Role of Wildlife in Emerging Zoonotic Disease

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Abstract

Zoonotic diseases, transmissible from animals to humans, present significant public health challenges, particularly with the rise of emerging zoonotic pathogens. This study explores the classification, transmission modes and historical emergence of zoonotic diseases, emphasizing their ecological and anthropogenic determinants. The research highlights the role of environmental alterations, urbanization, deforestation and wildlife exploitation in driving disease outbreaks, while also detailing specific viral, bacterial, parasitic and fungal zoonosis. Recent trends underscore the complex interplay between human-wildlife interactions and the spread of diseases such as HIV/AIDS, Nipah virus and Hendra virus. Furthermore, the analysis addresses the ethical implications of precautionary measures, such as culling and antimicrobial restrictions, under the One Health framework. The study calls for proactive strategies emphasizing preparedness and systemic solutions to mitigate zoonotic risks in light of global challenges like climate change and biodiversity loss. By integrating scientific, ethical and policy perspectives, this work advocates for balanced, sustainable approaches to zoonotic disease management. I am writing this chapter about the zoonotic diseases that are transmitted from wildlife.

Keywords: Pathogen transmission, Wildlife Reservoirs, Biodiversity loss, Zoonosis, Ecosystem disruption.

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Introduction

Zoonotic diseases are highly contagious illnesses that primarily affect animals, which then transmit these diseases to humans. Emerging zoonotic diseases that are newly recognized and recently evolved occur on a significant scale (Abdulrazaq et al., 2024). The biomedical researchers indicated a sudden rise in the prevalence of zoonotic diseases over the past few years (Leal et al., 2025). Certain activities contribute to the rise of emerging diseases in wildlife as follows: The human population continuously grows, leading to greater interaction between humans and wildlife environments. Additionally, human-made products cause fluctuations in natural habitats, affecting numerous parasites and carriers due to increased variability in landscapes and atmospheric conditions. Zoonotic diseases are categorized into various groups: Diseases that move from animals to humans are infrequent, but once they are passed to a human, it becomes quite simple for the disease to spread to other humans and this cycle of transmission can persist for a while (Williams et al., 2002). This chapter aims to explore the ecological and anthropogenic drivers of emerging zoonotic diseases originating from wildlife and to evaluate preventive strategies under the One Health framework. It further seeks to highlight the role of human-wildlife interactions in the transmission dynamics of zoonotic pathogens.

Historical Perspective of Zoonotic Diseases

Infectious diseases returned to the forefront of political and health policy discussions in the 1970s and 1980s due to the rise of several new diseases, such as toxic shock syndrome and Legionnaire's disease, which caused HIV/AIDS to spread over the world (Smolinski et al., 2003). New illnesses kept appearing, frequently through novel routes and from unexpected sources. For instance, between 1994 and 1998, three new zoonotic viruses (Hendra, Menangle and Nipah viruses) were found in Pteropodid bats in Australia and Southeast Asia (Fields et al., 2007). Each of these belonged to the Paramyxoviridae and was spread by livestock, such as *pigs* or *horses* (Fields et al., 2007).

Classification of Zoonosis

Humans are the primary host in some parasite infections. *Taenia solium* and *Taenia saginata* infections are among the parasitic diseases known as euzoonoses (Kaminsky and Maser, 2025). The four classification types; pathogen type, transmission mode, life cycle and ecosystem category, that are incorporated into our framework were chosen to be comprehensive and to provide a broad view of zoonotic diseases in a particular wildlife species, all the while avoiding superfluous complexity (McMahon et al., 2018). The classification of zoonosis based on the causative agent which could be bacterial, viral, protozoan, parasitic, fungal, or prion is known as Pathogen Type (Janeway et al., 2001; Chomel, 2009; McMahon et al., 2018). The pathogen's requirements to complete its life cycle determine the type of life cycle, whether it be direct, metazoonosis, saprozoonosis, or cyclozoonosis. The infection can spread directly from non-human animals to humans in a direct zoonosis, such giardiasis (Hao et al., 2024).To finish their life cycle, saprozoonoses, like histoplasmosis, require both a vertebrate host and an environmental reservoir, such food, soil, or plants. Anthropozoonosis (transmission from animals to people), zooanthropozoonosis (transmission from humans to animals), or amphixenosis (transmission occurring in both directions) are the three categories of zoonosis that are based on the transmitting host. According to the concept put forth by zoologists, there are three main habitats for zoonoses: sylvatic, peridomestic and domestic (McMahon et al., 2018).

