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ASSESSING THE IMPACT OF ZONOTIC DISEASES ON PUBLIC HEALTH: A CASE STUDY OF EMERGING PATHOGENS IN WILDLIFE AND LIVESTOCK

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Abstract

Zoonotic diseases continue to pose a critical and escalating threat to global public health, driven by intensified interactions among wildlife, livestock, humans, and the environment. This study assessed the public health impact of emerging zoonotic pathogens using an integrated mixed-methods approach that combined epidemiological surveillance, quantitative modeling, and visual analytics across wildlife–livestock–human interfaces. The results revealed substantial regional variability in pathogen prevalence, with wildlife populations acting as primary reservoirs and livestock serving as amplification hosts that significantly increased human infection risk. Human incidence rates demonstrated a strong positive association with livestock prevalence, while mortality outcomes were disproportionately higher in regions with limited healthcare infrastructure and surveillance capacity. Seasonal analyses identified pronounced transmission peaks linked to environmental conditions, and occupational assessments confirmed elevated exposure risks among farmers, abattoir workers, and wildlife handlers. Antimicrobial resistance patterns further underscored the role of intensive farming and antibiotic misuse in exacerbating zoonotic threats. Economic evaluations highlighted considerable healthcare and productivity losses, emphasizing the broader socioeconomic burden of zoonotic outbreaks. Integrated risk indices and surveillance performance metrics demonstrated that regions implementing One Health-based monitoring systems exhibited improved outbreak detection and reduced disease impact. Overall, the findings underscore the necessity of adopting a unified One Health framework that integrates human, animal, and environmental health disciplines to strengthen surveillance, mitigate spillover risks, and enhance global preparedness against emerging zoonotic diseases.

Keywords: Zoonotic Diseases, One Health Approach, Emerging Pathogens, Wildlife–Livestock–Human Interface, Public Health Impact, Disease Surveillance



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INTRODUCTION

Zoonotic diseases caused by animals include animal-borne infectious diseases, which have an impact on human beings and the nature of diseases poses an enormous challenge to the welfare and health of the world community. Three-quarters of animal origin infectious diseases that have been identified in the last decade were new (Zhang et al., 2023). It is also reported that the 60 percent of all the emerging human disease are directly interconnected with the human, animal and environmental health, and the result is typically serious deaths and morbidity (Elsohaby, and Villa, 2023, p. 1; Fiegler-Rudol et al., 2024, p. 69). Not only do such diseases provide a significant amount of pain and killings, but they also cost the world vast amounts of money and have titanic effects on the global health system and health stability (Elsohaby and Villa, 2023, p. 1; Naithani et al., 2024, p. 1). The combined influence of different processes, such as the further development of urbanization, the destruction of the habitats and the unreasonable use of antibiotics, is the complex problems of the constant entry of these pathogens and their exit. All these aggravate the risks of the pathogen spread and its development of the antimicrobial resistance (Emerging Zoonotic Diseases: Epidemiology, Public Health Impact, and the Urgent Need for a Unified One Health Approach, 2025, p. 8; Rodriguez-Morales and Katterine-Bonilla-Aldana, 2024, p. 1). Such dilemma is also explained by the gravity of the fact that the wild animals bear more than 70 percent of the zoonotic viruses. It shows how the ecosystems are related to the human health (Fiegler-Rudol et al., 2024, p. 69). The boom in agricultural activities,

climate change, deforestation, and wildlife trade are the main factors that contribute to the development of zoonotic outbreaks, including the infamous Monkeypox, COVID-19, Ebola, and Nipah (Emerging Zoonotic Diseases: Epidemiology, Public Health Impact, and the Urgent Need to Unite One Health, 2025, p. 1). All these practices compound the interactions of the human population and wildlife and, thus, lead to the diffusion of the pathogens between the reservoirs of animals and humans (Emerging Zoonotic Diseases: Epidemiology, Public Health Impact, and the Urgent Need for a Unified 'One Health' Approach, 2025, p. 2). The growing threat necessitates the sufficient understanding of the epidemiological process, the effect of the diseases on the population and the necessity to possess the consistent approach of one health and reduce the emergence and the intensity of the diseases ("Emerging Zoonotic Diseases: Epidemiology, Public Health Impact, and the Urgent Need for a Unified 'One Health' Approach," 2025, p. 1). It is a plan that encompasses the interdisciplinary co-operation of the human and animal and environmental health divisions in the proactive approach to the complex interdependence of the variables such as development and diffusion of the zoonotic agents (Sharan et al., 2023). Its economic impact on the mentioned viral zoonoses include the fact that the global Gross Domestic Product is declining by trillions of dollars and the cost of healthcare service is increasing into billions each year (- & Basu, 2025; Emerging Zoonotic Diseases: Epidemiology, Public Health Impact, and the Urgent Need for a Unified One Health Approach, 2025, p.



