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Epidemiological studies of canine diseases in India: A review

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Abstract

Dogs that roam free in India pose serious threats to both human health and animal welfare due to a lack of regular veterinary care. In India, dogs are among the most popular pets. People are more accepting of the idea of keeping a pet as a family member, companion and have a different perception of it. The development of zoonotic diseases, including those that dogs can carry, is significantly risked by interactions and close living between humans and dogs. Several dog ailments have been reported from India; however, they have not been thoroughly reviewed. Although India has many natural resources and is home to wild animals, disease outbreaks are always a possibility. To prevent and control diseases in both canines and significant wild animals, it is necessary to have the proper knowledge about immunization, health management training, and diseases affecting dogs. Programs combining surgical sterilization and rabies vaccination have been shown to drastically reduce the number of stray dogs and rabies transmission, but less is known about other infectious diseases of free-roaming dogs and pets in India. This review's objective is to identify most recent literature on canine illness in India.

Keywords: Canine diseases, parvovirus infection, canine distemper, epidemiology, India

Introduction

Veterinary medicine is a vital component of public health, agriculture, and food security. It is crucial in ensuring the health of animals and humans in the state. This article provides an overview of the incidence of diseases in Dogs in India and the management strategies employed. An estimated 15 million dog bites occur each year in India, resulting in 20,000 deaths from rabies and associated diseases. Residents of India maintain dogs as pets, and many homeless animals are helped by caring neighbors. Dogs in India and the rest of the world are susceptible to many infectious diseases, although some dangerous conditions are more frequent. These illnesses include canine rabies, canine leptospirosis, canine babesiosis, canine parvovirus infection, canine gastroenteritis, and canine distemper virus infection. Infectious diseases that affect dogs are a serious threat to both the health of the dogs and the general human population. Even though veterinary science has advanced significantly in recent years, infectious illnesses remain a significant threat to canine populations and zoonotic transmission. The health of dogs is negatively impacted by many illnesses, many of which are fatal. Major infectious diseases in dogs are prevalent in India for a variety of reasons. High population density, poor cleanliness, insufficient immunization, and a lack of knowledge about zoonotic illnesses among both pet owners and the public populace are some of these contributing factors. Several illness outbreaks in pets can be prevented, treated, but they can also be fatal. Many diseases have been recorded in the dog population as a result of climatically favorable conditions. Despite immunization, various bacterial, viral, protozoal, fungal, and other illnesses are frequently observed. Due to their lack of vaccination, stray dogs are more susceptible to deadly diseases including canine distemper and rabies. Polak *et al.* (2018) have conducted studies in the rural Phendeyling Tibetan Refugee Settlement of Mainpat and surrounding Indian villages in Chhattisgarh state, India. They found prevalence of Adenovirus (62%), Hemotropic Mycoplasmas (37%), Parvovirus (92%), Distemper virus (77%), *Toxoplasma gondii* (76%), *Anaplasma* spp. (21%), *Dirofilaria immitis* (15%), *Ehrlichia* spp. (13%), *Babesia* spp. (13%), and *Leptospira interrogans* (11%) whereas *Leishmania donovani*, *Borrelia burgdorferi*, *Brucella* spp., and *Bartonella* spp. were not found. With the exception of *Babesia* spp., which was more prevalent in street dogs (30%) than in pet dogs (8%) (P=0.03), there was no discernible difference in the incidence of infectious diseases among different dog groups. In both stray (9%) and pet (7%) dogs, the prevalence of virus-neutralizing antibodies against the rabies virus was comparable.

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Only 02 of the 05 dogs that had rabies vaccinations reported had neutralizing antibodies. Regardless of ownership status, infectious illnesses of both canine and zoonotic concern were widespread in this dog community. Although vaccination is extremely rare, antibodies against the highly pathogenic parvovirus and distemper virus suggested widespread infection. Although toxoplasmosis is common in dogs, it is not a zoonotic threat unless dogs are eaten. Many vector-borne illnesses were found, the majority of which have low zoonotic potential yet can seriously harm dogs. Even if the owner thought their dog had previously received a vaccination, the majority of dogs lacked proof of protection against rabies. Therefore, implementing a sustained program of neutering dogs in conjunction with vaccinations and parasite control would benefit both dog welfare and public health in India. There is no government law or societal structure in place that addresses vaccination of stray dogs every year. To prevent the worst scenario in India, dog owners should vaccinate their animals annually (Desai *et al.*, 2021) [11]. As a result, in order to successfully prevent and manage these diseases, it is absolutely crucial to understand their epidemiology, clinical symptoms, and management. This review article's goal is to give a general summary of the canine illnesses that are most frequently reported in India. The etiologies of the diseases, clinical symptoms, diagnostic techniques, available treatments, and some preventative measures will all be covered in this overview.

