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Bridging Human and Veterinary Sector under One Health for Diagnosis of Various Bacterial Zoonotic Diseases in Human and Animal

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Abstract

Zoonotic diseases, or zoonoses, are infections that can spread between animals and humans. These diseases pose a serious public health risk, as they can lead to severe illness and, in some cases, death. Early detection and diagnosis are essential for effective treatment and prevention. This study, conducted from January to June 2024, aimed to test suspected cases of zoonotic diseases in both humans and animals at district surveillance and veterinary laboratories in Haryana. The study focused on tuberculosis, paratuberculosis and brucellosis in animal population whereas typhoid (salmonellosis), leptospirosis, and scrub typhus in humans. 1.18% seroprevalence was reported for brucellosis in animals as detected through RBPT. None of the samples were found positive for bovine tuberculosis and bovine paratuberculosis. The prevalence of human tuberculosis and salmonellosis among the tested samples was 19.28% and 20.15%, respectively. For scrub typhus, only one case is reported that is from Kurukshetra, while 2 out of 50 suspected samples were positive for leptospirosis. Identifying zoonotic diseases is a challenging task that requires collaboration across multiple fields. Early detection of these diseases and providing timely treatment are crucial to protecting human and animal health and preventing further spread.

Keywords: Bacterial zoonotic diseases, Diagnosis, Animal, Human, Haryana

Introduction:

Zoonotic diseases are infections that spread from vertebrate animals to humans through direct contact, inhalation, ingestion, or exposure to infectious substances and pose a substantial worldwide public health issue (Jones et al., 2008; Shaheen, 2022). Zoonotic diseases are caused by infectious agents such as bacteria, viruses, prions, parasites and fungi. Over 75% of newly emerging diseases come from animals, with 60% spreading from domestic or wild animals to humans (Yadav et al., 2019). Additionally, 80% of emerging and re-emerging zoonotic diseases are considered potential bioterrorism threats (Erkyihun and Alemayehu, 2022). Zoonotic diseases can cause serious illness and mortalities in both humans and animals (Taylor et al., 2001; Abdulrazaq et al., 2024). The inevitable connection between humans, animals, and the environment increases the risk of zoonotic disease transmission (Hassell et al., 2017). These diseases spread in different ways, show varied symptoms, and create challenges for healthcare and veterinary systems worldwide (Behera et al., 2021).

Among the many zoonotic diseases, Tuberculosis (TB) is a reemerging disease that affects both humans and animals. It is caused by bacteria from the *Mycobacterium tuberculosis* complex, which includes *M. tuberculosis, M. bovis, M. canettii, M. africanum, M. pinnipedii, M. caprae, M. microti*, and *M. mungi* (Thoen et al., 2016). It is a major global health concern affecting both humans and animals (Anaelom et al., 2010). Another zoonotic disease, paratuberculosis, caused by *Mycobacterium avium* subspecies *paratuberculosis*, mainly affects cattle, sheep, and goats but may also spread to humans (Whittington et al., 2005). *Salmonella typhi* (*S. typhi*) is the bacteria responsible for Salmonellosis (typhoid fever), a major global zoonotic health issue, capable to infect both humans and animals (Majowicz et al., 2010). Once inside the body, it moves toward intestinal M cells by utilizing proteins and multiply within cell compartments (Woods et al., 2019). This bacterium eventually spreads to the liver, spleen, and bone marrow, leading to infections that can range from mild gastroenteritis to serious systemic illnesses in humans. Brucellosis caused by bacteria belonging to genus *Brucella,* with *Brucella abortus*, *Brucella melitensis*, and *Brucella suis*; is a globally important disease that affects both humans and animals, causing significant health and economic impacts (Seleem et al., 2010). It is the most common bacterial infection transmitted from animals to humans, with over 500,000 new cases reported annually worldwide (Pappas et al., 2006). In India, Singh and coworkers estimated the overall economic loss to the tune of USD 3.4 billion to the livestock industry, with the dairy sector alone accounting for 96% of this total (Singh et al., 2015).

