucellosis and associated risk factors: a global meta-epidemiological study. Quality Assurance and Safety of Crops & Foods 14:55-93.

56. Mostafavi E, Ghasemian A, Abdinasir A, Seyed Alireza Nematollahi Mahani, Salman Rawaf, et al. (2022) Emerging and re-emerging infectious diseases in the WHO Eastern Mediterranean Region, 2001-2018. Int J Health Policy Manag 11:1286-1300.

57. Dauletova V, Al-Busaidi AS (2022) Socio-cultural factors as driving forces of rural entrepreneurship in Oman. J Small Bus Entrep 36: 1-21.

58. Alawi A (2024) Exploring Local Community Stakeholders' Attitudes Towards Eco-Cultural Tourism Development in Oman.

59. Gooding K, Bertone MP, Loffreda G, 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: 1441.

60. Moorkamp M, Torenvlied R, Kramer EH (2020) Organizational synthesis in transboundary crises: Three principles for managing centralization and coordination in the corona virus crisis response. J Contingencies Crisis Manag 28:169-172.

61. Aslam B, Khurshid M, Arshad MI, Saima Muzammil, Maria Rasool, et al. (2024) Corrigendum: Antibiotic resistance: One Health One World outlook. Front Cell Infect Microbiol 14:1488430.

62. Maves RC, Downar J, Dichter JR, Charles L. Sprung, Michael D. Christian, et al. (2020) Triage of scarce critical care resources in COVID-19 an implementation guide for regional allocation: An Expert Panel Report of the Task Force for Mass Critical Care and the American College of Chest Physicians. Chest 158: 212-225.

63. Zorpas AA (2020) Strategy Development in the Framework of Waste Management. Science of the Total Environment 716: 137088.

64. Moullin JC, Dickson KS, Stadnick NA, Bianca Albers, Per Nilsen, et al. (2020) Ten recommendations for using implementation frameworks in research and practice. Implement Sci Commun 1: 42.

65. Olatunji AO, Olaboye JA, Maha CC, Kolawole TO, Abdul S (2024) Revolutionizing infectious disease management in low-resource settings: The impact of rapid diagnostic technologies and portable devices. Int j appl res soc sci 6:1417-1432.

66. Blasi S, Ganzaroli A, De Noni I (2022) Smartening Sustainable Development in Cities: Strengthening the Theoretical Linkage between Smart Cities and SDGs. Sustainable Cities and Society 80: 103793.

67. Anthony B Jr (2024) The role of community engagement in urban innovation towards the co-creation of smart sustainable cities. J Knowl Econ 15:1592-1624.

68. Bordier M, Uea-Anuwong T, Binot A, Hendrikx P, Goutard FL (2020) Characteristics of One Health surveillance systems: A systematic literature review. Prev Vet Med 181: 104560.

69. Kelly TR, Machalaba C, Karesh WB, Paulina Zielinska Crook, Kirsten Gilardi, et al. (2020) Implementing One Health approaches to confront emerging and re-emerging zoonotic disease threats: lessons from PREDICT. One Health Outlook 2:1.

70. Egea I, Estrada Y, Flores FB, Bolarín MC (2022) Improving production and fruit quality of tomato under abiotic stress: Genes for the future of tomato breeding for a sustainable agriculture. Environ Exp Bot 204: 105086.

71. Winck GR, Raimundo RLG, Fernandes-Ferreira H, Marina G. Bueno, Paulo S. D'Andrea, et al. (2022) Socioecological vulnerability and the risk of zoonotic disease emergence in Brazil. Sci Adv 8: eabo5774.

72. Chaves MED, Mataveli G, Conceição KV, Adami M, Petrone FG, et al. (2024) AMACRO: the newer Amazonia deforestation hotspot and a potential setback for Brazilian agriculture. Perspect Ecol Conserv 22: 93-100.

73. Brown N, Pérez-Sierra A, Crow P, Parnell S (2020) The role of passive surveillance and citizen science in plant health. CABI Agric Biosci 1:17.

74. Pernat N, Kampen H, Jeschke JM, Werner D (2021) Citizen science versus professional data collection: Comparison of approaches to mosquito monitoring in Germany. J Appl Ecol. 58: 214-223.

