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Transmission of Zoonoses from Animals to Humans in Urban-Rural Interface Zones

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Abstract

Zoonotic illnesses pose a constant danger to public health across the world because they can be transmitted from animals to people. All across the world, people are in danger from zoonotic illnesses, which may be caused by anything from viruses to bacteria to parasites. One of the most important roles that wildlife plays in the transfer of diseases from one species to another is that of reservoir. All of these things raise the stakes since they facilitate the transfer of infectious diseases from animals to people. A one-health strategy, good communication, and focused treatments are necessary precautions to take in light of the public health consequences of animal zoonosis. We are all aware of the challenges posed by zoonotic infection monitoring in urban and wooded areas, as well as the burden on healthcare systems in developing nations. Despite urbanization's potential to cause zoonotic spillover and the amplification of certain human epidemics, numerous studies and calls for action have stressed the need of monitoring and preventing the emergence of zoonotic diseases along landscape interfaces, especially in tropical forests and agricultural and farming sectors. In habitats where animals are present, zoonotic illnesses can be transmitted by a variety of vectors. Zoonotic agents are animals that can spread illness to humans. Wild animals and plants are those that do not have a place in a zoo or aquarium. Mammals, birds, fish, amphibians, and reptiles all make up this group of animals.

Keywords: Transmission, Zoonoses, Humans, Urban and Animals

Introduction

The spread of infectious illnesses to people, often by wildlife, has become a major public health concern. Humans get zoonotic illnesses mostly via contact with mammals. These animals carry a plethora of diseases. The transmission of infectious agents across different species occurs as a result of interactions between people, livestock, and animals. The wide variety of animals that call forest ecosystems home increases the risk of zoonotic disease transmission to humans, whether or not vectors are involved. Forests have been the birthplace of several zoonotic illnesses that have spread to people all across the globe. Forests are a source of several zoonotic illnesses, such as Ebola, Lyme, Hantavirus pulmonary syndrome, Nipah, Leptospirosis, monkeypox, and many more. When it comes to zoonotic diseases, wildlife is crucial since they may act as reservoirs or carriers. These infections may be carried by many different kinds of animals without causing any major harm to themselves. This includes insects, birds, reptiles, and mammals. The infections are able to survive and spread inside these reservoir species because they serve as natural hosts. The danger of zoonotic disease transmission, however, increases when people come into touch with sick animals or their body fluids.

Although it may be challenging to entirely prevent the transmission of new infections from animals to humans, we can certainly work towards reducing the risks to humans through improved detection methods, early warning systems, and control or prevention policies. Our understanding of the activities that drive these zoonotic transmissions can help us make these efforts more effective. The goal of this study is to take a broader look at the anthropogenic causes affecting zoonoses and wildlife exploitation and repercussions as a whole, rather than focusing on these issues in isolation. Our goal in writing this study is to help inform public health awareness efforts, sanitation protocols, urban risk management, pest regulations, and other measures for preventing and controlling zoonotic diseases by illuminating human-related variables that raise these risks. The present COVID-19 pandemics are the most recent example of how the (re)emergence of zoonotic diseases has increased the frequency of human epidemics over the past few decades. Human footprints on nature are associated with animal-to-human infectious agent spillover, according to a large number of observational studies and meta-analyses of the existing scientific literature. Pestilence, Ebola, Nipah, influenza, SARS, MERS, and maybe SARSCoV-2 have all emerged in recent years, and human activities like hunting and eating wildlife, expanding into undeveloped areas, cutting down trees, and raising livestock for industrial purposes have all contributed to this.

Many studies and calls for action have emphasized the need to monitor and prevent the emergence of zoonotic diseases along landscape interfaces, particularly in tropical forests and agricultural and farming sectors, despite the fact that urbanization is also a potential factor for zoonotic spillover and the amplifying of certain human epidemics. Obviously, we concur wholeheartedly with these suggestions. On the other hand, a few of them neglected to include cities as a possible factor in the rise of zoonotic diseases in humans. Nevertheless, we think that urban, peri-urban, and sub-urban regions—where everyday interactions between humans, domestic animals, and wildlife are abundant but understudied—deserve further research on urban-associated zoonoses. It is believed that cities may also effectively foster evolutionary innovations. Repeated chains of known or unknown microbe transmission are likely to flourish in such an environment, which could lead to spillover events and the possible adaptation of certain pathogens to human-to-human transmission, which in turn could lead to the (re)emergence of these diseases and subsequent large-scale epidemics and pandemics. There is a growing consensus that interactions between animals and humans pose the greatest threat of epidemics and the development of new diseases. Approximately 60% of newly identified human diseases originate from animals.

