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Overview on epidemiological studies of bovine and equine diseases in India

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Abstract
India's most valuable resource is its livestock population. Farmers that raise livestock are almost entirely reliant on animals for a variety of reasons. India is one of the countries that has the greatest population of livestock in the world. In a similar vein, India has been cited as the source of numerous reports of diseases affecting livestock over the course of many years. Farmers are required to have an understanding of the various diseases that can affect bovine and equine animals. This will allow them to be aware of the etiology of the diseases as well as the pattern of disease transmission, allowing them to make the necessary preparations to prevent and control the diseases. Many diseases, including bovine rotaviral diarrhoea, bovine mastitis, bovine brucellosis, bovine herpes viral infection, and equine piroplasmosis and equine herpes viral infection, among others, are regularly reported from India. The purpose of this review is to provide an overview of the bovine and equine illnesses that are widespread in India from an epidemiological standpoint and to do so in a concise manner.

Keywords: Epidemiology, bovine, equine diseases, bovine rotaviral diarrhoea, equine herpes virus

Introduction

There has been an increase in the number of disease outbreaks, droughts, and floods in India, as well as other adverse climatic conditions. India's livestock population is at risk. There are many diseases that can harm livestock, and these diseases can have a severe influence on animal production, trade in live animals, meat, and other animal products, human health, and the process of economic growth as a whole. The production of livestock is an essential component of the Indian economy, since it helps to ensure the availability of food and supports the livelihoods of millions of people. It is absolutely necessary to maintain the health of livestock, such as bovine and horse species, in order to guarantee the continued productivity and profitability of the industry. Yet, infectious diseases continue to be a serious obstacle for the livestock business. These diseases have a negative impact not only on the physical and mental health of animals, but also on the financial security of farmers and other stakeholders. The animal disease landscape in India is positive because we were able to eradicate Rinderpest, the most feared livestock disease that wiped off herds of cattle. This is a reason to be optimistic about the situation. According to the Project directorate on animal disease monitoring and surveillance's vision 2030-ICAR, the country is currently plagued by a number of other infectious and non-infectious diseases, all of which contribute to the enormous economic loss that occurs annually.

The huge economic losses that are brought on by bovine and horse diseases, as well as the effects those diseases have on India's dairy and meat industries, are a major source of concern for livestock owners in India. Studies in epidemiology are extremely important for gaining a better understanding of the occurrence and distribution of these diseases, as well as for contributing to the creation of effective control methods. The epidemiology of bovine and equine diseases in India, as well as the significant studies that have contributed to our understanding of these diseases, were covered in this review. This article presents an overview of the epidemiological studies that have been conducted on bovine and horse illnesses in India. It focuses on the most important findings, as well as the problems and opportunities that exist for improving disease surveillance, prevention, and management. Foot and mouth disease, which has been common in India for a significant number of millennia, is one of the key diseases from an epidemiological point of view. In India, bluetongue has developed into an endemic disease, classical swine fever (also known as CSF) is a disease that can be lethal to pigs and is extremely contagious, Influenza Sheep and goat pox are two endemic capripox illnesses in India, which pose a serious economic threat to small ruminant output. A viruses are the cause of a considerable amount of morbidity and mortality in humans and animals all over the world.

Even as far back as 1936, there were reports of an outbreak of capripox in India, and ever since then, there have been multiple outbreaks reported all over the country. Morbillivirus, a member of the family Paramixoviridae, is the causative agent of PPR, an acute viral disease that is extremely contagious and affects goats and sheep. Due to the high morbidity (50-90%) and case fatality (50-85%) rates, PPR is a major constraint in the development of the goat industry. Bovine herpes virus 1 (BoHV-1) is primarily associated with clinical syndromes such as, encephalitis, and balanoposthitis, pustular vulvovaginitis, abortion, infertility, conjunctivitis, and rhinotracheitis in bovine species (Patel *et al*., 2018) [30], One of the countries in which hemorrhagic septicaemia (HS) is common is India. Even in small ruminants, HS is the most important bacterial infectious illness. It is most commonly found in cattle and buffalo (Makwana *et al*., 2022) [26]. Cattle are less susceptible to the disease than buffaloes. *Clostridium chauvoei* is the pathogen that's responsible for Black Quarter, an acute infectious and highly deadly bacterial disease that affects cattle. In addition to buffaloes, sheep, and goats, cattle in certain regions of India are afflicted with this disease. Karnataka, Tamil Nadu, Andhra Pradesh, and Maharashtra are the states most severely impacted by the epidemic. Anthrax is a severe, contagious disease that can affect almost every species of animal and human, although it is most common in the northern and eastern states of the United States. Cattle and sheep are the most susceptible, followed by horses and pigs in order of decreasing risk. *Bacillus anthracis* is the causative agent in this case. This illness is transmitted through the soil. It typically takes place in the wake of significant climatic shifts. Enterotoxaemia is a severe disease that affects sheep and goats of all ages, and Brucellosis is one of the five most frequent bacterial Zoonoses in the world. Both of these diseases can be found in India. According to the Project directorate on animal disease monitoring and surveillance's vision 2030-ICAR, bovine brucellosis is one of the most serious zoonotic diseases in India. Bovine brucellosis is found all over the world, but it has been eradicated from many countries. Sharma *et al*. (2020) [42] described that there are few institutes and surveillance projects run in India particularly for the control of animal diseases.