Transmission Mode of Zoonotic Diseases

When a wildlife reservoir is present, zoonotic illnesses can spread in several ways. Numerous zoonotic agents are directly transmissible to humans from wildlife. For instance, skin contact with a dead, sick, or infected hare or rat can spread the bacteria *Francisella tularensis*, which causes tularemia (Warsi et al.,2025). On the other hand, the rabies virus is transmitted by an infected animal's bites (saliva). Through aerosols present in rodent waste dust, hantaviruses are spread from rodents to humans. In everyday language, a 'mode' of transport (such as train, bus, car, or bicycle) is clearly different from a 'route' chosen to reach a destination (for instance, through which city or specific international departure and arrival point) (Handeland et al., 2000; Hofshagen et al., 2004). A "route" chosen to get to a destination (for instance, which city or which specific international departure and arrival point) is obviously distinct from a "mode" of transportation (such as a train, bus, vehicle, or bicycle) in daily English. This distinction is important because the mode influences expectations for the pathogen's possible evolution (e.g., sexual versus non-sexual transmission) and affects certain epidemiological characteristics of the virus and the disease. Regarding the nature of the transmission function in connection to the density of infected persons, another distinction is sometimes made, namely between frequency-dependent and density-dependent transmission (Antonovics et al., 2017).

Recent Emerging Diseases

A zoonotic illness that has been recently discovered, recently evolved, or that has previously existed but is currently experiencing an increase in incidence or a broadening of its geographic, host, or vector range is referred to as emerging zoonosis. At least 250 zoonosis have been recognized as developing and re-emerging zoonotic illnesses during the previous 70 years (Loegiudic et al., 2024). These diseases have spread rapidly around the world, increasing in frequency and geographic range (Grace et al., 2012). Close contact with animals that act as reservoirs for newly emerging and re-emerging zoonotic illnesses affects humans. Some of the main factors that lead to the emergence of zoonotic diseases include increased human-animal interaction brought on by changes in human and animal behaviors, habitats, ecology, vector dynamics, pathogen adaptability, changes in farming practices, livestock production methods, food safety, urbanization, deforestation and climate change (Whoolhouse & Gowtage, 2005; Lindahl et al., 2015). Both newly emerging and re-emerging zoonotic disease pathogens can be found in wildlife (Kruse et al., 2004).

Viral Zoonotic Diseases

1-Acquired Immune Deficiency Syndrome with Human Immunodeficiency Virus/Simian Immunodeficiency Viruses

Two of the 26 strains of the simian immunodeficiency virus (SIV) found in African primates are responsible for AIDS (Narayana, 2025). Chimpanzee (*Pan troglodytes*) and Sooty mangabey (*Cercocebus torquatus*) strains are the origin of HIV-1 and HIV-2, respectively. The evidence at hand and genetic studies indicate that the transfer of these SIV strains to humans was uncommon, yet it has taken place on at least seven distinct occasions over the last hundred years (Hahn et al., 2004; Mahy& Murphy, 2000).

2-Hendra Virus

Horses could be experimentally infected through both parenteral and oro-nasal routes, with cats and guinea pigs also being subject to experimental infection. The way through which the virus is transmitted from bats to horses is still unclear; however, high levels of virus found in bat urine could indicate that feed or water has been contaminated by urine (Westbury, 2000).

