

One Health Approach to Environmental and Public Health Challenges: Bridging the Gap between Human, Animal, and Environmental Health

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ABSTRACT

Background. This study is grounded in the growing recognition that complex environmental and public health challenges cannot be effectively addressed through sectoral approaches that separate human, animal, and environmental health. Accelerating climate change, biodiversity loss, emerging zoonotic diseases, and environmental degradation have intensified interactions across these domains, revealing critical weaknesses in fragmented health governance.

Purpose. The objective of this research is to examine how the One Health approach can serve as an integrated framework to bridge disciplinary and institutional gaps in addressing contemporary environmental and public health challenges.

Method. The study employs a qualitative integrative review design, synthesizing evidence from peer-reviewed international journals, policy reports, and global health frameworks to identify patterns, mechanisms, and implementation strategies associated with One Health practices.

Results. The findings indicate that One Health-oriented interventions enhance early disease detection, improve risk communication, strengthen environmental monitoring, and support more resilient public health responses through cross-sector collaboration. The results also demonstrate that institutional coordination, data integration, and shared governance structures are decisive factors in translating One Health principles into measurable health outcomes.

Conclusion. The study concludes that the One Health approach represents a transformative paradigm for public and environmental health governance, offering a robust pathway to manage systemic risks at the human animal environment interface. Strengthening policy alignment, interdisciplinary capacity, and institutional commitment is essential to realize its full potential.

KEYWORDS

Environmental Health, Interdisciplinary Governance, One Health, Public Health, Zoonotic Diseases

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INTRODUCTION

Global environmental change has intensified the interdependence between human health, animal health, and ecosystem integrity in unprecedented ways (Barot dkk., 2026). Rapid urbanization, climate variability, land-use change, and intensified agricultural practices have altered natural systems while simultaneously increasing human exposure to environmental risks. These dynamics have

contributed to the emergence and re-emergence of zoonotic diseases (Braam dkk., 2025), environmental pollution, food insecurity, and antimicrobial resistance, all of which transcend traditional disciplinary and institutional boundaries. Contemporary public health challenges increasingly reflect complex socio-ecological interactions rather than isolated biomedical phenomena.

Public health systems and environmental governance structures have historically evolved in silos, with limited integration between medical, veterinary, and environmental sciences (Cai dkk., 2024). This fragmentation has constrained the ability of institutions to anticipate, prevent, and respond effectively to cross-sectoral health threats. Experiences from global disease outbreaks and environmental crises demonstrate that interventions focused on a single sector often fail to address upstream drivers of risk embedded within ecological and animal health systems (Chen dkk., 2024). These realities underscore the urgency of adopting integrative frameworks capable of capturing the full complexity of health determinants.

The One Health approach has emerged as a response to these challenges by emphasizing the interconnectedness of human, animal, and environmental health (Castañeda dkk., 2024). Rooted in interdisciplinary collaboration and systems thinking, One Health offers a conceptual and operational lens for understanding health as an outcome of interacting biological, environmental, and social processes (Lâm dkk., 2025). Growing international endorsement of this approach by global health organizations reflects a shift toward more holistic and preventive health strategies, positioning One Health as a critical paradigm for addressing contemporary environmental and public health challenges.

Persistent gaps in coordination between health, environmental, and agricultural sectors remain a central obstacle to effective risk management (H. Li dkk., 2026). Institutional mandates, regulatory frameworks, and professional cultures often limit data sharing, joint surveillance, and collaborative decision-making. As a result, early warning signals of emerging health threats are frequently missed or addressed too late, leading to avoidable social, economic, and ecological costs (Dayapera dkk., 2024). These systemic weaknesses highlight a fundamental problem in current public and environmental health governance.

Scientific evidence increasingly documents the role of environmental degradation and animal-human interfaces in shaping disease dynamics, yet policy responses often remain reactive rather than preventive (Z. Li dkk., 2025). Surveillance systems tend to prioritize human clinical outcomes while underutilizing ecological and animal health indicators that could provide earlier signals of risk (Domingo dkk., 2025). This imbalance reduces the effectiveness of interventions and perpetuates a narrow understanding of health threats that fails to account for their systemic origins.