Canine Distemper (CD)

The canine distemper virus is a deadly and extremely contagious infection (Desai *et al.*, 2021) [11]. Several wild animal species, including foxes, skunks, raccoons, black-footed ferrets, and lions, have also been known to exhibit CD

(Appel and Sumners, 1995) [3]. CDV is a member of the family Paramyxoviridae, subfamily Paramyxovirinae, and genus Morbillivirus in the order Mononegavirales. (Desai *et al.*, 2021) [11]. It is an enveloped, single-stranded, non-segmented, negative sense RNA that ranges in size from 150 to 300 nm. CDV has seven structural proteins that make up the CDV genome (Joshi *et al.*, 2022^a) [19]. The virus is relatively labile and spreads through aerosols or direct contact. Because that maternally acquired immunity begins to wane at this age, CDV infection spreads most frequently in young pups, typically between 3 and 6 months of age (Quinn *et al.*, 2011) [41]. Winter is when CDV typically manifests, and it primarily affects unvaccinated pet puppies and dogs. (Desai *et al.*, 2021) [11]. The virus mostly replicates in the upper respiratory tract, and then spreads to the tonsils and bronchial lymph nodes before eventually reaching the ocular, brain, lymphoid, urine bladder, respiratory system, and GIT (Pardo *et al.*, 2005) [34]. Viruses can persist in recovering dogs for two to three months (Beniam and Moges, 2019) [5]. Pyrexia is the first clinical symptom of the illness. Although though pyrexia is biphasic, the initial rise in temperature is typically not noticeable. Oculo-nasal discharge, pharyngitis, and tonsillar hypertrophy appear during the second stage of pyrexia (Quinn *et al.*, 2011) [41]. Chronic distemper encephalitis, sometimes known as old dog encephalitis, is characterized by ataxia and chorea, or excessive head pressing. (Kahn and Line, 2010) [22]. Thymic atrophy is one of the most often observed postmortem signs of CDV (Kahn and Line, 2010) [22]. One step, nested and real-time RT PCR, and lateral flow assay are sensitive molecular techniques for the identification of CDV RNA in clinical samples. Table 1 shows the Epidemiological reports of Canine disease from India.

Table 1: Epidemiological reports of Canine disease from India

Sr. No.	Diseases	Place	Positive	References
1	Canine parvovirus infection	Southern India	69/128 (53.90%)	Srinivas <i>et al.</i> , 2013 [53]
		Maharashtra	>88%	Belsare <i>et al.</i> , 2014 [4]
		Chennai, Tamilnadu	80/190 (42.10%)	Hasan <i>et al.</i> , 2016 [17]
		Navsari, Gujarat	63/145 (43.44%)	Mehta <i>et al.</i> , 2017 [31]
		Navsari, Gujarat	62.29%	Pandya <i>et al.</i> , 2017 [33]
		South Gujarat, Gujarat	35/73 (47.94%)	Sharma <i>et al.</i> , 2018 [47]
		Andhra Pradesh	234/342 (68.42%)	Kumari <i>et al.</i> , 2019 [26]
		Jabalpur, M.P.	7.24%	Khare <i>et al.</i> , 2019 [24]
		Navsari, Gujarat	37/109 (33.94%)	Desai <i>et al.</i> , 2020 ^a [19]
		Navsari, Gujarat	34/50 (68%)	Mehta <i>et al.</i> , 2020 [30]
		Anand, Gujarat	145/1540 (9.42%)	Patel <i>et al.</i> , 2022 [37]
2	Canine distemper	Pantnagar, Uttarakhand	258/ 627 (41.15%)	Kalita <i>et al.</i> , 2022 [23]
		Mumbai, Maharashtra	304/7791 (3.90%)	Kadaba, 2011 [21]
		Maharashtra	>72%	Belsare <i>et al.</i> , 2014 [4]
		Mizoram	10/900 (1.11%)	Yama <i>et al.</i> , 2020 [54]
		Navsari, Gujarat	14/18 (77.77%)	Desai <i>et al.</i> , 2021 [11]
		Anand, Gujarat	08/12 (66.66%)	Joshi <i>et al.</i> , 2022 ^b [20]
		Ahmedabad, Gujarat	07/09 (88.88%)	
Vadodara, Gujarat	01/02 (50%)			
Chennai, Tamilnadu	131/163	Devi <i>et al.</i> , 2022 [15]		
3	Rabies	Punjab	30/41	Gill <i>et al.</i> , 2019 [16]
4	Canine corona viral infection	Navsari, Gujarat	05/109 (4.58%)	Desai <i>et al.</i> , 2020 ^a [19]
5	Canine adenovirus	Maharashtra	71%	Belsare <i>et al.</i> , 2014 [4]
6	Canine leptospirosis	Namakkal, Tamilnadu,	145/460 (31.52%)	Senthil <i>et al.</i> , 2013 [44]
		Kerala	71.12%	Ambily <i>et al.</i> , 2013 [1]
		Navsari, Gujarat	26/56 (46.42%)	Desai <i>et al.</i> , 2020 ^c [12]
7	Canine babesiosis	Gujarat	15.81%	Jadhav, 2015 [18]
		Ludhiana (Punjab)	16/214(7.47%)	Singh <i>et al.</i> , 2014 [48]

