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Geographical location-based prevalence of canine parvovirus gastroenteritis in Kumaon region of Uttarakhand

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Abstract
Canine parvovirus (CPV) infection is a contagious viral infection of canine population. It causes two types of clinical manifestations as myocarditis and clinically severe gastroenteritis in puppies. CPV infection is serious threat to canine health with high morbidity (100%) and frequent mortality (91%) in untreated cases. In present study, the prevalence of CPV gastroenteritis in dogs was conducted based on geographical location in Kumaon region of Uttarakhand during December 2021 to December 2022. It was recorded as incidence of CPV gastroenteritis in high altitude at 29^0 22' 49.09" N 79^0 27' 78.85" E elevations above sea level (2084 m) the prevalence recorded as 2.47% (201/8110). At $28^0$59'15.03" N 79^0 24' 50.84" E, 218.9 m above sea level was recorded as 17.52% (1452/8110). In high altitude average prevalence reported quite low 17.11% above 1000m of sea level. A high risk of CPV was recorded (82.88%) at low altitude below 1000m above the sea level.

Keywords: Prevalence, Geographical location, Altitude, Parvovirus, Dog

Introduction
Canine parvovirus (CPV) infection is an infectious and contagious viral infection of canine population. It causes two types of clinical entities as myocarditis and clinically severe gastroenteritis in puppies. Among the infectious diseases, canine parvovirus-2 (CPV-2) is most contagious DNA virus causing severe ailments in young and unvaccinated dogs. The virus was first discovered in 1967 and since then it has become a serious threat to canine health with high morbidity (100%) and frequent mortality (91%) in untreated cases (Nandi and Kumar, 2010; Sykes, 2014) [13, 14]. The canine parvovirus-1 (CPV-1) denoted as minute virus of canines and it was first identified in 1960s primarily causes respiratory and gastrointestinal infections in caninines. Later on Canine Parvovirus-2 (CPV-2) as discovered which is fundamentally different variant type. This mutation caused the first pandemic outbreak irrespective of age that had previously been immune against parvovirus gastroenteritis (Lamm and Rezabek, 2008) [10]. In accordance to Haque and Arfa (2012) [4] the clinical case of parvovirus gastroenteritis was reported in Mumbai and Madras, India in 1981. Clinical form of the disease typically occurs in any breed, sex of dog but puppies between 6 weeks to 6 months old age are highly susceptible to canine parvovirus (Prittie, 2004; Goddard *et al.*, 2008) [14, 3]. Immunity following infection or vaccination is long lived; therefore the maximum susceptibility occurs in younger population (Marcovich*et al.*, 2012; Hueffer *et al.*, 2003) [12]. The pervasiveness is highest in pups below 3 months (48.7%), followed by 4-6 months (17.2%) and over 6 months (8.3%) old canids (Hasan *et al.*, 2016) [2]. Pups become more susceptible to parvovirus gastroenteritis once the level of maternal antibodies shrink. Insufficient vaccination and higher population of non-descript breed of dogs extremely vulnerable (26.7%) to CPV infection (Khare *et al.*, 2019) [9]. The clinical manifestations of parvovirus gastroenteritis are nonspecific or referable to enteritis commonly incorporates inappetance or anorexia, lethargy, weakness, depression, foul-smelling diarrhoea ranging from mucoid to purely hemorrhagic, vomiting, dehydration and fever (Kalli *et al.*, 2010; Tatiana *et al.*, 2013; Salem 2014) [8].
Various studies recorded that the environmental factors like climatic condition, topography and weather influences on geographic distribution of animal's virus as Rota virus, Adeno virus and avian influenza virus are closely relates to temperature and humidity (Das *et al.*, 2017; Fagbo*et al.*, 2016 and Tain *et al.*, 2015) [1, 2, 18]. These viruses vary in terms of local and

seasonal condition (Lujan *et al*., 2014) [11]. Although, CPV gastroenteritis manifests local and seasonalcharacteristics feature. Nevertheless it is uncertain that the relationship between CPV incidence and environmental conditions (Zhao *et al*., 2016) [19]. In recent year the clinical case of CPV gastroenteritis in hospitals is day by day increasing. Hence the present study as aimed to record the prevalence of CPV gastroenteritis in Kumaon region of Uttarakhand.