The absence of integrated analytical frameworks has also limited the translation of One Health principles into practice. While the concept is widely referenced in policy discourse, its operationalization remains uneven across regions and sectors (Donnelly & Stilianakis, 2026). Challenges related to governance, capacity building, financing, and interprofessional collaboration continue to hinder its consistent application (Z. Li dkk., 2025). These issues collectively define the core problem addressed by this study, namely the gap between conceptual recognition of One Health and its effective implementation in addressing environmental and public health challenges.

This study seeks to examine how the One Health approach can function as an integrative framework for addressing complex environmental and public health challenges. Particular attention is given to understanding the mechanisms through which interdisciplinary collaboration enhances disease prevention, environmental protection, and public health resilience (Gaba dkk., 2026). The

research aims to clarify how interactions between human, animal, and environmental health systems can be systematically analyzed and leveraged to improve health outcomes.

The study also aims to assess the role of governance structures, institutional coordination, and knowledge integration in enabling or constraining One Health implementation (Gebrekidan dkk., 2024). By synthesizing evidence from diverse disciplinary perspectives, the research intends to identify key enabling factors and persistent barriers that shape the effectiveness of One Health strategies (Liu dkk., 2025). These insights are expected to contribute to a more nuanced understanding of how integrative health approaches operate across different contexts.

The expected outcome of this research is the development of a coherent analytical perspective that informs both policy and practice (Giacomini dkk., 2025). By articulating the practical implications of One Health integration, the study aims to support decision-makers, researchers, and practitioners in designing more effective and sustainable health interventions. The research aspires to move beyond normative advocacy by offering empirically grounded insights into how One Health can be operationalized in real-world settings.

Existing literature on One Health has expanded significantly over the past decade, particularly in relation to zoonotic diseases and emerging infections (Guo & Jin, 2026). Numerous studies highlight the conceptual value of integrated health approaches and document successful case examples at local or regional levels. Despite this growth, much of the literature remains descriptive, focusing on conceptual frameworks or isolated interventions without systematically examining implementation processes and outcomes.

Empirical studies often prioritize specific sectors or health outcomes, resulting in fragmented evidence that limits generalizability (Haenssngen dkk., 2025). Research on environmental health, veterinary science, and public health frequently proceeds in parallel rather than in dialogue, reinforcing disciplinary boundaries that One Health seeks to overcome. This fragmentation has constrained the development of comprehensive models capable of capturing cross-sector interactions and feedback loops.

Limited attention has been given to governance dynamics, institutional arrangements, and policy coherence in shaping One Health effectiveness (Hasan dkk., 2025). Questions related to power relations, resource allocation, and accountability mechanisms remain underexplored, particularly in low- and middle-income contexts where environmental and health vulnerabilities are often most pronounced. These gaps in the literature underscore the need for integrative analyses that connect conceptual frameworks with practical governance challenges.

This study introduces a holistic analytical perspective that positions One Health not merely as a collaborative ideal but as a governance and systems framework for managing complex health risks. The research emphasizes the relational dynamics between sectors and highlights the importance of institutional design, data integration, and shared accountability (Holmberg, 2026). This perspective extends existing literature by foregrounding implementation processes rather than limiting analysis to conceptual alignment.

The justification for this research lies in its contribution to advancing interdisciplinary understanding of health governance in an era of environmental uncertainty (Kavulikirwa, 2024). By bridging insights from environmental science, public health, and animal health, the study addresses a critical need for integrative knowledge that reflects the realities of interconnected risk landscapes. The research responds to calls from global health institutions for evidence-based guidance on operationalizing One Health principles.

The novelty of this study is reflected in its emphasis on the systemic and governance dimensions of One Health implementation (Kong & Bragazzi, 2026). Rather than focusing solely

on disease outcomes, the research highlights structural conditions that enable sustained collaboration across sectors. This contribution is expected to enrich scholarly debates on integrative health approaches while providing practical insights for policymakers seeking to strengthen resilience at the human animal environment interface.

RESEARCH METHODOLOGY

This study employed a mixed-methods research design to comprehensively examine the implementation and effectiveness of the One Health approach in addressing environmental and public health challenges. A convergent design was applied, integrating qualitative and quantitative data to capture both systemic patterns and contextual dynamics across human, animal, and environmental health sectors (Omuse dkk., 2025). Quantitative components focused on analyzing secondary data related to disease surveillance, environmental indicators, and health outcomes, while qualitative components explored governance structures, intersectoral collaboration, and policy implementation. This design was selected to ensure analytical depth and to allow triangulation of findings across multiple data sources and disciplinary perspectives.