Leptospirosis is a bacterial infection caused by *Leptospira interrogans* that affects both humans and animals worldwide and is a key One Health concern (Costa et al., 2015). Many human infections cause mild or no symptoms, but when illness develops, it can range from mild flu-like symptoms to severe disease. In serious cases, it may lead to kidney failure, liver damage, lung bleeding, meningitis, or pancreatitis, usually appearing 7 to 12 days after infection (Sykes et al., 2022). Scrub typhus, caused by *Orientia tsutsugamushi*, is a serious zoonotic disease spread by chiggers and poses major health risks (Luce-Fedrow et al., 2018). Due to the complex nature of zoonotic diseases, effective surveillance, prevention, and control require collaboration between public health authorities, veterinarians, and healthcare professionals (Taylor et al., 2001; Morse et al., 2012; Jhandai et al., 2023).

To improve zoonotic disease surveillance in Haryana, ICAR-National Research Centre on Equines, Hisar, serves as the regional coordinator for the National One Health Programme for Prevention and Control of Zoonoses (NOHP-PCZ) under NCDC, New Delhi. In a previous effort by ICAR-NRCE to prioritize zoonotic diseases in Haryana using the One Health approach, bovine tuberculosis was ranked second, while brucellosis was sixth on the priority list (Thukral et al., 2023). Previously, we conducted a similar study from July 2022 to July 2023 to assess the seroprevalence of various zoonotic diseases. The findings revealed a seroprevalence of 0.83% for brucellosis in the animal population. In humans, the seroprevalence of tuberculosis, salmonellosis, scrub typhus and leptospirosis were observed to be 14.95%, 17.07%, 15.15%, and 5.71%, respectively (Jhandai et al., 2023). This present study is in continuation with our previous study, reports presence of zoonotic diseases carried out during the period January - June 2024 in Haryana. This study aimed to collect data from both medical and veterinary fields to enhance surveillance, allowing for early detection and response to zoonotic disease outbreaks.

Materials and Methods:

Study area

Haryana is a state in northwestern India, consisting of 22 districts, around 6,848 villages, and 154 towns. It lies between 27.39°N to 30.35°N latitude and 74.27°E to 77.36°E longitude (Kumar et al., 2024).

Sample collection and study period

This study was carried out from January to June 2024 to test suspected animal and human samples for common zoonotic diseases in Haryana. Testing was conducted at district veterinary diseases diagnostic laboratories (n=22), district surveillance laboratories (n=22), and ICAR-National Research Centre on Equines (NRCE), Hisar. Animal samples were collected from suspected cases brought to government veterinary hospitals and sent to disease diagnostic labs for testing. Human samples were taken from individuals showing symptoms at government civil hospitals and sent to district diagnostic labs for examination.

The study focused on specific zoonotic diseases, including brucellosis, bovine tuberculosis, and paratuberculosis in animals, while tuberculosis, typhoid (salmonellosis), leptospirosis, and scrub typhus were examined in humans.

Diagnostic test

The Rose Bengal Plate Test (RBPT) is a simple and rapid screening method for detecting brucellosis in animals. The test was performed in district diagnostic labs using *Brucella abortus* antigen. Equal volume of serum and antigen was mixed with an on a plate card, spread into circle using a tip, and manually rotated for four minutes. The presence of agglutination was interpreted as a positive result, while its absence was considered negative (Legesse et al., 2023). For bovine tuberculosis and paratuberculosis, Single Intradermal Test (SIT) was performed by administering an intradermal injection of 0.1 ml Purified Protein Derivative (1mg/ml) of *Mycobacterium bovis* and *Mycobacterium paratuberculosis* into the caudal fold of cattle. The injection site was examined after 72 hours, and an increase in the skinfold thickness of a least 5 mm was recorded as a positive reaction (Pollock et al., 2000).