Literature Review

Latinne, Alice *et al*. (2025) [1]. Pathogens can be transferred from animals to humans through several high-risk points in Vietnam, which is a popular destination for wildlife trading. Nevertheless, in order to enhance policy discourse and legislative changes, it is necessary to evaluate the zoonotic disease risk, which is now under-characterized in the nation. To compile a list of pathogens found in Vietnam's terrestrial vertebrates, literature research was carried out. In addition, the number of zoonotic infections present in various families was estimated using data from an existing worldwide database. A total of eighty-seven records met the criteria set out in the literature study. In Vietnam, researchers found 162 different species of pathogens in 46 different families of land vertebrates, spread over 4 classes and 18 orders. These species included parasites, bacteria, fungus, protozoans, and viruses. Pythonidae (pythons), Cercopithecoidea (old world monkeys), and Muridae (rats and mice) have the greatest number of diseases. Of the 29 priority zoonoses in Vietnam, 12 were found in 27 different groups of terrestrial animals. An alarming eleven human-wildlife interactions were found to have zoonotic diseases. Primate institutions, wildlife farms, and free-ranging animals were the primary sites of priority zoonotic pathogen detections. Facilities with a very high risk of zoonotic spillover, according to a risk assessment based on the number of zoonotic pathogens found, include urban bushmeat markets, wildlife farms, restaurants, and rescue center's that trade in exotic animals, as well as those that house and breed birds of the families Columbidae, Phasianidae, and Ardeidae, and mammals of the families Cervidae, Suidae, Felidae, Ursidae, Mustelidae, Cercopithecoidea, Muridae, and Sciuridae.

Nomi, Zubair *et al*. (2025) [2]. The transmission of zoonotic illnesses from animals to people poses significant threats to human health, animal welfare, and the world economy. Yet, zoonotic epidemics, such as COVID-19, are showing signs of increasing frequency and severity. To better understand what causes zoonotic illnesses and how they spread, this chapter delves into the interconnected web of human, animal, and environmental health. In addition to that, these also encompass the following: intensification of agriculture, habitat loss, climate change, and globalization. Additionally, this chapter covers a broad range of zoonotic diseases, including bacterial, viral, parasitic, and fungal infections, as well as their consequences for agriculture, human populations, and animal health. Additionally, the importance of the One Health idea is emphasized as a crucial basis for reducing the dangers of zoonotic diseases. Disease surveillance, diagnosis, and management are all made easier when the human and animal health sectors are able to communicate with one another. Preventing and managing zoonotic epidemics requires early diagnosis, prompt response, and clear communication, as highlighted in the chapter. In conclusion, adopting a One Health approach and understanding the many origins of zoonotic diseases are critical to protecting public health and securing a sustainable future. The Effects of Zoonotic Diseases on Multiple Hosts and the General Population. The transmission of zoonotic illnesses from animals to people poses significant threats to human health, animal welfare, and the world economy.

Napit, Rajindra *et al*. (2025) [3]. The transmission of infectious illnesses from animals to people, known as zoonotic pathogens, constitutes approximately 75% of the emerging infectious diseases (EIDs) that threaten world health. Significant health and economic costs have frequently ensued from the traditional reactive approach to EIDs, which primarily aims at containing the disease after it has already spread. Our study in the buffer zone (Thakurdwara) of Bardia National Park, Nepal sought to build a zoonotic disease monitoring program in response to the growing awareness of the importance of a proactive One Health strategy. One hundred homes situated at the park's wildlife-human interface had their illness risk assessed and biological samples taken. Each household provided two samples of animals (n=289) and one sample of humans (n=100). We used DNA barcoding to identify feces samples taken non-invasively from the nearby forest. Using DNA sequencing and polymerase chain reaction (PCR), all samples were tested for ten target pathogens, six of which were viruses and four of which were bacteria. We explored possible zoonotic pathogen spillover and transmission dynamics by combining laboratory results with risk survey data using a One Health methodology. This allowed us to gain a better understanding of the interrelated elements that impact the risks of zoonotic diseases. Among the pathogens found in 97 human homes and 219 animal samples, Campylobacter stood out as the most frequent.