Material and Method

The present study was conducted within a time period of one year since December 2021 to December 2022. Two measures were taken in this study, distribution of CPV gastroenteritis in dogs and Altitude of Kumaon region of Uttarakhand. In high altitude, Hill areas of Nainital (VH-Nainital) located at $29^0$22' 49.09" N $79^0$27' 78.85" E, elevation 2084m above sea level with average temperature throughout year 17.1 ^{0}C, VH-Almora located at $29^0$35'50¨ N $79^0$39'33" E, 1861m above sea level with yearly average temperature 23.5 ^{0}C and nearby area of Ranikhet (VH-Tarikhet) situated at 29.614132 N 79.407036 E, 1526m elevation above the sea with maximum temperature 24.1^{0}C minimum 10^{0}C were undertaken. While in low altitude, plain area of Nainital (VH-Kaladhungi) situated at $29^0$17' 0" N $79^0$21' 0" E, 514m above sea level with temperature ranging 5^{0}C to 40^{0}C and VH- Haldwani located at $29^0$13' 5.75" N 79^0 30' 46.72" E and elevation above 433.39m of sea level with average annual temperature 22.7^{0}C and in district Udham Singh Nagar, Veterinary Clinical Complex, Pantnagar located at 29^0 01' 56" N 79^0 28' 27" E, 233m above sea level with temperature variation maximum 42-45 ^{0}C and minimum 2-4 ^{0}C, VH-Jaspur at 29^0 17'N 78^0 49' E, 243m above sea with average temperature 27.61^{0}C, VH-Kashipur, $29^0$12'37.5156" N $78^0$57'42.5880" E elevation above 233m of sea level with 27.61 ^{0}C average annual temperature,VH-Sitarganj 28^0 55' 45" N 79^0 42' 16" Eabove 221m of sea with average annual temperature 28.09 ^{0}C, VH-Khatima at $28^0$55' 15.29" N $79^0$58' 10.66" E, 219m above sea level with temperature ranges 4 ^{0}C to 40 ^{0}C annually, VH-Rudrapur at $28^0$59'15.03" N 79^0 24' 50.84" E above 218.9m above sea level with annual average temperature 24.3^{0}C, VH-Gadarpur $29^0$02'37.36" N $79^0$14' 47.46" E, 214m above sea with average yearly temperature 28.88 ^{0}C, VH-Kichha at 28^0 55' 12" N 79^0 30' 0" E elevation above 205m of sea level with 28.09 ^{0}C average yearly temperature were covered. The cases were selected based on typical clinical symptoms of CPV infection in dogs incorporated as anorexia, depression, lethargy, severe dehydration, vomition and foul smelling bloody diarrhoea under the age of one year. In both, higher and lower altitude suspected cases of canine parvovirus haemorrhagic gastroenteritis irrespective of breed and sex were recorded from various hospitals. Statistically, the recorded data were analyzed using MS Excel Office and prevalence was expressed in percentage of total cases.

Result and discussion

In present study altitude wise prevalence was recorded in different topographic area of Kumaon region of Uttarakhand. It was observed that at 29022' 49.09" N 79027' 78.85" E elevation above sea level (2084 m) the prevalence recorded as 2.47% (201/8110). It might be due to extreme cold as it is the foothills of outer Himalayas and bit dry during winter followed by wet in summer (subtropical highland climate) and low canine population. While the prevalence of CPV gastroenteritis at $29^0$3550¨ N $79^0$39'33" E, 1861 m above sea level was 12.42% (1008/8110). It might be due to humid subtropical climate with average year temperature 23.5^0 C and clustered dog population.At 29.614132 N 79.407036 E, an elevation from sea (1526m) level was noted 2.21% (179/8110). It may be because of low yearly temperature (21.5^{0}C) with 322.85 millimeter of precipitation and scattered canine population. The variation in the prevalence of CPV gastroenteritis indicated as virus might be persist in very extreme cold climatic condition and humid subtropical climate, low population density, and lack of awareness, vaccination status, feeding habits, hygiene and sanitary measures adopted. Incidence of CPV gastroenteritis at $28^0$59'15.03" N 79^0 24' 50.84" E, 218.9 m above sea level was recorded as 17.52% (1452/8110). It might be due to humid subtropical dry winter climate. While 29^0 17' 0" N $79^0$21' 0" E elevations above 514m of sea level as noted 2.03% (165/8110)(Table 1)(Fig. 1). It might be due to scattered canine population. In hot climatic condition parvovirus may survived, also suggested that in low altitude the variation in prevalence might be due to high population density, chance of close contact among dogs, feeding habits, low immunity, more visit to veterinary hospitals.

Table 1: Dispersal of Altitude wise prevalence in Kumaon region (n=8110)