For detection of salmonellosis Widal test was performed using *Salmonella typhi* O and H suspense antigen (Andualem et al., 2014) and for human tuberculosis sputum microscopy/ Cartridge Based Nucleic Acid Amplification Test (CB-NAAT) was used (Chaudhary et al., 2019). IgM ELISA was used to detect scrub typhus (Scrub Typhus Detect™ IgM ELISA by InBios, Catalog No.- STMS-R) and leptospirosis (Lepto IgM Microlisa by J. Mitra & Co. Pvt. Ltd., Catalog No.- IR026096) according to manufacturer guidelines.

Compilation of reports and analysis

Data on these zoonotic diseases was collected monthly from district surveillance laboratories (IDSP) and veterinary district diagnostic laboratories. The collected data was then compiled and analysed at ICAR-NRCE.

Results and Discussion:

Result revealed that 251 out of 21,193 animal samples were positive for brucellosis with sero prevalence of 1.18% (Table 1). Highest positivity rate (6.76%) was observed in Sonipat district followed by Panchkula (1.92%), Bhiwani (1.02%), Gurugram (0.96%),

Kurukshetra (0.78%), Ambala (0.67%) and Kaithal (0.63%) (Table 1, Figure 1). Overall seroprevalence for brucellosis has been increased from 0.83% (in July 2022 to July 2023) to 1.18% in this study (Jhandai et al., 2023). Previous serological studies have confirmed the presence of bovine brucellosis in Haryana (Kumar and Chand, 2011; Khurana et al., 2012; Chand and Chhabra, 2013). None of the 20 suspected cases of bovine tuberculosis and 20 suspected cases of bovine paratuberculosis in animals was found positive. The actual spread of these diseases is unclear due to the small sample size.

Among the human samples, 2,037 out of 10,563 suspected samples were positive for human tuberculosis (seroprevalence 19.28%) (Table 1). 92.48% positivity rate were observed in Nuh-Mewat, followed by Sirsa (13.40%), Kaithal (13.17%) and Kurukshetra (8.81%) (Table 1, Figure 2). Several studies in Haryana and other parts of India have assessed the positivity rate of tuberculosis among household contacts of newly diagnosed patients. We had reported seroprevalence of 14.95% in our previous study from July 2022 to July 2023 (Jhandai et al., 2023). This approach helps in the early detection and treatment of active TB, reducing its severity and limiting its spread (Nair et al., 2016; Chawla et al., 2020; Jhandai et al., 2023). Detecting active TB cases helps in focused public health efforts like contact tracing. This process involves screening people who have been in close contact with an infected person and providing treatment if needed, reducing the risk of further disease transmission. Despite significant efforts to eradicate tuberculosis (TB) in humans, achieving full control remains challenging without tackling the disease in animals. Zoonotic transmission of *Mycobacterium bovis*, the pathogen responsible for bovine tuberculosis, poses a serious threat to human health, particularly in regions where close interactions between livestock and people occur (OIE, 2021). Despite control measures that only target human cases, studies have shown that occupational exposure, unpasteurized dairy product consumption, and the uncontrolled movement of infected animals contribute to the persistence of tuberculosis in humans (Ayele et al., 2004; WHO, 2022). A One Health approach to TB control necessitates surveillance and systematic testing of TB in livestock, especially with tests like the Single Intradermal Tuberculin Test (SIT) and interferon-gamma release assays (Palmer, 2007). Failing to incorporate animal TB testing into India's national TB elimination program may lead to persistent zoonotic transmission and re-infection, posing a significant barrier to eradication efforts.

For salmonellosis in human population, a total of 13,099 were tested and 2,640 (20.15%) found to be positive (Table 1). For salmonellosis positivity rate in various districts were- 27.69% in Kaithal, 24.49% in Hisar, 20.07% in Faridabad, 19.30% in Fatehabad, 16% in Kurukshetra, 7.43% in Nuh-Mewat and 6.48% in Sirsa (Table 1) (Figure 2). Previously, in our study from July 2022 to July 2023, we observed the seroprevalence of 17.07% for salmonellosis (Jhandai et al., 2023). The Widal slide test, which detects agglutination, is commonly used for the early diagnosis of typhoid and paratyphoid fever. It has been in use for over a century in developing countries, but its accuracy is often questioned due to its low sensitivity, specificity, and positive predictive value (Sherwal et al., 2004; Begum et al., 2009; Deksissa and Gebremedhin, 2019). Researchers have reported varying incidence rates of salmonellosis across different districts of Haryana (Kumar et al., 2008; Banerjee et al., 2014; Sharma et al., 2015; Jhandai et al., 2023). The high rate of seropositivity may be due to population growth and inadequate hygiene. Since this disease is largely preventable, raising awareness about better hygiene practices and available vaccines is essential.