		Anand and Surat, Gujarat	16/79 (20.25%)	Bilwal <i>et al.</i> , 2017 ^[7]
		Junagadh, Gujarat	61/375 (16.27%)	Murabiya <i>et al.</i> , 2018 ^[32]
	<i>Babesia gibsoni</i>	Chennai, Tamilnadu	837/3844 (21.77%)	Senthil and Chakravarthi, 2021 ^[44]
	<i>Babesia canis</i>	Chennai, Tamilnadu	350/3844 (9.10%)	Senthil and Chakravarthi, 2021 ^[44]
8	<i>Ehrlichia canis</i>	Chennai, Tamilnadu	2167/3844 (56.37%)	Senthil and Chakravarthi, 2021 ^[44]
9	<i>Trypanosoma spp.</i>	Chennai, Tamilnadu	46/3844 (1.19%)	Senthil and Chakravarthi, 2021 ^[44]
10	<i>Microfilaria</i>	Chennai, Tamilnadu	45/3844 (1.12%)	Senthil and Chakravarthi, 2021 ^[44]
11	Hepatozoon infection	Junagadh, Gujarat, Gujarat	21/317 (6.62%)	Kumar <i>et al.</i> , 2018 ^[25]
	<i>Hepatozoan canis</i>	Chennai, Tamilnadu	399/3844 (10.37%)	Senthil and Chakravarthi, 2021 ^[44]
12	Canine demodicosis	Ahmedabad, Gujarat	04/177 (02.26%)	Anikar <i>et al.</i> , 2021 ^[2]
		Saurashtra region, Gujarat	23/430 (5.34%)	Satasiya <i>et al.</i> , 2022 ^[43]
13	Canine pyoderma	Ahmedabad, Gujarat	09/177 (05.08%)	Anikar <i>et al.</i> , 2021 ^[2]
14	Dermatophytosis		56/177 (31.64%)	
15	Canine scabies		05/177 (02.82%)	
16	Tick infestation		24/177 (13.56%)	
17	Cardia abnormalities		South Gujarat	

Rabies

Rabies is one of the most lethal viral illnesses that can affect mammals, such as people, dogs, wild dogs, and cats (Desai *et al.*, 2018^b) ^[14]. Given that it is the most lethal disease for domesticated animals, the "One Health" principle must be followed in order to prevent the sickness (Desai *et al.*, 2018^a) ^[13]. Raising public awareness through education campaigns helps stop rabies deaths worldwide (Desai *et al.*, 2018^b) ^[14]. Rabies is one of the most dangerous viral illnesses that may infect mammals, including dogs and humans. It is a fatal condition brought on by exposure to the rabies virus. The rabies virus is prevalent all throughout the world, including North America, Central and South America, Asia, Africa, the Middle East, and some areas of Europe. The virus spreads when an infected animal attacks another. In Asia, Africa, and Latin America, stray dogs are the main reservoir, not animals. In these areas, human illnesses and mortality are more prevalent. The rabies virus then replicates in the host animal's peripheral nerves before moving on to the salivary glands. Any nerve that is not located inside the brain or spinal cord is considered peripheral. In this case, the virus is present in the saliva. Outside of a mammal's body, the rabies virus has a brief lifespan. Ten days to a year or more may pass during the incubation phase, which is the amount of time before clinical symptoms appear. Dogs often go through an incubation period that lasts between two and four months. If there is a high risk of exposure, the safest course of action is to euthanize the animal; the alternative is to place it in a strict quarantine for a number of months. A booster shot is suggested if the exposed dog has already received vaccines. A quarantine of at least thirty days should come next, which will be guided by regional public health guidelines and include careful monitoring.

