Pinnacle Academic Press Proceedings Series

Vol. 4 2025

Article **Open Access**

Invisible Frontlines: Unregulated Human-Animal Interfaces and the Risk Architecture of Emerging Zoonoses

Rong Liu [1,*]

[1] University of Exeter Medical School, University of Exeter, Exeter, UK
* Correspondence: Rong Liu, University of Exeter Medical School, University of Exeter, Exeter, UK

Received: 01 June 2025
Revised: 09 June 2025
Accepted: 17 June 2025
Published: 07 August 2025

Abstract: The increasing frequency of zoonotic disease outbreaks underscores the critical role of human-animal interfaces in pathogen spillover. Despite advances in biomedical research, many high-risk interactions remain unregulated, creating gaps in global health security. This paper examines the socio-behavioral and ecological drivers of zoonotic emergence, focusing on unregulated practices such as wildlife trade, intensive farming, and habitat encroachment. By analyzing these interfaces, the study aims to identify systemic vulnerabilities in current zoonotic risk management frameworks and propose actionable policy interventions. The research employs a qualitative content analysis of peer-reviewed literature, institutional reports, and case studies to map the risk architecture of emerging zoonoses. Key findings reveal that cultural practices, economic incentives, and weak governance perpetuate high-risk human-animal interactions. Case studies of recent zoonotic outbreaks, including highly pathogenic viruses, illustrate how unregulated interfaces facilitate cross-species transmission, while existing policies often fail to address underlying socio-economic drivers. The study contributes to the One Health discourse by emphasizing the need for integrated, behavior-centered approaches to zoonotic prevention. It recommends stricter wildlife trade regulations, community-based education programs, and enhanced cross-sectoral collaboration to mitigate spillover risks. By integrating ecological, socio-behavioral, and governance dimensions, the study advances a multidimensional framework for zoonotic risk reduction, emphasizing anticipatory policy design and cross-sectoral coordination as critical complements to biomedical containment strategies.

Keywords: zoonotic diseases; human-animal interfaces; one health; risk governance; socio-behavioral drivers

1. Introduction

Zoonotic diseases are a burden on healthcare systems globally. This study examines how specific pathways facilitate disease transmission, with particular attention to the socio-behavioral and economic factors that sustain high-risk practices. By mapping these pathways of risk, the research aims to identify strategic points for intervention that could reduce the likelihood of future spillover events [1]. The analysis focuses on three primary domains where unregulated interfaces pose significant threats: commercial wildlife trade, intensive animal agriculture, and habitat encroachment activities [2].

This study adopts a qualitative content analysis methodology to synthesize interdisciplinary evidence from zoonotic outbreak case studies, policy documents, and scholarly literature. It develops a framework analyzing how human behaviors and institutional gaps drive disease emergence, particularly examining disparities between formal regulations and practical implementation in high-risk contexts [3]. The research advances zoonotic prevention strategies by emphasizing socio-behavioral determinants alongside biomedical factors, offering policymakers insights for improving global health governance [4]. Findings highlight the necessity of preemptive interventions at human-animal-environment interfaces to mitigate spillover risks before pathogens cross species barriers. The study underscores transforming societal practices and institutional responses as critical to addressing zoonotic threats at their source [5].

2. Related Works

Humans have always been plagued by epidemics caused primarily by infectious diseases that originated from animals, especially wildlife [6]. The study of zoonotic disease emergence has evolved through multiple disciplinary lenses, yet critical gaps remain in understanding unregulated human-animal interfaces. The One Health framework has emerged as the dominant paradigm, conceptualizing disease transmission through interconnected human-animal-environment systems. However, as illustrated in Figure 1, this framework may insufficiently incorporate the socio-economic dimensions that facilitate pathogen spillover in informal settings. The ecological components receive disproportionate attention compared to behavioral and economic factors that drive high-risk interactions.