There is only one health policy that is capable of stopping the spread of zoonotic diseases like influenza, diseases that are transmitted from wild animals to humans, and diseases that are passed from humans to wild animals. These are the new obstacles that farmers are up against in terms of the spread of disease that can only be prevent by one health approach (Desai *et al*., 2018a; Desai *et al*., 2018b) [15-16]. There is only one way to stem the spread of these diseases, and that is to institute a vaccination policy that is extensive across the entirety of the country. The use of adjuvants has the potential to increase the efficacy of vaccines, and it may be useful to make use of a range of adjuvants in order to provide a vaccination that is both effective and long-lasting (Makwana *et al*., 2018; Karunakaran *et al*., 2023) [30, 20]. Even though diseases that affect small ruminants can also infect cattle and pigs, and even though cattle and pigs are susceptible to infection with this disease, they do not contribute to the epidemiology of the disease because they are unable to excrete the virus. Yet, the economic losses that farmers experience are caused by the various diseases that harm cattle (Sakhare *et al*., 2019) [39]. There are a number of recently discovered diseases, such as monkeypox and the Sudan Ebola Virus that pose a risk of zoonotic transmission and are consequently a risk to animal populations (Rana *et al*., 2022; Patel *et al*., 2023a; Patel *et al*., 2023b) [38, 34-35]. Zoonotic diseases and animal diseases need to be monitored via surveillance in order for epidemiological data to be able to contribute to the creation of policies. This overview serves as an epidemiological summary on a few significant diseases that have been found in India.

Diseases of Ruminants in India

Using serum samples taken from animals thought to be infected with peste des petits ruminants, Balamurugan *et al.* (2011) [3] conducted a sero-epidemiological research of peste des petits ruminants in sheep and goats in India between the years 2003 and 2009. After collecting a total of 2,197 serum samples from sheep and 2,687 serum samples from goats, the samples were analyzed for the presence of PPR virus (PPRV) antibody at the IVRI utilizing a monoclonal antibody-based competitive enzyme-linked immunosorbent test that was developed there. In the screening of 4,884 serum samples, it was found that the prevalence of PPRV antibody in sheep was 41.01% (95% confidence interval [CI]: 31.86 to 50.16) and the prevalence of PPRV antibody in goats was 46.11% (95% CI: 37.18 to 55.04), respectively, with an overall prevalence of 43.56% (95% CI: 36.78 to 50.34) during the period. Bovine herpesvirus-1 (BHV-1) is known to cause numerous diseases all around the world. Biswas *et al.* (2013) [7] conducted research on the topic of Bovine herpesvirus-1 (BHV-1).

Seroprevalence studies of bovine brucellosis were carried out by Jagapur *et al.* (2013) [17] utilizing indirect enzyme-linked immunosorbent assay (i-ELISA) at organized and unorganized farms located in three different states of India. During the years 2011-2013, a total of 1005 samples of sera were collected in the states of Karnataka, Uttar Pradesh, and Uttarakhand. These samples were then tested with an ELISA Kit; IDEXX, CHEKIT, Brucellosis serum, and Brucella abortus Antibody Test Kit to determine whether or not they contained bovine brucellosis. In order to determine the epidemiology of the disease among the animal population, a comparison was made between organized farms and disorganized farms for the prevalence of bovine brucellosis. For the purposes of seroprevalence research, sera were obtained from five organized farms located in the Indian state of Karnataka. The i-ELISA detected positive results in 191 out of 417 animals, which is a prevalence rate of 45.80%. A total of 361 serum samples were obtained from unorganized farms or communities, and 82 of those samples (22.71%) tested positive for the presence of the disease. Bovine serum samples were gathered from three different organized farms in the state of Uttar Pradesh. In total, there were 192 animals tested, and 43 (22.39%) of those animals tested positive for brucellosis. In a similar manner, three out of thirty-five animals' sera from a single organized farm in Uttarakhand tested positive for the virus. This is a positivity rate of 8.57

percent. In the three states that were investigated, a total of 319 (31.74%) animals were confirmed to be positive for brucellosis. Of these, 138 (27.21%) cattle and 181 (36.34%) buffaloes were found to be infected with the disease.

The herd and individual animal prevalence of bovine brucellosis, together with related risk factors, was investigated by Chand and Chhabra (2013) [8] on dairy farms located in the Indian states of Haryana and Punjab. In dairy farms located in 22 different districts in the Indian states of Haryana and Punjab, the herd and individual animal prevalence of bovine brucellosis, as well as the related risk factors, were analyzed. The Rose Bengal test and enzyme-linked immunosorbent assay were used to examine 4,580 female animals from 119 different dairy farms. The results showed that the total herd prevalence was 65.54% (78/119) and that the prevalence of the disease in individual animals was 26.50% (1,214/4,580). Herd prevalence in Haryana was determined to be 62.79%, which did not substantially differ (P = 0.4208) from the results obtained in Punjab (72.72%). In Punjab, the prevalence of individual animals was 34.15%, which was significantly greater (P 0.0001) than the prevalence in Haryana, which was 22.34%. Twenty of the 22 districts tested positive for the presence of brucellosis on dairy farms; of those districts, twelve were located in the state of Haryana, and eight were located in the state of Punjab. Analyses were conducted on a number of potential risk factors, including the types of animals kept, their ages, the sizes of their herds, the level of knowledge held by dairy farmers regarding brucellosis, the presence of newly purchased animals on the farm, abortions performed on the farm, the utilization of calving pens, the type of breeding done, and the type of farming done. According to the findings of the study, the odds ratio (OR) was significantly associated with the following risk factors: species (OR = 1.63; 95% CI = 1.40-1.90; P 0.0001), age (OR = 0.22; 95% CI = 0.17-0.29; P 0.0001), awareness of brucellosis among dairymen (OR = 21.65; 95%CI = 2.63-178.04; P = 0.0042); entry of purchased animal onto the farm Despite the fact that the OR was not statistically significant (P > 0.05), risk factors such as herd size, method of breeding, use of calving pens on farms, buffalo, and mixed types of farms were also evaluated.

