

EMBRACING HARMONY IN ONE HEALTH: NAVIGATING ZONOTIC CHALLENGES AND HUMAN HEALTH SOLUTIONS WORLDWIDE

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Abstract

The One Health paradigm, emphasizes the interconnectedness of human, animal, and environmental health. Recognizing that disruptions in one domain affect others, the study underscores the importance of collaborative efforts across disciplines to address complex health issues. Herein we have highlighted the challenges posed by diseases such as Bovine TB, Brucellosis, Q fever, Leptospirosis, rabies, Crimean-Congo Hemorrhagic Fever, and others. The narrative extends to global warming, environmental impacts, and the intricate relationships between climate change, agriculture, and health in low-income countries. 60% of infectious diseases are zoonotic, emphasizing the need for a One Health strategy. One Health initiative in various countries, including the Netherlands, the U.S., Kenya, Thailand, Australia, Norway, and Canada has remained successful. The study delves into the challenges faced by low-income countries, in implementing the One Health approach amidst climate-induced events, floods, and disease outbreaks. Furthermore, it highlights the significance of health education, surveillance, and prevention strategies for mitigating the impact of zoonotic diseases on public health, animal health, and the environment in low-income nations. The complex interplay of environmental changes, agricultural dynamics, and socio-economic factors underscores the need for a comprehensive and transdisciplinary approach to address zoonotic challenges effectively.

Keywords One Health, Zoonosis, Plants, Epidemiology, Human Health.

INTRODUCTION

One Health is a comprehensive and interdisciplinary approach that recognizes the interconnectedness of human health, animal health, and environmental health. It emphasizes the collaborative efforts of professionals from various fields, including human medicine, veterinary medicine, environmental science, and public health, to address complex health issues at the interface of humans, animals, and their shared

environments. The core principle of One Health is that the health of humans, animals, and ecosystems are closely linked, and disruptions in one domain can have profound effects on the others (1). This approach acknowledges that many diseases are zoonotic, meaning they can be transmitted between animals and humans. Consequently, understanding and addressing health challenges require a holistic perspective that considers the health of entire ecosystems. One Health initiatives aim to prevent and control the spread of diseases,

promote environmental sustainability, and improve overall well-being by fostering collaboration between different sectors and disciplines. This approach is particularly crucial in addressing emerging infectious diseases, antibiotic resistance, food safety, and other health-related challenges that transcend traditional boundaries (2).

The World Health Organization (WHO), the World Organisation for Animal Health (OIE), and the Food and Agriculture Organization of the United Nations (FAO) are among the global entities that endorse and promote the One Health approach. Several countries have been recognized for their efforts in advancing both the One Health agenda and the Sustainable Development Goals (SDGs) (3). The landscape of global health initiatives is dynamic, and countries may evolve their one health strategies over time. The Netherlands has been recognized for its comprehensive approach to One Health, integrating human, animal, and environmental health. The country actively engages in research, policy development, and international collaborations to address health challenges. The U.S. has been at the forefront of One Health initiatives, emphasizing the interconnectedness of human health, animal health, and the environment (4). The country has also shown commitment to various Sustainable Development Goals, particularly those related to health, education, and environmental sustainability. Kenya has embraced a One Health approach to address zoonotic diseases and other health challenges. The country has recognized the importance of collaboration between human and veterinary health sectors and has implemented policies to support this integrated approach. Thailand has actively pursued a One Health strategy to address emerging infectious diseases and other health issues. The country has also shown commitment to SDGs, with efforts focused on health, poverty reduction, and environmental sustainability (5). Australia has been involved in One Health initiatives, recognizing the importance of collaboration between human and animal health professionals. The country has also aligned its policies with SDGs, emphasizing health and well-

being, sustainable cities, and responsible consumption and production. Norway has been involved in global health initiatives and has shown commitment to addressing health challenges through a One Health lens. The country is also actively engaged in promoting sustainable development and achieving SDGs. Canada has demonstrated leadership in One Health, emphasizing collaborative approaches to address health challenges at the human-animal-environment interface. The country aligns its policies with SDGs, particularly those related to health, climate action, and sustainable cities (6-10).

The One Health paradigm stands as a revolutionary, cross-disciplinary concept designed to synergize the improvement of human health, animal well-being, and environmental stability. In the global context, the adoption of this integrative approach has been notably lagging in underdeveloped nations, a phenomenon acutely observed in Pakistan. Constrained by insufficient resources, Pakistan grapples with the severe compromise of its ecological integrity, human health, and the vitality of its animal populations. The ramifications are particularly stark in regions where communities, intimately connected to farm animals and wildlife, bear the brunt of zoonotic illnesses (1).