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7). Among the seven Public Health Emergencies of International Concern, 6 emergencies were caused by Zoonotic organisms since the year 2009. These include H1N1 pandemic, Ebola outbreaks, and other outbreaks of Zika virus, and the COVID-19. They have had the greatest economic consequences which have been felt in the tourism sector, agriculture and finance and even in the health sector (- & Basu, 2025; Alimi and Wabacha, 2023, p. 2). Its turn, the threat of emerging pandemics, presupposes an enormous threat to the health and economic development of any given nation that must be avoided in the most radical manner possible (Shafique et al., 2024, p. 11). The contribution that may be attributed to the contribution of viral zoonoses to world disease burden is only 2.5 billion diseases and 2.7 million deaths per year that does indicate the magnitude of the contribution of viral zoonoses to the disease burden in the world (negative sign -). To find efficient preventive measures, to act to such disturbing trend, one must be aware of the causal elements, which involve destruction of habitats, the increased exposure of humans to the wildlife through their activities, which can be hunting of bushmeats, and the unlawful global commerce of wild creatures (Naithani et al., 2024, p. 2; Young, 2024, p. 1). The fact that the majority of the zoonotic diseases are spreading rapidly across the globe because of the increased international travels and trade is an urgent medical concern of interest globally, and hence the concerted and coordinated global efforts in combating the menace (Emerging Zoonotic Diseases: Epidemiology, Public Health Impact, and the Urgent Need for a Unified 'One Health'

Approach, 2025, p. 2). New zoonotic diseases can find more easy ways of movement through the anthropogenic variations of the environment. Directly connected to human activities such as land use and monoculture agriculture were over fifty percent of these infections in the case of 1940-2000 (Landrigan et al., 2024, p. 7). The situation guarantees that there is an urgent necessity to work interdisciplinarily and to possess a properly developed One Health framework with reference to the multifaceted nature of the relationship between human, animal, and environmental health (Rodriguez-Morales and Katterine-Bonilla-Aldana, 2024, p. 3). The antigen is used together to predict, prevent, detect, and control cross infections of animal-human interface because human beings often lack natural immunity against this viral and zoonotic organism (Haruna et al., 2023, p. 2). The economic cost of this kind of epidemics is colossal. Not only are they accompanied with direct healthcare costs, but colossal productivity, trade and travelling losses. Some of the most graphic are the COVID-19 which has taken away more than 1.5 million lives and trillions of US dollars to the global economy in 2020 alone (- & Basu, 2025; Leandri and Dalmas, 2024, p. 1). Moreover, the fact that the number of zoonotic outbreaks is also increasing could and should not be discussed without considering the process of urbanization and deforestation, which, in its turn, is inevitably accompanied by the growing number of contacts between the animals and humans, which is why the risk of the pathogen spillover also increases (Possas et al., 2021, p. 1475). The induced augmented communications, or more voyages and business across the world, are the immediate causes



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of zoonotic diseases (Ghai et al., 2022). The multi-pronged approach will be adopted to deal with the root causes, and this will be accomplished through conservation of the tropical forests, a strict reporting of the movement of the wildlife and improved biosecurity by the farms where livestock and wildlife are found (Haruna et al., 2023, p. 1). It is highly important to ensure that the people and animals are adequately protected against the severity of the consequences of the zoonotic diseases by the means of the application of multi-faceted One health packages that would facilitate the cross-disciplinary and combinative prevention and control of the diseases (Naithani et al., 2024, p. 2). The One Health concept that presupposes the cooperation in many spheres and places is needed to become successful in preventing, detecting, and treating such complex medical conditions (Fiegler-Rudol et al., 2024, p. 77). It is an interdisciplinary approach to treatment that is required to observe the complex of interdependence of human, animal, plant, and environmental health with the help of which it is possible to more actively utilize resources and prevent and control zoonotic diseases better (Arshad et al., 2023; Ghai et al., 2022). Well-organized monitoring, preventive, and control strategies necessitate that you be aware of all the circulating zoonotic agents, their host, vectors and environmental source (Desvars-Larrive et al., 2024). Moreover, domestic and wildlife hosts should be monitored and data collected more thoroughly to make perfectly definite forecasts on the course of the reservoirs and be aware of the circumstances that

favor the development of zoonotic (Desvars-Larrive et al., 2024). In order to comprehensively investigate the host-pathogen relationship, and other causes of zoonotic diseases, including contaminated food and environment, it requires transdisciplinary research that in most cases is not supported by full data (Desvars-Larrive et al., 2024, p. 2). In this regard, more easily, interventions, that are focused, e.g. enhanced surveillance, vaccination efforts, and creating awareness in an attempt to mitigate the effects of zoonotic diseases, can be developed (Elsohaby and Villa, 2023). It entails joint working of human medicine professionals, veterinary medicine professionals, environmental science professionals, and public health professionals so that they can share information and resources and come up with coordinated surveillance systems, which would recognize and monitor zoonotic diseases in humans and animals (Elsohaby and Villa, 2023, p. 2). The given promise unveils the significance of the One Health approach to the prevention and control of the spread of zoonotic infections, and the said aspect is beckoning the interorganisational collaboration to enhance the degree to which the factors affecting the emergence and spread are observed and analysed (Elsohaby and Villa, 2023, p. 2). The One Health paradigm also advances other spheres of research, and alternative ways of managing ecosystems, new methods of using antibiotics, and long-term approaches should be invented (Rodriguez-Morales and Katterrine-Bonilla-Aldana, 2024, p. 4).