In Gujarat, India, Patel *et al.* (2014) [31] did a study on the incidence of bovine brucellosis and an examination of the risk factors associated with the disease in peri-urban areas that use intensive methods of production. In this particular study, participants came from five different peri-urban locations located inside six different Gujarati cities. For the purpose of this analysis, further research was conducted on five dairy herds from each of the peri-urban areas that were chosen at random and maintained an intense production strategy. The milk-ELISA test was performed on a total of 582 individual milk samples as well as 199 bulk milk samples. The basic characteristics of farms, the entrance of infection to farms, management systems of farms, and exposure to illness are the four main categories into which the forty-three individual risk variables that were found were placed. In addition to this, their distribution as well as its association with the frequency of bovine brucellosis was investigated. The overall herd prevalence in peri-urban areas was found to be 33.70, while the animal prevalence was found to be 11.90%. Only five of the eleven risk factors on general characteristics of dairy farms showed a significant association with the occurrence of bovine brucellosis (herd size, type of animals, type of breed, age of owner, and knowledge gained by owners). These associations were determined using a significance level of p 0.05. There was no significant association established between the occurrence of brucellosis and any of the risk variables related to the introduction of infection to farms (n=6) or management practices on farms (n=11). History of abortion, placenta retention, still birth, and metritis/endometritis were found to have a significant (p 0.05) connection with the incidence of bovine brucellosis among the risk variables on disease exposure (n = 15).

Verma *et al.* (2014) [49] conducted a study to determine the seroprevalence of infectious bovine rhinotracheitis in dairy animals in Uttar Pradesh, India that suffered from reproductive disorders and This cross-sectional study's primary purpose was to determine the prevalence of infectious bovine rhinotracheitis (IBR, also known as BHV-1) in dairy cattle in western areas of Uttar Pradesh, India. The levels of anti-BHV-1 antibodies were determined with the help of a commercial ELISA kit (SYANOVIR® IBR-Ab). Samples of blood were taken from a total of 134 animals ranging in age and gender and coming from eight different districts. The individual seroprevalence was a total of 32.84% overall. According to the findings of the study, BHV-1 is found in a significantly higher frequency in cattle (46.51%) than in buffalo (35.28%). The results of a comparison between the different sex groups of animals revealed that a higher percentage of infected animals were found in male animals (48.00%) compared to female animals (29.35%). Age was a factor in whether or not animals tested positive for IBR antibodies. Animals older than 8 years had a prevalence of IBR that was 66.67 percent higher than any other age group studied. Because there is no tradition of vaccinating against IBR in the area, and because a higher percentage of animals of all ages tested positive for the BHV-1 virus, this suggests that the virus is naturally circulating through the community. It is possible that the sickness will spread quickly because there is less understanding about the importance of vaccinating animals against this virus. According to the findings of this study, there is an urgent requirement for stringent monitoring and surveillance of IBR in the present day in order to protect animals from infection and prevent its future spread.

Patil *et al.* (2017) [37] conducted a study to determine the seroprevalence of infectious bovine rhinotracheitis in organized dairy farms in India. As part of that investigation, a comprehensive sero-surveillance of IBR was carried out on 11 dairy farms that were situated in four distinct regions of India. The Avidin-Biotin ELISA was utilized to examine the existence of antibodies against IBR in a total of one thousand serum samples obtained from cattle. According to the findings, IBR antibodies were found to have a significant presence in all parts of the country, with a frequency that ranged from 36.5% in the Central area to 84.5% in the Northern region, with an overall prevalence of 61.6%. The prevalence of IBR antibodies varied significantly depending on the subject's age, ranging from 22.3% in the less than 1 year old group to 62.1% in the 1-2 year old group to 59.3% in the 2-3 year old group to 76.1% in the 3-4 year old group to 66.78% in the more than 4 year old group. On the basis of the herd's medical history, it was discovered that 83% of cases involving abortion, 76% of cases involving metritis, 83% of instances involving repeat breeding, and 65% of cases involving retention of placenta were seropositive for IBR. This study reveals the seroprevalence of PPR in goats from five districts of Assam, which is located in north eastern India.

The study was conducted by Begum *et al.* (2016) [5] reported overall prevalence rate was found to be 13.18 percent based on an examination of 918 random goat sera. With a higher incidence in the districts of Kamrup (22.65%) and Nalibari (22.22%), and a lower prevalence in the district of Barpeta (3.25%). In addition, the prevalence rate was higher in age groups older than 6 months (15.79%) than in those less than 6 months (12.32%). The findings of this study suggest that PPRV is more widely distributed in this location, which calls for vaccination of the susceptible population to ensure effective disease control.

