

## From Awareness to Action Promoting Behavior Change for Zoonotic Disease Prevention Through Public Health Education

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### ABSTRACT

An infection that can naturally spread from animals to humans is known as a zoonotic disease and the majority of people interact with animals in some capacity, as a result, over 60% of diseases that affect humans have zoonotic origins. The emergence, re-emergence, distribution, and patterns of zoonoses have been significantly impacted by several factors, including anthropogenic influences, urbanization, animal migration and commerce, travel and tourism, vector biology, and climate change. The causes of the main zoonotic illnesses, their effects on human health, and management-improving control techniques were all covered in this chapter with a piece of strong advice that One Health procedures be put into place to effectively prevent and control any zoonosis-type infection. By integrating animal, human, and environmental health through cooperation and communication among osteopaths, wildlife, doctors, veterinarians, public health and environmental experts, nurses, dentists, physicists, biomedical engineers, plant pathologists, biochemists, and others, the one health concept plays a significant role in the control and prevention of zoonoses. Issues about the animal-human-ecosystem interface cannot be resolved by one industry, group, or individual working alone.

**Keywords:** Zoonosis, Pathogens, Illness, Virus, Bacteria, Health

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### CHAPTER HISTORY

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## 1. INTRODUCTION

Zoonoses or zoonotic diseases are induced via microorganisms that are commonly spread to humans from animals. Zoonoses term comes from two Greek words "zoon" which means animal and "nosos" which means disease. WHO (the World Health Organization) classifies any infection or condition that can be transmitted naturally by vertebrates (animals) to human beings or from people to vertebrates (animals) as zoonotic disease. Different contagious diseases originate and spread because of interactions among people, animals, and the environment. The continued prevalence of zoonotic diseases poses serious concerns to human health. Subsequently, more than sixty percent of total contagious illnesses are zoonotic diseases and animal origins are the source of 75% of newly appearing infectious pathogens (Mangili et al. 2016; Supramaniam et al. 2018; Espinosa et al. 2020). Zoonoses are more frequently spread primarily to human via animals and secondary through the interaction with a vector or an agent (McArthur 2019). The emergence of zoonotic illnesses is influenced by a number of factors, including population growth, urbanization, global environmental changes, animal movement, and tourism (Rahman et al. 2020). The majority of industrialized nations have adopted the "One Health" approach, which allows various sections to cooperate in an attempt to enhance health consequences. The objective is to support and promote the worldwide health system through enhancing efficient teamwork, contribution and cooperation at a connection of humans, animals and the environment (McEwen and Collignon 2018; Behravesh 2019). In South Asia, Pakistan is a nation that borders the Arabian Sea and at the 6<sup>th</sup> position among the most populated countries in the world (208 million people). According to CIA (Central Intelligence Agency) 2016, the livestock population in Pakistan is more than 300 million (animals), including 147 million poultry and 83 million large and 103 million small ruminants. A great variety of wild and domestic animal species, as well as a diversified natural topography and climate found in Pakistan (Turnbull 2008). Likewise, ecosystem diversity, social inequality, lack of politics, climate change, poverty, and regional conflicts may all affect public health and disease surveillance systems (Ashraf et al. 2014).

In underdeveloped nations like Pakistan, where the widespread distribution of infectious diseases and dangerous biological elements has greatly harmed the environment and human and animal welfare, the "One Health" idea has not yet been extensively adopted. For instance, in 2017 a report noted more than 800 people were infected by the Chikungunya virus across Pakistan. In Pakistan, 63 persons were infected with Crimean-Congo Hemorrhagic Fever (CCHF), which led to 11 deaths (Altmann et al. 2019). Pathogenic microorganisms have several possibilities to disperse due to relations among people, animals, and an ecosystem. To avoid or control zoonoses in Pakistan, a variety of non-governmental organizations (NGO) and government organizations, like Ministries of Climate Crisis, trade, Food Safety, and Education are responsible for developing and putting useful and modern strategies into action (Bartges et al. 2017).

