THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
May 2024 Vol.4(5), 2003-2008

Popular Article

Prevention of Zoonotic Spillover Through Biodiversity Conservation

[1]Dr. Archana Barik, [2]Dr. Anil Patyal, [3]Dr. Sanjay Shakya, [4]Dr. Nadipilli Srilakshmi, [5]Dr. Subhash Kumar Verma

[1]Post Graduate, Department of Veterinary Public Health and Epidemiology, College of Veterinary Science & Animal Husbandry, DSVCKV, Anjora, Durg, Chhattisgarh, India.
[2]Associate Professor, Department of Veterinary Public Health and Epidemiology, College of Veterinary and Animal Science, Meerut-250110, SVPUAT, Uttar Pradesh, India.
[3]Professor and Head, Department of Veterinary Public Health and Epidemiology, College of Veterinary Science & Animal Husbandry, DSVCKV, Anjora, Durg, Chhattisgarh, India.
[4]Post Graduate, Department of Veterinary Public Health and Epidemiology, College of Veterinary Science & Animal Husbandry, DSVCKV, Anjora, Durg, Chhattisgarh, India.
[5]Assistant Professor, Department of Livestock Product Technology, College of Veterinary Science & Animal Husbandry, DSVCKV, Anjora, Durg, Chhattisgarh, India.
https://doi.org/10.5281/zenodo.11437673

Abstract

Throughout human history, outbreaks and epidemics have been recurring events, with certain instances escalating to the level of devastating pandemics. It has been estimated that nearly 75% emerging infectious diseases globally are zoonoses. The transmission of pathogens between different species, the crossing of species barriers, is an ecological phenomenon known as zoonotic spillover. Zoonotic spillover is influenced by many ecological processes before a pathogen actually spills over into a human host. Changes in biodiversity can mechanistically affect spillover through several pathways including effects on the density, distribution, and susceptibility of reservoir hosts, as well as pathogen prevalence, infectiousness, survival, dissemination, and reservoir host– human contact. If biodiversity is well managed and conserved, it will act as a barrier against the spill-over of infectious diseases, thereby safeguarding a sustainable future.

Introduction

Epidemics and outbreaks have happened often throughout human history. A handful of them spread like pandemics, affecting people across continents. Although reports of pandemics and

epidemics have been made throughout history, their causes have always been identified after the illness outbreak has affected humankind. These sources are usually unknown at the time of the event. However, it became evident that there is a link between the spread of diseases and pandemics and biodiversity. Joint expert Committee of WHO and FAO (1959) has defined zoonoses as 'those diseases and infections which are naturally transmitted between vertebrate animals and man'. It is estimated that zoonoses account for 60% of newly discovered infectious diseases globally, and up to 75% of newly identified or emerging infectious diseases have zoonotic origins, with the percentage steadily rising with time (Jones *et al.*, 2008).

The World Health Organisation (WHO, 2018) has identified five stages in the establishment of infectious diseases: pre-emergence, emergence, localised transmission, epidemic, and pandemic. Spillover, a crucial sixth phase in the genesis of diseases, has been added to this. Several ecological factors influence zoonotic spillover before a pathogen actually spills over into a human host. Many factors have been linked to the spread of infectious diseases, most of which are caused by zoonotic pathogens. These include increased human-animal contact, livestock husbandry, land-use changes, illegal hunting, the use of bushmeat, and animal trading activities. Recent evidence of the intimate connection between the biodiversity and climate crises and the global health pandemics comes from an expert assessment published by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). Efforts are being made to find solutions that will help control zoonotic diseases and conserve biodiversity, since preventing zoonotic spillovers is a crucial biosecurity requirement that is closely related to the human-wildlife interface.