Simpson, Gregory *et al*. (2018) [4]. Clinicians in rural areas are not as well-informed about zoonotic infections due to a lack of diagnostic tools and monitoring systems. In a South African pastoral community that is home to an HIV epidemic and has poor incomes, we measured the frequency of nine zoonotic diseases along the borders of wildlife reserves. Participants were divided into two groups: first, febrilers, who were malaria-negative and seen at three clinics (n = 74); and second, dip-tanksters, who were farmers, herders, and veterinary workers found at five government cattle dip-tanks (n = 64). Questionnaires were administered to evaluate potential risk factors, and blood samples were examined with one polymerase chain reaction (PCR) (*Bartonella* spp.) and eight antibody-ELISAs. With regard to dip-tanksters, 98% got a good result, whereas 77% were febrilers. Frigorifers may have contracted their fever from one of many bacteria, including *Bartonella* spp. (9.5% PCR), *Rickettsia* spp. (24.1%), *Coxiella burnetii* (2.3%), or Leptospira spp. (6.6%). Results showed that 92.2% of dip-tanksters and 63.4% of febrilers exhibited evidence of prior infection to *Rickettsia* spp. and C. *burnetii*, respectively, with IgG levels of 60.9% and 37.8%. The dip-tanksters did not have any current or *Brucella infections*, but they had a greater rate of recent exposure to Leptospira spp. (IgM 21.9%) than the febrilers. Both groups tested negative for Rift Valley fever and had low levels of Sindbis and West Nile virus. Going to dip-tanks in febrilers for Q fever was the only risk factor that was shown to be significant (p = 0.007).

Magouras, I. *et al*. (2020) [5]. Infectious illnesses originating in animals, particularly wildlife, have historically been the leading source of epidemics affecting humans. Complex and poorly understood systems interact to create persistent transmission from early spillover occurrences. We propose many interface types that might serve as vectors for new infectious illnesses in this opinion piece. We provide a variety of epidemiologic scenarios that potentially enhance the likelihood of infectious outbreaks by facilitating the spill-over of viruses across domestic animal populations, wildlife, and humans.

Transmission Mode of Zoonotic Diseases

Multiple vectors exist for the transmission of zoonotic diseases in environments with animal reservoirs. Animals may transmit many diseases to people, a phenomenon known as zoonotic agents. For example, the tularemia-causing bacterium Francisella tularensis can be transmitted by skin contact with a sick, dead, or otherwise diseased hare or rat. However, saliva from an infected animal's bites is what really spreads the rabies virus. Hantaviruses are transmitted from rodents to humans by aerosols found in rat waste dust. Common parlance distinguishes between a "route" that specifies the exact cities travelled through or the international departure and arrival points and a "mode" of transportation that includes things like trains, buses, cars, and bicycles. Different from a "mode" of transportation (such a train, bus, automobile, or bicycle) in everyday English is a "route" that is chosen to reach a destination (like which city or which precise international departure and arrival point). This difference is significant because the mode impacts specific epidemiological features of the virus and illness, as well as expectations on the potential development of the pathogen (e.g., sexual vs non-sexual transmission). Another difference that is occasionally noted is between density-dependent transmission and frequency-dependent transmission, which relate to the type of the transmission function in relation to the density of infected individuals.

Urbanization and Zoonotic Diseases

Urbanization trends and Projections

The process of urbanization entails not only the transformation of rural regions into urban settlements but also the movement of people from rural to urban areas. City and urban system administrators and planners should think about migration when making decisions, as cities are major entrance and departure sites for people moving throughout the country and the world. By 2018, urban regions had more people living in them than rural ones, with about 55% of the global population residing in metropolitan areas. From 30% in 1950 to 68% in 2050, the projected percentage of the global population living in urban areas is rising rapidly. More people, animals, and food are constantly moving about, which can lead to an increase in the spread of infectious diseases like zoonosis. Experts predict that 2.5 billion additional people will call cities home between 2018 and 2050. An estimated 1.2 million individuals have relocated to metropolitan areas every week throughout the past decade. Both Asia and Africa are seeing rapid growth at the moment. In comparison, annual city population growth in the United States was only 1% between 2005 and 2010. The expansion of modern cities has brought new risks and challenges, not the least of which are the new infectious illnesses. Urbanization has been linked to the spread of infectious and communicable illnesses, according to a plethora of research done in China, East and Southeast Asia, and Africa. Some of these factors include changes in pre-urban land uses, migration from rural to urban areas, higher population densities, and pollution of both the air and water.