1 out of 68 humans tested were positive for scrub typhus, and 2 out of 50 were positive for leptospirosis. Positive case of scrub typhus reported from Kurukshetra and for leptospirosis it was reported from Kurukshetra and Faridabad districts (Table 1, Figure 1). In rural areas, farmers and agricultural workers are more vulnerable to infection, especially during sowing, harvesting, and monsoon seasons. Leptospiral infection spreads mainly through farm animals and rodents, which carry the bacteria. The bacteria thrive in wet and humid conditions, and frequent human contact with livestock and farmlands increases the risk of transmission (Sethi et al., 2010; Bradley et al., 2023). The northern areas of Kurukshetra district receive more rainfall during the monsoon compared to other parts of Haryana. It is a fully irrigated district with extensive land used for rice and wheat cultivation (Kalra et al., 2001). This might be the reason of positive cases of leptospirosis and scrub typhus in Kurukshetra.

Currently, human health professionals primarily focus on diagnosing zoonotic diseases in humans, while veterinarians test for these diseases in animals, however they are working independently with little or no coordination. This lack of collaboration creates gaps in disease surveillance and control efforts. To control of zoonotic diseases through One Health, NCDC launched National One Health Program for Prevention and Control of Zoonoses (NOHP-PCZ), ICAR-NRCE, as a regional coordinator under this program, plays a crucial role in bridging this gap. To strengthen the capacity building and improve coordination between the medical and veterinary sectors, we conduct workshops and training sessions for veterinary officers, medical professionals, and the general public from past five years. These efforts aim to

strengthen disease surveillance, enhance diagnostic capabilities, and improve zoonotic disease control through an integrated One Health approach. Testing individuals who have been in contact with infected animals, and vice versa, can aid in the early detection of disease transmission. This approach also helps to identify the sources of infection and supports the development of effective control measures, including biosecurity practices and health education programs for animal handlers and the public.

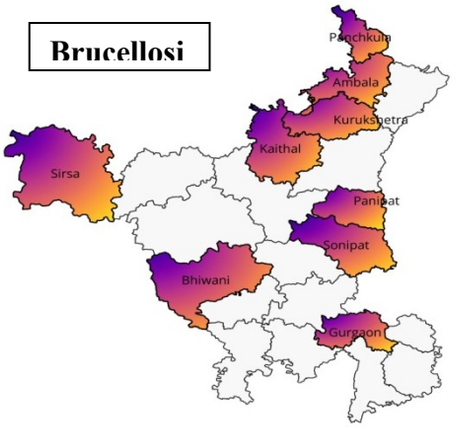

Figure 1: Map showing the districts of Haryana with reported positive cases of brucellosis in animal population