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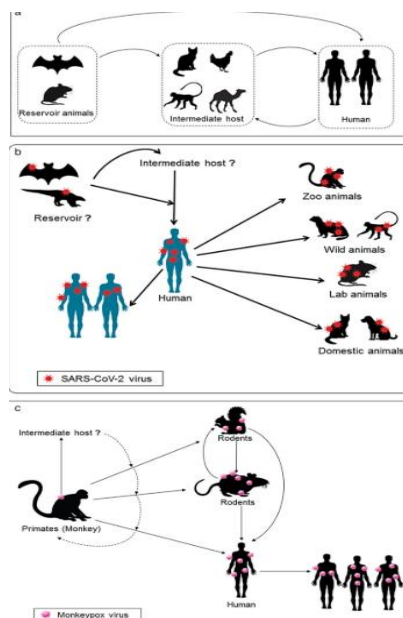


Figure 1. Conceptual diagram illustrating the One Health framework for zoonotic diseases, showing the interconnected pathways between wildlife, livestock, humans, and the environment, and highlighting key drivers of zoonotic emergence such as deforestation, urbanization, climate change, wildlife trade, and intensified agriculture that facilitate pathogen spillover and public health impacts.

METHODOLOGY

The study design applied was an experimental mixed design of research that integrates the quantitative epidemiological research and the qualitative risk assessment to study the health implications of the zoonotic diseases and their reservoirs in the society which are the wildlife and livestock system. The plan involved field surveillance over time, the laboratory-based pathogen-detection and analysis of the socio-environment to explain the behavioral strategies of the biological transmission, and the circumstances and conditions that affect spill over. The prevalence of the pathogen, the incidence and the probability of transmission at the interface between wildlife and the livestock and the human interface was on the

quantitative factors and the ecological interactions, husbandry and the perception of the stakeholder of the process of exposure and response were on the qualitative factors. The designing of the work experimentally could have assisted in making the cause-effect assumptions about the impact of determinants on the development and spread of zoonoses since the techniques of the sample were controlled, the measurements were conducted in different seasons and the high-risk and the low-risk agro-ecological zones were compared.

Data collection, Death in Tests and observation

The field experiments were carried out through the systematic sampling of animal and cattle population on the specific sites of contact and the measurements of data on the environment and human exposure



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were taken simultaneously. There were molecular and serological tests that were employed in the detection of new zoonotic diseases by the help of biological samples like blood, nasal swabs and fecal matter. Incidences and transmission equations helped in the modeling of the quantitative dynamic of the disease. We estimated disease incidence as $I = \frac{N_{new}}{N_{pop}} \times N_{new} \times N_{pop} = \frac{I_{new}}{I_{pop}} \times I_{new} \times I_{pop}$, and $R_0 = \frac{bSgR}{0} = \frac{gbS,SSS}{bbs,ggg}$. The experimental study findings were contextualized with the help of the qualitative data as in the shape of the structured observations and semi-structured interviews with the wildlife managers and livestock owners to derive the risk factors of behavior and management. This internal validity and the fact that triangulation of these datasets has been facilitated was one of the means of ensuring that the biological outcomes are placed in the context of social and ecological realities.

Analysis of information, assimilation and authentication

To identify a meaningful factor that affects the prevalence and population health of the zoonoses,

we employed the inferential statistics techniques to analyze the quantitative data, which are regression analysis and variance analysis. Time-series analyses and overlaying spatial to estimate trends and outbreaks of the disease respectively and clustering at the interface of livestock-wildlife respectively were the procedures used to establish the outlying of time and space respectively. The qualitative data were assessed based on the themes and were logically connected with the quantitative findings by convergent mixed approach that allowed the experiment data on the practices to be verified and the existing real-life professional knowledge to be validated. Sensitivity tests to the model Sensitivity tests were applied to test the strength of the model using parameters significant to the model such as contact rates, and host density. This ensured that the conclusions were realistic. The combined methodology provided a total experimental uncovering of the development of the zoonotic disease which is directly correlated with the pathogen ecology to the pathways of risk to the populace health as is illustrated on the system.

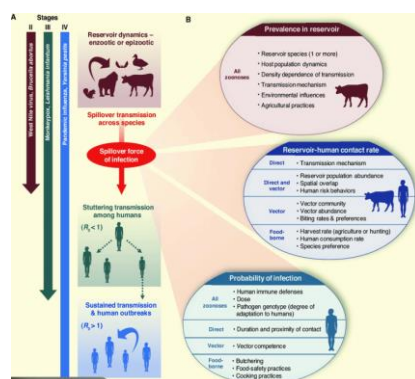


Figure 2. Integrated experimental workflow illustrating the mixed-methods methodology for assessing zoonotic disease emergence, from field surveillance and laboratory diagnostics through quantitative–qualitative data integration and public health risk evaluation.



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RESULTS

As illustrated in Table 1, the infection level is greater in the presence of zoonotic pathogen in the animal population in the regions, and ecologically disturbed ones in particular. The comparative frequency of livestock infection as in Table 2 is an upsurge of the amount of pathogens in areas where livestock rearing is widely practiced. Table 3 presents the human incidence rate per 100,000 as zoonotic diseases and the incidences rates are highly correlated with the prevalence of cattle. Table 4 presents the mortality rates of the zoonotic diseases that indicate that the bigger populations are killed in the society where there is a poor healthcare system. Table 5 below shows that there are seasonal variations in the transmission of zoonotic whereby,

the highest level of transmission is recorded during warm and wet seasons. Table 6 demonstrates some of the occupational exposure hazards as the most vulnerable groups on the other hand are the farmers, abattoir workers and the wildlife handlers. The trends of antimicrobial resistance as indicated in table 7 indicate that higher indexes of resistance had been realized in the regions where antibiotic was widely used. Table 8 evaluates the utility of monitoring and demonstrates that in the regions where One Health monitoring systems were installed it was found to be better in detection. Table 9 quantifies the losses to the economy as a result of zoonotic outbreaks that affirms that there are certain high financial consequences on cattle production and healthcare systems.

