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Major zoonotic threats in Bangladesh: A public health overview

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ABSTRACT

Zoonotic diseases are prevalent all over the world and pose a significant threat to humans and animals. The tight connection between people and animals promotes the spread of zoonotic diseases. One of the main worldwide hotspots for zoonotic transmission to humans is Bangladesh. Bangladeshi people (farmers, laborers, butchers, and live animal market workers) are at high risk of it. Anthrax, brucellosis, Nipah, rabies, avian influenza, and zoonotic tuberculosis are among the six diseases that the Bangladeshi government has designated as priority zoonotic diseases. Pabna and Sirajgonj districts in Bangladesh are known as the "anthrax belt" due to high animal anthrax cases. Brucellosis, a neglected zoonotic disease, is a class B bioterrorist agent, affecting individuals in high-risk occupational groups in Bangladesh. A study revealed that zoonotic TB has a prevalence rate of 6.67% in humans in Bangladesh. The first Nipah virus disease was first identified in 2001. Since then, 335 individuals have been infected with the NiV virus, with 237 dying; the fatality rate is 70% in Bangladesh. Bangladesh has the 3rd highest number of human rabies deaths among rabies-endemic nations, with over 200,000 animal bite cases. To overcome this, it's necessary for a one-health approach to combat this public health hazard.

Key Word: Zoonotic disease, Zoonoses, Public health, Emerging disease

INTRODUCTION

The Greek words "Zoon," which means animal, and "nosos," which means nose, are the sources of the phrase "Zoonoses." It denotes disease. Approximately 1415 human pathogens are known to exist; 61% of them come from animals, and 70% are newly discovered diseases that come from nature (Jones *et al*., 2008; Slingenbergh *et al*., 2004 and Wang & Crameri, 2014). Among the many different types of pathogens are bacteria, viruses, fungi, protozoa, and parasites, which are major concerns. Zoonotic disease reservoirs are found in domestic and wild animals (Han *et al*., 2016). Bats have been found to serve as reservoir hosts for several newly discovered human diseases, including Ebola, MERS-CoV, SARS, rabies, and Nipah (Wang & Crameri, 2014). There are categories of zoonotic diseases: neglected, reemerging, and emerging. Public health concerns regarding the transmission of zoonotic diseases are heightened by the intimate relationship between people and companion animals (Mamun *et al*., 2024). Zoonotic diseases have a direct and indirect impact on animal health and production. The direct impact of zoonoses can have significant consequences, including disease, financial loss, staff morale, negative publicity, and legal complications. Indirect effects include the risk of human infection, impediments to animal commerce, increased expenses for control measures, marketing food for human use, and loss of market share, leading to decreased customer confidence (Newman *et al.,* 2005). Bangladesh is widely recognized as a significant global hub for zoonotic spillover to humans (Allen *et al*., 2017).

The likelihood of zoonotic disease emergence may be increased by human behavior, a high population of both humans and animals, a greater degree of the animal-human interface, many live animal markets, flora and fauna assortment, urbanization, deforestation, and vulnerable ecosystems. Numerous outbreaks of emerging zoonotic diseases, including COVID-19, Nipah, highly pathogenic avian influenza, and pandemic H1N1, have been reported from Bangladesh. Many other possible zoonotic infections, including Ebola, Middle East respiratory syndrome coronavirus, Kyasanur forest sickness virus, and Crimean-Congo hemorrhagic fever, could arise in the future. During a one-health zoonotic disease prioritization workshop, the Bangladeshi government identified six diseases as priority zoonotic diseases: anthrax, brucellosis, NIPAH, rabies, avian influenza, and zoonotic tuberculosis (Chowdhury *et al*., 2017). There is a lack of a clear summary of the total risk of zoonotic diseases to public health and disease-emerging factors. The people of Bangladesh are living close to their household cattle and poultry. Farmers, farm laborers, butchers, and workers at live animal markets face a significant risk of animal exposure. People are not fully aware of the transmission of the

zoonotic disease spread. it is essential to identify the knowledge gap about the transmission of zoonotic diseases and their effect on public health.

This review emphasizes the major zoonotic diseases found in Bangladesh that are discussed. After reading the relevant study article, we concluded that in Bangladesh, Anthrax, Brucellosis, Nipah, Rabies, and Zoonotic tuberculosis are the major concerns in humans. The government of Bangladesh has already given priority to controlling those zoonotic diseases. This review article outlined the major zoonotic diseases in Bangladesh (Fig. 1).