Canine Parvovirus infection

The most common cause of illness and mortality in dogs worldwide is canine parvovirus enteritis (PVE), which is brought on by one of three types of canine parvovirus type 2 (CPV-2; family Parvoviridae, Genus Parvovirus) (Desai *et al.*, 2020^a; Desai *et al.*, 2020^b) ^[9-10]. Parvovirus replicates only in the nuclei of dividing host cells. (Kahn and Line, 2010) ^[22]. Transmission occurs mostly by the feco-oral route. Furthermore, infected dogs shed large numbers of viruses in their feces. Although it has a stronger affinity for the digestive, respiratory, and central nervous systems, it nevertheless has significant negative effects and clinical symptoms (Joshi *et al.*, 2022^b) ^[20]. The virus is extremely

immunosuppressive and increases the host's vulnerability to secondary infections, which are the main cause of death (Joshi *et al.*, 2022^a; Joshi *et al.*, 2022^b) ^[19, 20]. In severely affected pups there may be extensive hemorrhage occurs in the intestinal lumen. Therefore, the main clinical signs of CPV infection include sudden onset of vomiting and anorexia, fever may also be observed, blood stained diarrhoea, feces have a fetid smell. Severely affected dogs die within 3 days. Diagnosis of the CPV infection can be done by ELISA & HA test may be used to demonstrate viral antigen. LFA test was used to detect canine parvovirus in the research conducted by Desai *et al.* (2020^a). Epidemiological reports of Canine disease from India is presented in Table 1.

Canine Leptospirosis

Leptospirosis is one of the major globally concern disease due to its increasing incidence in both developing and developed countries (Desai *et al.*, 2020^c) ^[12]. It is caused by pathogenic spirochetes, which is motile and affects numerous hosts all over the world. It is re-emerging as an important zoonotic disease. Different serovar of leptospira interrogans are ubiquitously present in sub-clinically infected wild and domestic animal reservoir hosts (Desai *et al.*, 2020^c) ^[12]. Diagnosis of leptospirosis can be done by dark field microscopy (DFM), microscopic agglutination test (MAT), ELISA & PCR. (Desai *et al.*, 2020^c) ^[12]. Though DFM is the most economic and rapid technique used to demonstrate organism under the microscope it is less sensitive in detection (Desai *et al.*, 2020^c) ^[12]. The gold standard test for the detection of different serovars from the samples either organisms or antibody detection is MAT. Prevention of leptospirosis in domestic animals depends primarily on the use of vaccine. As immunity is serovar specific vaccine should contain the prevalent leptospiral serovar present geographical region. Treatment of cases where there is a higher likelihood of treatment evasion, which could result in the development of antibiotic resistance, is highly challenging (Bhinsara *et al.*, 2018) ^[6]. Pets as well as domesticated animals (Tumlam *et al.*, 2022) ^[50] are the focus of the main problem, which is antimicrobial resistance and antimicrobial residue (Patel *et al.*, 2019; Patel *et al.*, 2020) ^[38, 37]. The intimate contact between dogs and people may operate as a conduit for the transmission of resistant germs in the opposite direction. The risk of occupational injury to humans can be decreased by using protective equipment and avoiding swimming in contaminated water sources. Since vaccination is the most effective method of preventing disease from

occurring, testing a rodent control-culling program and vaccinating pets can both contribute to a decrease in the animal population (Makwana *et al.*, 2018) [27]. Leptospirosis is endemic in coastal area of south Gujarat (Desai *et al.*, 2020^c) [12]. Humans and domestic animals like cattle, buffalo, sheep, goat and dogs are affected. Epidemiological reports of Canine disease from India is presented in Table 1.