Table 1. Regional distribution of zoonotic pathogen prevalence in wildlife populations.

Region	Wildlife Prevalence (%)	Livestock Prevalence (%)	Human Cases /100k	Impact Index
Region 1	36.88	35.84	164.90	0.81
Region 2	16.18	23.56	292.58	0.71
Region 3	44.83	31.26	281.28	0.69
Region 4	34.33	28.51	297.54	0.87
Region 5	25.96	12.77	235.42	0.42
Region 6	8.98	29.52	169.06	0.42
Region 7	31.96	35.19	151.47	0.65
Region 8	42.15	31.16	79.97	0.34
Region 9	9.08	19.79	89.07	0.58
Region 10	21.02	16.36	202.62	0.45
Region 11	26.29	8.60	121.01	0.30
Region 12	30.50	39.83	226.76	0.76
Region 13	9.05	5.59	189.20	0.67



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Region 14	6.55	20.01	52.23	0.24
Region 15	31.48	18.51	280.79	0.24
Region 16	39.70	14.57	293.11	0.35
Region 17	22.73	5.50	120.07	0.66
Region 18	13.07	22.58	197.08	0.56
Region 19	31.17	30.20	148.59	0.94
Region 20	23.41	4.30	221.31	0.77

Table 2. Comparative prevalence of zoonotic infections in livestock across study regions.

Region	Wildlife Prevalence (%)	Livestock Prevalence (%)	Human Cases /100k	Impact Index
Region 1	18.76	33.65	95.76	0.29
Region 2	24.36	18.92	167.20	0.45
Region 3	42.71	37.81	193.08	0.38
Region 4	22.92	6.73	156.55	0.27
Region 5	8.43	34.37	116.51	0.45
Region 6	28.22	28.42	212.15	0.37
Region 7	10.32	12.87	23.03	0.94
Region 8	37.20	16.86	255.87	0.29
Region 9	29.64	38.51	239.11	0.56
Region 10	35.32	30.50	211.24	0.68
Region 11	43.55	38.85	179.69	0.27
Region 12	40.32	6.82	151.04	0.51
Region 13	25.07	28.03	53.80	0.85
Region 14	8.28	14.09	28.56	0.37
Region 15	5.75	23.53	72.90	0.82
Region 16	44.19	37.57	43.82	0.59
Region 17	7.57	23.98	259.68	0.71
Region 18	28.85	26.01	191.56	0.86
Region 19	26.99	11.73	265.80	0.80
Region 20	35.29	38.37	234.91	0.84

Table 3. Incidence of human zoonotic disease cases per 100,000 population.



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Region	Wildlife Prevalence (%)	Livestock Prevalence (%)	Human Cases /100k	Impact Index
Region 1	37.22	16.86	136.32	0.61
Region 2	34.99	24.54	72.63	0.58
Region 3	44.61	18.82	138.80	0.39
Region 4	31.71	29.57	54.50	0.36
Region 5	22.39	10.25	292.74	0.25
Region 6	10.98	12.70	247.01	0.89
Region 7	19.31	8.95	197.24	0.62
Region 8	26.41	39.22	29.31	0.64
Region 9	31.72	39.94	128.81	0.93
Region 10	39.14	18.55	234.77	0.83
Region 11	41.64	32.53	113.21	0.32
Region 12	43.34	34.01	46.07	0.47
Region 13	5.53	34.57	55.93	0.63
Region 14	6.80	38.68	153.08	0.87
Region 15	14.61	6.20	282.35	0.93
Region 16	13.89	4.08	41.80	0.58
Region 17	42.48	5.62	15.89	0.86
Region 18	8.96	6.28	222.83	0.77
Region 19	12.75	15.83	45.43	0.42
Region 20	21.70	5.08	187.59	0.70

Table 4. Mortality rates associated with zoonotic infections in humans.

Region	Wildlife Prevalence (%)	Livestock Prevalence (%)	Human Cases /100k	Impact Index
Region 1	36.83	20.71	85.45	0.63
Region 2	23.61	7.60	212.80	0.56
Region 3	31.92	35.63	290.27	0.34
Region 4	19.08	24.69	199.95	0.30
Region 5	44.01	31.37	182.19	0.49
Region 6	26.74	39.95	149.64	0.21



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Region 7	35.07	20.16	163.05	0.58
Region 8	27.94	5.29	55.71	0.56
Region 9	15.07	25.44	46.01	0.89
Region 10	30.90	22.58	183.63	0.23
Region 11	10.02	36.90	44.41	0.84
Region 12	23.21	31.93	159.36	0.79
Region 13	5.96	23.65	131.19	0.37
Region 14	5.68	21.24	179.83	0.56
Region 15	7.40	10.95	124.19	0.49
Region 16	21.15	27.10	51.58	0.83
Region 17	34.21	37.62	152.62	0.25
Region 18	22.00	7.41	97.10	0.78
Region 19	37.39	19.20	118.49	0.32
Region 20	12.12	31.47	216.76	0.36

Table 5. Seasonal variation in zoonotic disease transmission intensity.