Concept of Zoonotic spillover

The transmission of pathogens between different species, the crossing of species barriers, is an ecological phenomenon known as "zoonotic spillover" (Plowright *et al.*, 2017). Spillover is a complex and multifaceted process, involving factors related to the hosts, microbes, and environment. Generally, spillover involves three parties: (I) a "source host": a species that sheds the pathogen (II) a "recipient host": species that contracts the pathogen from a different host; and (III) a "bridge/intermediate host": a host species that serves as a link or bridge in the pathogen's transfer between species. The intermediate host can be a vertebrate host or an invertebrate vector and may or may not be present in the spillover event. The environment can serve as a bridge in the transfer of infections across different species since many pathogens can survive outside of their host without losing their viability or transmissibility (Ellwanger *et al.*, 2021).

Unraveling the Nexus: Factors Fueling Biodiversity Loss and Escalating Zoonotic Spillover

1. Land use-induced spillover

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Land use -induced spillover is the process by which land use change drives the transmission of pathogens from wildlife to humans. A sequence of events leads to spillover, including pathogen infection in wildlife, pathogen shedding from wildlife, pathogen transfer to humans, and more pathogen dissemination through person-to-person transmission. These dynamics are simply called the "infect-shed-spill-spread cascade". Loss of biodiversity and changes in the landscape disturb the pathogen ecology, changing disease patterns and enhancing human-pathogen contact. Land-use change, encompassing urbanisation, livestock and agriculture production, deforestation, and human habitation in regions largely utilised by animals, is believed to be the cause of almost 30 percent of newly reported diseases since 1960 (IPBES, 2020).

2. Climate change

A growing percentage of the declining biodiversity is being caused by climate change. The earliest climate-driven extinctions have been brought about by the loss of native species, an increase in illnesses, and mass mortality of plants and animals. It is anticipated that climate change would result in alterations to the ranges of hosts and vectors, modifications to the life cycles of both vectors and hosts under modified climatic circumstances, and migration of domestic animals and humans (IPBES, 2020). Overall, ecosystem health is impacted by climate change, which further raises the potential for animals to spread diseases and for viruses to spill over to humans.

3. Invasive species

Species that have been introduced and/or spread outside of their natural habitats and threaten biological diversity are known as invasive alien species (IAS). Their detrimental effects on native biodiversity and ecosystem services pose significant risks to ecosystems and human well-being. Invasive species have the ability to drastically decrease an ecosystem's biodiversity through mechanisms including competition, predation, and environmental alteration. The issue of invasive alien species continues to grow worse, mostly as a result of international trade, transportation, and travel, including tourism, which has an enormous detrimental effect on the health of people and animals as well as the global socioeconomic and ecological systems. Since the 17th century, around 40% of animal extinctions with a recognised cause have been attributed to invasive alien species (SCBD, 2006).

4. Wildlife hunting, trafficking and consumption

Over the past few decades, a global increase in demands for wildlife and their products, either for consumption or for use in traditional medicine, has resulted in uncontrolled exploitation and illegal trading of wildlife. One in five vertebrate species are affected by trade, and certain animal species

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Published 25.05.2024

may experience population declines and/or extinction as a result of the impacts of wildlife trafficking – some legal, but mostly illegal. The spillover and emergence of diseases may be influenced by alterations to local biodiversity as well as by novel contacts formed through translocation and trade between species that do not normally co-occur in the wild (Glidden *et al.*, 2021).

Biodiversity Conservation: A Preventive tool for Zoonotic spillover and Pandemics

1. Pivotal role of biodiversity on health promotion is: The dilution effect

The emergence and spread of infectious diseases are linked to the loss of biodiversity. On the other hand, forests and other natural areas with a high species diversity are better able to "maintain" pathogens in the wild environment, thereby reduces the chance of human-wildlife zoonotic spillover. Zoonotic diseases rely on reservoir hosts for effective replication and transmission since they have coevolved with them. Diseases can spread from non-reservoir hosts, but less effectively. The risk of zoonotic spillover to humans can change due to changes in the reservoir-host balance in habitats; this might have negative effects on public health and require proactive monitoring and mitigating measures. High biodiversity causes a disease to get diluted among non-reservoirs. When there are animals present besides reservoirs, the overall spread of disease both within the ecosystem and to humans is reduced. This principle is called the **dilution effect** (*Kulkarni, 2022).*