Area	Topographic distribution		Elevation from sea level (M)	Total CPV Gastroenteritis cases	Prevalence (%)
	Latitude	Longitude			
Nainital	$29^0$22' 49.09" N	$79^0$27' 78.85" E	2084	201	2.47
Almora	$29^0$3550¨ N	$79^0$39'33" E	1861	1008	12.42
Tarikhet	29.614132 N	79.407036 E	1526	179	2.21
Kaladhungi	$29^0$17' 0" N	$79^0$21' 0" E	514	165	2.03
Haldwani	$29^0$13' 5.75" N	79^0 30' 46.72" E	433.39	1016	12.52
Pantnagar	29^0 01' 56" N	79^0 28' 27" E	233	613	7.56
Jaspur	29^0 17'N	78^0 49' E	243	434	5.35
Kashipur	$29^0$12'37.5156" N	$78^0$57'42.5880" E	233	984	12.13
Sitarganj	28^0 55' 45" N	79^0 42' 16" E	221	265	3.26
Khatima	$28^0$55' 15.29" N	$79^0$58' 10.66" E	219	575	7.09
Rudrapur	$28^0$59'15.03" N	79^0 24' 50.84" E	218.9	1421	17.52
Gadarpur	$29^0$02'37.36" N	$79^0$14' 47.46" E	214	564	6.95
Kicchha	28^0 55' 12" N	79^0 30' 0" E	205	685	8.44

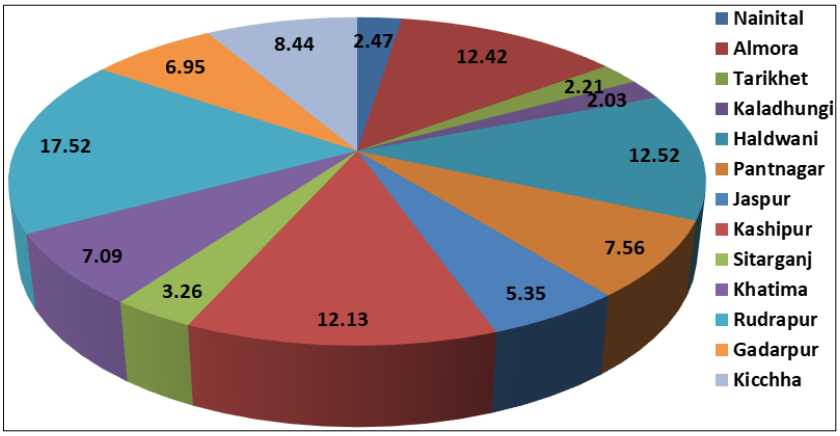

Fig1: Pie chart depicting Altitude wise prevalence in Kumaon region

The present study also recorded average prevalence of CPV gastroenteritis in higher and lower altitude. It was noticed that in high altitude the average prevalence of CPV gastroenteritis was quite low 17.11% (1388/8110). In high altitude the prevalence was low that might be due to low average canine population density, less disease associating factors and moderate climate. On other hand and in low altitude the incidence of CPV gastroenteritis was very high 82.88% (6722/8110). The variation in altitude wise distribution was might be due to variation in sample size, survivability of virus may not be certain with climate, immune status, in low altitude huge population density compared to high altitude, more visit to hospital, feeding habits, adoption of cleaning and hygiene measure (Table 2) (Fig. 2).

Table 2: Dispersal of Altitude wise average prevalence in Kumaon region (n=8110)

Altitude (Elevation from sea level)	Total no of CPV gastroenteritis case	Prevalence (%)
High Altitude (>1000 M)	1388	17.11
Low Altitude (<1000M)	6722	82.88

The present study was favored to Jiang (2018) [7] reported the prevalence of CPV-2 infection in canine population was low in high altitude while CPV-2 infection is occurs mainly in low altitude area. Worldwide, the risk of CPV-2 infection is primarily in Eastern and Northern part of Asia in the range of 20^0 N to 45^0 N.

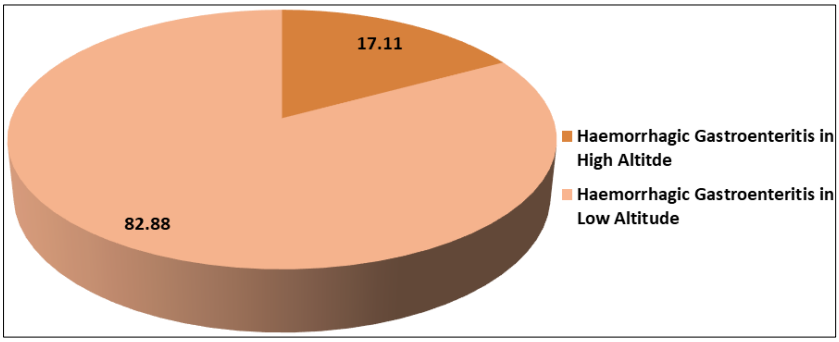

Fig2: Pie chart depicting Altitude wise prevalence in Kumaon region

Conclusion

The prevalence of CPV gastroenteritis based on altitude concluded in high altitude the prevalence of CPV gastroenteritis is quite low might be due to low canine population and probably moderate climate for health. While in low altitude high prevalence might be due to large canine population with cluster and high disease associating factors prone for CPV infection. Canine parvovirus gastroenteritis is fetal condition for young puppies if the maternal antibodies are not sufficient and climate not bothers for CPV virus. The acute stage of infection needs proper diagnostics and aggressive treatment to encourage the health status of the young once.

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