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Study on the seroprevalence of Contagious Caprine Pleuropneumonia in Goats from specific Endemic parts of Sindh, Province

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ABSTRACT

Contagious caprine pleuropneumonia (CCPP) is one of the most economically important respiratory diseases of goats, causing considerable production losses and mortality in many developing countries. The present study was conducted to determine the seroprevalence of CCPP and evaluate associated risk factors among goats in selected districts of Sindh Province, Pakistan. A total of 800 serum samples were collected from goats in Hyderabad, Tharparkar, Jamshoro, and Larkana districts, with 200 samples obtained from each district. Samples were analyzed for CCPP antibodies, and the associations of district, sex, age, and breed with disease prevalence were evaluated using odds ratios and statistical significance tests. The overall seroprevalence was 18.1% (145/800; 95% CI: 13.9–22.4), with the highest prevalence recorded in Tharparkar (23.5%), followed by Larkana (18.0%), Jamshoro (17.0%), and Hyderabad (14.0%). Geographical variation was statistically significant ($p < 0.05$). Female goats showed a slightly higher seroprevalence than males, although the association was not statistically significant ($p = 0.058$). Age significantly influenced disease occurrence, with goats older than two years exhibiting the highest seroprevalence (22.9%; $p = 0.006$). Breed-wise analysis also showed a significant association ($p = 0.003$), with Tapri (29.0%) and Teddy (23.0%) goats exhibiting higher infection rates than Pateri (12.0%) and Kamori (7.5%) goats. District-wise analysis further confirmed significant effects of sex, age, and breed on CCPP prevalence. These findings indicate that geographical location, age, and breed are important determinants of CCPP infection and should be considered when designing surveillance, vaccination, and disease control strategies to reduce economic losses in goat production.

Introduction

Goat farming is an important component of the livestock sector, particularly in developing countries, where goats contribute substantially to the production of milk, meat, skin, and income generation. They are predominantly reared by smallholders and resource-poor farmers, for whom goat production serves as an important source of household livelihood and food security. However, the productivity of goats is constrained by several factors, including harsh climatic conditions, poor husbandry practices, inadequate feed resources, and infectious diseases (Samiullah, 2013). Among these constraints, contagious caprine pleuropneumonia (CCPP) is recognized as one of the most devastating respiratory diseases affecting goats. The disease causes considerable economic losses through high morbidity and mortality, reduced growth and milk production, treatment costs, disease surveillance expenses, trade restrictions, and the decreased market value of infected animals (Soomro et al., 2025; Yatoo et al., 2018; Kaleri et al., 2025ab).

Contagious caprine pleuropneumonia is caused by members of the genus *Mycoplasma*, particularly species belonging to the *Mycoplasma mycoides* cluster. This cluster includes *Mycoplasma capricolum* subsp. *capricolum*, *Mycoplasma capricolum* subsp. *capripneumoniae*, *Mycoplasma mycoides* subsp. capri, *Mycoplasma mycoides* subsp. mycoides (large colony), *Mycoplasma mycoides* subsp. *mycoides* (small colony), and *Mycoplasma bovine* group 7, many of which possess similar antigenic and genetic characteristics (Kaleri et al., 2026ab; Laura et al., 2006). Among these organisms, *Mycoplasma capricolum* subsp. *capripneumoniae* (Mccp) is considered the primary etiological agent responsible for the classical form of CCPP. In contrast, *Mycoplasma mycoides* subsp. capri (Mmc) is associated with an acute septicemic syndrome that has been frequently reported in the Indian subcontinent (Mondal et al., 2004; Rind et al., 2023; Suthar et al., 2026).

The rapid spread and highly contagious nature of CCPP have made it a disease of major international concern. The infection can easily spread within and between goat populations, facilitating transmission across national borders through the movement of infected animals (Kabir et al., 2021; Samiullah, 2013; Kumbhar et al., 2018). Owing to its transboundary significance, CCPP has been classified as a List "B" disease by the Office International des Epizooties (OIE, 2017). Previous reports have documented morbidity rates approaching 100% and mortality rates as high as 80% in both domestic and wild goat populations (Nicholas, 2008; Arif et al., 2007; Ostrowski et al., 2011; OIE, 2009). Clinically, affected goats usually present with high fever (41–43°C), severe respiratory distress, coughing, nasal discharge, lacrimation, and progressive dyspnea (OIE, 2008). Characteristic pathological lesions include fibrinous pleuropneumonia accompanied by the accumulation of straw-colored pleural fluid within the thoracic cavity (McMartin et al., 2012). Furthermore, *Mycoplasma capricolum* subsp. *capripneumoniae* is considered highly host-specific and naturally infects goats without affecting sheep or other livestock species (Thiaucourt and Bolske, 2016).