Increased Human-animal Interface in Urban Areas

The rise and return of several infectious illnesses are made possible by the growing human-animal contacts, putting human lives in danger. Between 6 million and 11,000 years ago, when humans first started farming and changing their environment, zoonotic diseases started to spread across the interface. This was also the beginning of an era of increased rodent activity near settlements and animal domestication, which led to more human-animal contact with pathogens. Environmental conditions are changing rapidly, and people and food items, particularly animal products, are moving about a lot. This makes it easier for viral vectors to (re)emerge, which adds another layer of complexity to epidemiological studies. the most common vectors for the transmission of zoonotic illnesses are certain foods, particularly meat and dairy products. The abundance of garbage and pet food, as well as the abundance of shelter in urban and pre-urban environments, has led many adaptive animals to relocate from their native habitats. Because of this urbanization, zoonotic vector-borne diseases have become more common, since these infectious pathogens are carried by adaptive species.

In addition, domestic animals can serve as carriers for several infectious agents, allowing zoonotic illnesses to readily spread to humans. The transmission of infectious illnesses from animals, both domestic and wild, accounts for over 75% of all human infections. As an example, diseased carnivores (dogs) can transmit the eggs of the fungus *Echinococcus granulosus*, which can cause fluid-filled cysts to develop in the lungs or liver, a condition known as cystic echinococcosis. This infection can lead to severe illness or even death in humans. A number of zoonotic illnesses may infect humans through insects that serve as vectors, such as fleas, ticks, mosquitoes, and Lyme disease.

Human-Wildlife Interaction

The interaction between humans and other animals, especially in woodlands, can be harmful because of the important role that forests play in the spread of zoonotic diseases. Humans pose a significant threat of zoonotic transmission when they hunt and cook animals. Because the forest borders are degraded along logging routes, animals are less able to move freely throughout forest regions, thus reducing habitat diversity. The danger of disease transmission increases when infected animals or their bodily fluids come into close contact with humans through activities such as hunting, consuming bush meat, trading wildlife, and ecotourism. In addition, there is the risk of zoonotic disease spillover and the intensification of human-wildlife interactions brought about by human expansion into natural ecosystems, such as the clearance of forests to make way for farms or communities.

Wildlife and Source of Zoonotic Diseases

Animals and plants that do not belong in a controlled environment are called wildlife. Animals that fall under this category include birds, fish, amphibians, reptiles, and mammals. Zoonotic infections originate in animals and account for 62% of the 1,415 human pathogens. Humans inherit them. Because of its cultural, medicinal, aesthetic, and ecological significance, wild life is a resource that man may use for more than one purpose. Animals and plants in their natural habitats can also serve as bio-indicators of environmental health. However, when individuals come into touch with wild animals, they run the danger of contracting zoonotic diseases caused by pathogens that can be transferred by direct contact, droplets, or vectors. Concerns about human health have been shaped by zoonotic illnesses. Around 23 ADS, the Mycobacterium leprae pandemic illness leprosy struck several areas, including the Middle East, Greece, and India. The widespread societal effects of leprosy, which is believed to have originated in armadillos, are profound. One such persistent danger is TB, which has long been associated with elephants and other animals and is caused by the Mycobacterium tuberculosis. This disease was once known as "king's evil" in Europe. An example of the catastrophic effects that may be caused by the transmission of viruses carried by animals is the Spanish flu of 1918, which started in the United States and killed some 50 million people throughout the world.