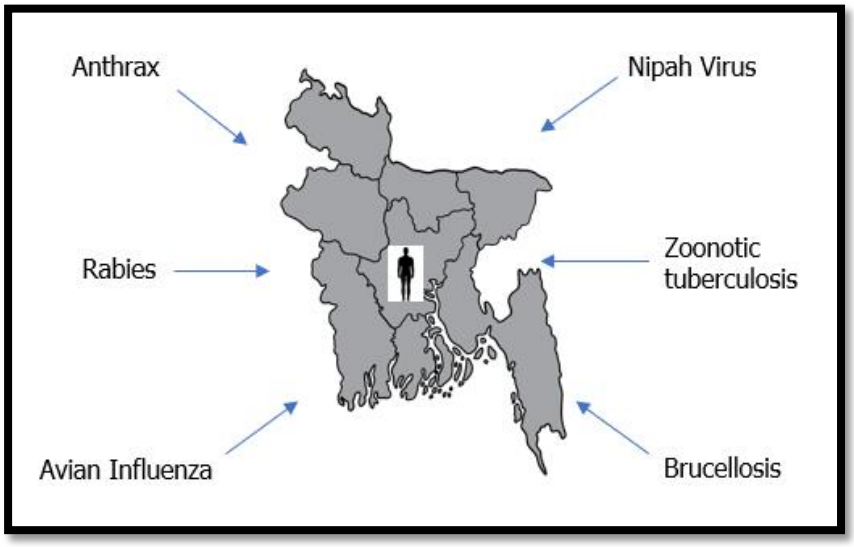

Fig. 1. Major Zoonotic Threats in Bangladesh

ANTHRAX

The word anthrax is derived from the Greek word "anthrakis" (or "coal"). The disease spreads globally and is similarly endemic in Bangladesh. Bacillus anthracis is a bacterium mainly found in anthrax-affected carcasses. It has been reported this bacterium is used as a biological weapon (Kamboj, *et al*., 2012). This also produces resistant spores that can cause airborne transmission. This disease causes acute illness in both wild and domestic animals. Humans can become infected with anthrax by contact with infected animal carcasses, handling diseased animal products (such as skin, wool, bone, and meat), or inhaling spores from contaminated soil (Samad, 2008; Thappa and Karthiklyan, 2001; Chakraborty *et al*., 2012). Anthrax infection can affect humans in three ways: cutaneously (skin), inhaled (lungs), and ingested (digestive tract) (Rahim *et al*., 2023). Incubation periods (IPs) of the disease range from a few hours to up to 60 days. IPs for cutaneous and gastrointestinal anthrax vary from a few hours to three weeks but typically last between two and six days. The incubation time for inhaled anthrax is 4 days on average, although it can go up to 10 or 11 days (WHO, 2008). From a study, it was revealed that out of 414 human cases, 378 (91.30%) had cutaneous anthrax, 27 (6.52%) had gastrointestinal anthrax, and 11 (2.66%) had both (Icddr, 2011). Anthrax is known as 'Torka' in Bangladesh.

The first reports of anthrax in humans and animals were from Bangladesh in 1980 (Samad, *et al*., 1986). Cattle, sheep, and goats are mostly affected. There have only been reports of cutaneous and gastrointestinal anthrax diseases in Bangladesh (WHO, 2008). In the cutaneous anthrax papule and vesicle, ulcers, erythema, central black eschar, surrounding edema, and pain were the features that identified the skin lesion. The lesions were found on the face, chest, back, neck, and scalp, in addition to the upper limbs (Chakraborty, 2010). Between 1986 and 2008, there were no recorded incidences of human anthrax (Chakraborty *et al*., 2012). The disease was frequently found in Bangladeshi humans and animals until 2009 (Ahmed *et al*., 2010), but it has been found repeatedly in recent years. Anthrax is enzootic in Bangladesh (Ahmed *et al*., 2010 and Ahsan, *et al*., 2013). Based on findings in scientific publications and daily media, the danger of anthrax was evaluated. Districts in Bangladesh were divided into three categories: Mymensingh, Pabna, and Kushtia districts were chosen as high, medium, and low-risk zones (Islam *et al*., 2017). More than 25 outbreaks occurred in both cattle and humans between 2009 and 2012, and 650 human cases were recorded in 15 districts during the summer and monsoon seasons (April to October) in Bangladesh (Samad, 2011). Another study found that from 2009 to 2015, there were over 1,500 recorded instances of anthrax in humans, with no fatalities and all being cutaneous (Chakraborty *et al.,* 2012; Siddiqui *et al*., 2012). Animal anthrax outbreaks have mostly been seen in Sirajganj, Pabna, Bogra, and Meherpur districts. The regions of Pabna and Sirajgonj are called the "anthrax belt." (Biswas *et al*., 2012; Siddiqui *et al*., 2012; Hassan *et al*., 2015). A study revealed that between 1980 and January 2023, 6354 cases of anthrax infection in animals were