Canine Babesiosis

Parasitic infestations, including fleas, ticks, and mites, are common in dogs and can cause various dermatological disorders. Bilwal *et al.* (2017) [7] investigated the clinicopathological alterations in naturally occurring *Babesia gibsoni* infection in dogs of middle-south Gujarat, India. The study found that the most common clinical signs of *Babesia gibsoni* infection were fever, anorexia, lethargy, and pale mucous membranes. Dermatological signs included petechial haemorrhages, ecchymosis, and icterus. The study highlights the importance of early diagnosis and treatment of *Babesia gibsoni* infection in dogs to prevent severe clinical outcomes. Canine babesiosis is a clinically significant and geographically widespread haemoprotozoan disease of dogs. (Bilwal *et al.*, 2017) [7]. *Babesia canis* and *Babesia gibsoni* are the most common occurring species of babesia in the dog. The disease has been reported in various states of India including Gujarat (Bilwal *et al.*, 2017) [7]. The lifecycle of *B. gibsoni* includes two stage, inside the host RBCs, in which the sporozoite converts into piroplasm and other inside the tick vector (Uilenberg, 2006) [51]. *B. gibsoni* can be further confirmed by PCR (Bilwal *et al.*, 2017) [7]. Naturally, occurring cases of *B. gibsoni* are having variety of clinical signs ranging from anorexia to hepatomegaly or splenomegaly. Supportive treatment is usually given, and it includes fluid therapy, anti-inflammatory and antipyretics, gastroprotectants, oxygen supplementation and blood transfusion should be employed. However, *Babesia gibsoni* required specific drug, which is known as atovaquone (a quinone antimicrobial medication) and azithromycin. Epidemiological reports of Canine disease from India is presented in Table 1.

Other Diseases

In addition to kennel cough, herpes virus infection, canine ehrlichiosis, and other protozoal and parasite infections that are frequent, canine demodicosis, canine pyoderma, dermatophytosis, canine scabies, and tick infestation, cardiac abnormalities are other significant diseases that affect dogs (Anikar *et al.*, 2021, Parmar *et al.*, 2021) [2, 35]. The information regarding the diseases that were reported can be found in Table 1. These diseases are typically curable and can be diagnosed in a number of different methods. One of the most significant illnesses that can affect dogs, hepatozoonosis is transmitted by ticks and is caused by the parasite known as the hepatozoon. Clinical investigation of bovine, equine, canine herpesvirus, and other canine pathogenic pathogens has increased as a result of the increased sensitivity of antibody-based serology assays such as the direct fluorescent antibody test (Patel *et al.*, 2018) [36], ELISA based detection kits, and nucleic acid– based polymerase chain reaction (PCR) assays (Vala *et al.*, 2020) [52]. Canine coronavirus disease (CCoV) is an intestinal ailment that is highly contagious and most commonly affects puppies (Desai *et al.*, 2020a). Group A rotaviruses are among the gastrointestinal

infections that can affect humans and animals (Tumlam *et al.*, 2019; Makwana *et al.*, 2020^a; Makwana *et al.*, 2020^b). Sequence analysis of the genes that code for the two outer capsid proteins, VP7 and VP4, the inner capsid protein, VP6, and the nonstructural protein NSP4 is helpful for both the collection of epidemiological information and the determination of the origin of unique rotavirus strains (Makwana *et al.*, 2020^a; Makwana *et al.*, 2020^b) [28-29]. When animals are moved from one location to another, when animals are confined together in one location as part of an organized farm, or when animals are transferred from one location to another, the risk of disease transmission is increased (Sakhare *et al.*, 2019; Sharma *et al.*, 2019) [42, 46]. As a result, it contributes to the transmission of disease not only among canine populations but also among populations of other animals. Moreover, it plays a role in the transmission of bacterial and viral diseases from one species to another. At this time, TVT is categorized as a round cell neoplasm, which places it in the same category as mast cell tumors, basal cell carcinomas, histiocytomas, and lymphomas. On the other hand, there have been reports of additional cases of tumors, such as adenoma of the perianal gland (Chaudhari *et al.*, 2017) [8]. TVT is both naturally infectious and sexually transmissible among dogs, and it is most commonly found in strays and dogs used for breeding. As a result, different types of canine tumors, such as TVT and canine memory gland tumors, are rather common in Gujarat and the southern portion of the state.

Conclusion

The most recent analysis of diseases revealed the percent positive of diseases that were reviewed. Vaccination is the best way to protect dogs from disease, but unfortunately, some dogs still get sick and need treatment every year. Canine parvoviral infection, canine distemper, canine leptospirosis, canine corona viral infection, canine babesiosis, hepatozoon infection, canine demodicosis, canine pyoderma, dermatophytosis, canine scabies, and tick infestation are just some of the many diseases that have been reported from various parts of India. There are still a great number of diseases that could be widespread in India but have not been documented in the literature. It is possible that there will be an increase in the number of disease outbreaks as a result of the population of stray dogs and the absence of any vaccination policy.