The World Health Organization (WHO) defines zoonosis as the silent interplay of diseases, an intricate dance where ailments gracefully transition from vertebrate animals to humans (WHO 2020). In the mosaic of Pakistan's health landscape, bacterial, viral, vector-borne, helminthic, and protozoan zoonotic diseases weave a complex narrative that demands our attention and innovation for a sustainable future (1,3,8).

Bovine TB, an insidious player in the public health arena, casts a shadow over developing states like Pakistan. Its prevalence echoes loudly among the butchery workforce, cattle farmers, and veterinary health professionals, a somber reminder of the challenges we face (11). This airborne menace, transmitted through coughs, sneezes, and the seemingly innocuous act of consuming raw milk, underscores the urgency for a proactive approach

(1,7,12).

Within the bacterial realm, Brucellosis and Q fever emerge as silent predators, often neglected but posing severe health hazards. Brucellosis, an endemic enigma, disguises itself in multi-organ complexities, with osteoarthritis and spondylitis leading its clandestine charge (13). Meanwhile, *Coxiella burnetii*, a resilient adversary thriving in adverse conditions, remains underdiagnosed, revealing its presence through a silent surge in abortions (14,15). The subtlety of these bacterial threats demands a vigilant gaze.

Leptospirosis, a stealthy traveler in animal urine, traverses silently, causing a spectrum from flu-like discomfort to the ominous Weil's disease, a journey that may end in multiorgan failure (16). In its emergence, Leptospirosis often languishes in the shadows, a tale of negligence that awaits due emphasis in Pakistan (12). Turning the pages to viral adversaries, rabies stands as the ancient sentinel, haunting the annals of Pakistan's health history. While the developed world battles this foe with extensive vaccination, developing countries, including Pakistan, still grapple with its shadows, resulting in up to 70,000 deaths annually (11-16). The saga of Crimean-Congo Hemorrhagic Fever unfolds in distinct phases, with mortality casting a looming shadow, exacerbated by factors like poor sanitation and unsafe transportation of slaughter waste (17,18). Hepatitis E, a zoonotic interloper from cattle, orchestrates outbreaks intertwined with sewage and contaminated drinking water, marking its presence in the northern and western corners of Pakistan (19). In the realm of vector-borne diseases, Leishmaniasis emerges as a formidable adversary, its impact intricately linked with poverty, echoing the broader challenges we face (20). As the dengue epidemic resurfaces cyclically, it paints a vivid picture of hospitalizations and mortalities, a stark reminder of the urgency to address this recurring menace (21,22). The helminthic onslaught, led by Strongyloids, Trichuris, enterobius vermicularis, and *ancylostoma duodenale*, exemplifies the intertwining of animal and human destinies, underscored by alarming positivity rates in certain

regions (23,24).

In the realm of protozoan parasites, *Giardia intestinalis* emerges as a common culprit, disproportionately affecting children and leaving a trail linked with residency and socioeconomic status (11,18). *Cryptosporidium* spp., a strategic infiltrator transmitted from sheep to humans, thrives in certain seasons, painting a vivid portrait of opportunistic zoonotic dynamics (18,20).

Navigating through academic literature, the focus on zoonosis is not merely a scholarly pursuit; it is a clarion call to decipher the state of the One Health approach. In this pursuit, the tapestry of zoonotic challenges unravels, beckoning us to reimagine the future with innovative strategies and a resolute commitment to holistic health (25).

Zoonotic diseases, emanating from microorganisms spontaneously crossing from animals to humans, constitute a staggering 60% of the total infectious disease burden (21-24). The intricate web of interactions—whether direct or indirect—between animals and humans, catalyzed by factors such as population growth, urbanization, globalization, and environmental dynamics, contributes to the perpetual threat of zoonotic diseases (14,15). Pakistan, with its diverse terrain and a rich array of domestic and wild animal species, faces a nuanced challenge where climatic variations, ecological nuances, socio-economic factors, and political intricacies must be navigated for effective disease monitoring and public health management (26,27).

In the battle against zoonotic diseases, the One Health strategy emerges as a linchpin. The World Health Organization (WHO) and insights from experts like Graham underline that a staggering 75% of emerging infectious diseases in humans have a zoonotic origin, establishing a critical link between vertebrate animals and public health (18). The symbiotic relationship between humans and animals, alongside an escalating reliance on animal products, has ushered in a new era where zoonosis stands as the foremost risk factor for human health and overall well-being.