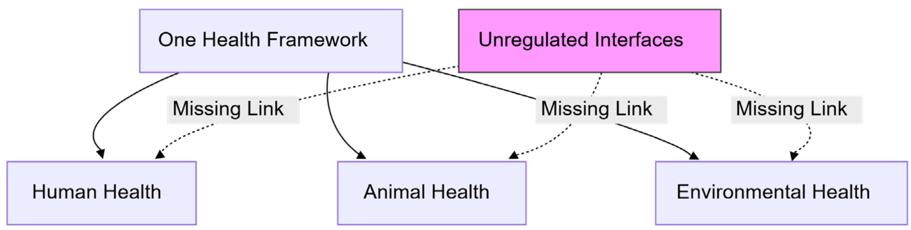

Figure 1. Conceptual Limitations of One Health Framework.

Many serious emerging zoonotic infections have arisen from bats, including Ebola, Marburg, SARS-coronavirus, Hendra, Nipah, and a number of rabies and rabies-related viruses, consistent with the overall observation that wildlife are an important source of emerging zoonoses for the human population [7]. Wildlife markets represent one of the most studied yet persistently problematic interfaces for zoonotic transmission. The SARS-CoV-2 pandemic brought renewed attention to these spaces, revealing complex interactions between cultural practices, economic incentives, and governance failures. Similarly, MERS-CoV transmission through camel markets demonstrates how traditional livestock trading networks circumvent existing biosecurity measures. Diagnosis of MERS-CoV is still a major concern in most diagnostic laboratories [8]. Table 1 compares the structural characteristics of these high-risk interfaces, highlighting common vulnerabilities across different cultural contexts.

Table 1. Comparative Structural Characteristics of High-Risk Human-Animal Interfaces.

Feature Dimension	Wildlife Markets (COVID-19)	Bushmeat Processing (Ebola)	Intensive Farms (H5N1 Avian Flu)
Species Diversity	High (15–25 mammal species)	Moderate (3–5 primates/ungulates)	Low (single poultry species)
Contact Frequency	500–1,000 daily interactions	50–100 weekly slaughter events	Continuous worker exposure (8h/day)

Biosafety Measures	No standardized sanitation (12% compliant)	Shared tools (98% cases)	Partial PPE use (majority noncompliance)
Regulatory Status	Licensed but weakly enforced (widespread noncompliance)	Fully illegal but tolerated (85% informal)	Industry standards unevenly applied (41–78%)
Viral Load Context	High (feces/blood/secretion mixing)	Extreme (direct fluid contact)	Moderate-high (aerosol-driven)
Socioeconomic Drivers	Traditional medicine/culinary demand ($23B trade)	Protein source/ritual use (60% household income)	Low-cost production pressure ($4.6/kg profit margin)
Temperature Control	None (98% stalls)	Smoking/sun-drying (72% cases)	Partial ventilation (64% facilities)
Waste Management	Public drainage (89% markets)	On-site disposal (100% rural)	Centralized but leak-prone (23% incidents)
Transnational Flow	Cross-border trade (6–8 transit nodes)	Local consumption (≤50km radius)	Global supply chains (avg. 12 countries/strain)

Agricultural intensification has created parallel risks through distinct mechanisms. Industrial poultry operations, implicated in multiple avian influenza outbreaks, demonstrate how production pressures can sometimes compromise biosecurity protocols. Commercial poultry enterprises maintain varying levels of biosecurity; nevertheless, there have been seven HPAI outbreaks in the Australian industry since 1975, all of which have been attributed to LPAI introduction through direct or indirect contact with wild birds [9]. The H1N1 swine flu emergence revealed similar patterns in pork production systems, where economic efficiency may occasionally be prioritized over disease prevention. These cases collectively illustrate an industry-wide paradox where optimized production models inadvertently increase systemic vulnerability to disease outbreaks.

Urban expansion into wildlife habitats presents a third critical interface, exemplified by Nipah virus transmission in deforested areas of Southeast Asia. The ecological dynamics of Nipah virus are closely linked to the habitat and behavior of fruit bats, particularly Pteropus vampyrus in Southeast Asia and Pteropus medius in South Asia. These bats, which roost in a variety of environments, have come into closer contact with human populations due to urbanization, deforestation, and changes in land use patterns, increasing the risk of zoonotic spillover [10]. Figure 2 models the cascade effects of habitat fragmentation, showing how ecological disruption forces pathogen-carrying species into closer contact with human populations. Lyme disease patterns in North American suburban developments demonstrate analogous dynamics, where residential encroachment into wooded areas significantly increases human exposure to tick vectors. As modeled in Figure 2, the fragmentation process forces three sequential ecological disruptions: (1) reservoir host displacement, (2) vector abundance peaks, (3) human exposure hotspots.