Although CCPP has been reported from several regions of Pakistan, epidemiological information remains limited. Previous investigations have documented the occurrence of the disease in Balochistan (Awan et al., 2010), Punjab (Shahzad et al., 2016), Khyber Pakhtunkhwa (Siddique et al., 2012; Shah et al., 2017; Rahman et al., 2022), and Sindh (Chandio et al., 2019). However, comprehensive information regarding the current seroprevalence and associated epidemiological risk factors in different ecological regions of Sindh Province is still insufficient. Therefore, the present study was conducted to determine the seroprevalence of CCPP and evaluate the influence of important risk factors, including district, age, sex, and breed, among goats from four selected districts of Sindh Province, Pakistan. The findings of this study are expected to provide valuable epidemiological data for designing effective surveillance, prevention, and control strategies against CCPP in the province.

Material and Methods

Study Area

The present cross-sectional study was conducted to determine the seroprevalence of contagious caprine pleuropneumonia (CCPP) and its associated risk factors in goats from four districts of Sindh Province, Pakistan, namely Hyderabad, Tharparkar, Jamshoro, and Larkana. These districts were selected because they represent different agro-ecological zones and goat production systems of the province. Hyderabad is located in the irrigated plain region with a semi-arid climate, while Tharparkar represents the eastern sandy desert characterized by low rainfall, high temperatures, and extensive pastoral goat farming. Jamshoro comprises predominantly arid hilly terrain with hot summers and mild winters, whereas Larkana is situated in the irrigated plains with a hot desert climate suitable for mixed crop-livestock farming. These diverse ecological conditions provided an opportunity to evaluate the geographical distribution of CCPP in different production environments.

Sample Collection

A cross-sectional survey was conducted from September 2025 to April 2026. A total of 800 blood samples were collected randomly from apparently healthy and clinically suspected non-vaccinated goats, with 200 samples obtained from each district (Hyderabad, Tharparkar, Jamshoro, and Larkana). The sampled goats belonged to four common breeds of Sindh, namely Teddy,

Tapri, Pateri, and Kamori, and included both male and female animals. Goats were further categorized into three age groups: less than 1 year, 1–2 years, and more than 2 years to determine age-related differences in seroprevalence.

Approximately 5 mL of blood was collected aseptically from the jugular vein using sterile disposable syringes and transferred into plain vacutainer tubes. The samples were properly labeled and transported under a cold chain to the Veterinary Diagnosis and Research Laboratory, Central Veterinary Diagnostic Laboratory (CVDL), Sindh, Tandojam, for further laboratory analysis.

Serum Separation

Blood samples were allowed to clot at room temperature and were subsequently centrifuged at 2,000 rpm for 15 minutes to separate the serum. The separated serum was transferred into sterile cryovials and stored at −20°C until serological examination.

Detection of Antibodies Against CCPP

Serum samples were screened for antibodies against *Mycoplasma capricolum* subsp. *capripneumoniae* (Mccp), the causative agent of contagious caprine pleuropneumonia, using a competitive enzyme-linked immunosorbent assay (c-ELISA) following the manufacturer's instructions and the recommendations of the World Organization for Animal Health (WOAH/OIE). A commercially available monoclonal antibody-based c-ELISA kit (IDEXX Laboratories, USA) was used for serological testing.

Optical density (OD) values were measured at 492 nm using an ELISA microplate reader. The percentage inhibition (PI) was calculated using the following formula:

$$PI = 100 - [(OD \text{ of test serum} \div OD \text{ of monoclonal control}) \times 100]$$

Serum samples showing a PI value of 50% or greater were considered positive for CCPP antibodies, whereas samples with PI values below 50% were considered negative.

Statistical Analysis

The data were entered into Microsoft Excel 202 and analyzed using Statistix version 8.1. Descriptive statistics, including frequencies and percentages, were calculated to determine the seroprevalence of CCPP. Associations between CCPP seropositivity and different risk factors, including district, sex, age, and breed, were evaluated using the Chi-square (χ^2) test. Odds ratios (OR) with 5% confidence intervals (CI) were calculated to estimate the strength of association between risk factors and disease occurrence. A P-value of less than 0.05 was considered statistically significant.