Recognizing the urgency, a consortium of non-

governmental organizations (NGOs) and government bodies, spanning ministries for climate change, town development, and food safety, has joined forces. Their collaborative efforts aim to craft and implement innovative strategies to control and prevent zoonotic diseases in Pakistan (5). Amidst the varied approaches to disease control, the overarching efficacy of the One Health perspective, encompassing the entire supply chain, emerges as a potent solution. Beyond its immediate impact on disease prevention, this holistic approach presents a transformative opportunity to enhance food safety and alleviate the economic and health burdens imposed by diseases in emerging nations (3,8).

GLOBAL WARMING AND IMPACTS OF ENVIRONMENT ON ONE HEALTH

In India, the impact of global warming on wheat production is evident, with a 5.2% decrease noted from 1981 to 2009 (28). Adapting to climate variability for sustainable food production becomes imperative, contingent on well-guided information dissemination and thoughtful government policies (29). In the realm of environmental dynamics, the repercussions of global changes resonate globally and locally. Global warming, characterized by a steady elevation of sea levels, reveals a notable surge from 1.7 ± 0.2 mm/year in the early 20th century to 3.2 ± 0.4 mm/year from 1993 to 2009 (18). This shift submerges coastal lands exceeding 100,000 acres due to sea intrusion, accompanied by a significant reduction in mangrove distribution from 250,000 hectares to approximately 98,000 hectares over the last few decades (14-18). The implications extend to communities dependent on coastal ecosystems for sustenance, posing substantial social and economic threats. In the symphony of climate-induced agricultural fluctuations, the "fertilizer effect" promises uneven crop yields. However, this promise, when distributed disparately, forewarns challenges for African and South Asian agriculture, oscillating between heavy floods and prolonged droughts (11). The orchestration continues as rising temperatures quantifiably diminish wheat, rice, and sugar cane

yields in low income countries (6). The imperative of food and water hygiene surfaces prominently, with viral and bacterial pathogens finding transmission avenues through aerosols or water contamination (28). In Pakistan, grappling with water-related challenges intensified by climate change, the deteriorating water quality becomes a breeding ground for waterborne diseases like hepatitis, typhoid, dysentery, cholera, and mosquito-borne illnesses (28). Industrialization, urbanization, unsanitary conditions, and inadequate water management amplify these concerns, accentuated in regions with limited access to healthcare (29).

COMMUNICABLE AND NON-COMMUNICABLE DISEASES AND ONE HEALTH

Both industrialized and underdeveloped nations grapple with severe health repercussions linked to foodborne illnesses. In low-income nations, challenges magnify due to improper food handling, scarce food safety laws, weak regulatory systems, financial constraints, illiteracy, and a lack of awareness among food handlers (30). Foodborne illnesses, primarily transmitted through unclean hands, contribute to a significant disease burden, emphasizing the need for prioritizing hygiene and food safety in these regions (25). Arthropod-borne diseases persist as a public health concern despite advancements in medicine. Arthropods, particularly insects and arachnids, serve as primary vectors, transmitting diseases through stings, bites, tissue invasion, and indirect pathogen transmission. Common vectors like house flies and cockroaches, ubiquitous in their global distribution, pose a significant risk for transmitting zoonotic diseases, necessitating stringent measures for cleanliness, vector population control, and vaccination (15). Street food vending, prevalent in many developing nations, introduces its own set of risks for zoonotic infections. Studies reveal inadequacies in covering food stalls, allowing unhindered access for flies and insects, posing contamination risks. The need for specific municipal and federal laws, coupled with professional training and education for street vendors, emerges as a cost-effective strategy for

preventing infectious diseases (16). Ensuring access to clean water, sanitation, and promoting personal, household, and community cleanliness emerges as pivotal for enhancing the health and quality of life for millions. Addressing neglected tropical diseases, such as diarrhea, respiratory infections, and malnutrition, underscores the multifaceted impact of adequate hygiene (19).