recorded, with 998 deaths and an overall case fatality rate of 15.7%. (Islam *et al*., 2024). Bangladeshi people were unaware of the transmission of anthrax from sick animals to humans. In Bangladesh, it was normal to see sick animals slaughtered and their flesh sold at a reduced price (Islam *et al*., 2013). The environment and grazing area are contaminated due to improper disposal of carcasses and throwing them into open fields, rivers, canals, or floodwater (Chakraborty, 2010). To control anthrax in Bangladesh, public education and raising awareness of the dangers of animal-to-human anthrax transmission. Steps must include regular cattle vaccination programs, testing and quarantining imported and slaughtered cattle, and properly disposing of carcasses and contaminated materials. Meat sold by approved meat vendors and examined by veterinarians is required.

BRUCELLOSIS

The bacterium Brucella is the causal agent of the reemerging neglected zoonotic disease named brucellosis. People also called it “Mediterranean fever," "Malta fever," or "undulant fever.". It influences both human health and cattle production (Ariza *et al*., 2007). This disease is widespread worldwide and is prevalent in Bangladesh and other less-developed nations in Asia, Africa, and Latin America. This disease is also considered a class B bioterrorist agent (Greenfield, 2002). *Brucella circulates* among domesticated animals like cattle, buffalo, sheep, goats, swine, and dogs. Although brucellosis in humans is rarely deadly, it can be extremely debilitating and disabling (Fig. 2). Those who deal with livestock, in artificial insemination, in slaughterhouses, and with animals are more vulnerable to contracting Brucella infection. The disease tends to be chronic and persistent, developing a granulomatous disease capable of affecting every organ system (Pappas *et al*., 2006). Pregnant women often have abortions, whereas men often experience orchitis and epididymitis (Radostits *et al*., 1997). *Brucella melitensis* is the most pathogenic species for humans rather than the others e.g. *Brucella suis*, *Brucella abortus*, and *Brucella canis* (Pal *et al.,* 2020). It can be diagnosed by polymerase chain reaction (PCR) and bacterial isolation (culture) methods. Another way is antibody detection from serum or milk samples. Animal contact and animal-derived food are the main ways for brucellosis in humans. The disease is spread through human contact with secretions, primarily during calving and abortion. Rahman *et al*. (1983) conducted the first seroprevalence study of brucellosis in humans in Bangladesh among dairy and agricultural workers who interacted with animals. The standard tube agglutination test (STAT) and the Rose Bengal test (RBT) were conducted. According to the findings of this study, brucellosis was present in 21.6% of goat farmers and 12.8% of dairy and agricultural workers. A significant risk factor for contracting Brucella infection is consuming tainted and unpasteurized milk and dairy products, including ice cream, yogurt, and soft cheeses (Islam, *et al*., 2013). There are no official statistics on the prevalence or frequency of brucellosis in humans in Bangladesh. Numerous investigations revealed that in different Bangladeshi areas, 4.4%–12.8% of individuals in high-risk occupational groups had brucellosis serology positive. 3% to 7% of animals in Bangladesh had antibodies against the Brucella species (Rahman *et al.,* 2010 and Islam e*t al*., 2013).