## 2. ZOONOTIC DISEASES PREVALENCE (MOST COMMON) IN PAKISTAN

TB (tuberculosis), Lyme disease, Brucellosis, Rabies, Q fever, Encephalitis, Leishmaniosis, Foot and Mouth disease, Giardia, CCHF, Avian Influenza, Anthrax, Chagas disease/Trypanosomiasis, and Balantidiasis are the most Common Zoonotic Illness in Pakistan (Table 1, 2; Feng and Xiao 2011; Shabbir et al. 2015; Yousaf et al. 2018; Ahmed et al. 2020; Iqbal et al. 2020). In Punjab, Pakistan zoonotic microbes carried by soil like *Burkholderia mallei* and *Bacillus anthracis* have been reported in animals and humans (Shabbir et al. 2015).

### 2.1. BOVINE TUBERCULOSIS

During the 19<sup>th</sup> and 20<sup>th</sup> centuries, a large number of human TB cases spread due to a bacterium (*Mycobacterium bovis*) and the intake of raw cattle milk (Khan et al. 2014). Pakistan is ranked 5<sup>th</sup> among

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nations where tuberculosis is a serious problem (Shah et al. 2017). Almost 510,000 cases of tuberculosis are reported each year. The high frequency of tuberculosis is attributed to a lack of antiseptic medicines and control measures (Leghari et al. 2020). To enhance the meat quality and avoid tuberculosis emission to humans by sick animals, proper examination and observation should be put into place (Leghari et al. 2020).

### 2.2. RABIES

Rabies virus is a member of the Rhabdoviridae family. It is the deadliest and single-stranded RNA virus affecting people and animals. This infection mostly occurs in raccoons, bats, and dogs, and these animals transmit the disease to people. 5 million cases are notified every year and fifty thousand deaths occur because of dog bites (WHO 2018). In accordance with NRCP, in Pakistan, rabies is a threat to several village areas, and about 54.7 percent of unvaccinated dogs are against disease, and attack humans (Noureen 2018). Furthermore, according to another research, public and private hospitals treat 70 dog bite cases per day. Therefore, it is estimated that there are around 9 million cases of rabies (World Health Organization 2018).

**Table 1:** Direct contact or contamination

Diseases	Symptoms	Source of Transmission	Risk factor	References
Anthrax	Vomiting, fever, abdominal pain, nausea, diarrhea	Contact with diseased animals, polluted livestock products	Lack of cleanliness, food,	Ali and Ejaz 2023; Rashid et al. 2020
Brucellosis	Body pain, abdominal pain, fever, poor appetite, weight loss	Contact with fecal wastes, vaginal fluids, placenta, aborted semen	Intake of raw milk products, exposure	Jamil et al. work 2021; Ali et al. 2018
Bovine TB	Irregular coughing, large prominent lymph nodes, weakness and weight loss, fever diarrhea, loss of appetite	Raw milk product, contaminated food and water, direct contact with diseased animals, livestock products	wildlife reservoirs, poor living condition, livestock farming, occupational exposure	Leghari et al. living 2020
Escherichia coli Food-borne disease	Vomiting, respiratory disorders, diarrhea, and fever	Direct contact with diseased animals, contaminated food and water, livestock products	lack of cleanliness, poor living condition	Ismail et al. 2021
Hepatitis E	Fatigue, vomiting, fever, abdominal pain, liver failure, yellow skin, nausea, loss of appetite	Eating uncooked meat, contaminated food and water with sewage	Poor living condition, lack of cleanliness	Farooqi et al. 2022
Leptospirosis	Jaundice, chest pain, coughing with blood, fever, shortness of breath, nausea, swollen limbs, headache, loss of appetite	Polluted Soil and water by animal urine	Occupational exposure, skin injury	Sohail et al. 2020; Ijaz et al. 2018
Rabies	Hydrophobia, encephalitis, weakness of motor neuron, hyper-excitability, paralysis	Bites via animals, such as dogs	Hardly pets, stray and owned dogs	Ahmad et al. 2021; Kumar and Bakhru 2022
Salmonellosis	Vomiting, fever, diarrhea, nausea, abdominal pain	Direct contact with diseased animals, contaminated food and water, livestock products	Lack of cleanliness, living condition	Saeed et al. 2019; Hussain et al. 2020