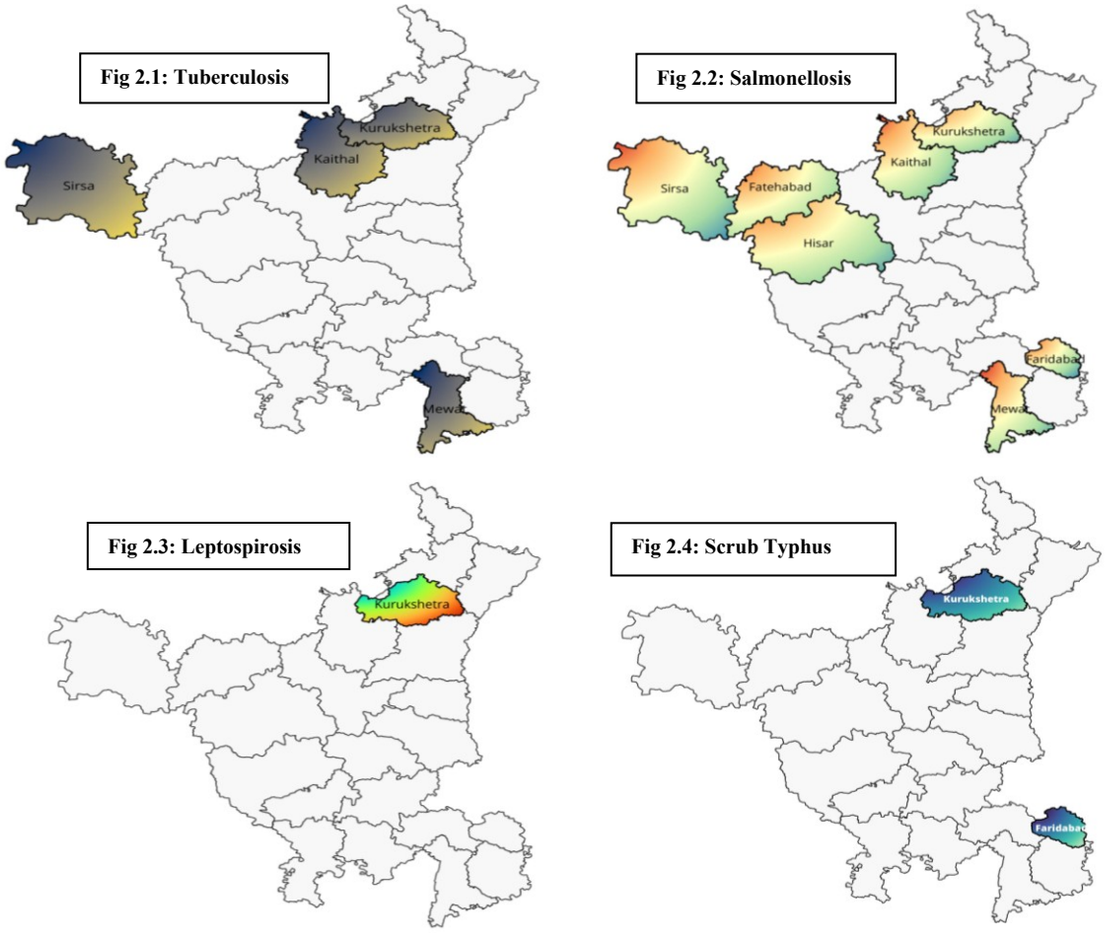

Figure 2: Map showing the districts of Haryana with reported positive cases of various zoonotic diseases in humans (2.1: Tuberculosis; 2.2: Salmonellosis; 2.3: Leptospirosis; 2.4: Scrub Typhus)

Table 1: Prevalence of zoonotic diseases in animals and humans of Haryana

Diseases	Suspected case	Positive case	Prevalence (%)	District from which positive case reported
Bovine Brucellosis	21,193	251	1.18	Sonipat, Panchkula, Bhiwani, Gurugram, Kurukshetra, Ambala and Kaithal
Bovine tuberculosis	20	0	-	-
Bovine paratuberculosis	20	0	-	-
Human tuberculosis	10,563	2,037	19.28	Nuh-Mewat, Sirsa, Kaithal and Kurukshetra
Human Salmonellosis	13,099	2,640	20.15	Kaithal, Hisar, Faridabad, Fatehabad, Kurukshetra, Nuh-Mewat, and Sirsa
Human Scrub Typhus	68	1	1.47	Kurukshetra
Human Leptospirosis	50	2	4	Kurukshetra and Faridabad

Conclusions:

In conclusion, detecting zoonotic diseases requires collaboration between public health officials, veterinarians, and healthcare professionals. Timely diagnosis and treatment are essential to protect both humans and animals from infection. The results highlight the importance of improved surveillance, preventive measures, and public health initiatives, particularly in high-risk areas. This study provides a foundation for future research, emphasizing the need for a multidisciplinary approach to effectively control zoonotic diseases.

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Conflict of Interest:

The authors declare no conflict of interest.

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