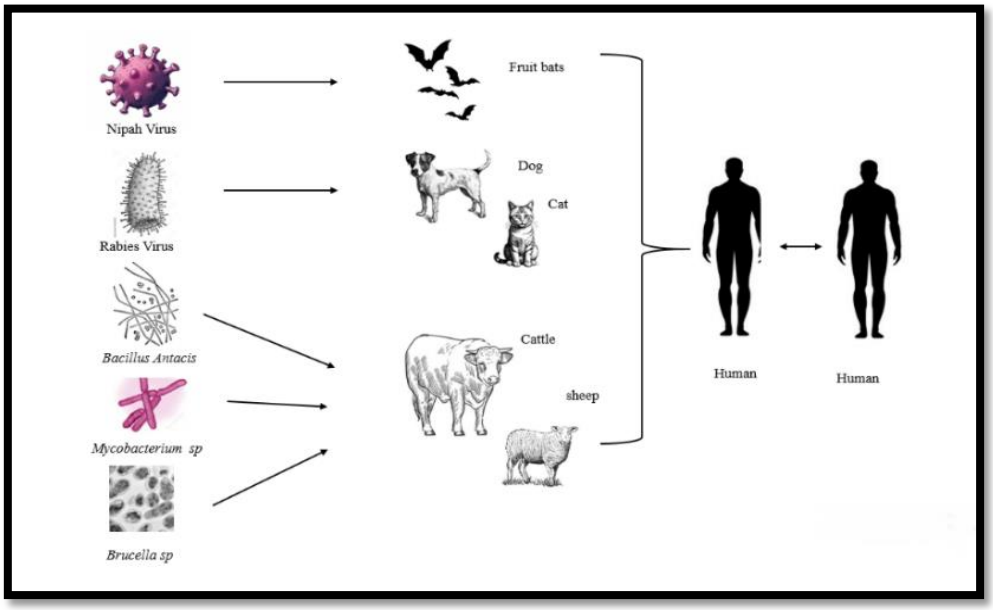

Fig. 2. Transmission pathway of different zoonotic diseases at a glance

ZOONOTIC TUBERCULOSIS

Human tuberculosis, known as zoonotic tuberculosis (zTB), is mostly caused by *Mycobacterium bovis*, with a lesser extent occurring by *M. tuberculosis, M. caprae,* and *M. orygis* together known as the Mycobacterium tuberculosis complex (MTC). The primary causal agent of zoonotic TB in humans is *M. bovis*. The primary source of zoonotic TB is cattle. Due to the similar environment between people and animals, the disease presently poses a serious threat to human populations in developing countries. 10 to 15% of new cases of tuberculosis in humans occur because of zoonotic *M. bovis* transmission in developing countries (Bapat *et al*., 2017). Humans contracted *M. bovis* mostly via consuming unpasteurized milk and coming into close contact with infected livestock (Müller *et al*., 2013). Herd size, inadequate husbandry, and sanitary methods introducing a new animal from an unidentified breed, age range, or source, or bringing it into proximity to existing animals, and communal grazing and watering have all been identified as risk factors for BTb (Basit *et al*., 2018).

In Bangladesh, the incidence of tuberculosis (TB) is found to be the highest. In 2019, the anticipated annual incidence rate was 361 per 100,000 people or 3.6% of all cases worldwide. In the world in 2019, there were an estimated 140,000 new cases of zTB in humans and 11,400 deaths. 2,020 people died, and 43,400 cases were reported in the Southeast Asian area, which includes Bangladesh. (WHO, 2020). A study stated a prevalence rate of 6.67% bTB in humans (Rahman *et al*., 2015). Furthermore, there are no safety or personal hygiene compliance measures in place during slaughtering operations to prevent the zoonotic spread of bTB to people. There are more crossbred cattle with higher yields to fulfill the growing demand for milk. These exotic breeds intensify the spread of zTB since they are more prone to BTb (Ameni *et al*., 2007). Cattle that are older than 10 years of age are at a higher risk of tuberculosis (Cleaveland *et al*., 2007). The estimated range for the total prevalence of bTB at the animal level is 2–11.3%. The results of a survey verified that 42.6% of the respondents do not possess sufficient information about ZTB management and preventative measures (Islam *et al*., 2021). Several investigations have shown *M. bovis* in Bangladeshi cattle (Rahman & Samad, 2008 and Sarker *et al*., 2015). Several studies using the tuberculin test (TST) from various regions of Bangladesh reported the incidence of bovine TB (BTb). The records that are currently available indicate that the prevalence rates of bTB in cattle, buffaloes, sheep, and goats in Bangladesh were 33.73, 6.12, 9.15, and 1.29%, respectively (Hossain *et al*. 2012). According to reports, the percentage of TST-positive cattle in the Pabna district was 5.9%, whereas in Mymensingh district it was 3.05% (Samad and Rahman *et al.,* 1986). Islam *et al*., 2007 and Biswas *et al*., 2017) reported that the frequency of BTb in breeding bulls at the Bangladesh Livestock Research Institute farm in Savar, Dhaka, and the Central Cattle Breeding and Dairy Farm was reported to be 27.5% of the bulls. In several parts of Bangladesh, 4.08% of cattle were documented as TST-positive in dairy farms, both private and government-owned (Hossain *et al*., 2016).