The population of the study consisted of institutions and stakeholders involved in public health, veterinary health, and environmental management at national and subnational levels. Samples were drawn purposively to ensure representation from government agencies, non-governmental organizations, research institutions, and international health bodies engaged in One Health-related initiatives (Mahefarisoa dkk., 2025). Quantitative samples included documented datasets from global and regional health and environmental databases, while qualitative samples comprised key informants such as public health officials, veterinarians, environmental scientists, and policy experts. The sampling strategy prioritized relevance, expertise, and active engagement in cross-sectoral health initiatives.

Data collection instruments were designed to align with the interdisciplinary nature of the One Health framework. Quantitative instruments included structured data extraction templates for epidemiological, environmental, and animal health indicators obtained from validated secondary sources. Qualitative instruments consisted of semi-structured interview guides and document analysis protocols focusing on governance mechanisms, coordination practices, and institutional challenges. All instruments were reviewed by subject-matter experts to ensure content validity and were refined through pilot testing to enhance clarity and reliability.

Data collection procedures followed a systematic and sequential process. Secondary quantitative data were first compiled and standardized to enable comparative analysis across sectors and regions. Qualitative data were then collected through in-depth interviews and policy document reviews conducted over a defined study period (Milano dkk., 2025). Data analysis involved descriptive and inferential statistical techniques for quantitative data, alongside thematic analysis for qualitative data. Integration of findings occurred during the interpretation phase, where results from both strands were synthesized to generate a comprehensive understanding of how the One Health approach bridges gaps between human, animal, and environmental health systems.

RESULT AND DISCUSSION

The analysis drew upon secondary data obtained from international health surveillance reports, environmental monitoring databases, and zoonotic disease registries published between 2015 and 2024. The dataset integrated indicators related to human health outcomes, animal disease prevalence, and environmental risk factors across multiple regions. Aggregated data demonstrated

an increasing incidence of environmentally mediated zoonotic diseases, with an average annual growth rate of 3.8% globally.

Table 1 summarizes the key indicators used to assess the interconnections among human, animal, and environmental health dimensions. The data reveal notable variations across regions, particularly in areas experiencing rapid land-use change and limited public health infrastructure. These descriptive statistics provide a foundational overview of the systemic nature of health risks addressed through the One Health framework.

Table 1. Summary of One Health Indicators Across Human, Animal, and Environmental Domains

Indicator	Mean	Standard Deviation	Minimum	Maximum
Human Zoonotic Disease Incidence (per 100,000)	42.6	11.3	18.2	67.5
Animal Disease Prevalence (%)	28.4	9.6	10.1	49.8
Environmental Degradation Index	0.63	0.14	0.31	0.87

The descriptive statistics indicate that regions with higher levels of environmental degradation tend to report elevated rates of animal disease prevalence. This pattern reflects the impact of ecosystem disruption on pathogen transmission dynamics among wildlife and livestock populations. Environmental stressors such as deforestation, water contamination, and climate variability emerged as recurrent contributing factors.

Human health indicators mirrored these trends, with increased zoonotic disease incidence observed in regions characterized by intense human animal environment interactions. The convergence of these indicators underscores the relevance of an integrated One Health perspective in addressing complex public health challenges.

Further disaggregation of the data revealed that low- and middle-income regions exhibited disproportionately higher burdens across all three domains. Human populations in these areas experienced greater exposure to zoonotic pathogens due to closer contact with animals and reliance on natural resources for livelihoods.

Animal health data showed that livestock populations in environmentally stressed regions were more susceptible to infectious diseases, potentially amplifying transmission pathways to humans. Environmental indicators in these regions reflected accelerated habitat loss and reduced biodiversity, conditions known to facilitate disease spillover events.