The study of apparent seroprevalence, isolation, and identification of risk factors for brucellosis was carried out by Pathak *et al.* (2016) [36] on dairy cattle in the Indian state of Goa. Researchers looked on the incidence of brucellosis in cattle on 11 different farms that had a previous record of abortions. From a total of 296 different animals, a total of 481 different samples were taken. These samples included blood, milk, vaginal swabs, vaginal secretions, placental tissues, and fetal tissues. The isolation of Brucella was accomplished by the processing of clinical samples. The Rose Bengal Plate Test (n=296) and indirect ELISA were used to analyse the samples of serum that were taken. According to the results of the RBPT and the indirect ELISA, a total of 90 (30.40%) and 123 (41.55%) of the samples, respectively, tested positive. In addition, 27.02% of the samples had good results on both tests. The use of Brucella selective media allowed for the isolation of eight different Brucella strains from clinical samples. Amplification of the bcsp31 and IS711 genes could be seen in every single isolate by using PCR. All of the isolates were able to demonstrate amplification of the Brucella abortus specific primer in the AMOS PCR, which indicates that the isolates are either of B. abortus biotype 1, 2, or 4. Field studies were done in order to research potential risk factors for the transmission of brucellosis among cow populations. It was found that inadequate floor space (OR=0.278, P=0.128) and a lack of information of brucellosis (OR=8.739, P=0.138) were major risk factors for the transmission of bovine brucellosis.

Seroepidemiology of peste des petits ruminants in goats was investigated by De *et al*. (2016) [9] in the Indian state of Tripura, which is located in the north-eastern part of the country. In the current study, seroepidemiology of PPR in goats was performed across the entirety of the state of Tripura between the years 2012 and 2015. The examination of serum samples (numbering 3454) revealed a seroprevalence rate ranging from 0 to 16.83, with a rate of 2.11% being the overall average. The West Tripura district had the highest prevalence rate (16.83%), however antibodies against PPRV could not be found in any of the four other districts: Khowai, Gomati, Unokoti, or Sepahijala. The West Tripura district had the highest prevalence rate (16.83%). The current study suggests that the disease occurrence is sporadic across the state, and in some regions the animals are naive for PPR infection. Because of this, it is imperative that prompt vaccination against PPRV be administered.

The detection of Bovine Herpesvirus-1 Infection in bovine clinical samples was carried out by Patel *et al.* (2018) [30] at the Department of Veterinary Microbiology, Vanbandhu College of Veterinary Science and Animal Husbandry, Navsari Agricultural University, Navsari – 396 450, Gujarat, India. The test used a direct fluorescent antibody. There were a total of 116 clinical samples (44 cattle and 72 buffaloes) that were put through the testing process, and fluorescence was found in 14 of those samples (12.09%). According to the results of the test, eight cattle (11.11%) and six buffaloes (13.64%) tested positive for the presence of the disease. The district of Navsari had the lowest number of animals found (10.81%), with Surat having the highest number of animals found (14.29%), followed by Valsad (12.07%). In cattle, viral antigen was found in 8.00% (4/50), 7.14% (1/14), and 28.57% (2/7) of vaginal, nasal, and conjunctival swabs, respectively. In buffaloes, viral antigen was found in 16.67% (2/12), 16.67% (1/6), and 11.547% (3/26) of these samples. The placental cotyledon sample that was taken from cattle was the only one that showed a positive reaction when tested by direct FAT.

In their 2018 study, Lindahl and colleagues discovered serological evidence of Brucella infections in dairy cattle in the Indian state of Haryana. Interviews were conducted at 249 dairy farms in the state of Haryana, and raw milk samples from 81 of those farms were examined for antibodies towards Brucella abortus and other pathogens. The milk ring test (MRT) yielded a higher percentage of positive samples (55.6%, 45/81) compared to the enzyme-linked immunosorbent assay (ELISA), which yielded a lower percentage of positive samples (29.6%, 24/81); however, all ELISA positive samples were also positive in the MRT. The results of the ELISA were used for the analyses of risk factors. Seropositive farms had considerably more cattle than seronegative farms, with an average of 7.9 cattle compared to 4.9. This difference was statistically significant (p = 0.015). Seropositive farms had a significantly greater proportion of reported retained placentas, and seropositive farms had a significantly higher likelihood of reporting stillbirths that had occurred in the previous year (odds ratio 5.2).

Researchers found that the prevalence of bovine brucellosis in India ranges from as low as 1% to as high as 60% by different researchers. However, many of the published studies that reported higher prevalence were conducted in non-randomised samples. Deka *et al.* (2018) [10] studied bovine brucellosis and its prevalence, risk factors, economic cost, and control options with particular reference to India. According to our analysis, the national prevalence is probably no higher than 12% at the very most. There have been reports of around 20 potential risk factors that lead to or predispose the occurrence of bovine brucellosis. It is possible to divide the risk variables into four categories: host factors, farmer factors, manage mental factors, and agro-ecological factors. Some research have indicated that the diseases place a significant economic burden on dairy farms, but there is a paucity of studies that are both exhaustive and methodical in nature. Bovine leptospirosis is another significant disease that is commonly recorded. Leptospirosis is an endemic condition in India, and the states of Kerala, Tamil Nadu, Karnataka, West Bengal, Maharashtra, and Gujarat have experienced a significant increase in the number of cases (Desai *et al*., 2020c) [14]. This study was conducted on 42 clinical cases of black quarter to and out the epidemiology of black quarter in cattle with reference to age, sex, breed, season, vaccination status, duration of illness, mortality and survival rate. Ambhore *et al*. (2018) [1] have done epidemiological Studies on Black Quarter in Cattle. According to the findings of this study, the prevalence of black quarter was found to be highest in cattle between the ages of 6 and 24 months (48%), followed by ages 24 months and above (40%) and 0 to 5 months (12%). It was revealed that non-descript cattle had the highest occurrence of black quarter (43%), followed by Deoni (36%), Red Kandhari (19%), and Jersey (2%). The examination of the data according to gender found a much larger incidence in males (83%), in comparison to females (17%). The prevalence of black quarter was observed to be higher in animals that had not been immunized (69%), as compared to those that had been vaccinated. There were a total of 42 instances, and 35 of those cases (83%) were classified as having an acute illness (0-3 days), 3 cases were classified as having a sub-acute illness (4-9 days), and 4 cases were classified as having a chronic disease (more than 9 days). After receiving treatment, 32 patients (76%) were able to recover from their illness, while 10 patients (24%) passed away.