NIPAH VIRUS INFECTION

Nipah virus infection is another zoonotic disease that is also found in Bangladesh. This virus is transmitted from one to another through contaminated food. It has a high mortality rate, and currently, no therapy has been invented to cure this disease. Nipah virus outbreaks have been observed in many South Asian countries throughout specific seasons. NiV infection in humans was initially reported in 1998-1999 (Chua, 2003). At that time in Malaysia, this pandemic killed 105 individuals (Lam *et al*., 2002). In 2001, Siliguri, India, identified an outbreak of encephalitis caused by NiV. It killed 45 infected people (Chadha, *et al*., 2006). The natural reservoir host for this disease is fruit bats. The respiratory secretions and urine of infected people have been proven to contain this fatal virus (Clayton *et al*., 2013). India encircles Bangladesh on three sides, and its first incidence of NiV infection was identified in 2001, along with India. It was identified in Bangladesh in 2001. Since then, outbreaks occurred almost every year during the winter season, mainly from December to March (Luby, *et al*., 2009).

Since the first outbreak in 2023, 335 individuals have been infected by it, with 237 of them dying (Nazmunnahar *et al*., 2023). 70% of cases are fatal (IEDCR, 2020). Date palm sap (DPS) and contaminated food can both spread the NiV virus. NiV is present in bat secretions. Moreover, bodily fluids from an infected person (e.g., saliva and respiratory droplets) can spread the infection. People who climb trees may be more susceptible to disease (Montgomery *et al*., 2008 and Gurley *et al*., 2007). Encephalitis is one of the common characteristics of NiV infection, which has a high fatality rate (Alam, 2022). The source of the NiV infection in Bangladesh is raw DPS contaminated by a bat during winter (Khan *et al.,* 2010 and Luby *et al*., 2006). Fruit bats were identified as a natural reservoir for NiV in Bangladesh (Anderson *et al*., 2019 and Epstein *et al*., 2016). Raw date palm juice should thus not be permitted for human consumption. Furthermore, it's best to avoid eating fruits that bats have partially digested. IEDCR and ICDDR, B, have performed surveillance since 2006 to identify NiV encephalitis cases among hospitalized patients. They suggest Nipah virus encephalitis-affected patients can be identified more quickly by passive surveillance (Sazzad *et al*., 2015). There are no recognized

therapies for the NiV infection. Treatments for symptoms and supportive care are the mainstays of therapy for people with infections. This virus is more deadly than coronavirus and has the potential to cause death due to its high mortality rate. It poses a risk for the spread of another pandemic since it may also be spread from person to person.