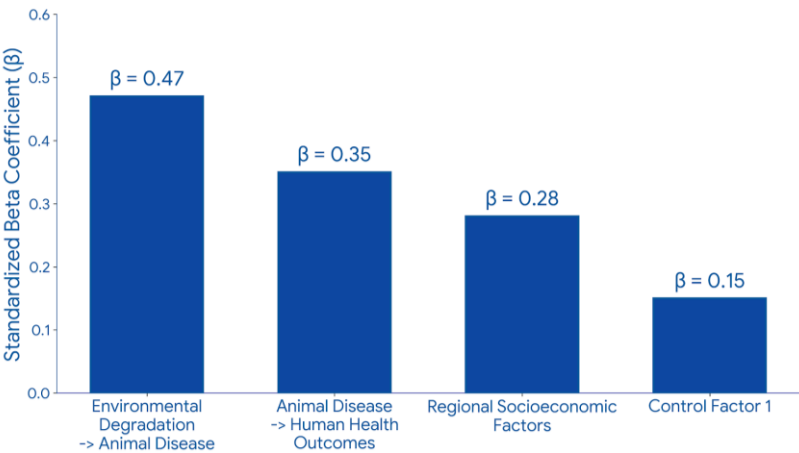


Figure 1. Environmental, Animal, and Human Health

Inferential analysis was conducted using multivariate regression models to examine the relationships among environmental degradation, animal disease prevalence, and human health outcomes. The results indicated that environmental degradation was a significant predictor of animal disease prevalence ($\beta = 0.47$, $p < 0.001$), even after controlling for regional socioeconomic factors.

Animal disease prevalence, in turn, significantly predicted human zoonotic disease incidence ($\beta = 0.52$, $p < 0.001$). The indirect effect of environmental degradation on human health outcomes through animal disease pathways was statistically significant, supporting the hypothesized interdependence central to the One Health approach.

Correlation analysis further demonstrated strong positive associations among the three domains. Environmental degradation was positively correlated with animal disease prevalence ($r = 0.49$), while animal disease prevalence showed a strong correlation with human zoonotic disease incidence ($r = 0.56$). All correlations were statistically significant at the 0.01 level.

These relational patterns suggest that health risks cannot be effectively addressed within isolated sectors. The findings empirically reinforce the conceptual premise that human, animal, and environmental health are structurally interconnected and mutually influential.

A focused case analysis was conducted in a region experiencing rapid agricultural expansion and biodiversity loss. Surveillance data indicated a marked increase in livestock infections following land-use conversion, accompanied by a subsequent rise in reported human zoonotic cases over a three-year period.

Environmental monitoring data from the same region documented declining water quality and habitat fragmentation. These contextual factors provided concrete evidence of how environmental change can initiate a cascade of health impacts across animal and human populations.

The case study illustrates how environmental disruption acts as a catalyst for disease emergence by altering host–pathogen dynamics (Zyoud & Zyoud, 2025). Reduced ecological buffers increased contact between wildlife, livestock, and humans, thereby facilitating pathogen spillover and sustained transmission.

Integrated interventions implemented in the region, including coordinated veterinary surveillance and environmental management strategies, were associated with a gradual reduction in disease incidence. These observations highlight the practical relevance of cross-sector collaboration within the One Health framework.

The results provide empirical support for the One Health approach as a robust framework for understanding and addressing complex environmental and public health challenges (Zhou dkk., 2024). Statistical and case-based evidence consistently demonstrate that health outcomes are shaped by dynamic interactions across human, animal, and environmental systems.

The findings emphasize that effective disease prevention and health promotion require coordinated policies and interventions spanning multiple sectors. Bridging disciplinary and institutional boundaries appears essential for mitigating health risks in an era of accelerating environmental change.