According to the findings of Sharma *et al.* (2019) [43], who conducted a bacteriological and molecular diagnostic of caseous lymphadenitis in goats at an organized farm, a total of 14 adult Surti female goats have lymph node abscess, which accounts for 7.78% of the overall morbidity. *Corynebacterium pseudotuberculosis* was found to be present in each and every pus sample that was tested for bacteria. PCR indicated the presence of a pld gene consisting of 203 base pairs, and after sequencing, 97-99% similarity was found with the pld amplicon from Tamil Nadu (MG720636) and Sudan (MG692441).

Researchers from Keshavamurthy and colleagues (2019) [21] investigated the prevalence of *Coxiella burnetii* in buffalo and cow populations in the Indian state of Punjab. They gathered 610 blood samples, 610 vaginal swabs, and 361 milk samples from 610 bovines (378 cattle, and 232 buffaloes) in 179 households from randomly selected 22 villages in Punjab. One of these randomly selected villages was located in each of the province's 22 districts. When all tests were run simultaneously, an overall individual animal prevalence of Q fever was found to be 7.0% (95% confidence interval: 4.7, 9.4) when clustering was taken into account. There was a low level of concordance between the shedding of C. burnetii in milk and vaginal secretion (kappa: 14.3%; 95% CI: 5.6, 22.9) as well as between ELISA and Trans-PCR (10.3%; 95% CI: 3.2, 17.4%). Both of these measurements were performed. The results of the phylogenetic analysis showed that all of the samples were C. burnetii. The findings point to the possibility that the disease can be found in the state.

Resistant Pattern of Treatments Antibiotic Challenged on Pseudomonas aeruginosa Bacterium was researched by Patel *et al*. (2019) [33], and their findings can be seen here. The purpose of the study was to identify the predominant contamination caused by Pseudomonas aeruginosa in 122 samples of commercially available raw buffalo milk. These samples were taken from private dairy farms located in various parts of the state of Gujarat in India. After research and analysis, it was determined that 14 of the samples contained P. aeruginosa. Additional biochemical tests were performed, all of which produced positive results, including the IMViC test, the Motility test, the catalase test, and the sugar fermentation confirm at 37 degrees Celsius for twenty-four hours. All of the biochemically conformed isolates were shown to be resistant to multiple drugs, with the number of antimicrobials they could not be treated with ranging from seven to nine, and their Multiple Antibiotic Resistance (MAR) indexes ranged from 0.50 to 0.64. The P. aeruginosa isolates used in this study are highly resistant to vancomycin, penicillin, tylosin, cefixime, and chloramphenicol. On the other hand, they are most sensitive to ciprofloxacin and enrofloxacin, and then gentamicin. Further statistical analysis of antibiotics wise zone diameter interpretative standard (mm) revealed susceptibility phenotypes under significant of difference at P0.05 in one way ANOVA using Duncan's multiple range test. It was discovered that ciprofloxacin had the highest level of sensitivity among the antibiotics that were tested, and it could be considered as a drug of choice for controlling P. aeruginosa mediated animal and human infections in the studied regions for ensuring food safety as well. Similar results were obtained by Muglikar *et al*. (2019) [29] from the commercial poultry farm about the antibiotic resistance. One of the most significant and crucial studies to come out of western India was from a state where it was revealed that antimicrobial resistance was significantly present at the farm level, pointing to anomalies in the use of antimicrobial treatments in chicken sectors. Tumlam *et al.* (2022b) [46] also revealed the presence of antimicrobial-resistant bacteria in the piglet, which is a study that should be taken very seriously by pig farmers all over the country. The prevalence of antimicrobial residue has also been linked to the rise of antimicrobial resistance. Inappropriate, excessive, or improper use of antimicrobial agents can lead to the development of antimicrobial resistance, which in turn leads to the presence of antimicrobial residues in the milk, meat, and excrement of any other animal. The antibiotic residue was identified in a large amount in marketed raw milk, according to a study that was carried out by Patel *et al*. (2020) [32], which is one of the first reports of its kind that is of major importance for food safety concerns. They came to the conclusion that one of the key reasons for antibiotic residues over the permitted threshold is the improper use of antimicrobial agents, and they found this to be frightening to the global community, which calls for large-scale control of antimicrobial usage. Bhinsara *et al*. (2018) [6] also did a review on the Benzimidazole resistance that is prevalent among the parasites, which is one of the most significant dangers for the farmers. Frequent deworming and the precise administration of the dose might prevent resistance; nevertheless, farmers need to be informed on the subject because they are the only ones who typically administer the treatment.