3-Nipah Virus

Between 1998 and 1999, a new highly infectious respiratory and neurological illness in pigs was documented on the Malaysian peninsula. In nursing piglets, a mortality rate of up to 40% was noted. In humans, there were 265 documented cases of viral encephalitis, resulting in a 38% death rate (Chua, 2003). The Nipah virus outbreak was managed through an initial 'stamping out' strategy in affected regions, succeeded by a comprehensive testing and culling initiative for farms/herds across the Peninsula. The expense to the national *pig* population was immense, as nearly 45% of the current *pig* herd was eradicated (Chua, 2003; Mohd Noor et al., 2000).

Zoonoses of Pets, Companion Animals and Birds

The risk of zoonosis may be increased since between 14 and 62% of pet owners let their animals sleep in their bedrooms (Cholel and Sun, 2011). Although pets and companion animals have grown in popularity in recent years, they are also a significant source of infections. The growing popularity of companion animals and pet ownership has put human health at risk due to the possibility of disease transmission (Bertelloni and Ebani, 2025). In many homes today, exotic pets are kept with domestic animals. Overweight people are therefore more susceptible to catching new zoonotic diseases from exotic birds and animals, pets and companion animals (Cholel and Sun, 2011).

How Human-Wildlife Contacts Affect Zoonotic Risks

Together with the global climate changes brought on by human activity, human activities like urban sprawl, deforestation, wildlife exploitation and tourism not only alter natural landscapes but also act as catalysts for the emergence of zoonotic diseases, which raises the prevalence of already existing zoonosis. Numerous animals and arthropod hosts, including rodents, birds, pigs, cows, bats, monkeys, camels, mosquitoes, ticks and fleas, have been linked to the connection between human impacts and the onset of diseases (White & Razgour, 2020; Cavallero et al., 2021).

1-Urbanization

Urban development causes changes in animal reservoirs, such as arthropod vectors and microbes, which raises the risk of emergence, especially in relation to environmental and tick-borne pathogen spread, according to extensive, multidisciplinary research conducted in Kuching, Malaysia (Blasdell et al., 2022). Since zoonotically afflicted animals need more energy, it is thought that urban areas draw more of them. This is because the abundance of food, warmth and shelter in cities attracts these animals (Plumer et al., 2014).

2-Deforestation

Deforestation, a consequence of the expanding human population, is associated with a higher risk of zoonotic illnesses. The spread of infectious diseases is not caused by just one of the previously listed variables; rather, a combination of different human activities raises the probability of transmission (Singh et al., 2025). Curiously, even though numerous studies emphasize the connection between deforestation and a rise in zoonosis, one study noted that while deforestation raises the prevalence of certain infections, these infections may also lead to a reduction in deforestation. Following the tree removal, the pathogen moved to the forest floor, where it subsequently infected human hosts (Figure 1) (MacDonald & Mordecai, 2019). The escalating deforestation leads to ecological imbalances, reduced biodiversity and the forced migration of wildlife into nearby communities, all linked to a rise in zoonotic transmissions (Tajudeen et al., 2022).