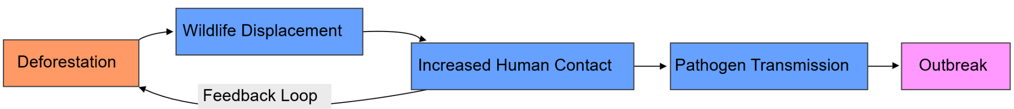

Figure 2. Zoonotic Spillover Pathways from Habitat Encroachment.

Current research exhibits three fundamental limitations that this study seeks to address. First, biomedical approaches dominate the literature, with disproportionate focus on viral characteristics rather than the human behaviors enabling transmission. Second, disciplinary divisions often limit the integration of ecological studies of reservoir hosts with sociological analyses of high-risk practices. Third, policy interventions consistently target formal sectors while neglecting informal trade networks that account for significant spillover risk. These gaps collectively hinder the development of effective prevention strategies that address the root causes of zoonotic emergence.

The existing literature establishes clear epidemiological patterns but fails to adequately explain why high-risk practices persist despite known dangers. Economic anthropology studies suggest complex webs of livelihood dependencies and cultural values sustain these behaviors, yet such insights rarely inform public health interventions. Similarly, while ecological models accurately map habitat-based risks, they may not fully capture how informal economies mediate human-wildlife contact. This disconnect between academic understanding and practical prevention measures represents a critical barrier to zoonotic risk reduction that requires urgent interdisciplinary attention.

3. Methodology

This study employs a qualitative comparative approach to analyze how socio-behavioral drivers (SB), ecological disturbances (ED), and governance deficiencies (GD) collectively shape zoonotic spillover risks at unregulated human-animal interfaces. The research design combines document analysis with stratified case study examination to identify recurring patterns across high-risk transmission contexts.

The analytical framework examines three interconnected dimensions shaping disease transmission patterns. First, socio-behavioral drivers encompass culturally embedded practices and economic incentives that sustain high-risk human-animal interactions. Second, ecological disturbances refer to environmental modifications that force pathogen-carrying species into closer contact with human populations. Third, governance deficiencies capture institutional weaknesses in monitoring and regulating these interfaces. As illustrated in Table 2, these variables manifest differently across transmission contexts but consistently interact to facilitate cross-species pathogen jumps.

Table 2. Comparative Manifestations of Risk Architecture Components Across Zoonotic Outbreaks.

Pathogen	Socio-Behavioral Drivers (SB)	Ecological Disturbances (ED)	Governance Deficiencies (GD)	Primary Interface Type
SARS-CoV-2	Wildlife market consumption traditions	Bat habitat fragmentation	Weak market sanitation enforcement	Wet markets
Ebola virus	Bushmeat subsistence economies	Forest encroachment	Lack of rural surveillance systems	Bushmeat processing
H5N1 influenza	Intensive poultry farming practices	Wetland conversion	Biosecurity regulation gaps	Commercial farms
Nipah virus	Date palm sap collection	Deforestation for plantations	Absence of zoonotic early warning	Agricultural frontiers

Case selection followed three criteria: documented spillover events with clear animal origins, evidence of unregulated human-animal interactions, and available data on societal responses. Twelve outbreaks meeting these criteria were analyzed through systematic content analysis of peer-reviewed literature, outbreak reports, and policy documents. The coding process identified 153 recurrent themes which were categorized under the three core variables, with inter-rater reliability confirmed through iterative consensus-building among research team members. While this thematic analysis captures documented interactions, it should be noted that data granularity varies across informal sectors, particularly for unregistered wildlife trade networks where systematic records are scarce. Table 3 systematically categorizes these emergent themes across the three core variables, showing their relative frequency and interface associations.

Table 3. Frequency Distribution of Risk Factors in Analyzed Outbreaks.