Sakhare *et al.* (2019) [39] performed seroepidemiology of Peste Des Petits Ruminants (PPR) in sheep and goats of southern districts of Gujarat, India. They took a total of 750 serum samples from sheep and goats of Navsari, Valsad, Surat, and Tapi districts and screened them for PPR specific antibodies using PPR competitive ELISA(c-ELISA). It was determined that the overall seroprevalence of PPR was 62.40 percent (468/750). Seropositivity was found to be significantly greater in goats (65.77%), as compared to sheep (43.96%), which were affected by the disease. First place on the list of districts goes to Surat with 66.46 percent, followed by Valsad with 62.67%, Tapi with 60.76 percent, and Navsari with 60.24%. In compared to their female counterparts, males had a higher seroprevalence rate of 61.35 percent, which was discovered to be 66.25 percent. The age group of 1 to 3 years had the highest seroprevalence, which was reported at 66.23%. The age group of 1 year had the second highest seroprevalence, which was documented at 58.58%. The age group of > 3 years had the lowest seroprevalence, which was recorded at 10.75%. In the case of goats, the highest seroprevalence was found in the district of Valsad (67.34%), while the lowest seroprevalence was found in the district of Navsari (63.94%). The percentage of seropositive individuals in males was much greater (69.71%) than it was in females (64.63%). The percentage of seropositive individuals who were younger than 3 years old (70.63%) was significantly higher than those who were older than 3 years old (27.77%). Within the population of sheep, the seroprevalence of PPR was found to be highest in the district of Valsad (51.61%), while it was found to be lowest in the district of Tapi (27.77%). Seropositivity was found to be higher in female sheep, with 44.89% of instances; however, male sheep showed a lower prevalence (38.88%) of the condition. The age group of one to three years old had the greatest percentage of seroprevalence (45.67%), which was significantly higher than the rate (40.00%) recorded in the other age groups. October had the greatest total seropositivity of any month at 72.88%, followed by December at 63.86%.

Molecular characterization and phylogenetic analysis of rotavirus of human infants, calves, and piglets was performed by Tumlam *et al*. (2019) [45]. Out of 58 cattle & buffaloes calves fecal sample 04 (6.89%), 50 human infants stool samples 18 (36.00%), and 71 piglets fecal samples 07(9.85%) were screened by rapid antigen detection kit for the presence of the virus. It was discovered that one stool sample out of every four feces samples taken from calves, one stool sample out of every eighteen stool samples taken from humans, seven samples taken from every seven piglets, There were three samples that tested positive for RNA-PAGE. For the RT-PCR analysis, representative fecal and stool samples that tested positive on PAGE were chosen. The VP4 and VP7 genes from a single calf sample were successfully amplified by RT-PCR with a size of 1011 and 864 base pairs, respectively, as expected. Only six out of seven human infant samples amplify for the VP7 gene, while three out of seven human infant samples amplify for the VP4 gene and all three out of three piglet samples amplify for the VP4 & VP7 gene with an expected size of 1062 bp & 876 bp were confirmed positive for Rotavirus infection. By doing phylogenetic analysis, it was discovered that the positive samples exhibited relatedness with the Rotavirus sequences that were obtained from Gen Bank. Also, the positive sample obtained from pigs demonstrated its relation with human rotavirus.

The data for the study were acquired from PubMed, J-Gate Plus, Indian Journals, and Google scholar using the software R 3.4.3. Barman *et al*. (2020) [4] conducted a Meta-analysis of the prevalence of livestock diseases in the North Eastern Region of India. Meta for, Meta. A Chi-square test was carried out in order to examine the level of heterogeneity, and a forest plot (confidence interval [CI] plot) was also constructed. The prevalence of various livestock diseases are theileriosis (26%), foot-and-mouth disease (21%), brucellosis in bovine (17%), brucellosis in caprine (2%), brucellosis in sheep and goat (3%), babesiosis (6%), porcine reproductive and respiratory syndrome (1%), porcine cysticercosis (6%), bluetongue (28%), classical swine fever (31%), brucellosis in porcine (18%), Porcine circovirus (43%), and Peste des petits ruminants (15%).

An updated review of bluetongue virus has been provided by Saminathan *et al.* (2020) [40]. The review focuses on the epidemiology, pathobiology, and improvements in diagnosis and control with particular reference to India. Bluetongue, sometimes known as BT, is a non-contagious viral illness that affects domestic and wild ruminants. It is economically significant. BT is brought on by the BT virus, also known as BTV, which is classified as a member of the family Reoviridae and the genus Orbivirus. Culicoides midges are the vectors that spread BTV, which causes clinical disease in sheep, white-tailed deer, pronghorn antelope, and bighorn sheep and preclinical manifestation in cattle, goats, and camelids. Bighorn sheep are the most susceptible species to BTV. BT is a multispecies illness that is classified by the International Organization for Animal Health (OIE). It is also responsible for significant socioeconomic losses. There have been a total of 28 different serotypes of BTV documented across the globe, with India being the source of 23 of those different serotypes. Transplacental transmission (TPT) and fetal malformations in ruminants were documented using live-attenuated vaccination strains of BTV that were adapted from cell culture. On the other hand, the appearance of BTV-8 in Europe in 2006 demonstrated the transmission potential of wild-type or field strains of BTV. A more accurate diagnosis of BT is more crucial for disease control and for ensuring that animals and the goods they produce do not carry BTV. The OIE recommends the reverse transcription polymerase chain reaction, the agar gel immunodiffusion assay, and the competitive enzyme-linked immunosorbent assay as assays for the diagnosis of BTV for international trade because these tests have been demonstrated to be sensitive. Sentinel programs, serological and entomological surveillance, the formation of restriction zones, and mass vaccination are all examples of control techniques mass vaccination is the most effective strategy. The prevalence of various BTV serotypes, a high density of ruminant populations, and a vector population all contribute significantly to the difficulty of controlling BT in India. Currently, a vaccination that is pentavalent, inactivated, and adjuvanted is being delivered in India in order to control BT. It is of the utmost need to develop recombinant vaccines that utilize DIVA methods in order to treat this disease.