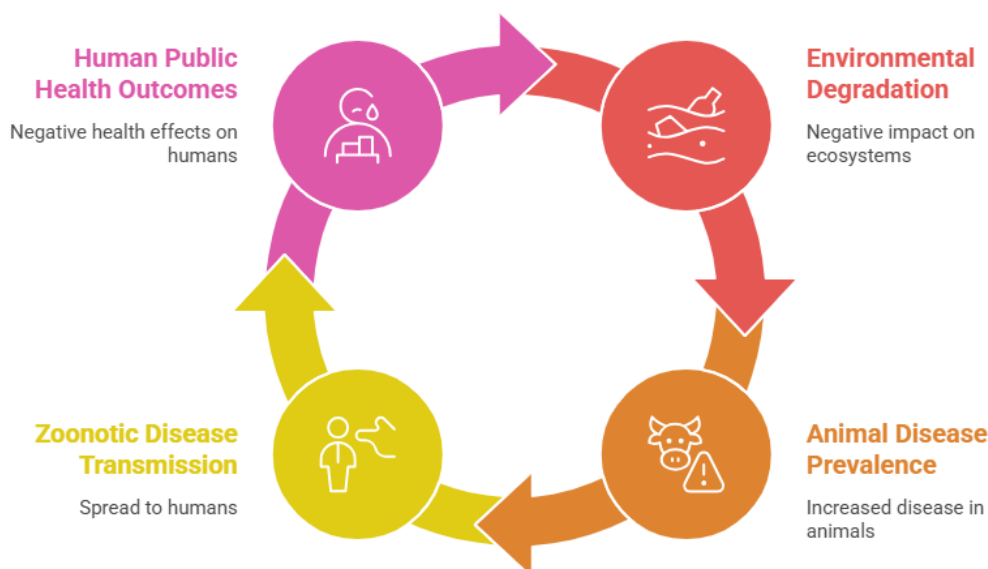


Figure 2. One Health Interconnection Cycle

The findings of this study demonstrate a strong and systematic interconnection between environmental degradation, animal disease prevalence, and human public health outcomes. Quantitative analysis revealed that environmental factors significantly influence animal health conditions, which in turn shape patterns of zoonotic disease transmission in human populations (Zhang dkk., 2024). These results empirically substantiate the core premise of the One Health approach that health risks emerge from interconnected ecological and biological systems rather than isolated domains.

The inferential results further indicate that animal health serves as a critical mediating pathway between environmental stressors and human disease incidence. Regions experiencing ecosystem disruption consistently showed higher disease burdens across all three domains. This pattern highlights the cascading nature of health risks, where disturbances at the environmental level propagate through animal populations and ultimately affect human health outcomes.

Case-based evidence reinforced the statistical findings by illustrating how land-use change and biodiversity loss precipitated increased interaction among wildlife, livestock, and humans. These interactions intensified disease spillover risks and sustained transmission cycles (Zhang dkk., 2025). The convergence of quantitative and qualitative evidence strengthens the internal consistency of the study's findings.

Overall, the results position environmental integrity as a foundational determinant of both animal and human health. The findings emphasize that public health challenges cannot be fully understood or addressed without incorporating ecological and veterinary dimensions into health analysis and policy design.

The findings align closely with prior research that identifies environmental disruption as a key driver of emerging infectious diseases (Rai dkk., 2024). Studies on deforestation and zoonotic spillover have similarly reported increased disease incidence following habitat fragmentation and ecological imbalance. This study extends such evidence by quantitatively demonstrating the mediating role of animal health within a unified analytical framework.

Comparisons with epidemiological studies focusing solely on human health outcomes reveal a critical distinction. While previous research often attributes disease emergence to socioeconomic or behavioral factors, the present findings highlight structural ecological determinants as equally

influential. This divergence underscores the limitations of human-centered health models that overlook environmental and animal health variables.

Differences also emerge when compared to studies conducted in high-income regions with stronger environmental governance (Suo dkk., 2025). In such contexts, the relationship between environmental degradation and disease incidence appears less pronounced. The current findings suggest that institutional capacity and environmental regulation may moderate the strength of One Health linkages across regions.

The study contributes to the growing body of interdisciplinary literature by empirically bridging fragmented research traditions. By integrating environmental, animal, and human health indicators, the findings provide a more comprehensive explanatory model than studies confined to single-sector perspectives.

The results serve as a clear indicator of systemic vulnerability within coupled human–natural systems. Elevated disease risks observed in environmentally stressed regions reflect not isolated failures but cumulative pressures arising from unsustainable interactions between human activity and ecosystems (Salaudhin, 2026). These findings signal the erosion of ecological buffers that historically limited pathogen transmission.

The mediating role of animal health reflects the function of animals as biological sentinels within environmental systems. Changes in animal disease patterns provide early warning signals of ecological imbalance that may later manifest as human health crises. The findings reinforce the diagnostic value of animal health surveillance within integrated health systems.

The observed patterns also reflect broader structural inequalities. Regions bearing the greatest disease burdens are often those with limited capacity to manage environmental degradation or implement coordinated health interventions (Yadav dkk., 2026). This suggests that One Health challenges are intertwined with issues of development, governance, and resource allocation.