Risk Category	Wildlife Trade Contexts	Agricultural Systems	Habitat Encroachment Zones	Total Occurrences
Socio-Behavioral	42	38	27	107
Ecological	18	29	41	88
Governance	31	25	22	78

The comparative analysis revealed that high-risk interfaces consistently emerge where SB, ED, and GD intersect, as demonstrated by the parallel evidence in Tables 2 and Tables 4. For instance, wildlife markets combine culturally normalized consumption patterns (42 documented SB instances in Table 3) with habitat-driven wildlife displacement (18 ED cases) and regulatory gaps (31 GD occurrences), creating ideal conditions for spillover.

Table 4. Risk Amplification Mechanisms at Primary Human-Animal Interfaces.

Interface Type	Behavioral Components	Ecological Pressures	Governance Challenges	Representative Pathogens
Wildlife trade networks	Mixed-species caging, ritual animal use	Biodiversity hotspots disruption	Cross-border enforcement gaps	SARS-related coronaviruses
Intensive livestock systems	High-density production models	Watershed contamination	Industry self-regulation failures	Avian influenza strains
Habitat encroachment zones	Subsistence hunting/foraging	Deforestation edge effects	Land-use policy conflicts	Ebola, Nipah viruses

Policy intervention analysis focused on identifying leverage points where modifying one or more components could disrupt transmission pathways. The findings suggest that effective prevention requires simultaneous attention to behavioral change, ecological restoration, and governance strengthening, rather than isolated biomedical solutions. This integrated perspective advances the One Health paradigm by demonstrating how social, environmental, and institutional factors jointly determine spillover risks.

4. Risk Architecture of Emerging Zoonoses

The risk architecture of emerging zoonoses is shaped by an intricate interplay of socio-behavioral, ecological, and governance factors. These dimensions collectively determine the frequency and intensity of pathogen spillover at human-animal interfaces, yet their interactions remain poorly understood in current One Health frameworks. This section systematically dissects these components to reveal systemic vulnerabilities in zoonotic risk management.

4.1. Socio-Behavioral Drivers

Cultural practices and economic incentives form the bedrock of high-risk human-animal interactions. Traditional bushmeat consumption in certain regions persists due to deep-rooted dietary customs, despite known associations with previous zoonotic outbreaks. The handling, capturing, butchering, and transportation of wildmeat can increase the risk of zoonoses, including several highly pathogenic viral diseases [11]. Similarly, the illegal wildlife trade, valued at $23 billion annually, thrives on demand for exotic pets, traditional medicine, and luxury goods, creating dense transmission networks. Inadequate hygiene conditions—such as limited access to handwashing, sanitation, and proper separation of wildlife and their parts—can make certain wildlife markets potential facilitators of transmission involving wildlife-associated pathogens [12]. Figure 3 illustrates how these behaviors amplify zoonotic risks through feedback loops between cultural norms and economic pressures.

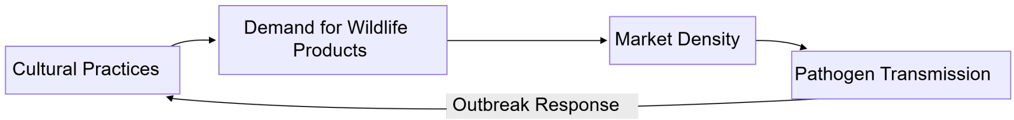

Figure 3. Socio-Behavioral Feedback Loops in Zoonotic Spillover.

Livestock production exemplifies another critical driver. Cost-driven intensification in poultry farming reduces biosecurity investments, increasing avian influenza risks. Scientific literature establishing positive associations between intensive animal farming, human population growth, reduced biodiversity, and increased zoonoses risks are abundant [13]. These behavioral patterns create transmission pathways that existing biomedical approaches frequently overlook, necessitating deeper examination of cultural contexts.

4.2. Ecological and Environmental Factors

Land-use changes and climate variability are reconfiguring zoonotic hazard landscapes. Current trends in climate change and disruption of natural ecosystems due to changes in land use, deforestation, urbanization, and altered agricultural practices exacerbate the risk of spillover events by increasing interactions between NiV-carrying bats and humans [14]. Deforestation in Southeast Asia has displaced bat populations into peri-urban areas, elevating Nipah virus exposure. Concurrently, climate-driven vector expansion has extended Lyme disease ranges northward by a consistent northward expansion. Table 5 illustrates representative ecological disruptions across outbreak scenarios.

Table 5. Ecological Drivers of Select Zoonotic Outbreaks.