ONE HEALTH IN LOW-INCOME COUNTRIES

The One Health concept propounds a transdisciplinary approach to food and animal health, recognizing their intricate interconnection with human health. Pakistan, a leading milk producer and consumer, grapples with compromised milk quality. Pakistan, situated in the throes of climate-induced challenges, experiences a heightened frequency of floods, particularly notable in June and August 2022. The aftermath, quantified in a staggering economic loss of 3.7 billion dollars to the agricultural sector, underscores a poignant narrative of inadequate compensation for affected farmers (23). Further analysis reveals a nutritional disarray in affected communities, marked by deficiencies in essential micronutrients and an increased vulnerability to nutritional and infectious disorders. The floods of 2022 exacerbate the situation, leading to a surge in skin diseases, acute respiratory ailments, and a series of diarrheal outbreaks (22). A longitudinal study in Islamabad reveals alarming levels of aflatoxin M1 in various milk products, emphasizing the need for comprehensive approaches, including farmer education, strict monitoring, and legislation (19,22). Brucellosis, a significant burden in Pakistan's agricultural community, necessitates a one-health approach, emphasizing animal vaccination, screening, and farmer education (21). Echinococcus, labeled as a neglected tropical disease, inflicts substantial economic losses and human morbidity. Prevention strategies, including periodic deworming of dogs, hygienic slaughtering practices, and public education, emerge as crucial (WHO). Avian flu prevalence in layers farms in Karachi adds a layer of complexity, highlighting the endemic nature of the disease. Vaccination plans are imperative to curb potential outbreaks,

ensuring both economic stability and public health safety (6,18). The prevalence of food-borne helminths and protozoa in food handlers, as well as high infection rates among school-going children, underscores the urgent need for improved food handling practices and deworming initiatives (20,22). Vector-borne illnesses, intricately linked to climate change and evolving agricultural practices, pose an escalating threat. Zoonotic diseases, such as malaria, leishmaniasis, plague, and Japanese encephalitis, are projected to contribute significantly to increased annual deaths by 250,000 between 2030 and 2050 (18). The rise in temperature and humidity amplifies the burden of insect-vector-borne diseases, demanding robust vector control strategies, surveillance systems, and community education (6). Dogs, ubiquitous as pets in both urban and rural areas, emerge as potential carriers of zoonotic diseases, including rabies, leishmaniasis, and echinococcosis. Pakistan grapples with high rabies incidence, necessitating accessible prophylaxis, widespread dog vaccination, responsible animal ownership, One Health implementation, and well-equipped laboratories for effective disease prevention (4). Dengue fever, a recurring menace in Pakistan with four serotypes in circulation, necessitates multifaceted prevention strategies, including insecticide sprays, waste management, and public awareness (2,7,15).

The burgeoning population, exceeding 230 million, coupled with economic challenges, poses a formidable barrier to healthcare advancements. Overpopulation fuels the spread of epidemics and pandemics, influencing plant and animal biodiversity, intensifying transmission and pathogenicity of zoonoses (28). The concomitant rise in large-scale concentrated animal farms amplifies the risk of harboring pathogens (19). Urban slums, a byproduct of housing crises, create hotspots for zoonotic diseases, particularly affecting the underprivileged population (17). The burden of zoonotic diseases disproportionately affects low- and middle-income countries, reflecting the absence of adequate healthcare programs and veterinary care (17,19).

Surveillance, a pivotal tool for gauging disease burden, encounters challenges in Pakistan. Limited accessibility, logistical constraints, and inadequate financial resources impede an effective surveillance infrastructure. The healthcare sector's allocation of a mere 1% of GDP further exacerbates the situation, resulting in event-based surveillance, unreliable data, and underdiagnosis of zoonotic diseases (20,28). Collaborative efforts with organizations like the CDC aim to enhance disease control strategic plans, emphasizing a One Health approach to studying, preventing, and controlling diseases in low income countries (17). The role of health education surfaces as a critical component in the prevention and control of infectious diseases. The World Health Organization defines health education as consciously constructed opportunities for learning to improve health literacy, knowledge, and life skills conducive to individual and community health (18). In Pakistan, however, despite recent growth in the field of public health education, standards fall short of international guidelines. Reluctance among health professionals to work in rural areas, political mismanagement, resource limitations, and inconsistencies in policies contribute to the lag in health sector development (27-30). The imperative for large-scale promotion of health education aligns with the One Health paradigm, calling for a concerted effort to bridge the existing gaps in public health literacy and preventive measures (29,30).

CONCLUSION

The intricate web of environmental changes, agricultural dynamics, and socio-economic factors intertwines to create a complex landscape of zoonotic challenges in low-income countries. The multifaceted nature of these challenges demands a holistic, transdisciplinary approach, embracing the principles of the One Health paradigm. As we navigate through these intricate dynamics, a concerted effort in surveillance, prevention, and health education emerges as paramount for mitigating the impact of zoonotic diseases on public health, animal health, and the environment in low-income countries.

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