75. Eritja R, Delacour-Estrella S, Ruiz-Arrondo I, Mikel A. González, Carlos Barceló, et al. (2021) At the tip of an iceberg: citizen science and active surveillance collaborating to broaden the known distribution of Aedes japonicus in Spain. Parasit Vectors 14: 375.

76. McClary Gutierrez JS, Mattioli MC, Marcenac P, Silverman AI, Boehm AB, et al. (2021) SARS- Cov-2 wastewater surveillance for public health action. Emerg Infect Dis 27: e210753.

77. Wan S, Guan S, Tang Y (2024) Advancing bridge structural health monitoring: Insights into knowledge-driven and data-driven approaches. J Data Sci Intell Syst 2:129-140.

78. Wenger NK, Lloyd-Jones DM, Elkind MS, Conrow GC, Warner JJ, et al. (2022) Call to action for cardiovascular disease in women: epidemiology, awareness, access, and delivery of equitable health care: a presidential advisory from the American Heart Association. Circulation 145: e1059–e1071.

79. Bordier M, Uea Anuwong T, Binot A, Hendrikx P, Goutard FL (2020) Characteristics of One Health surveillance systems: a systematic literature review. Prev Vet Med 181:104560.

80. Lustgarten JL, Zehnder A, Shipman W, Gancher E, Webb TL (2020) Veterinary informatics: forging the future between veterinary medicine, human medicine, and One Health initiatives - a joint paper by the Association for Veterinary Informatics (AVI) and the CTSA One Health Alliance (COHA). JAMIA Open 3: 306-317.

81. Mader R, Muñoz Madero C, Aasmäe B, Bourély C, Broens EM, et al. (2022) Review and analysis of national monitoring systems for antimicrobial resistance in animal bacterial pathogens in Europe: a basis for the development of the European Antimicrobial Resistance Surveillance network in Veterinary medicine (EARS-Vet). Front Microbiol 13:838490.

82. Mader R, Damborg P, Amat JP, Bengtsson B, Bourély C, et al. (2021) Building the European antimicrobial resistance surveillance network in veterinary medicine (EARS-Vet). Euro Surveill 26:2001359.

83. Soberón M, Sánchez Chaparro T, Urquijo J, Pereira D (2020) Introducing an organizational perspective in SDG implementation in the public sector in Spain: The case of the former Ministry of Agriculture, Fisheries, Food, and Environment. Sustainability 12:9959.

84. Arredondo AMP, Yasobant S, Bruchhausen W, Bender K, Falkenberg T (2021) Intersectoral collaboration shaping One Health in the policy agenda: A comparative analysis of Ghana and India. One Health 13:100272.

85. Osman AY, Mohamed H, Mumin FI, Mahrous H, Saidouni A, et al. (2023) Prioritization of zoonoses for multisectoral, One Health collaboration in Somalia, 2023. One Health 17:100634.

86. Cui J (2024) Moving Beyond Regulation: Cross-Sectoral Coordination in Providing Holistic Care in For-Profit Residential Homes for Disabled People. Soc Policy Adm 58:1054-1070.

87. Misra V, Sedig K, Dixon DR, Sibbald SL (2020) Prioritizing coordination of primary health care. Can Fam Physician 66: 717-719.

88. Sloan CE, Zhong J, Mohottige D, Hall R, Diamantidis CJ, et al. (2020) Fragmentation of care as a barrier to optimal ESKD management. Semin Dial 33:440-448.

89. Shapiro JT, Víquez R L, Leopardi S, Vicente Santos A, Mendenhall IH, et al. (2021) Setting the terms for zoonotic diseases: effective communication for research, conservation, and public policy. Viruses. 13:1356.

90. Ebata A, Hodge C, Braam D, Waldman L, Sharp J, et al. (2020) Power, participation and their problems: A consideration of power dynamics in the use of participatory epidemiology for One Health and zoonoses research. Prev Vet Med 177:104940.

91. Majiwa H, Bukachi SA, Omia D, Fèvre EM (2024) Knowledge, perceptions, and practices around zoonotic diseases among actors in the livestock trade in the Lake Victoria Crescent ecosystem in East Africa. Front Public Health 12:1-9.

92. Engelhard GH, Howes EL, Pinnegar JK, Le Quesne WJ (2022) Assessing the risk of climate change to aquaculture: a national-scale case study for the Sultanate of Oman. Clim Risk Manag 35:100416.