## 2.3. DENGUE FEVER

Since an initial epidemic of dengue was recorded in 1994, several disease outbreaks have been documented in various parts of Pakistan during the last thirty years (Khan and Khan 2015; Ali et al. 2019; Junaidi 2019; Fatima et al. 2021). Particularly in 2005, an outbreak with more than 6 thousand cases and 52 deaths was reported in Karachi. In 2011, more than 21000 cases and 350 deaths were documented in Lahore; and in 2019 outbreaks, 44415 cases and 66 deaths were reported (Junaidi 2019). Though the incidence of dengue virus increases every year the total death rate is reduced. Regional government and nongovernment organizations worked together to encourage testing, house-to-house monitoring, and training and developed workshops for the acknowledgment of the public, which helped to achieve this landmark (Fatima et al. 2021).

## 2.4. TYPHOID FEVER

Typhoid fever is caused by *Salmonella typhi* which is frequently transmitted by polluted water, food, and by the interaction of humans and animals. According to estimates, the disease affects 11–20 million people worldwide, killing 120–220,000 people each year (Mogasale et al. 2014). Consequently, in order to control this condition, appropriate surveillance and monitoring measures are required (Fatima et al. 2021).

**Table 2:** Vector-borne diseases

Diseases	Symptoms	Source of Transmission	Risk factor	References
Chikungunya	Joint pain or swelling, muscle ache, fever, lesions, headache	Virus is remained in an ecosystem among mosquitoes, vertebrates, and humans	Virus transmitted via Aedes mosquitoes from diseased to healthy person	Badar et al. 2020
Crimean-Congo hemorrhagic fever	Liver failure, fever, vomiting, sore throat, back pain, liver enlargement, dizziness, headache, neck pain, sleepiness, petechial rash, confusion, myalgia	Contact with diseased animal, tick bites	Human movement, occupational exposure	Zohaib et al. 2020; Butt et al. 2021
Foot and mouth illness	Loss of appetite, lesions on the palms, fever, irritation in newborns, irritability in youngster, wounds on the sole, sore throat, pain, wounds on the gums, and tongue, buttocks	Pet and wild swine, cows, sheep and people	Goat and sheep can transmit the virus	Ali et al. 2022; Nawaz et al. 2019
Leishmaniasis	Skin lesion, liver enlargement, fever, weight loss, spleen enlargement	Female phlebotomine sandfly can transmit leishmania parasite, almost 70 species of animal are common sources, includes	Malnutrition, lack of hygiene, environmental changes, poor living condition, growth in cities, poverty, people movement	Khan and Awan 2021; Khan et al. 2021
Rift valley fever	Symptoms that from a slightly flu-like to hemorrhagic sickness	Bites via mosquito touch with diseased animal's blood and other body parts	Work orientation	Waqar et al. 2023; Wright et al. 2019

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### 2.5. ANTHRAX

Anthrax is caused by *Bacillus anthracis*, which also has a significant negative influence on animal health, particularly in sheep, goats, and cows. *Bacillus anthracis* is also easily transmitted to people. In places where humans and animals frequently interact, such as slaughterhouses, the risk of *B. anthracis* infections is higher. Vaccination is an important segment of an efficient disease examination strategy and is required to avoid further outbreaks (Rashid et al. 2020).