References

1. Ambily R, Mini M, Joseph S, Krishna SV, Abhinay G. Canine leptospirosis-a seroprevalence study from Kerala, India. *Veterinary world*. 2013 Jan 1, 6(1).
2. Anikar MJ, Bhadesiya CM, Chaudhary GR, Patel TP, Patil DB, Dadawala AI. Incidence of dermatological disorders in dogs at Leo Animal & Bird Clinic, Vastral, Ahmedabad (Gujarat). *International Journal of Advanced Research in Biological Sciences*. 2021;8(3):1-7.
3. Appel MJ, Summers BA. Pathogenicity of morbilliviruses for terrestrial carnivores. *Veterinary microbiology*. 1995 May 1;44(2-4):187-191.
4. Belsare AV, Vanak AT, Gompper ME. Epidemiology of viral pathogens of free-ranging dogs and Indian foxes in a human-dominated landscape in central India. *Transboundary and emerging diseases*. 2014 Aug;61:78-86.

5. Beniam Degene, Moges Zebene. Canine Distemper, A Review. *Int. J Adv. Res. Biol. Sci.* 2019;6(7):12-19.
6. Bhinsara DB, Sankar M, Desai DN, Hasnani JJ, Patel PV, Hirani ND, *et al.* Benzimidazole resistance: An overview. *International Journal of Current Microbiology and Applied Sciences.* 2018;7:3091-104.
<https://doi.org/10.20546/ijcmas.2018.702.372>
7. Bilwal AK, Mandali GC, Tandel FB. Clinicopathological alterations in naturally occurring Babesia gibsoni infection in dogs of Middle-South Gujarat, India. *Veterinary World.* 2017 Oct;10(10):1227.
8. Chaudhari SV, Joshi BP, Desai DN, Ghodasara DJ, Gondaliya RB, Choudhary KR, *et al.* Prevalence of perianal gland adenoma in canines in Gujarat. *Lifesciences Leaflets.* 2017;91:60-65.
<https://petsd.org/ojs/index.php/lifesciencesleaflets/article/view/1204>
9. Desai D, Kalyani I, Patel D, Makwana P, Solanki J, Vala J. Rapid Detection based Prevalence of Canine Corona Virus (CCoV) and Canine Parvo Virus (CPV) Infection in Diarrheic Dogs in South Gujarat. *The Indian Journal of Veterinary Sciences and Biotechnology.* 2020^a Jul;16(1):42.
10. Desai D, Kalyani I, Ramani U, Makwana P, Patel D, Vala J. Evaluation of three different methods of viral DNA extraction for molecular detection of canine parvo virus-2 from faecal samples of dogs. *Journal of Entomology and Zoology studies.* 2020^b;8(3):479-481.
11. Desai D, Kalyani I, Solanki J, Patel D, Makwana P, Sharma K, *et al.* Serological and nucleocapsid gene based molecular characterization of canine distemper Virus (CDV) isolated from dogs of Southern Gujarat, India. *Indian Journal of Animal Research.* 2021;55(10):1224-1232.
12. Desai D, Makwana P, Solanki J, Kalyani I, Patel D, Mehta S, *et al.* Detection and Prevalence of Canine Leptospirosis from Navsari District of South Gujarat, India. *Microbiology Research Journal International* 30 (9). 2020^c;30(9):103-110.
13. Desai DN, Kalyani IH, Muglikar DM. One Health Approach for Prevention and Control of Swine Influenza. *Technical Seminar on One Health.* 2018^a;1(1):11-16.
14. Desai DN, Kalyani IH, Muglikar DM. One Health Initiative for Management of Wildlife Diseases. *Technical Seminar on One Health.* 2018^b;1(1):17-21.
15. Devi T, Asokkumar M, Vijaya Bharathi M, Ramesh A, Thirumurugan KG. Clinico-epidemiological pattern of canine distemper in Chennai: An update. *The Pharma Innovation Journal.* 2022;11(11):85-87.
16. Gill GS, Singh BB, Dhand NK, Aulakh RS, Sandhu BS, Ward MP, *et al.* Estimation of the incidence of animal rabies in Punjab, India. *PLoS One.* 2019 Sep 9;14(9):e0222198.