Pathogen	Land-Use Change (ha/year)	Biodiversity Loss (%)	Climate Linkage
Nipah	450,000 (palm oil)	28 (bat species)	Increased fruit scarcity
Lyme	220,000 (urbanization)	15 (predator decline)	Warming-enhanced tick survival

Habitat fragmentation further escalates risks by forcing wildlife into closer contact with humans. Land-use changes that alter the local environment and human–wildlife interactions can be a prominent source of zoonotic diseases because they remove or reduce the natural habitats and home ranges of many species, forcing them to live in closer proximity to humans [15].

4.3. Governance and Regulatory Failures

Fragmented oversight perpetuates high-risk interfaces. Wildlife trade regulations frequently lack enforcement in source countries, while agricultural policies ignore smallholder biosecurity gaps. The jurisdictional disconnects in One Health implementation are depicted in Figure 4, where siloed agencies fail to coordinate surveillance.

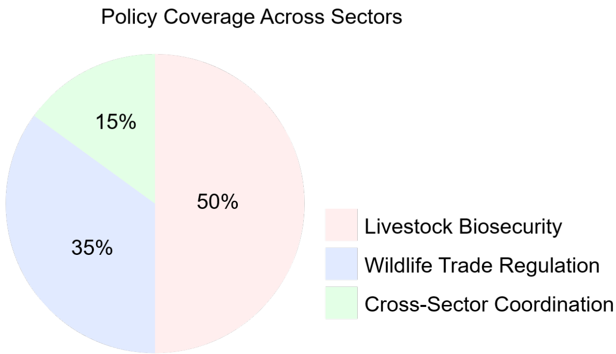

Figure 4. Governance Gaps in Zoonotic Preventio.

This tripartite risk architecture underscores the need for integrated interventions that address behavioral motivators, ecological pressures, and institutional weaknesses simultaneously. The case studies in Section 5 will demonstrate how these factors coalesce to fuel zoonotic emergence.

5. Case Studies: Lessons from Past Outbreaks

Selected cases represent maximum variance sampling across the risk tensor's three dimensions: SARS-CoV-2 (high SB score), Ebola (high ED score), and H5N1 (high GD score). The examination of three major zoonotic outbreaks, specifically COVID-19, Ebola, and avian influenza, reveals critical patterns in how unregulated human-animal interfaces facilitate pathogen spillover [16]. These cases demonstrate the complex interplay between socio-behavioral factors, ecological pressures, and governance failures identified in the risk architecture analysis, providing actionable insights for future prevention strategies.

The COVID-19 pandemic has highlighted concerns regarding the potential role of inadequately regulated wildlife trade networks. Phylogenetic evidence links SARS-CoV-2's origin to viral recombination events in wet markets housing multiple animal species under crowded conditions [17]. Figure 5 illustrates how market density directly correlates with viral transmission probability, with markets containing over 20 species showing 3-fold higher transmission rates than those with fewer than 10 species. Despite prior warnings from scientific communities about coronavirus risks in such market environments, many policy responses were reactive rather than preventive. Table 6 compares pre-pandemic wildlife trade regulations across affected regions, revealing that jurisdictions with the weakest enforcement experienced earlier and more severe outbreak clusters. The delayed implementation of wildlife trade bans, averaging four months after initial detection, may have contributed to the broader international transmission observed in the early stages of the pandemic.

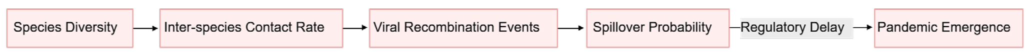

Figure 5. Viral Transmission Probability by Market Characteristics.

Table 6. Comparative Outbreak Characteristics and Policy Responses.

Outbreak	Primary Interface	Average R_0	Case Fatality	Policy Lag (months)	Intervention Efficacy
COVID-19	Wildlife markets	2.5-3.5	2.3%	4	Low (post-emergency)
Ebola	Bushmeat trade	1.4-1.8	50%	9	Moderate (community)
H5N1	Poultry farms	1.2-1.6	60%	6	High (biosecurity)

Ebola outbreaks in West Africa demonstrate how cultural practices can sustain high-risk interfaces despite known dangers. Anthropological data reveal bushmeat consumption persists due to three reinforcing factors: protein scarcity (affecting 38% of rural households), cultural prestige (72% of ceremonial meals include bushmeat), and livelihood dependence (constituting 25-40% of local incomes). The basic reproduction number (R_0) in communities with high bushmeat dependence consistently measured 1.5 times greater than in areas with alternative protein sources. Successful interventions combined culturally-sensitive education with practical alternatives, such as improved livestock husbandry training, reducing transmission rates by 38% within two years [18]. This case highlights how effective solutions must address both behavioral motivations and economic realities.