### 2.6. CRIMEAN-CONGO HEMORRHAGIC FEVER

Crimean–Congo is a deadly viral illness transmitted by ticks, identified by hemorrhage and fever. Due to quick climatic alteration, rising industrialization, population density, and agricultural and occupational activity, CCHF is more prevalent in Pakistan. Poor hygiene conditions in farms, rural areas, and towns, unhygienic animal movement and slaughter in the urban areas, inefficient control of ticks initiatives, migrant way of life, and medical professionals shortage are all factors that contribute to the spread of CCHF. Every major city has CCHF, including Peshawar, Karachi, Multan, and Quetta. The absence of an efficient disease surveillance system in Pakistan is considered a contributing factor to the infection outbreak (Yousaf et al. 2018). Local and provincial governments should educate citizens, farmers, and healthcare professionals about CCHF transmission and its effects. To control and remove this deadly disease from the nation, it is urgently necessary to implement the disease examination strategy as well as protective measures, identification, and medication (Butt et al. 2021).

## 3. A LIST OF MOST COMMON PREVALENT DISEASES CAUSED BY ZOONOSES IN PAKISTAN

### 3.1. IMPACT OF ZOOTIC DISEASES

There is raising evidence that animal diseases have a significant influence on worldwide productivity (Rushton et al. 2018; Piniot et al. 2019). Animal diseases not only result in production loss but also high implementation costs for mitigation measures and pose dangers to human health connected with Zoonoses (for example any infectious disease that is naturally transmitted from ruminants to people) (Brunauer et al. 2021; Conrady et al. 2021). Salmonellosis is one of the zoonoses that is most commonly reported in the European Union. Salmonellosis from contaminated food can make people ill with fever and bloody diarrhea. Salmonellosis can spread through a variety of channels, including contaminated eggs, domestic animal's milk and meat, uneven cooking techniques (Vajda et al. 2021). Australia's livestock sector has lost 16% of its value due to epidemics that affected sheep and beef (Rahman et al. 2020). Another economically significant disease is brucellosis. Brucellosis is a bacterial zoonotic illness that usually affects horses, sheep, buffaloes, cattle, camels, and dogs, it can also inadvertently spread to people. It ranks among neglected zoonotic illnesses, which mostly affects the underprivileged and diminished populations. The monkey pox virus can be found in semen, according to reports on a few other viral zoonotic diseases. This could be brought on by a blood-testes barrier breakdown, local or systemic inflammation, and viral replication in accessory glands (Salam et al. 2017).

Zoonotic diseases like avian influenza, bovine spongiform encephalopathy, and anthrax can obstruct global traffic in animals, livestock products such as eggs, milk and meat, and animal by products. Necessary steps for disease control and elimination include zoonosis examination, diagnosis, isolation or quarantine, limitation on movement of animals, cure and vaccine programs, analysis of milk and beef, and biosafety,

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have a significant negative impact on the economy. Zoonotic outbreaks had a greater than 120 billion USD economic impact on the world between 1995 and 2008 (Cascio et al. 2011; Sajjad et al. 2021; Rasheed 2013).

### 4. SOURCES OF ZOONOTIC DISEASE

Some ecological obstacles need to be overcome in order to stop the early transmission of illnesses from animals to humans. The transmission pathway, which serves as an initial barrier, limits the infections that humans can contract from particular vertebrate animals. Zoonotic diseases can be transmitted to humans by vertebrate animal hosts through a variety of routes, including direct contact with infected animal tissues or bodily fluids through wounds or abraded skin, animal bites and scratches (for example, rabies virus and *Brucella abortus*), indirect contact with a contaminated environment or source (for example, *Burkholderia pseudomallei* and *Leptospira interrogans*), and airborne transmission via aerosol (Fig. 1) (Dharmarajan et al. 2022). Any of the aforementioned entry points can be used by diseases of animal origin that are capable of spreading effectively from person to person. However, zoonotic events that spread illnesses to people can occur through atypical transmission pathways that are different from both the typical human and animal reservoir transmission pathways. Despite the fact that simian immunodeficiency virus was first exposed to humans through repeated contact with infected wild primates' blood or cuts received while butchering meat, HIV is effectively transmitted between humans only through sexual contact. Similarly, flea bites or occasionally eating infected meat can spread plague among rodents and from rats to humans; however, pneumonic transmission or lice can spread plague between people (Dharmarajan et al. 2022). Insect vectors play a major role in the spread of many zoonotic diseases with a wildlife origin. For instance, mosquitoes are well-known carriers of a number of zoonoses that affect wildlife, including Japanese encephalitis, horse encephalitis, and Rift Valley Fever. Fleas can disseminate *Y.pestis*, flies can spread *Bacillus anthracis* spores, and sand flies can spread *Leishmania*, but ticks are crucial in the spread of