Table 1. Prioritize zoonotic diseases in Bangladesh

Disease	Animal Hosts	Transmission Routes	Risk Groups	Symptoms in Humans	Symptoms in Animal	Prevention Measures
Anthrax	Cattle, sheep, goats	Direct contact with infected animals, handling diseased animal products (such as skin, wool, bone, and meat), and inhalation spores. (Thappa and Karthiklyan, 2001; Samad, 2008; Chakraborty, *et al.*, 2012)	❖ Farmers, livestock handlers, and butchers ❖ Tannery and wool workers ❖ Consumers of undercooked meat ❖ Rural people live in hotspot areas	Cutaneous anthrax presented with popular to vesicular ulcer, edema, and malignant carbuncle associated with Fever, chills, and fatigue (Rume, *et al.*,2020)	High Fever, Sudden death, and bleeding from the natural opening in dying animals (Islam *et al.*, 2017).	Vaccination of livestock, protective clothing, proper disposal of animal carcasses, etc. (Islam et al., 2017).
Brucellosis	Cattle, goats, sheep	Direct contact with infected animal discharge and ingestion of contaminated dairy products (Islam, *et al.*, 2013).	❖ Dairy farmers and veterinarians ❖ Workers in slaughterhouses and meat-processing industries ❖ Consumers of unpasteurized milk or dairy products	Fever, Orchitis, and epididymitis in males, Abortion in women (Radostits, *et al.*, 1997)	Fever, Productivity loss, Infertility, abortion, weight loss, etc.	Pasteurization of milk, culling the infected animal, hygiene practices, etc.
Nipah Virus	Fruit bats, pigs	Direct contact, saliva and respiratory droplets (Clayton, *et al.*, 2013)	❖ Farmers and those handling pigs ❖ People in contact with bat-contaminated fruit (especially date palm sap) ❖ Healthcare workers treating Nipah patients	Encephalitis, Fever	Fever, headache, respiratory issues	Avoiding contact with bats, biosecurity on farms, surveillance etc.
Rabies	Dogs, bats, wild animals	Bite or scratch from an infected animal (Ghosh, *et al.*, 2016).	❖ People bitten by rabid animals, especially stray dogs ❖ Veterinarians and animal handlers ❖ Children (more prone to animal bites)	Hydrophobia, paralysis, Hyperactivity and aggression, Death	Anxiety, confusion, paralysis	Vaccination of pets, immediate wound care, public awareness campaigns etc.
Zoonotic Tuberculosis	Cattle, sheep, Goat, pig, dog, cat, wildlife	Inhalation, ingestion of contaminated products (Islam, *et al.*, 2021).	❖ Dairy farmers and workers handling cattle ❖ Consumers of unpasteurized milk	Emaciated, weight loss, fever	Cough, fever, weight loss	Testing and culling of infected animals, pasteurization of milk, etc.

RABIES

Rabies is a deadly zoonotic disease. It affects all species, including humans. Rabies is prevalent worldwide. Bangladesh has the third highest number of human rabies deaths among rabies-endemic nations, indicating a significant public health issue (Hossain *et al*., 2011). In Bangladesh, over 200,000 animal bite cases and over 2000 human rabies deaths are recorded annually, and most of them are kids below 15 years old who live in rural areas (Hossain *et al*., 2012 and Tenzin *et. al*., 2015). However, domestic dogs account for almost 99% of human cases (WHO, 2013). This vulnerability is likely due to their inherent fondness for animals, particularly cats and dogs. Provocation by youngsters, such as throwing stones, beatings, chasing, or rushing in front of dogs, can lead to bites (Ghosh *et al*., 2016). Bangladesh's main referral facility for rabies patients is the Infectious Disease Hospital (IDH) in Dhaka City. They treat roughly 350–450 dog bite victims for free (Hossain *et al.,* 2011 and Mondal & Yamage, 2014).

Dog bite victims can receive free anti-rabies vaccinations (ARV) and treatment at rabies prevention and control centers at the district level. In a passive monitoring study conducted in Bangladesh from 2010 to 2012, 3425 rabies deaths were observed in domestic animal populations, including 2845 cattle, 547 goats, and 13 sheep (Mondal & Yamage, 2014). Every year, over 3,000 dog bites are reported (Gongal & Wright, 2011). Dog bites were linked to 86% of the human cases (Ghosh *et al*., 2016). To decrease dog and human rabies infections, the government launched a widespread dog vaccination campaign (Ghosh *et al*., 2020). A survey found that 86% were aware that dog bites are the leading source of rabies, and 85% believed vaccination might prevent the disease (Ghosh *et al*., 2016). An integrated health monitoring system is required for understanding the present state of rabies in animals (domestic and wildlife) and humans. Controlling rabies in humans and animals requires community awareness of how the disease is spread, how to treat dog bites, how to prevent exposure after exposure, and how to vaccinate dogs.

CONCLUSIONS

The epidemiological data of many zoonotic diseases like Rabies and Nipah virus has been well documented in Bangladesh. Information about other potential zoonotic diseases is inadequate. Few studies have been undertaken to design and implement effective strategies to reduce zoonotic disease transmission in rural communities. It is necessary to understand the burden of zoonotic diseases and their solutions. People's incomprehensive approach is needed to address this knowledge gap and combat this public health hazard. Bangladeshi people are not well aware of zoonotic diseases and related risk factors. Bangladeshi people, including occupational workers who closely work with animals, are at risk of exposure to zoonotic diseases. A comprehensive strategy is required to close this knowledge gap and stop these public health hazards. This review helps to alert Bangladeshi people and others about the major zoonotic diseases.

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