Recent high-profile instances have shown that zoonotic illnesses can pose serious health hazards when transferred directly to people; for example, in 2012, the Middle East respiratory syndrome (MERS) emerged from camels and in 2003, SARS from bats. Upon its first identification in 1976 in Africa, the Ebola Virus Disease was marked by exceptionally high rates of case fatalities and severe hemorrhagic fever. As new viruses emerge and propagate, this remains a possible risk of zoonoses. Case fatality rates for MERS-CoV, a virus carried by Arabian camels, are rather high, and the disease has the potential to spread from humans to humans. Quickly transmitted from person to person, SARS was originally detected in China and then confined by quarantine protocols. Recently, a novel SARS-CoV-2 virus surfaced. The COVID-19 virus first appeared in bats and may have spread to pangolins through zoonotic transmission due to changes that make the virus more contagious to humans. The COVID-19 pandemic has spread widely across the population, and it is distinct from SARS in that it is more easily transmitted and has less rapid pathogenicity. Evidence suggests that SARSCoV-2 evolved from a cross-species transmission capability that evolved through recombination between coronaviruses found in bats and pangolins.

Consequences for wildlife conservation and public health

The impact of infectious illnesses on animal conservation has grown in recent years, even though human activities such as habitat loss and overexploitation are commonly acknowledged as key drivers of wildlife population losses. In addition to the obvious effects of cities on biodiversity, changes in epidemiological processes brought about by city dwellers' environments provide additional threats to animal populations. The impact of multi-host diseases on animals with low population densities is significant because of the ways in which these infections interact with other host species. The rate of nest failure was more than twice as high for Cooper's hawks (*Accipiter cooperies*) that made their homes in cities compared to those that made their homes in the suburbs. Trichomoniasis, a protozoan illness spread by eating infected birds like doves and pigeons, was the leading cause of death for nestlings. Efforts to reduce transmission among urban-adapted animals, such as by immunization, anti-parasitic medication treatment, or restricting supplemental food resources, might potentially limit the spread of pathogens to wildlife hosts that are less numerous.

Urban areas are home to few kinds of animals, and those that are tend not to be worthy of conservation efforts. stress the importance of urban and suburban dynamics on remaining animal populations both within and outside of cities. At least one study found a clear correlation between raccoon contamination with B. procyonid and the reduction of the Allegheny woodrat Neotoma magister population, an endangered host species. Limiting the accumulation of environmental pathogen contamination or lowering reservoir host population densities and tracking their migration from urban to more rural locations would be necessary to decrease dangers to wildlife for this and other diseases.

Wild Animals and Re-Emerging Zoonoses

Many infectious illnesses are spread and maintained in part because of the close relationships that exist between wild animals, people, domesticated animals, and environmental factors. Zoonotic infections develop and transmission patterns shift because ecological linkages among one-health components are disrupted by globalization, habitat degradation, climate change, species and biodiversity loss, and other human-caused changes. Animal and human health, agricultural output, and wildlife habitats can all be negatively affected by pathogens carried by wild animals.

Zoonotic infections can be transmitted to humans or other animals from wild creatures that include reptiles, birds, fish, amphibians, and mammals. It is concerning that zoonotic illnesses are transmitted by wild animals. Climate factors including temperature, humidity, and precipitation have an impact on the patterns of animal zoonoses transmission.