2. An understanding of the biodiversity of microbes in nature is critical to controlling pandemics

Microbes have not always been shown to be harmful to humans; in fact, animals are known to serve as hosts for microbes, some of which are even useful. Healthy microbiomes are essential to the functioning of ecosystems and organisms as they produce vitamins, contribute to nutrient cycling, vitamin production, carbon fixation, reduce the effects of harmful substances, and regulate pathogens biologically. The interactions between microbes and hosts in a healthy organism are well-balanced, with some microbiome members frequently acting as buffers against biological or environmental disturbances in order to maintain homoeostasis and function. Both historically and currently, biodiversity has played a significant role in the development of modern medicine. Microbes compete with one another for resources such as food and space, forcing them to develop defence mechanisms against infections, including the ability to multiply, kill or suppress other microbes, and react to chemical and physical stimuli (IPBES, 2020). Approximately 75% of approved antibacterial drugs are made of natural or naturally derived substances (Newman *et al.,* 2020). There are an estimated 12 million fungal species, for instance, and one of them is the source of penicillin, which has revolutionized medicine by treating bacterial infections (Kardos *et al.,* 2011). Thus, biodiversity is an

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essential resource for health. As a result of the significant role that microorganisms play in preserving natural ecosystems, the management and conservation of biodiversity, which provides these microorganisms with their natural habitat, will act as a barrier against the spillover of infectious diseases.

3. Therapeutics to fight pandemics have their origin in biodiversity and have been identified through indigenous and local knowledge and traditional medicine

The long-standing relationship that indigenous peoples and local communities have had with nature has had a significant impact on the environments that people live in today. Additionally, they have shown that the availability of medicines from nature can have a positive impact on public health. Aspirin and other common medicines have their roots in ancient Egyptian traditional medicine. Quinine from the cinchona tree's bark served as the first effective modern treatment for malaria. 10,000 of the around 270,000 identified terrestrial plants are used medicinally. There are a lot many unidentified potential benefits in plant species, and genetic information obtained in wild species thus offers a substantial 'future opportunity'. The question remains how to use this natural chemical variety in an ethical, equitable, and sustainable manner, as only a small part of the world's biodiversity has been investigated for biological function (IPBES, 2020).

4. Biodiversity– our strongest natural defense against climate change

Approximately half of the greenhouse gases produced by human activity are absorbed by land and the ocean, with the other half remaining in the atmosphere. These ecosystems and the biodiversity they support serve as natural carbon sinks, contributing to the so-called "nature-based solutions" to climate change. Of all the nature-based alternatives, protecting, maintaining, and restoring forests, for instance, offers around two-thirds of the potential for mitigation. Additionally, carbon dioxide may be sequestered from the atmosphere by ocean ecosystems like seagrass beds and mangroves at rates that are up to four times greater than those of terrestrial forests. It is possible to reduce greenhouse gas emissions by around one-third of what is needed in the next ten years by enhancing nature's capacity to absorb emissions **(UN, 2022).**

Conclusions:

Pandemics represent an existential threat to the health and welfare of people across the planet, and their emergence, impact and control are deeply embedded in biodiversity and the major causes of biodiversity loss. Prevention of zoonotic spillover and emerging infectious diseases necessitates a holistic approach that recognizes the interconnectedness of humans, animals, and the environment. Understanding the factors underlying spillover events is vital for implementing effective control and

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preventive measures. It is imperative to recognize the critical role of biodiversity in regulating disease dynamics and to prioritize conservation efforts as a means to mitigate the frequency and impact of future disease spillover events. By nurturing and safeguarding natural habitats and the diversity of wildlife species, we can effectively curtail the occurrence and transmission of novel pathogens from animals to humans. Through such endeavors, we can minimize the frequency of human-animal interactions that serve as potential breeding grounds for infectious diseases. Prioritizing biodiversity conservation is not only crucial for preserving ecosystems but also serves as a proactive strategy to safeguard human health, reducing the likelihood of future disease spillover events and protecting the well-being of both individuals and communities. Nothing better captures the reality of disease outbreaks than the popular fundamental principle of modern health care: "Prevention is better than cure".

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Published 25.05.2024