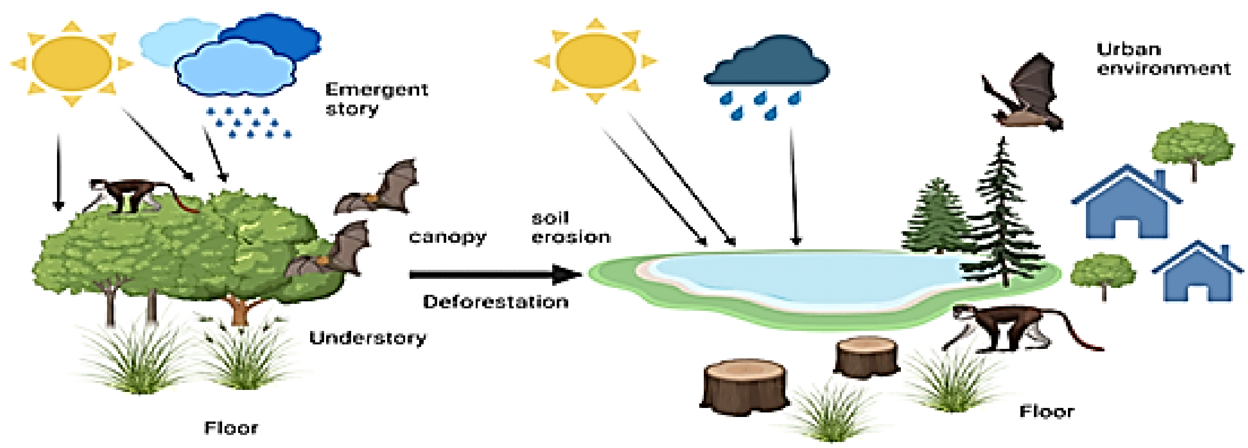

Fig. 1: Deforestation eliminates the upper layers of forest structure, such as the canopy, light and rainfall, resulting in the previously shielded floor level being exposed, which causes soil erosion and the formation of pools. The altered environmental conditions encourage the reproduction and spread of vectors. Additionally, organisms reliant on living in the canopy are now found at ground levels nearer to human activities and have heightened movements toward urban areas. Heightened vectors and elevated human-animal interactions lead to a rise in infection transmissions.

3-Tourism and Zoos

The ability of humans to travel huge numbers of people across longer distances every day has significantly enhanced human-animal interactions as transportation technologies have evolved (Mavroidi, 2008). According to Stirling et al. (2008), the practice of petting zoos is one aspect of zoo visits and tourism that increases the danger of zoonosis (De Angelo, 2024). Crucially, petting zoos and recreational parks pose a zoonotic risk akin to a primary cause of deforestation; here, animals that typically live in high canopies descend to the ground, increasing human-animal contact (Cuenca et al., 2021; Norris & Mosquito-borne, 2004; Molyneaux et al., 2021).

Precautionary Measures in Emerging Zoonotic Disease Control

The negative impact of cattle farming on public health has become evident in recent years. Among these threats to public health include particle emissions, antibiotic resistance and zoonotic diseases such as avian influenza and Q-fever (Anomaly, 2015; O'Neill). Additionally, consideration is given to the wellbeing of both humans and animals (Gee et al., 2025). Through organic farming and the rearing of *horses* and other companion animals, we demonstrate how preventing zoonotic health diseases can present unique ethical challenges, particularly when applying the One Health principle (Vlaanderen et al., 2019). Based on the precautionary principle, medical practitioners usually suggest extreme measures to lessen the risks of zoonotic diseases (Degeling et al., 2020; van Herten et al., 2020). In essence, the precautionary principle says that scientific uncertainty shouldn't hold down attempts to avert possible serious harm to the environment, animals and human health (European Commission, 2000).

Ethical Considerations for Preventive Actions in the Control of Zoonotic Diseases

There are several approaches to implement the precautionary principle to prevent the spread of zoonotic diseases. To prevent them from serving as an animal reservoir for COVID-19, all animals on infected mink farms were recently put down in the Netherlands and other European countries (Salajegheh et al., 2025). This action was taken after a comparison of viral DNA showed that mink had infected the crew (Oreshkova et al., 2020). About 4,000 people was infected with the *Coxiella Burnetii* bacteria, which causes this sickness, between 2007 and 2012. Additionally, throughout that time, Q-fever was linked to 74 deaths. It was quickly determined that the most likely source of the virus was goat farms in the southeast of the Netherlands. To halt the spread, the authorities began vaccinating the animals and enforcing stringent sanitary restrictions in 2008 (Wambua et al., 2025). However, the number of infected people continued to rise. Nonetheless, the number of afflicted individuals kept increasing. The Dutch Institute for Public Health and the Environment suggested that all 90 goat farms in this region slaughter all of their goats by the end of 2009 in accordance with the precautionary principle (Bruschke et al., 2016).