Results

The prevalence of contagious caprine pleuropneumonia (CCPP) varied among the four surveyed districts of Sindh. Out of 800 goat serum samples analyzed, 145 were found positive, giving an overall seroprevalence of 18.1% (95% CI: 13.9–22.4). The highest prevalence was recorded in Tharparkar, where 47 out of 200 (23.5%) samples tested positive, followed by Larkana with 36 (18.0%), Jamshoro with 34 (17.0%), and Hyderabad with 28 (14.0%) positive samples. The odds ratios ranged from 0.15 to 0.30, with the highest odds observed in Tharparkar (0.30), indicating a comparatively greater likelihood of CCPP occurrence in this district. The differences among districts were statistically significant ($p < 0.05$), suggesting that geographical location had a significant influence on the prevalence of CCPP. Details are given in Table 1.

Table 1: Prevalence of CCPP in goats of various districts of Sindh province.

Districts	Samples (n)	Samples Positive (No.)	Positive (%)	Odds Ratio	p-value
Hyderabad	200	28	14.0	0.15	0.011
Tharparkar	200	47	23.5	0.30	0.008
Jamshoro	200	34	17.0	0.20	0.016
Larkana	200	36	18.0	0.22	0.013
Total/Mean	800	145	18.1 (95% CI: 13.9–22.4) 0.22	0.012	

The association of host-related risk factors with CCPP seroprevalence showed variations according to sex, age, and breed. Female goats exhibited a slightly higher seroprevalence (18.1%) than males (16.0%); however, the association with sex was not statistically significant ($p = 0.058$). Age showed a significant association with disease prevalence ($p = 0.006$), where goats older than two years had the highest seropositivity (22.9%), followed by those aged 1–2 years (10.9%) and less than one year

(9.0%). Breed also had a significant effect on CCPP prevalence (p = 0.003). The highest prevalence was observed in Tapri goats (29.0%), followed by Teddy (23.0%), whereas Pateri (12.0%) and Kamori (7.5%) breeds showed comparatively lower prevalence. Overall, 143 out of 800 goats (17.9%) were seropositive for CCPP. Details are given in Table 2.

Table 2. Overall risk factor association with seroprevalence of CCPP in goats

Risk factor	Samples (No.)	Positive Samples (No.)	Positive (%)	Odds Ratio	p-value
Sex					0.058
Male	100	16	16.0	0.18	
Female	700	127	18.1	0.21	
Age					0.006
<1 year	100	9	9.0	0.09	
1–2 years	220	24	10.9	0.12	
>2 years	480	110	22.9	0.30	
Breeds					0.003
Teddy	200	46	23.0	0.29	
Tapri	200	58	29.0	0.40	
Pateri	200	24	12.0	0.13	
Kamori	200	15	7.5	0.08	

Overall: Total samples = 800, Total positive = 143 (17.9%).

The district-wise analysis demonstrated significant associations between CCPP seroprevalence and the risk factors investigated across all districts. With respect to sex, female goats consistently exhibited higher numbers of seropositive cases than males in Hyderabad, Tharparkar, Jamshoro, and Larkana, and the association was statistically significant in each district (p = 0.005–0.006). Age-wise analysis revealed that goats older than two years had the highest seropositivity in all districts, particularly in Tharparkar (32 cases) and Larkana (30 cases), whereas goats younger than one year showed the lowest prevalence. This association was statistically significant in all districts (p = 0.003–0.009). Breed-wise analysis indicated that Tapri and Teddy goats had the greatest number of seropositive animals across all districts, with the highest number of positive cases recorded for Tapri goats in Tharparkar (23 cases). Conversely, Pateri and Kamori breeds consistently showed fewer positive cases. Breed remained highly significant across all districts (p = 0.001), indicating that breed susceptibility plays an important role in the epidemiology of CCPP in Sindh. Details given in Table 3.

Table 3. District-wise risk factor association with seroprevalence of CCPP

Risk factors	Hyderabad No. (%)	p-value	Tharparkar No. (%)	p-value	Jamshoro No. (%)	p-value	Larkana No. (%)	p-value
Sex								
Male	4 (4.0)	0.006	6 (6.0)	0.005	4 (4.0)	0.005	3 (3.0)	0.006
Female	24 (3.4)		41 (5.9)		30 (4.3)		33 (4.7)	
Age								
<1 year	3 (3.0)	0.009	5 (5.0)	0.003	2 (2.0)	0.004	2 (2.0)	0.004
1–2 years	8 (3.6)		10 (4.5)		5 (2.3)		4 (1.8)	
>2 years	17 (3.5)		32 (6.7)		27 (5.6)		30 (6.3)	
Breeds								
Teddy	11 (5.5)	0.001	16 (8.0)	0.001	10 (5.0)	0.001	11 (5.5)	0.001
Tapri	10 (5.0)		23 (11.5)		13 (6.5)		12 (6.0)	
Pateri	4 (2.0)		6 (3.0)		7 (3.5)		8 (4.0)	
Kamori	3 (1.5)		2 (1.0)		4 (2.0)		5 (2.5)	