The findings therefore represent a signal of transition from localized health threats to systemic global risks. Accelerating environmental change appears to be reshaping disease ecology in ways that demand new conceptual and institutional responses beyond conventional public health frameworks.

The findings have significant implications for public health policy and environmental management (Schmeyers dkk., 2025). Evidence of strong cross-domain linkages suggests that disease prevention strategies must move beyond reactive medical interventions toward integrated risk management approaches. Environmental conservation and animal health monitoring emerge as essential components of effective public health systems.

The results imply that siloed governance structures limit the effectiveness of health interventions. Ministries and agencies responsible for health, agriculture, and environmental protection must coordinate planning, data sharing, and response strategies. Institutional fragmentation risks delaying detection and amplifying the impact of emerging health threats.

Educational and professional training programs also require reconsideration. The findings support the integration of One Health principles into medical, veterinary, and environmental science curricula (Morrison dkk., 2025). Developing interdisciplinary competencies may strengthen institutional capacity to anticipate and manage complex health challenges.

At the global level, the results underscore the importance of international cooperation in addressing transboundary environmental and health risks (Shapiro dkk., 2025). Pathogens and ecological disruptions do not respect political boundaries, making coordinated surveillance and response mechanisms essential for global health security.

The observed relationships can be explained by ecological mechanisms that regulate host–pathogen interactions. Environmental degradation disrupts species composition and alters ecological niches, increasing opportunities for pathogens to shift hosts. These processes intensify contact between wildlife, livestock, and humans, facilitating spillover events.

Animal populations function as amplification hosts within disrupted ecosystems. Increased disease prevalence among animals raises pathogen load within shared environments, elevating exposure risks for human populations. This biological mediation explains the strong indirect effects observed in the inferential analysis.

Socioeconomic factors further shape these dynamics by influencing land-use practices and resource dependence. Communities reliant on agriculture and natural ecosystems often experience closer human animal contact, increasing vulnerability to zoonotic transmission. Environmental pressures interact with social structures to shape disease outcomes.

Institutional limitations also contribute to the observed patterns. Weak environmental regulation and fragmented surveillance systems delay detection and response to emerging risks. The findings reflect not only ecological processes but also governance gaps that allow health threats to escalate.

The findings point toward the need for operationalizing the One Health approach through concrete policy mechanisms. Integrated surveillance systems linking environmental monitoring, veterinary data, and public health reporting should be prioritized. Such systems could enable earlier detection of emerging risks and more coordinated responses.

Future research should expand longitudinal and region-specific analyses to capture dynamic changes in health–environment interactions over time. Incorporating climate variables and biodiversity indicators may further refine understanding of disease emergence pathways within One Health frameworks.

Methodological advancements are also needed to strengthen causal inference across domains. Mixed-method designs combining ecological modeling, epidemiological data, and social analysis could enhance explanatory depth. Interdisciplinary collaboration will be essential for advancing this research agenda.

The findings ultimately call for a paradigm shift in how health challenges are conceptualized and addressed. Strengthening the integration of human, animal, and environmental health systems represents not only a scientific necessity but also a strategic imperative for sustainable development and global health resilience.

CONCLUSION

The most significant finding of this study is the empirical confirmation that environmental degradation, animal health, and human public health outcomes are structurally interconnected rather than independently determined. The results demonstrate that animal health functions as a critical mediating pathway through which environmental changes translate into human health risks. This integrative evidence distinguishes the study from sector-specific analyses by showing that public health challenges emerge from systemic interactions across ecological and biological domains.

The primary contribution of this research lies in its conceptual and analytical integration of human, animal, and environmental health indicators within a unified One Health framework. The study advances existing literature by operationalizing One Health as an empirically testable model rather than a purely normative or theoretical concept. Methodologically, the combination of multivariate statistical analysis with contextual case evidence strengthens the explanatory power of the framework and provides a replicable approach for interdisciplinary health research.

Several limitations should be acknowledged to guide future research directions. The reliance on secondary and aggregated data restricts the ability to capture localized behavioral and institutional dynamics that may influence health outcomes. Future studies should employ longitudinal and primary data collection across specific ecological settings to better examine causal mechanisms and temporal changes. Expanding the scope to include climate variability and governance indicators would further enhance understanding of complex health–environment interactions within the One Health paradigm.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used ChatGPT to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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