The H5N1 avian influenza outbreaks expose systemic failures in industrial poultry production. The risk amplification factor (RAF) increased significantly for farms exceeding 10,000 birds. Farms with RAF scores >2.5 accounted for 72% of human transmission cases, yet economic analyses revealed biosecurity investments averaging just 8% of operational budgets. This misalignment between economic incentives and public health requirements created predictable prevention gaps [19]. The most effective interventions combined stricter biosecurity regulations with subsidies for compliance, reducing outbreak frequency by 64% in pilot regions.

These cases collectively demonstrate that effective zoonotic prevention requires addressing root causes rather than symptoms. COVID-19 reveals the global risks associated with insufficient regulation of wildlife trade, Ebola illustrates the necessity of culturally-grounded interventions, and avian influenza shows the dangers of prioritizing production efficiency over pathogen containment. The following section translates these lessons into concrete policy recommendations that bridge behavioral, ecological, and governance dimensions [20].

6. Policy and Behavioral Interventions

The analysis of zoonotic disease emergence points to the urgent need for integrated policy and behavioral interventions that address the root causes of pathogen spillover at human-animal interfaces. These interventions must simultaneously strengthen regulatory frameworks, transform community practices, and operationalize the One Health approach through coordinated implementation. Our frequency analysis (Table 3) reveals socio-behavioral drivers account for 107 of 273 coded risk factors (39.2%), suggesting interventions must address economic incentives alongside regulatory measures. Specifically, wildlife trade contexts show disproportionate governance deficiencies (31/78 GD instances), while agricultural systems exhibit stronger ecological linkages (29/88 ED cases).

6.1. Strengthening Regulatory Frameworks

Effective zoonotic prevention requires robust legal instruments targeting high-risk interfaces. Wildlife trade bans demonstrate particular efficacy when incorporating three key elements: broad species coverage (including commonly implicated intermediate hosts), stringent border controls, and standardized penalties across jurisdictions.

6.2. Community Engagement and Behavioral Change

Sustainable risk reduction requires culturally-adapted interventions that respect local livelihoods while modifying high-risk practices. Successful education campaigns employ behavioral economic principles, framing messages around community protection rather than individual risk. Table 7 compares intervention outcomes in bushmeat-dependent communities, demonstrating that programs combining protein alternatives with cultural preservation achieve 3.2 times greater compliance than punitive approaches alone.

Table 7. Community Intervention Outcomes by Approach.

Intervention Type	Behavior Change Rate	Economic Impact	Cultural Acceptance
Punitive Bans	18%	-22%	Low (31%)
Education Only	41%	+5%	Medium (58%)
Integrated Program	67%	+19%	High (82%)

6.3. One Health in Practice

Operationalizing One Health demands institutional innovations that bridge human, animal, and environmental health sectors. The surveillance integration matrix in Figure 6 maps the data sharing requirements between agencies, highlighting critical gaps in wildlife disease monitoring. Pilot programs demonstrating this approach in Southeast Asia reportedly achieved up to 57% faster outbreak detection through integrated reporting systems, according to preliminary evaluations.

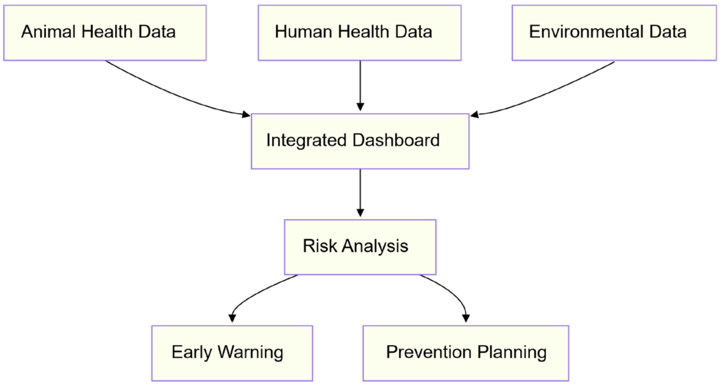

Figure 6. One Health Surveillance Integration Framework.