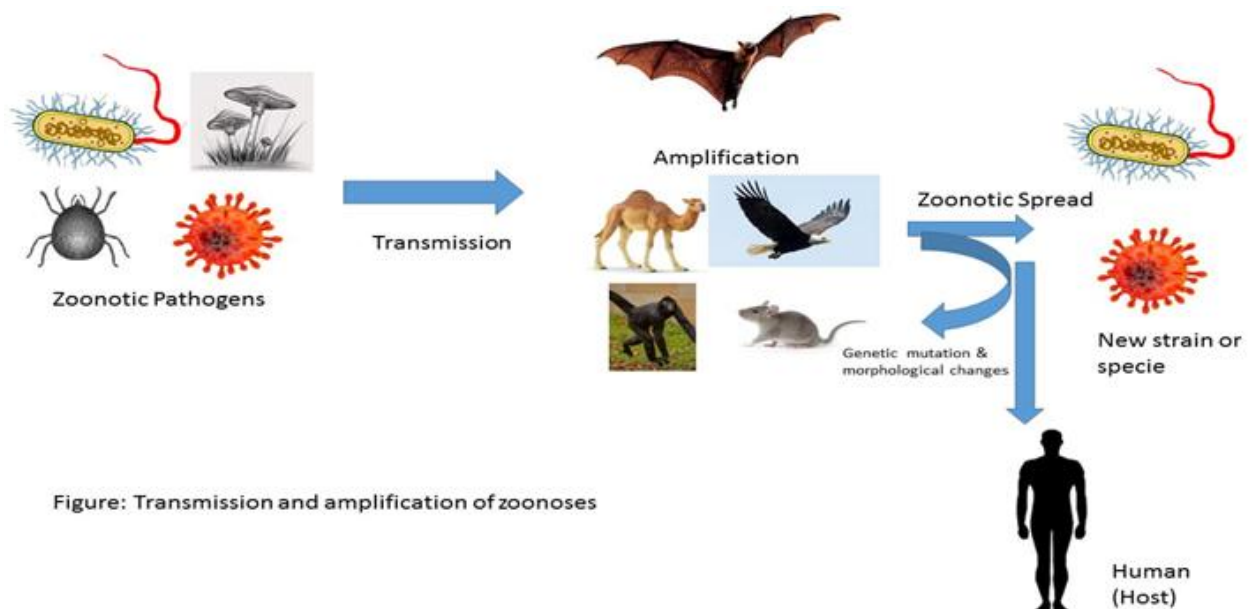


Figure: Transmission and amplification of zoonoses

Fig. 1: Transmission and amplification of zoonoses

Ehrlichia/Anaplasma and *Borrelia burgdorferi*. *F.tularensis* is an excellent example of a zoonotic agent with a variety of transmission methods. The primary carriers of the disease are rodents and hares, and hunters

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are particularly vulnerable to contracting it (Kruse et al. 2004). The clinical presentation in humans is likewise impacted by the transmission mode. The pathogen can spread through tick or mosquito bites, which initially result in skin signs like ulcers, as well as direct contact while handling an infected cadaver. Infection can also spread through inhaling contaminated dust, which can result in a pneumonia-like sickness, or eating improperly cooked meat from an infected animal or drinking contaminated water (Kruse et al. 2004). Hantaviruses are also found in wild rodents as a reservoir. Humans are typically infected aerogenically by breathing contaminated aerosols, and the viruses are shed in urine, feces, and saliva. Important environmental elements like as precipitation, habitat design, and food availability have an impact on rodent population dynamics, animal-to-animal virus transmission, and ultimately the likelihood of human infection (Kruse et al. 2004).