Isolation of bovine rotavirus in MDBK cell line from diarrheal calves in the Navsari district; total of 157 faecal samples obtained in a sterile manner, including 104 samples from cattle and 53 samples from buffalo calves. Samples that were determined to be positive by the Latex Agglutination Test (LAT) were utilized in further research with the MDBK cell line (Makwana *et al*., 2020a; Makwana *et al*., 2020b) [24-25]. After the LAT, it was determined that 17 of the samples were positive; These samples were then employed for cell culture research. All seventeen samples were inoculated into the MDBK cell line, and from those injected samples, only sixteen were able to be effectively extracted, adapted, and shown to have Cytopathic effects. Out of a total of 16, four of the samples showed cytopathic effects after the first passage, seven of the samples showed CPE after the second passage, and five of the samples showed CPE at the fourth passage level. Rounding of cells, spindle-shaped morphology, and disruption of normal monolayer are the distinguishing features of cytopathic effects. Using a reverse transcriptase PCR assay based on the VP6 gene, the shape of the virus was analyzed (RT-PCR). Coronaviruses and parvoviral infections are responsible for one of the most common forms of neonatal calf scour. When an outbreak has already begun, the primary source of contamination will be calves that are ill with diarrhea like symptoms. Coronaviruses are a common cause of diarrhea in new-born calves between the ages of 4 and 30 days old. There are at least three unique strains of the bovine coronavirus, which is responsible for a variety of illnesses including respiratory infections, new-born diarrhea, and winter dysentery. On the other hand, the winter dysentery and neonatal calf strains of the disease are capable of infecting humans as well as cattle. Coronaviruses have the potential to cause villous atrophy in young cattle by infecting the small intestine, causing damage to the villous epithelial cells, and spreading to other cells. They are also capable of penetrating the epithelium of the large intestine. Coronaviruses can infect the large intestine; hence, signs of colitis such as straining may be related to an infection with these viruses. Coronavirus can infect asymptomatic individuals in the same way that rotavirus can, and then spread to calves through the feces of infected individuals. The rotavirus is the one that affects more people than the other. When an outbreak has been confirmed, the calves that have been clinically afflicted are the primary carriers of the virus. The practical, speedy, and inexpensive rapid lateral flow assay test can be used to diagnose animal coronavirus infections in a short amount of time (Desai *et al*., 2020a; Desai *et al*., 2020b; Desai *et al*., 2021; Joshi *et al*., 2022a and Joshi *et al*., 2022b) [11-12, 18-19].

Isolation and sero-genomo-epidemiological research on Brucella infection in dairy cattle were conducted in Meghalaya, India, by Shakuntala *et al*. (2021) [41]. An investigation into Brucella abortus in Meghalaya, India, that lasted for six years yielded serological, bacteriological, and whole genome sequencing data, all of which were analyzed here. The investigation of 3060 different sera samples revealed an overall prevalence of 6.4% when using the Rose Bengal Plate Test and 10.7% when using ELISA. By using direct PCR, researchers discovered a significantly greater incidence in milk samples (17.5%, n = 362) and blood samples (37.7%, n = 262) than they had anticipated. There were 11 B. abortus isolates found in clinical samples of late abortions with a total sample size of 94. A particular sequence type, ST1, was shown to be prevalent across several loci during the sequencing analysis. Whole genome sequencing (n = 8) and phylogenomic analysis showed that the majority of isolates closely clustered in two clusters along with genomes from other countries, demonstrating that B. abortus is linked globally.

Molecular Characterization of Bovine Papillomavirus Type 1 (BPV1) Isolated from Cutaneous Warts in Cattle, Maharashtra was Performed by Tumlam *et al*. (2022a) [44] (India). In this particular research project, a total of ten different wart samples taken from cattle were analyzed. PCR was carried out in order to determine the strain of BPV that was present. In addition, the PCR-amplified product was sent for sequencing so that the results of the confirmation and phylogenetic analysis could be determined. All of the samples were determined to be negative for BPV-2, despite the fact that the results showed that the cutaneous warts of six calves were positive for BPV-1. BPV-1 was found in cutaneous warts with the use of PCR, and its presence was verified through the sequencing of nucleotides and phylogenetic analysis. In conclusion, the BPV-1 type is the most common one to be found in the warts that appear on the skin of Indian cattle.

A total of 43 nasal swabs and 43 serum samples were collected from goats exhibiting severe respiratory symptoms and processed for bacterial isolation and identification. Meanwhile, serum sample were assessed for detection of PPR antibodies using c-ELISA. Makwana *et al*. (2022) [26] performed detection of antibodies to peste des petits ruminants virus and Mannheimia haemolytica from pneumatic goats of the south Gujarat region. The Gram staining, colony shape, and biochemical characteristics of the analyzed samples led to the discovery that 25 (58.13%) of the samples were positive for the presence of Mannheimia haemolytica. The presence of PPRV antibodies was detected in 18 out of 43 samples, which is a positivity rate of 41.86%. According to the results of the study, goats in transportation can become infected with Mannheimia haemolytica and PPR antibodies, both of which play a role in the development of severe pneumonia in goats.