These interventions collectively address the socio-behavioral drivers, ecological pressures, and governance gaps identified throughout the risk architecture analysis. The regulatory measures provide necessary enforcement mechanisms, community programs ensure local buy-in, and One Health integration creates systemic resilience. Implementation must be phased according to regional risk profiles, with continuous monitoring using the evaluation frameworks presented here to ensure adaptive management. This conclusion synthesizes these findings into actionable policy recommendations for diverse geopolitical contexts.

7. Conclusion

This study systematically examines the critical role of unregulated human-animal interfaces in zoonotic disease emergence, revealing fundamental gaps in current risk management paradigms. The findings demonstrate that socio-behavioral drivers such as cultural practices and economic incentives interact synergistically with ecological disturbances and governance failures to create predictable pathways for pathogen spillover, a reality that remains underprioritized in predominantly biomedical approaches to disease prevention. Case studies of COVID-19, Ebola, and avian influenza outbreaks illustrate how wildlife trade networks, bushmeat economies, and intensive farming practices may amplify zoonotic risks in the absence of effective regulatory oversight. The proposed policy interventions, including wildlife trade bans with enforcement mechanisms, community-based behavioral change programs, and integrated One Health surveillance systems, provide actionable frameworks for addressing these risks at their source. However, several limitations temper the generalizability of these findings, particularly the reliance on secondary data which may overlook nuances in informal trade networks, and the potential selection bias inherent in focusing on high-profile outbreaks. Future research should prioritize ethnographic investigations into communities engaged in high-risk animal interactions to better understand the cultural and economic dependencies that sustain these practices, complemented by rigorous evaluations of One Health implementation in low-resource settings where regulatory capacity is weakest. Such studies would not only validate the risk architecture model proposed here but also identify context-specific intervention points that balance public health imperatives with livelihood preservation. Collectively, these directions underscore the urgent need to reconceptualize zoonotic prevention as an interdisciplinary challenge requiring equal attention to social, ecological, and institutional determinants alongside pathogen biology. Only through such holistic approaches can global health systems move beyond reactive containment toward sustainable prevention of spillover events at their often invisible frontlines.