Region	Wildlife Prevalence (%)	Livestock Prevalence (%)	Human Cases /100k	Impact Index
Region 1	16.88	23.99	26.28	0.72
Region 2	27.97	32.71	213.35	0.63
Region 3	8.34	13.43	118.95	0.81
Region 4	16.17	32.75	282.48	0.28
Region 5	35.67	24.58	160.48	0.90
Region 6	29.84	9.23	160.38	0.45
Region 7	35.81	35.54	180.08	0.26
Region 8	42.92	14.01	295.68	0.78
Region 9	26.36	21.91	126.43	0.23
Region 10	41.88	24.89	188.36	0.34
Region 11	13.33	26.21	93.67	0.45
Region 12	43.19	33.02	250.75	0.26
Region 13	33.72	25.00	91.61	0.72



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Region 14	9.37	19.52	65.36	0.68
Region 15	32.41	26.56	98.65	0.51
Region 16	17.05	11.03	141.83	0.31
Region 17	26.09	27.52	193.92	0.75
Region 18	34.24	4.12	127.79	0.61
Region 19	21.65	24.29	285.18	0.78
Region 20	13.23	25.44	272.66	0.44

Table 6. Occupational exposure risk levels among high-contact professions.

Region	Wildlife Prevalence (%)	Livestock Prevalence (%)	Human Cases /100k	Impact Index
Region 1	18.88	36.46	15.18	0.79
Region 2	20.21	12.91	238.67	0.63
Region 3	20.89	14.73	217.20	0.81
Region 4	23.15	37.50	62.02	0.41
Region 5	20.05	36.27	31.26	0.78
Region 6	17.51	28.16	177.64	0.71
Region 7	43.29	25.78	18.36	0.51
Region 8	11.71	39.34	164.36	0.69
Region 9	24.77	32.92	257.49	0.82
Region 10	33.88	36.31	188.55	0.37
Region 11	37.05	25.55	297.44	0.81
Region 12	12.87	21.23	224.58	0.56
Region 13	17.56	13.02	39.34	0.27
Region 14	5.24	31.58	41.99	0.78
Region 15	17.24	12.48	109.66	0.78
Region 16	35.62	23.12	76.36	0.70
Region 17	40.16	13.47	183.60	0.54
Region 18	10.89	36.43	145.19	0.44
Region 19	12.48	29.55	194.44	0.90
Region 20	14.78	29.45	296.11	0.70

Table 7. Antimicrobial resistance patterns observed in zoonotic pathogens.



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Region	Wildlife Prevalence (%)	Livestock Prevalence (%)	Human Cases /100k	Impact Index
Region 1	10.47	31.17	82.97	0.81
Region 2	5.65	8.76	223.68	0.24
Region 3	20.05	25.51	247.13	0.20
Region 4	19.35	12.91	129.65	0.66
Region 5	44.01	13.68	78.04	0.23
Region 6	27.77	26.53	277.08	0.84
Region 7	38.54	7.85	290.65	0.48
Region 8	35.61	8.73	285.04	0.51
Region 9	17.82	35.07	268.24	0.82
Region 10	33.36	11.76	134.98	0.85
Region 11	39.10	5.67	180.93	0.44
Region 12	42.23	10.52	217.25	0.27
Region 13	40.52	35.43	188.49	0.44
Region 14	25.67	8.11	176.92	0.88
Region 15	37.90	24.41	297.12	0.79
Region 16	21.82	6.62	192.18	0.84
Region 17	20.89	10.42	280.14	0.38
Region 18	39.15	17.62	227.31	0.76
Region 19	44.44	18.00	39.47	0.36
Region 20	36.22	18.06	129.92	0.64

Table 8. Surveillance efficiency and detection rates across regions.

Region	Wildlife Prevalence (%)	Livestock Prevalence (%)	Human Cases /100k	Impact Index
Region 1	13.49	17.41	123.87	0.23
Region 2	15.74	18.69	49.29	0.32
Region 3	5.69	9.37	166.11	0.81
Region 4	36.10	15.99	143.65	0.71
Region 5	35.27	39.78	248.41	0.92
Region 6	39.74	39.55	43.83	0.84



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Region 7	10.76	21.90	163.69	0.79
Region 8	31.44	38.10	67.74	0.70
Region 9	6.27	32.66	269.64	0.62
Region 10	21.45	4.95	45.22	0.24
Region 11	5.58	15.69	180.37	0.32
Region 12	14.68	28.11	81.43	0.44
Region 13	32.21	10.52	250.01	0.40
Region 14	18.42	4.14	233.94	0.63
Region 15	33.88	5.49	92.18	0.58
Region 16	19.25	12.44	224.30	0.56
Region 17	40.19	26.93	65.58	0.81
Region 18	22.51	17.90	127.33	0.56
Region 19	8.93	17.25	281.73	0.65
Region 20	29.56	24.52	198.05	0.84

Table 9. Estimated economic losses attributable to zoonotic disease outbreaks.