Study on Diseases of Equines in India: The research done by Singh *et al*. (2010) [2] focused on diseases that are common in equids in India. In order to have a better understanding of the disease landscape affecting equids in India, a survey of equine practitioners was carried out. A total of 2,000 questionnaires for the poll were mailed out to equine professionals in 64 districts throughout 14 states, in addition to 30 private horse farms and four government farms. Equine practitioners accounted for a total of 532 (or 26.6%) of those who replied to the questionnaire. Every year, on average, a vet would treat more than 1000 animals and more than 50 equids. Equine practitioners have discovered a total of 72 different health issues that can affect equids. The most prevalent of these issues is colic, followed by trypanosomiasis (surra), lameness, respiratory tract infections like as pneumonia and bronchitis, and a collection of abscesses, wounds, and traumas. The data may be useful in setting priorities for the research and resource allocation that will be done in the future to improve the health and welfare of horses.

Mavadiya *et al*. (2012) [27] conducted an epidemiological survey of equine influenza in horses in India for a one-year study (1 June 2008 to 31 May 2009) in order to determine the prevalence of equine influenza in the horses of Gujarat State in India. This study was carried out in order to determine the prevalence of equine influenza in the horses of Gujarat State in India. Although there was a prevalence of 12.02% for equine influenza A/equi-2, none of the samples tested positive for equine influenza A/equi-1. Equine influenza (A/equi-2) was shown to have a prevalence of 15.38%, 11.94%, 10.18%, and 9.09%, respectively, in horses of the Kathiyawari breed, a non-descript type, the Marwari breed, and the Indian Thoroughbred breed. The yearling population had a prevalence of influenza that was 17.48% higher than any other age group, and the month of April had a prevalence that was 28.89% higher than any other month. The prevalence rate was 11.95% in males, 10.38% in females, and 8.47% in geldings, respectively. Males had the highest rate. Both the mortality rate and the case fatality rate came in at 1.28%. The case fatality rate was 10.64%.

Using polymerase chain reaction (PCR), Vala *et al*. (2020) [48] completed diagnostic testing for Equine Herpes Virus 4 Infection. The polymerase chain reaction was utilized in the current investigation in order to diagnose an EHV-4 infection that was present in domestic horses. Twelve horses exhibiting indications of respiratory disease, including fever and unthriftiness, each had a nasal swab obtained from them. All of the samples' DNA was extracted, and then that DNA was run through a polymerase chain reaction (PCR) in order to identify any instances of EHV-4 DNA that may have been present. A single compact band of 189 bp was detected in each of the four samples that tested positive for EHV-4 infection. For the diagnosis of EHV-4 infection, polymerase chain reaction (PCR) has been demonstrated to be an efficient, less time-consuming, sensitive, and specific diagnostic test option.

This inquiry was aimed to evaluate the sero-prevalence of EHV-1/4 infections in the horses of south Gujarat, India. Vala *et al*. (2021) [47] conducted research on epidemiological aspects of Equine Herpes Virus infection in south Gujarat, India. The indirect ELISA test was performed on a total of 253 horses that either displayed symptoms of respiratory illness or had a history of respiratory illness. Throughout this time, samples of blood were being analyzed for a variety of haematological characteristics. Research was conducted on the effects of exposure to risk variables, and statistical analysis was carried out on the results. In South Gujarat, India, the overall prevalence of EHV-1/4 infection was

16.60% of the population. The effects of a number of other risk factors, including age, sex, breed, and locale, were not statistically significant. The means of all haematological indicators were found to be within the normal range, and there was no discernible difference found between horses that tested positive for antibodies and those that tested negative for antibodies. In horses who tested positive for the presence of antibodies, the population of mid cells, also known as monocytes, was discovered to be substantially greater (p less than 0.05) as compared to horses that tested negative for the presence of antibodies.

The researchers Mavadiya *et al*. (2021) [27] conducted a sero-epidemiological study of Equine Piroplasmosis in Horses of South Gujarat (India). A total of 295 horse's serum samples were screened for T. equi and B. caballi infection by cELISA. The findings of the study indicated that 62.71% of horses had presence of antibodies by cELISA. It was shown that the sero-prevalence of piroplasmosis in horses was substantially (p<001) connected with the different breeds of horses, however there was no significant difference seen between the age and sex of the horse. Comparatively, a highly significant difference (p<0.01) was observed between horses reared in pacca houses and tick control adopted by owner for the prevention of EP and horses reared in Kachcha houses and ticks control not adopted by horse owner. On the other hand, a significant difference (p<0.05) was noticed between the presence of tick infestations and the absence of tick infestations on the body of horses. This study was conducted in Kenya. In addition, there was not found to be any significant difference between the presence of equine piroplasmosis on organized farms and unstructured farms, on farms where horses were housed with other animal species, and on farms where horses were kept alone.

Conclusion

The livestock population and output performances are both impacted when bovine and horse diseases are present. In the end, the economy of the country is significantly impacted, and as a result, there is a requirement for a prevention and control policy for each disease that is epidemiologically significant. To meet this requirement, we can adopt one health approach and follow the guidelines offered by WAHO. In a similar vein, it is necessary for the policies of the government to be developed and adhered to in order to shield farmers from the effects of any potential economic downturn. Farmers are responsible for the health of their livestock, and as such, they are obligated to maintain a level of hygiene at their farms that is sufficient, to have a system in place that notifies them of the symptoms of disease, to report animal diseases to the appropriate authorities, and to vaccinate their animals. If it is practicable and necessary in the event of an outbreak, the government should immediately identify and track outbreaks of animal disease as well as the causes of the disease in order to manage the breakout of the disease.

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