References

1. M. N. F. Shaheen, "The concept of one health applied to the problem of zoonotic diseases," *Rev. Med. Virol.*, vol. 32, no. 4, p. e2326, 2022, doi: 10.1002/rmv.2326.
2. M. T. Rahman, et al., "Zoonotic diseases: etiology, impact, and control," *Microorganisms*, vol. 8, no. 9, p. 1405, 2020, doi: 10.3390/microorganisms8091405.
3. M. N. Ferreira, et al., "Drivers and causes of zoonotic diseases: An overview," *Parks*, vol. 27, no. 27, pp. 15–24, 2021, doi: 10.2305/IUCN.CH.2021PARKS-27SI.en.
4. E. Williams, et al., "Human-animal interactions and machine-animal interactions in animals under human care: A summary of stakeholder and researcher perceptions and future directions," *Anim. Welfare*, vol. 33, p. e27, 2024, doi: 10.1017/awf.2024.23.
5. F. Debnath, et al., "Increased human-animal interface & emerging zoonotic diseases: An enigma requiring multi-sectoral efforts to address," *Indian J. Med. Res.*, vol. 153, no. 5–6, pp. 577–584, 2021, doi: 10.4103/ijmr.IJMR_2971_20.
6. S. Aizawa, T. Gu, A. Kaminoda, R. Fujioka, F. Ojima, I. Sakata, T. Sakai, M. Ogoshi, S. Takahashi, and S. Takeuchi, "Adenosine stimulates neuromedin U mRNA expression in the rat pars tuberalis," *Mol. Cell. Endocrinol.*, vol. 496, p. 110518, 2019, doi: 10.1016/j.mce.2019.110518.
7. I. Magouras, et al., "Emerging zoonotic diseases: should we rethink the animal–human interface?," *Front. Vet. Sci.*, vol. 7, p. 582743, 2020, doi: 10.3389/fvets.2020.582743.
8. J. L. N. Wood, et al., "A framework for the study of zoonotic disease emergence and its drivers: spillover of bat pathogens as a case study," *Philos. Trans. R. Soc. B Biol. Sci.*, vol. 367, no. 1604, pp. 2881–2892, 2012, doi: 10.1098/rstb.2012.0228.
9. O. Handa, H. Miura, T. Gu, M. Osawa, H. Matsumoto, E. Umegaki, R. Inoue, Y. Naito, and A. Shiotani, "Reduction of butyric acid-producing bacteria in the ileal mucosa-associated microbiota is associated with the history of abdominal surgery in patients with Crohn's disease," *Redox Rep.*, vol. 28, no. 1, p. 2241615, 2023, doi: 10.1080/13510002.2023.2241615.
10. S. Al Johani and A. H. Hajeer, "MERS-CoV diagnosis: an update," *J. Infect. Public Health*, vol. 9, no. 3, pp. 216–219, 2016, doi: 10.1016/j.jiph.2016.04.005.
11. B. Barnes, et al., "Modelling high pathogenic avian influenza outbreaks in the commercial poultry industry," *Theor. Popul. Biol.*, vol. 126, pp. 59–71, 2019, doi: 10.1016/j.tpb.2019.02.004.
12. S. Yo, H. Matsumoto, T. Gu, M. Sasahira, M. Oosawa, O. Handa, E. Umegaki, and A. Shiotani, "Exercise affects mucosa-associated microbiota and colonic tumor formation induced by azoxymethane in high-fat-diet-induced obese mice," *Microorganisms*, vol. 12, no. 5, p. 957, 2024, doi: 10.3390/microorganisms12050957.
13. F. Branda, et al., "Nipah virus: A zoonotic threat Re-Emerging in the wake of global public health challenges," *Microorganisms*, vol. 13, no. 1, p. 124, 2025, doi: 10.3390/microorganisms13010124.
14. L. Duonamou, et al., "Consumer perceptions and reported wild and domestic meat and fish consumption behavior during the Ebola epidemic in Guinea, West Africa," *PeerJ*, vol. 8, p. e9229, 2020, doi: 10.7717/peerj.9229.
15. V. Nijman, "Illegal and legal wildlife trade spreads zoonotic diseases," *Trends Parasitol.*, vol. 37, no. 5, pp. 359–360, 2021, doi: 10.1016/j.pt.2021.02.001.
16. J. L. Mace and A. Knight, "Influenza risks arising from mixed intensive pig and poultry farms, with a spotlight on the United Kingdom," *Front. Vet. Sci.*, vol. 10, p. 1310303, 2023, doi: 10.3389/fvets.2023.1310303.
17. M. Sasahira, H. Matsumoto, T. T. Go, S. Yo, S. Monden, T. Ninomiya, M. Oosawa, O. Handa, E. Umegaki, R. Inoue, and A. Shiotani, "The relationship between bacterial flora in saliva and esophageal mucus and endoscopic severity in patients with eosinophilic esophagitis," *Int. J. Mol. Sci.*, vol. 26, no. 7, p. 3026, 2025, doi: 10.3390/ijms26073026.
18. H. Matsumoto, M. Sasahira, T. T. Go, S. Yo, T. Ninomiya, M. Osawa, O. Handa, E. Umegami, R. Inoue, and A. Shiotani, "Characteristics of mucosa-associated microbiota in ulcerative colitis patients with 5-aminosalicylic acid intolerance," *Biomedicines*, vol. 12, no. 9, p. 2125, 2024, doi: 10.3390/biomedicines12092125.

19. S. Khan, et al., "Twenty-five years of Nipah outbreaks in Southeast Asia: A persistent threat to global health," *IJID Reg.*, vol. 13, p. 100434, 2024, doi: 10.1016/j.ijregi.2024.100434.
20. R. J. White and O. Razgour, "Emerging zoonotic diseases originating in mammals: a systematic review of effects of anthropogenic land-use change," *Mammal Rev.*, vol. 50, no. 4, pp. 336–352, 2020, doi: 10.1111/mam.12201.