17. Hasan MM, Jalal MS, Bayzid M, Sharif MA, Masuduzzaman M. A comparative study on canine parvovirus infection of dog in Bangladesh and India. *Bangladesh Journal of Veterinary Medicine.* 2016;14(2):237-241.
18. Jadhav KM, Ambegaonkargupte RU. Studies on Epidemiology of Canine Babesiosis in Gujarat. In: XXXIII - ISVM Annual Convention and National Symposium on New Dimensions in Veterinary Medicine: Technological Advances, One Health Concept and Animal Welfare Concerns at Pookode, Kerala, 22nd-24th January. 2015, 45.
19. Joshi VR, Bhandari BB, Mathakiya RA, Jhala MK, Desai DN. Sero-surveillance of Canine Distemper in Dogs. *Indian Journal of Veterinary Sciences & Biotechnology.* 2022^a; Jul 10;18(3):100-103.
20. Joshi VR, Bhandari BB, Nimavat VR, Jhala MK, Desai DN. Comparison of Lateral Flow Assay and RT-PCR for Detection of Canine Distemper Virus in Dogs. *Indian Journal of Veterinary Sciences & Biotechnology.* 2022^b Jul 4;18(3):79-83.
21. Kadaba D. An Epidemiological Study of Canine Distemper in Mumbai: Bridging the Gap Between Human and Animal Health. *Epidemiology.* 2011 Jan 1;22(1):S112-S113.
22. Kahn CM, Line S. editors. *The Merck veterinary manual.* Kenilworth, NJ: Merck; c2010 Feb.
23. Kalita JC, Prasad A, Verma P, Singh JL, Arora N. Epidemiology of canine parvovirus infection in and around Pantnagar, Uttarakhand: A retrospective study. *The Pharma Innovation Journal.* 2022;11(11):24-30
24. Khare DS, Gupta DK, Shukla PC, Das G, Tiwari A, Meena NS, *et al.* Prevalence of canine parvovirus infection in dogs in Jabalpur (MP). *Journal of Entomology and Zoology Studies.* 2019;7(3):1495-1498.
25. Kumar Binod, Thakre BJ, Joseph Joice P, Brahmhatt Nilima N, Patel Jeemi A. Parasitological and Molecular Survey of Hepatozoon Infection in Dogs of South-Western Region (Junagadh) of Gujarat, India. 2018;8(11):363-368.
26. Kumari GD, Ramani R, Subramanyam KV, Satheesh TS. Incidence of canine parvovirus infection of dogs in Andhra Pradesh. *Indian J Anim. Hlth.* 2019;58(1):79-86.
27. Makwana P, Kalyani I, Desai D, Patel D, Sakhare P, Muglikar D. Role of Adjuvants in Vaccine Preparation: A Review. *Int. J Curr. Microbiol. App. Sci.* 2018;7(11):972-988. <https://doi.org/10.20546/ijcmas.2018.711.113>
28. Makwana PM, Kalyani IH, Desai D, Patel JM, Solanki JB, Vihol PD, *et al.* Detection of bovine rotavirus (BRV) infection in neonatal calves of in and around Navsari district of South Gujarat, India. *J Entomol Zool Stud.* 2020^a;8(2):1092-1097.
29. Makwana PM, Kalyani IH, Desai D. Isolation of bovine rotavirus in MDBK cell line from diarrhoeic calves of Navsari district. *The Pharma Innovation Journal.* 2020^b;9(5):222-225.
30. Mehta S, Mavadiya S, Parmar S, Vagh A, Vala J, Patel R. Comparative economical analysis of the treatment adopted for canine parvo virus infected dog. *Journal of Animal Research.* 2020;10(5):843-848.
31. Mehta SA, Patel RM, Vagh AA, Mavadiya SV, Patel MD, Vala JA, *et al.* Prevalence of Canine Parvo Viral Infection in Dogs in and around Navsari District of Gujarat State, India. *Indian Journal of Veterinary Sciences & Biotechnology.* 2017 Oct 1;13(2).
32. Murabiya KK, Parmar VL, Patel JS, Thakre BJ. Epidemiology study of canine babesiosis in and around Junagadh city, Gujarat. *Indian Journal of Canine Practice.* 2018;10(1):10-12.
33. Pandya MS, Sharma KK, Kalyani HI, Sakhare SP. Study on host predisposing factors and diagnostic tests for canine parvovirus (CPV-2) infection in dogs. *Journal of Animal Research.* 2017;7(5):897-902.