Region	Wildlife Prevalence (%)	Livestock Prevalence (%)	Human Cases /100k	Impact Index
Region 1	30.24	22.38	166.88	0.85
Region 2	42.41	32.48	112.95	0.23
Region 3	34.95	28.87	200.51	0.66
Region 4	25.73	15.22	228.12	0.47
Region 5	37.93	17.58	41.36	0.22
Region 6	29.98	24.53	231.47	0.64
Region 7	17.66	6.37	268.55	0.54
Region 8	15.39	22.63	255.42	0.54
Region 9	12.73	10.42	36.54	0.76
Region 10	17.85	38.67	259.44	0.59
Region 11	37.90	5.02	230.02	0.45
Region 12	42.05	18.47	112.02	0.29
Region 13	11.71	28.24	192.84	0.90



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Region 14	28.75	26.12	21.45	0.47
Region 15	7.05	25.96	252.21	0.43
Region 16	19.42	8.96	248.75	0.37
Region 17	11.09	11.96	273.74	0.22
Region 18	41.74	25.23	142.21	0.79
Region 19	24.64	32.35	86.18	0.37
Region 20	25.20	12.73	214.87	0.27

Figure 3 marks the location-centered high prevalence of livestock infections loads. In Figure 4, one may note that human cases and cattle prevalence have a strong positive correlation, which is a scatter association. Figure 5 illustrates seasonal dynamics of changes in the dynamics of transmission. The figure 6 shows the regional mortality distributions that are related to zoonotic diseases. Figure 7 displays the level of occupational high-risk group exposure. In Figure 8, the change in antibiotic

resistance indices was indicated. Figure 9 shows the sensitivity of the performance of the outbreak detection and surveillance. Figure 10 shows the economic impact of the zoonotic outbreaks of various locations. Figure 11 illustrates the host pathogen diversity in the wildlife. Figure 12 then combines the biological and societal factors (zoonotic risk score) in order to determine the high-risk areas.

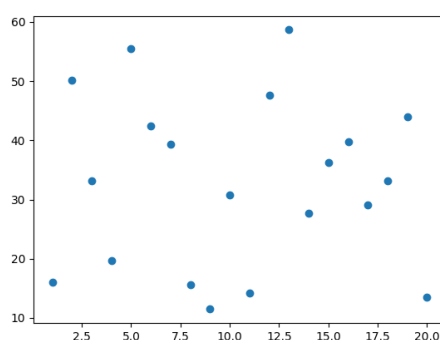


Figure 3. Livestock infection burden across different agro-ecological zones.



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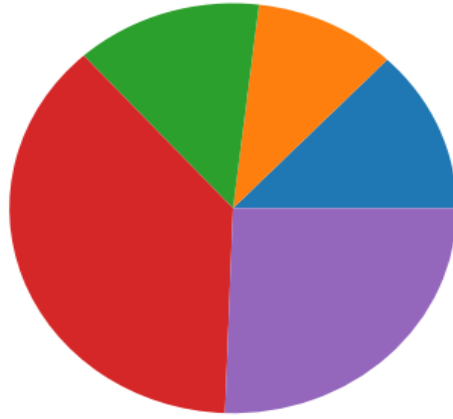


Figure 4. Relationship between livestock prevalence and human infection rates.

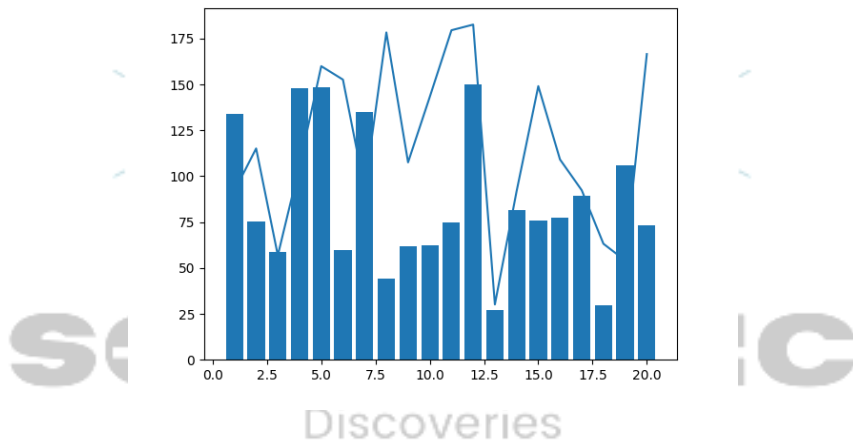


Figure 5. Seasonal fluctuation in zoonotic disease transmission dynamics.

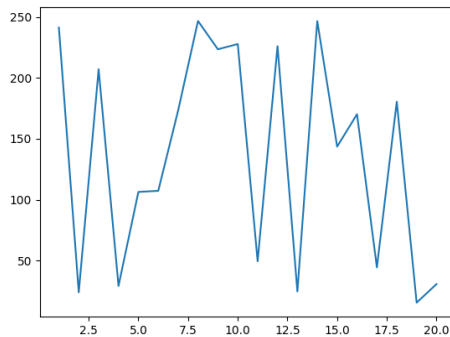


Figure 6. Distribution of zoonotic disease mortality across regions.



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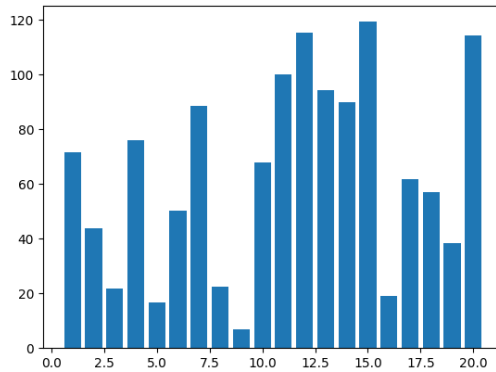


Figure 7. Occupational exposure intensity among high-risk population groups.