Of the fifty thousand animals killed, many were pregnant. Although it was still uncertain whether all of them were sick, officials decided not to make any exceptions since testing was too expensive and time-consuming. The Dutch government's slow response to this zoonotic disease was widely criticized by the public. This implies that public health is frequently given precedence over other values in cultural attitudes (Van Dijk et al., 2010). Beyond the removal of healthy animals, the precautionary approach has other troubling consequences. For example, many months of the year, free-range chickens are often kept indoors to avoid Avian Influenza outbreaks. The Animal welfare may suffer greatly because of the frequent usage of housing systems that are inappropriate for these free-range farms (Pandos, 2025). Another example of how antimicrobial resistance is being addressed is through (European) legislation aimed at lowering the use of antibiotics in livestock farming. These include limitations on the use of specific antibiotics in animals due to their critical value to public health. They demonstrate an increase in the mortality and morbidity rates caused by animals not receiving the appropriate medical care. According to the Dutch Council on Animal Affairs, "the desire for significant decreases in antibiotic usage in livestock should never foster the mindset that increased disease rates and mortality are tolerable" due to this point of view (Council on Animal Affairs, 2016). Value conflicts may arise during the decision-making process for controlling zoonotic illnesses, including those pertaining to public health, animal welfare, or economic considerations (Capps et al., 2015; Degeling et al., 2017; van Herten et al., 2020).

Requirements and Limitations for the Precaution Policy

The precautionary principle has multiple applications and manifestations, as was previously mentioned (Pandos, 2025). This criterion of knowledge requires that there be at least a bare minimum of scientific proof that taking preventative action can reduce health risks. This approach raises the worry that strict preventative measures would be put in place very fast, even in the unlikely occurrence of a serious health danger (Flor. et al., 2025). Wilson and Atkinsons agreed that attempts to avoid the damage may do more harm than the injury itself due to overreaction. A paradigm for calibrated precaution that balances the potential impact of the risk-reducing activity against the theoretical risk was provided by Wilson and Atkinson (2017) and Gupta Strategists (2020). From the perspective of One Health, this assessment must also consider the risks to the environment and animal health (Gupta Strategists, 2020). The impact of the zoonotic disease and the outcomes of disease control measures should be the main topics of discussion in this context which brings us to the second reason for taking precautions: avoiding counter productivity. No safety measure should do more harm than it is supposed to (Zeppelini, 2025).

A Practical Application of the Precautionary Principle to Zoonotic Disease Management

What can we learn from these insights about managing zoonotic illnesses using the precautionary principle? The two rational approaches to risk management—prevention and readiness—can be distinguished to respond to this query (Lakoff, 2007). Prudence is often the wisest course of action when scientific uncertainties prevent a standard cost-benefit analysis. In general, precaution refers to avoiding danger by abstaining from behaviors or taking measures to lower associated risks. As has been mentioned, this is not always possible in terms of zoonotic disease concerns (Karhausen, 2025). It is nearly hard to forecast which organism will trigger the next pandemic, where it will occur, or when it will occur. As COVID-19 has shown, zoonotic infections can arise suddenly. Preparedness is probably a better approach for risks related to these zoonotic disease kinds (Gomez et al., 2025). According to Lakoff (2007) being prepared turns potentially catastrophic dangers into vulnerabilities that may be handled, rather than restricting activity in the face of uncertainty. The Short-term risk management is emphasized heavily in this approach. We propose two additional strategies for controlling zoonotic diseases, each of which takes a different stance on the precautionary principle. The first rule emphasizes readiness. In the event of an unexpected or sudden breakout of a zoonotic disease, this tactic may be employed (Javed et al., 2025).

Conclusion

Zoonotic diseases remain a critical public health challenge, shaped by complex interactions among ecological, social and human behavioral factors. The analysis underscores the profound influence of urbanization, deforestation, wildlife exploitation and climate change in exacerbating zoonotic risks. Historical and emerging zoonotic diseases demonstrate the need for vigilant surveillance and proactive management strategies. Ethical considerations in controlling these diseases, particularly under the One Health framework, highlight the importance of balancing human health priorities with animal welfare and environmental sustainability. In short, the zoonotic diseases are contagious illness that is transmitted from wildlife to human being and precautionary measures must be implemented to prevent its effects on human being.

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