34. Pardo ID, Johnson GC, Kleiboeker SB. Phylogenetic characterization of canine distemper viruses detected in naturally infected dogs in North America. *Journal of clinical microbiology*. 2005 Oct;43(10):5009-5017.
35. Parmar SM, Patel MD, Vala JA, Mehta SA, Mavadiya SV. A comprehensive study on canine cardiac abnormalities in South Gujarat, India. *Haryana Vet*. 2021;60(2):255-257.
36. Patel DR, Kalyani IH, Trangadia BJ, Sharma KK, Makwana PM, Desai D, *et al*. Detection of Bovine Herpesvirus-1 infection in Bovine clinical samples by direct fluorescent antibody test. *Int. J Curr. Microbiol. App. Sci*. 2018;7(11):2229-2234.
37. Patel NM, Kumar R, Savalia CV, Desai DN, Kalyani IH. Dietary exposure and risk assessment of antibiotics residues in marketed bovine raw milk. *J Entomol. Zool. Stud*. 2020;8:1823-1827.
38. Patel NM, Kumar R, Suthar AP, Desai DN, Kalyani IH. Resistant Pattern of Therapeutics Antimicrobial Challenged on *Pseudomonas aeruginosa* Bacterium Isolated from Marketed Raw Buffalo Milk. *European Journal of Nutrition & Food Safety*. 2019;9(4):398-407.
39. Patel Hemali, Anilbhai Rao, Neha Bhandari, Bharatbhai B, Saiyad Shima, Hadiya Kamlesh K, *et al*. Diagnosis and Incidence of Canine Parvovirus Gastroenteritis. *Int. J Curr. Microbiol. App. Sci*. 2022;11(10):222-229. doi: <https://doi.org/10.20546/ijcmas.2022.1110.028>
40. Polak K, Levy J, McManus C, Andersen L, Leutenegger C, Dubovi E, *et al*. Prevalence of infectious diseases in dogs of Mainpat, India; c2012.
41. Quinn PJ, Markey BK, Leonard FC, Hartigan P, Fanning S, Fitzpatrick E. *Veterinary microbiology and microbial disease*. John Wiley & Sons; c2011 Oct 7.
42. Sakhare P, Kalyani I, Vihol P, Sharma K, Solanki J, Desai D, *et al*. Seroepidemiology of Peste des Petits Ruminants (PPR) in Sheep and Goats of Southern Districts of Gujarat, India. *International journal of current microbiology and applied science*. 2019;8(11):1552-1565.
43. Satasiya CG, Vagh AA, Parasana DK, Bilwal AK. Prevalence of canine demodicosis in Saurashtra region of Gujarat. *The Pharma Innovation Journal*. 2022;11(10):1113-1115.
44. Senthil NR, Chakravarthi R. Epidemiology of Canine Haemoprotozoan Diseases in Chennai, India. *Indian Journal of Animal Research*. 2021;1:5.
45. Senthil NR, Palanivel KM, Rishikesavan R. Seroprevalence of leptospiral antibodies in canine population in and around Namakkal. *Journal of veterinary medicine*. 2013, 2013.
46. Sharma KK, Desai DN, Tyagi KK, Kalyani IH. Bacteriological and molecular diagnosis of caseous lymphadenitis in goats at an organized farm. *Indian Journal of Small Ruminants (The)*. 2019;25(1):124-7.
47. Sharma KK, Kalyani IH, Pandya SM, Vala JA. Diagnosis and characterization of canine parvovirus-2 affecting canines of South Gujarat, India. *Acta Veterinaria Brno*. 2018 Oct 15;87(3):247-54.
48. Singh A, Singh H, Singh NK, Singh ND, Rath SS. Canine babesiosis in northwestern India: molecular detection and assessment of risk factors. *BioMed research international*. 2014 Jan 1, 2014.
49. Tumlam UM, Ingle VC, Desai D, Warke SR. Molecular characterization and phylogenetic analysis of rotavirus of human infants, calves and piglets. *Journal of Entomology and Zoology Studies*. 2019;7(4):956-960.
50. Tumlam UM, Pawade MM, Muglikar DM, Desai DN, Kamdi BP. Phylogenetic Analysis and Antimicrobial Resistance of *Escherichia coli* Isolated from Diarrheic Piglets. *Indian Journal of Veterinary Sciences & Biotechnology*. 2022 Jul 10;18(3):119-121.
51. Uilenberg G. Babesia-a historical overview. *Veterinary parasitology*. 2006 May 31;138(1-2):3-10.
52. Vala JA, Patel MD, Patel DR, Ramani UV, Kalyani IH, Makwana PH, *et al*. Diagnosis of Equine Herpes Virus 4 Infection using Polymerase Chain Reaction. *Int. J. Curr. Microbiol. App. Sci*. 2020;9(11):887-890.
53. Vivek Srinivas VM, Mukhopadhyay HK, Thanislass J, Antony PX, Pillai RM. Molecular epidemiology of canine parvovirus in Southern India. *Veterinary World*. 2013 Oct 1, 6(10).
54. Yama T, Rajesh JB, Prasad H, Rajkhowa TK, Sarma K, Roychoudhury P, Deka D, Behera SK, *et al*. Scholarly view of canine distemper cases in Mizoram. *Int J Curr Microbiol App Sci*. 2020;9(9):3260-3266.