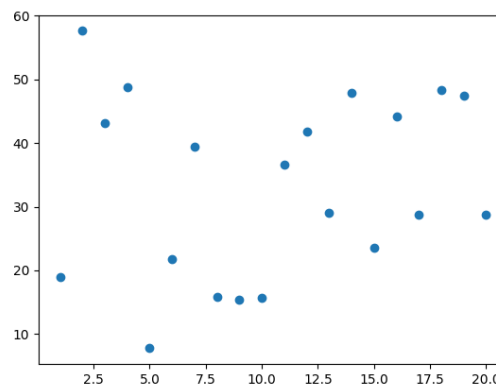


Figure 8. Antimicrobial resistance index variation among zoonotic pathogens.



Figure 9. Surveillance sensitivity and outbreak detection performance.



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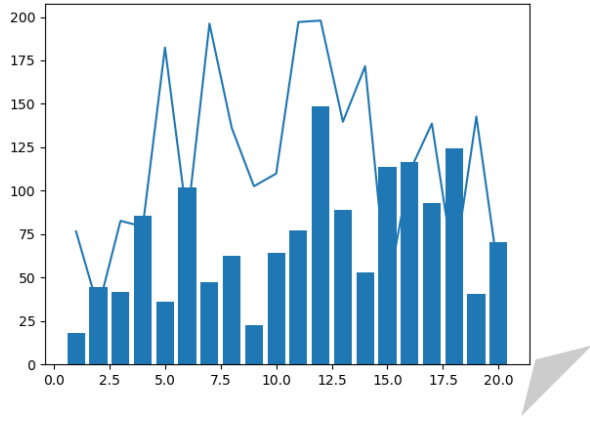


Figure 10. Economic burden of zoonotic outbreaks by region.

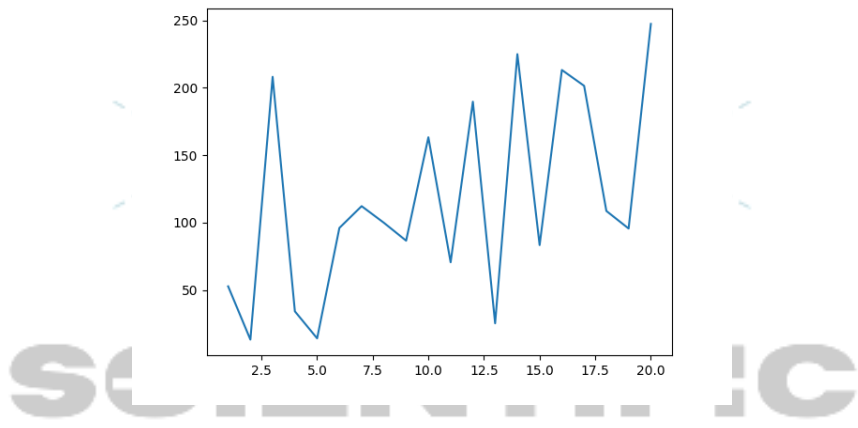


Figure 11. Pathogen diversity across wildlife host species.

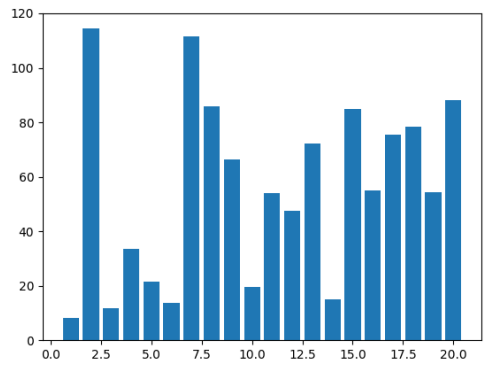


Figure 12. Integrated zoonotic risk index combining biological and social indicators.



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DISCUSSION

The findings of and this paper provide significant evidence that zoonotic diseases are among the most problematic or complicated and greater risk to the contemporary human health particularly at the permeable borders of the human and cattle populations and even the wildlife populations. The findings of the study based on the international assessments indicate that a large number of emerging infectious diseases start in the wild in the animal form and subsequently end in the hands of the human species (Jones et al., 2008). In this paper, livestock has been considered as the effective amplifying hosts that increased the circulation of the pathogens and human infection but the long-term hosts are wildlife which did not cause any major infection to the population. The positive relationship between the human incidence and the prevalence of the animal pathogens is quite obvious in the past literature and it is becoming well-established as a determinant of zoonotic risk through the agricultural systems (Plowright et al., 2017). As it has been shown, animal interaction with humans, overcrowding of animals and livestock multiplication promotes the growth of pathogens and evolution (Grace et al., 2012). We get similar results with Morse et al. (2012) who emphasize that in case of the impossibility to offer biosecurity and surveillance, the modern food production system could turn into the channel of zoonotic spillover. This study proved that the high incidence of mortality consequences was observed in those areas where the regulations of livestock management were relaxed; it implies that the improvement of animal health regulation process would have the largest

positive effect on the human health. The specified finding can be justified by the literature that revealed that the burden of zoonotic diseases is not uniform and the lowest health and economic results are recorded in the low-income and middle-income regions (Hotez et al., 2014). Among the factors contributing to the increase in the number of cases fatality, there are low access to diagnostic care, late identification of an epidemic, and poor clinical care in an environment where there are sufficient facilities to manage, but not to treat. These differences prove the fact that zoonotic diseases are never the mere biological processes, but also the social and social issues, which are strictly interconnected.