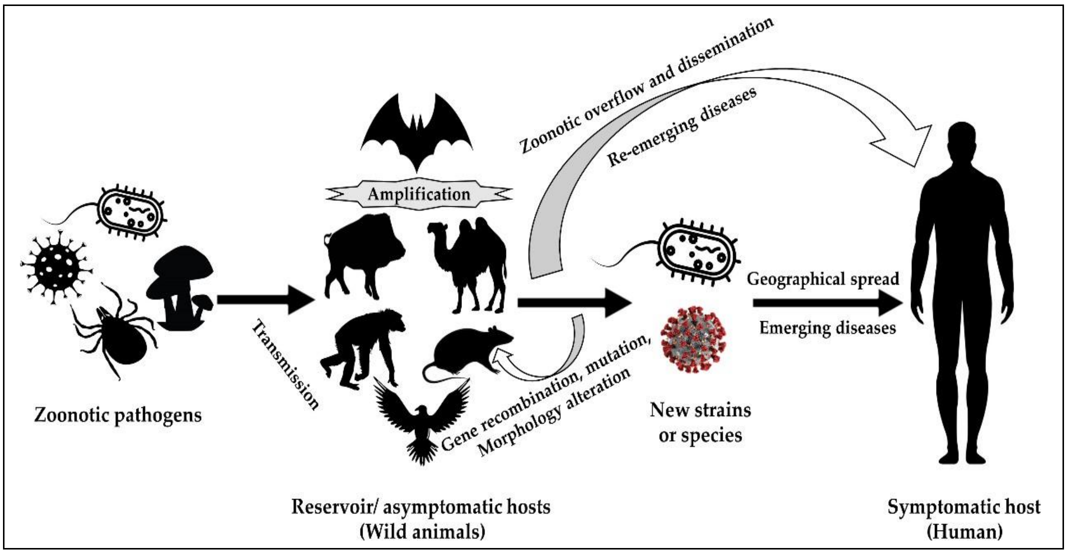

Fig 1: The involvement of the wild animals in the transmission and amplification of etiological agents of emerging and re-emerging zoonoses

The function of wild animals in the propagation, intensification, and zoonotic surplus of infectious pathogens responsible for new and re-emerging zoonoses is depicted in Figure 1. Animals in their natural habitats often store infectious pathogens that can remain latent for extended periods of time until they are activated. Agents in uncommon hosts can occasionally raise the chance of RNA replication mistakes, which can cause mutations. Because of this, more dangerous and antibiotic-resistant strains or species may emerge in the future. Among the possible outcomes is a rise in the transmission rates among vulnerable communities.

The urban environment and urban wildlife

Built environments, roadways, and open areas all come together to form urban regions' intricate habitat mosaic. The urban matrix is not uniform; it may include both low- and high-density building clusters, linear features like rivers, highways, and railway lines, and tiny to huge green areas with anything from highly maintained parkland to remnants of natural habitat. Because of factors such as size and extent, as well as the mixing of habitats, every metropolitan region has its own distinct mosaic of ecosystems. Simultaneously, urban environments worldwide share some ecological traits, even in incredibly diverse biogeographic regions. Changes to the structure and operations of ecosystems can be important outcomes of urbanization's enormous influence on the environment. Changes to physicochemical features including hydrology, soil geochemistry, nutrient cycling, and temperature can occur with the loss or fragmentation of existing natural habitats and the creation of new habitats. New or absent predators, diseases, and invading species are only a few examples of the unique stresses that have recently emerged on the environment. These effects have far-reaching consequences for the plant and animal groups that call cities home, making them less conducive to wildlife survival.

Since the beginning of human settlements, wildlife has been a part of these spaces. Scavenger birds and animals, for instance, were known to venture inside Egyptian cities in search of food in antiquity. Basic descriptions of plant variety were the earliest scholarly investigations into urban ecology, which did not happen until the late 1600s. Research on urban animals did not emerge as a distinct field until the '60s and '70s. It has grown substantially since then, but it still accounts for a negligible share of total wildlife research publications put out there. Research on the ecology of urban animals, and in particular their interactions with people, is urgently needed as the world's metropolitan areas continue to grow at an alarming rate. Species native to cities Across the urban-rural gradient, biotic diversity is generally declining in urban settings, and this tendency is amplified as habitats are more and more populated. Even though there is less biotic variety in cities, the local flora and wildlife usually stay put.

Conclusion

Animal reservoirs can transmit diseases to urban populations, putting strain on healthcare systems and posing a threat to public safety in the event of an outbreak. To effectively lessen the risks linked with these diseases, one must understand their transmission channels, the importance of identification and surveillance, and the effects on public health. In order to safeguard public health and lessen the effect of forest-borne zoonotic illnesses on urban populations, it is crucial to implement policies and measures supported by evidence. Because they may be passed from one species to another, zoonotic diseases are a continual threat to global public health. Zoonotic diseases, which can be caused by parasites, bacteria, viruses, or even other animals, pose a threat to humans worldwide. Tragically, wildlife has been a major vector for the spread of contagious illnesses that can kill people. Human exposure to mammalian animals is the primary risk factor for zoonotic illnesses. Only a small number of animal species call urban regions home, and those that do often do not merit protection. place an emphasis on the significance of suburban and urban dynamics on the surviving animal populations in and around cities.

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