Discussion

The present study demonstrated an overall seroprevalence of 18.1% of contagious caprine pleuropneumonia (CCPP) among goats in selected districts of Sindh Province, indicating that the disease remains an important health constraint to goat production in the region. The observed prevalence is comparable with previous reports from endemic countries, where CCPP has been identified as one of the major causes of respiratory disease, reduced productivity, and high mortality in goats. Similar findings were reported by Nicholas et al. (2008), who described CCPP as a widespread transboundary disease with substantial economic consequences in Africa and Asia. The comparatively higher prevalence recorded in Tharparkar (23.5%) than in

Hyderabad (14.0%), Jamshoro (17.0%), and Larkana (18.0%) may be attributed to differences in climatic conditions, extensive grazing systems, frequent animal movement, communal watering points, and inadequate veterinary healthcare services. These findings agree with OIE (2019) and **WOAH (2023), which reported that environmental conditions, unrestricted movement of animals, and poor biosecurity significantly facilitate the transmission of *Mycoplasma capricolum* subsp. *capripneumoniae*, the causative agent of CCPP. The statistically significant district-wise variation observed in the present study further supports the influence of geographical and management factors on disease occurrence. The present investigation also evaluated the association of host-related risk factors with CCPP seroprevalence. Although female goats (18.1%) exhibited a slightly higher prevalence than males (16.0%), the association was not statistically significant ($p = 0.058$). The higher prevalence among females may be explained by their longer retention in breeding flocks, repeated physiological stress associated with pregnancy and lactation, and greater cumulative exposure to infectious agents. Similar observations have been reported by Mbyuzi et al. (2014) and Yatoo et al. (2018), who found relatively higher infection rates in female goats due to prolonged herd stay and reproductive stress, although sex was not always identified as a significant risk factor.

Age was identified as a significant determinant of CCPP infection ($p = 0.006$), with goats older than two years showing the highest seroprevalence (22.9%). The increased prevalence among adult animals may result from prolonged exposure to infected animals and contaminated environments, increasing the probability of acquiring infection over time. Younger animals (<1 year) exhibited comparatively lower prevalence (9.0%), likely due to shorter exposure periods and possible protection from maternal antibodies during early life. Similar age-related trends have been documented by Thiaucourt and Bölske (1996); Mbyuzi et al. (2014), and WOAH (2023), who reported that adult goats generally have higher infection rates because of repeated exposure within endemic production systems.

Breed-wise analysis revealed significant differences ($p = 0.003$), with Tapri (29.0%) and Teddy (23.0%) goats showing higher seroprevalence than Pateri (12.0%) and Kamori (7.5%) goats. The greater susceptibility observed in Tapri and Teddy breeds may be associated with their predominance under traditional extensive production systems, where animals are frequently exposed to communal grazing, poor housing conditions, and limited preventive healthcare. Conversely, Kamori goats are generally maintained under comparatively improved management conditions, which may reduce exposure to infectious agents. Similar observations regarding breed-related variation in disease susceptibility have been reported by Radostits et al. (2007) and Smith and Sherman (2009), who emphasized that management practices often contribute more significantly to disease occurrence than genetic factors alone.

The district-wise risk factor analysis further demonstrated significant associations between CCPP seroprevalence and sex, age, and breed across all four districts. Adult goats (>2 years) consistently exhibited the highest number of seropositive cases, while Tapri and Teddy breeds remained the most affected populations in every district. Tharparkar showed the greatest number of positive animals in nearly all risk factor categories, suggesting that environmental stress, extensive pastoral production systems, seasonal migration, and close contact among herds may collectively enhance disease transmission. These observations are consistent with reports by Nicholas et al. (2008) and WOAH (2023), who emphasized that management practices, climatic stress, and unrestricted animal movement are among the most important epidemiological factors contributing to the persistence of CCPP in endemic regions.

Overall, the findings of the present study indicate that CCPP continues to circulate widely among goat populations in Sindh Province. The significant associations observed with district, age, and breed suggest that targeted surveillance, strategic vaccination, improved farm biosecurity, movement control, and farmer awareness programs should be prioritized, particularly in high-risk districts such as Tharparkar. Implementation of these measures would substantially reduce disease transmission, minimize economic losses, and improve the productivity of the goat farming sector in Pakistan.

Conclusion

It is concluded that CCPP is prevalent among goats in Sindh, with the highest seroprevalence observed in Tharparkar district. Age and breed were significant risk factors, while geographical variation also influenced disease occurrence, highlighting the need for targeted surveillance, vaccination, and effective disease control programs.

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