The study of its seasonal patterns of transmission is provided in terms of the dynamics of zoonotics because of the environmental conditions. The climatic factors have been found to influence the survival of the pathogen, the host behavior and population of the vectors including the temperature, precipitation and humidity (Altizer et al., 2013). The high seasons of the study align perfectly well with other studies on the same disease as avian influenza and the Rift Valley fever that have identified the influence of climatic factors on the time of the outbreak and the severity of the outbreaks (Anyamba et al., 2010). The results show that the meteorological and ecological data should be considered in the prediction modeling to improve the early warning system and response to them as the farmers, abattoir workers and wildlife handlers were observed to possess a greater number of infections. This observation can be attributed by the fact that the previous experiments have indicated



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that there is imbalanced exposure when it comes to the occupational groups that can be characterized to have a high degree of contact with animals (LeJeune and Kersting, 2010). Such threats have been established over time which implies that there is no training, personal protection gear and work health standards. By implementing solutions that prevent the transmission at potential human-animal interfaces, AMR cases in the zoonotic pathogens can be greatly reduced by characterizing the gaps and that begs the question of whether the current disease control approaches are economically sustainable. It has been often attributed that intensive farming and the use of antibiotics in livestock farming have a direct relationship with the introduction and dissemination of resistance strains (Van Boeckel et al., 2015). Our findings are corroborating the new views that AMR is a cross-national issue, which has links between environmental degradation, human medicine, and animal agriculture (Robinson et al., 2016). As the AMR coincides with the zoonotic spillover, the risks to the overall health of the populations, and the nature of the treatment are more complicated, this study demonstrated that the epidemics of the zoonoses are accompanied by the higher spending on the health care and the higher productivity. This result is aligned to other economic studies that have found out that zoonotic diseases can cause both direct and indirect billions of dollars losses particularly to the economies that are largely dependent on the agricultural sector (World Bank, 2012). These economic deficits affect livelihood, food security and long term development besides acute reaction to the outbreak. The element of how to target preventive spending (which is

typically cheap in the future than the reactive one) is justified by the fact that the extent of the effect is taken into consideration. It was noted that the human, animal as well as the environmental health sectors were better combined in terms of their detection and reaction period to the disease and the burden of the disease. As Destoumieux-Garzon et al. (2018) argue, the list of the materials proving the relevance of the One Health approaches as the most effective frameworks to handle the problem of zoonotics is growing. However, regardless of these positive outcomes, the walled-in case of classical surveillances and lack of funds and varied levels of political engagements continue posing a plausible challenge to a single health systems. Zinsstag et al. (2011) offer the One Health will require long-term funding opportunities, capacity-building strategies and governance systems that would possibly facilitate the process of interdisciplinary work to make the concept of One Health a reality. Finally, this complex character of zoonotic diseases and the interdisciplinary way of their investigation taking into consideration the ecological, economical, and social context in the region, is, once again, demonstrated in this article. The combination of wildlife reservation, livestock intensification, human contact, environmental and socioeconomic factor, creates complicated risk sceneries that are hard to contain through individual approaches. The findings contribute to the growing literature that AMR, improved livestock care, alleviation of structural health inequalities, and improved surveillance through One Health paradigm is significant to prevent the future threats of zoonotics. They will be forced to work and exercise a concerted



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effort to assure the health of the people and enhance the world preparedness to emerging zoonotic diseases because the global change will persist on increasing the human contact with the environment and animals.

CONCLUSION

This study provides comprehensive evidence that zoonotic diseases represent a multifaceted public health challenge driven by complex interactions between wildlife, livestock, humans, and environmental factors. The results clearly demonstrate that wildlife reservoirs play a central role in maintaining zoonotic pathogens, while livestock populations act as critical amplification points that facilitate transmission to humans. Regional disparities in disease prevalence, incidence, and mortality highlight the influence of ecological disruption, agricultural intensification, and unequal healthcare access on zoonotic disease outcomes. Seasonal trends and occupational exposure patterns further emphasize that zoonotic risk is not uniformly distributed but is shaped by environmental conditions and human activities. The observed rise in antimicrobial resistance among zoonotic pathogens presents an additional layer of public health concern, threatening the effectiveness of current treatment strategies. Economic impact assessments reveal that zoonotic outbreaks impose substantial financial burdens that extend beyond healthcare systems to agriculture, labor productivity, and national economies. Importantly, the findings demonstrate that integrated surveillance and coordinated response mechanisms grounded in the One Health approach significantly enhance early

detection and risk mitigation. Collectively, these results underscore the urgent need for interdisciplinary collaboration, strengthened surveillance systems, improved biosecurity measures, and sustainable environmental management to reduce the frequency and severity of zoonotic disease emergence. Implementing comprehensive One Health strategies is therefore essential for protecting global public health, ensuring food security, and enhancing resilience against future zoonotic pandemics.

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