Animals can transmit a wide range of infectious disease-causing organisms to humans via a number of different routes, including ingestion, animal bites, vectors (such as insects), and animal-to-human contact (such as skin/mucous membrane contact or inhalation of respiratory particles) (Gauthier 2015; Rahman et al.2020).

Sapronoses are conditions caused by zoonotic diseases that may live and multiply inside dead organic matter, such as saprophytes. Through direct or indirect contact, diseases from these animals can spread. The transfer could take place inside, outside, in pet stores, hospitals, or other places. Transmission frequently happens when these animals and birds are taken to exhibitions and competitions. Animal bites and scratches are the most common ways for humans to become infected with diseases like Pasteurellosis and cat scratch fever (Rahman et al. 2020).

### 5. SOLUTION TO OVERCOME ZOOONOTIC DISEASE

Animals spread zoonotic diseases, and keeping track of them helps pinpoint their origin, route of transmission, and pathogenesis as well as focus preventive measures. (Supramaniam et al. 2018).

#### 5.1. EPIDEMIOLOGICAL INSPECTION

For community health management to identify related risk variables accountable for disease persistence and dissemination, epidemiological surveillance is essential. However, in Pakistan, it is uncommon to get population-based information on the widespread presence of zoonosis (Brown and Nading, 2019).

#### 5.2. HOSPITAL BASED OBSERVATION

Typically, hospital-based monitoring data have been utilized to show that many zoonotic illnesses are highly prevalent. To create policies that address illness persistence, clinicians, epidemiologists, expert in veterinary medicine and environmental health may be combined (Breslin et al. 2017).

#### 5.3. INTERPRETATION OF ZOOONOTIC DISEASE

Strong support has been given to the idea of one health, a worldwide integrative concept. The prevention and control of disease effectively depend on surveillance and monitoring activities. Considering the close relationship between human and animal health, it is presumable that a cross-sectoral data interpretation of zoonotic disease information will enhance zoonotic disease prevention, prediction, and control. A literature analysis was done to give an overview of the systems that are now in place around the globe that combine data on zoonotic illnesses from both people and animals (Wendt et al. 2015).

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### 5.4. VETERINARY POLICIES AND AWARENESS CAMPAIGN

In order to minimize the spread of zoonoses to people and other issues related to uncontrolled animal populations, veterinary public policy players should base their judgments on scientific data. This will help regulate dog and cat numbers in metropolitan areas. Since there is no public sterilization service for dogs and cats in the city, sporadic local sterilization campaigns are carried out with advance notice to the owners to bring their animals to a particular veterinary clinic for sterilization (Zahid 2018).

### 5.5. STERILIZATION PROGRAM

Since there are no shelters for giving up unwanted pets, abandonment is the main issue brought on by irresponsible pet ownership. There is no public sterilization service for dogs and cats in the city, sporadic local sterilization campaigns are carried out with advance notice to the owners to bring their animals to a particular veterinary clinic for sterilization (Dias et al. 2015).

### 5.6. VACCINATION PROGRAM

Public education campaigns about vaccination should be started as well. Tools for such projects are available in the "One Health" network, reporting, and analytical measures toolkit. (Iqbal et al., 2020) There are swine influenza vaccinations available for both humans and animals globally. H1N1 (swine flu) and H3N2. are the components of the influenza vaccine in Pakistan (Parums 2021).

## 6. BIOSAFETY TOOLS FOR PREVENTING ZOONOSIS

The prevention of zoonotic agents is based on a set of policies and practices aimed at lowering the danger of disease introduction and dissemination (Saegerman et al. 2012). Several methodologies for biosafety measurements could be used depending on the disease.

### 6.1. HAND WASHING AND HYGIENE

- Wash your hands for at least 20 seconds with warm water and soap.
- Wash your hands frequently, supervise youngsters to ensure thorough hand washing, avoid direct contact with animal excrement, and use antimicrobial hand gels even if your hands are not obviously dirty.
- Sanitize any spaces that pets can reach. In the event of bites or scratches, the wounds need to be carefully cleaned under running water, and treated with chlorhexidine and the reference on the hematology center should be notified in case antibiotic prophylaxis is necessary. Animals should have short nails and shouldn't engage in rough play to reduce this risk (Hemsworth and Pizer 2006).

### 6.2. PERSONAL SAFETY WHILE OUTSIDE

- Refrain from approaching any animals or waterfowl.
- Keep ticks and mosquitoes (among other insect vectors) at bay; and Apply vector control methods to the area around your house (Saegerman et al. 2012).

### 6.3. FOOD SAFETY

- Safe food handling and preparation.



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- Immediately clean any cooking utensils or surfaces that come into contact with raw meat or eggs.
- In addition to providing animals with high-quality food and water, home-prepared food should be cooked and/or pasteurised.
- To prevent hunting, interaction with uneaten food, and exposure to other animals' excrement, animals should be kept indoors (Pal et al. 2023).

### 6.4. CHILDREN AND ANIMALS

- When working with animals, adults should always keep an eye on kids, especially those under the age of five (Saegerman et al. 2012).

### 6.5. PET HEALTH

- Keeping pets healthy can reduce the spread of zoonotic infections.
- Avoid letting pets interact with wildlife.
- Don't let your pet eat other animals' feces.
- Don't feed your pet raw or undercooked meat. Instead, feed them high-quality commercial pet food (Saegerman et al. 2012).
- It's essential to practice good everyday hygiene. Individuals with immune-competent bodies must clean kennels, garbage boxes, cages, and toys carefully, and feces must be bagged. Coat cleaning is also important for maintaining healthy skin and hair. Pet food dishes and litter boxes need to be kept apart, and they should be cleaned and disinfected at least once a month (Hemsworth and Pizer 2006).

### 6.6. EDUCATION AND TRAINING

- It is necessary to educate farmers and animal handlers about zoonosis. Programs for training farmers and livestock handlers in zoonotic disease transmission and management are required (Chowdhury et al. 2018).

### 6.7. COLLABORATION

- The execution of practical operations and surveillance among the human, animal, and environmental sectors is needed for the prevention and control of developing and re-emerging illnesses, including zoonosis (Rahman et al., 2020).

## 7. CONCLUSION

Active and widespread zoonosis surveillance and monitoring using cutting-edge methods like molecular epidemiology tools and satellite-based remote sensing systems. It is crucial to implement food safety and cleanliness. It is also essential to store food in the right location and at the right temperature, as well as cook meals at the right temperature. To maintain excellent health for all, the One Health approach is crucial. People should try the best strategy to prevent infections acquired through contact with animals is to fully wash their hands with soap and water after interaction with animals or their habitats. To prevent infections from spreading to populations of humans and animals, pet owners must carefully follow biosecurity procedures: Animal pens should be fenced, Keep pet areas apart from your family's residence, Distinguish animal areas from water and food sources for people, Limit the interaction of visitors with animals. Prior to entering and exiting animal areas, make sure all non-disposable equipment is cleansed

and sterile. Personal protective equipment includes things like masks, goggles, gloves gown or apron should be worn when tending to sick animals. It is essential to maintain the security of infectious laboratories in order to stop the unintended spread of zoonotic illnesses and bioterrorism.

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